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# Domestication of red fin mahseer (*Tor tor*) with supplementary feeds in captive condition in Bangladesh

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## Abstract

Effects of supplementary feeds on growth, survival, and production of red fin mahseer, *Tor tor* (Hamilton) was assessed in captive condition under a monoculture system. Experiments were conducted for a period of 12 months where two feeds varying in protein contents were used in treatments. One laboratory formulated feed with 36.67% protein and a commercial feed with 28% protein were characterized as treatment-1 (T1) and treatment-2 (T2), respectively. At the same time water quality parameters were measured. The net increment in weight after 12 months was 671.60 g and 509.80 g in T1 and T2 respectively. The feed conversion ratio (FCR) was 4.72 and 5.26, and the specific growth rate (SGR) was 1.39 and 0.10 % day$^{-1}$ in T1 and T2 respectively. In both treatments 100% fish were survived and provided the net production (kg/ha) 2807.06 and 2557.78 in T1 and T2, respectively. The water quality parameters were within the suitable range for fish culture. Between the feeds evaluated, feed with 36.67% protein (T1) proved best result considering the growth and production performance of the fish. Overall growth performance of *T. tor* was satisfactory; however, further research is needed.

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## Introduction

Among the fishes of family Cyprinidae, red fin mahseer *T. tor* is one of the most attractive fish of Bangladesh. It has high demand as table fish and lure for anglers as a game fish and is potential contender for aquaculture (Haque *et al*. 1995; Ingram *et al*. 2005, Ogale, 2002). Due to attractive color, it has high potential as ornamental fish in the aquarium fish industry (Ng, 2004). In the past, *T. tor* was reported to be available in the hilly streams of Sylhet, Mymensingh, Netrokona, Dinajpur, and Kaptai reservoir of Chittagong Hill tracts in Bangladesh (Rahman, 1989). But in last couple of years, it is very rarely found only in the River Someshwari of Netrakona District (DoF, 2016). Because of various natural causes and manmade activities, the water flow of Someshwari has been reducing abruptly resulting loss of habitat of mahseer. Besides, the river is being used for livelihood of poor and ultra-poor people which is also responsible for degrading the habitat. People especially women, even children go to the river to collect coal particle and sand for their livelihood. Illegal gears are also used in the Someshwari for fishing. Moreover, unscientific coal mining in the upstream of the Someshwari at Meghalaya, India has provoked the problem incorporation with acid mine drainage (Mallik *et al*. 2015). Consequently, *T. tor* has been ranked as critically endangered in Bangladesh (IUCN, 2015). *T. tor* is the symbol of aristocracy but did not get due attention from any corner of stockholders for its conservation. As *in-situ* conservation is practically impossible in the existing habitat, *ex-situ* conservation through domestication in captivity is a must to protect *T. tor* from extinction. Domestication of mahseer in captivity will also help to determine its culture potential. Over the last few decades, though some research on growth parameter and nutritional requirement of other species of *Tor* (Bista *et al*. 2002; Chatta *et al*. 2015a, 2015b and 2015c; Islam *et al*. 2002; Islam and Tanaka, 2004; Joshi *et al*. 1989; Misieng *et al*. 2011; Rahman *et al*. 2005; Rahman *et al*. 2007, Sawhney and Gandotra, 2010) have been conducted, very little information (Akram and Swapna, 2014; Lone and Lone, 2014) on *T. tor* have come to the light. Therefore, the present study was aimed to domesticate *T. tor* in captivity and to find out the appropriate supplementary feed as well as protein requirement for this species.

## Materials and Methods

### Experimental Design

The present experiment was conducted in earthen ponds under natural conditions for 1 year from 1 August, 2015 at the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. The experiment was conducted under two treatments without any replication. Two feeds with different proximate composition, particularly in the crude protein content were used. Formulated pelleted feed containing 36.67%

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crude protein was used in treatment-1 (T1) and a commercial pelleted grower feed (Mega feed) with 28% crude protein was used in treatment-2 (T2) and both the feeds were sinking in nature.

**Feed Formulation and Preparation**

The commercial feed was purchased from Spectra–Hexa Feeds Ltd., Bangladesh and the other feed was formulated by Pearson's square method and prepared at Bangladesh Fisheries Research Institute, Mymensingh. Feed was prepared by using locally available ingredients where water was added for proper mixing and the dough was extruded in an electric pelletizer. Pellet was dried by sun light. Vitamin-E (Vitax-ES, Eon Pharmaceuticals Ltd.) at the rate of 1 g $kg^{-1}$ feed was added. Proximate composition of the experimental diets was determined following AOAC (1984) in the Fish Nutrition Laboratory at BAU, Mymensingh. Formulation and proximate composition of the experimental diets are shown in Table 1.

**Table 1. Formulation and composition of the experimental feeds**

| Feed Ingredients | Composition (%) | |
|---|---|---|
| | T1 | T2 |
| | | Commercial feed (Mega feed) |
| Fish meal | 35 | |
| Soybean meal(ACI) | 18.53 | |
| Mustard oil cake | 18.53 | |
| Rice bran | 10.47 | |
| M&B meal | 10.47 | |
| Binder (molasses) | 3 | |
| Megabind | 2 | |
| vitamin-mineral premix (Vitatech, Aqua Tech Multipurpose Hatchery Ltd.) | 2 | |
| Proximate composition (% moisture basis) | | |
| Crude protein (%) | 36.67 | 28 |
| Crude lipid (%) | 9.80 | 8.08 |
| Crude fibre(%) | 4.80 | 5.20 |
| Moisture (%) | 12.72 | 12.27 |
| Ash (%) | 10.48 | 15.53 |
| Carbohydrate (%) | 25.53 | 30.92 |

**Pond Preparation, Stocking of Fish and Husbandry**

Two rectangular earthen ponds each of 4.0 decimal with an average depth of 1.5 m and having a routine water supply, inlet and outlet facilitates were used for stocking. Ponds were sun-dried for better mineralization, escape of toxic gases and to make free from aquatic weeds, harmful aquatic insects, predatory and weed fishes. Ponds were treated with lime at the rate of 1kg / decimal and then filled with water. After seven days urea and triple super phosphate (TSP) were applied at the rate of 200 g and 100 g / decimal, respectively. *T. tor* was collected from the fish traders of Durgapur Upazila of Netrokona District who earlier collected those from the River Someshwari (Fig. 1). The stocking was done in ponds at the rate of six fish per decimal and reared for twelve months. Since the test species is critically endangered, and collection of fry is nearly impossible, large sized fish (size varying: 1179-1253 g) was used for the experiment. Fish were fed two times daily at 0900 h and 1700 h at the rate of 1.5 to 2% of body weight in both the treatments and the amount of feed was adjusted monthly based on body weight.


Fig. 1. Collection site (the River Someshwari) of *T. tor* in Durgapur Upazila, Netrakona

**Sampling of Fish**

Ten fish from each treatment were sampled randomly at each month, weighed individually and released back. At the end of experiment, all the fish were captured from both the treatments and determined their survivability.

**Water Quality Parameters**

Water quality parameters (water temperature, pH and dissolved oxygen) were recorded for a year at 9.00am and 2.00pm in each sampling date. Temperature was measured by Celsius thermometer; whereas dissolved oxygen (DO) and pH were recorded by Hanna DO meter (Model-HI 9146, Romania) and Milwaukee pH meter (Model-$P^H55/P^H56$, USA), respectively.

**Estimation of Growth and Survival**

For estimating the growth of fish, ten fish from each treatment were sampled monthly. Growth was studied regarding weight gain (g), weight gain (%) and SGR. Weight gain was figured just by deducting the mean initial weight values from that of the final. Weight gain (%) and FCR were estimated following Sawhney and Gandotra (2010) as follows:

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

$$\text{Food conversion ratio (FCR)} = \frac{\text{Feed fed}}{\text{Live weight gain}}$$

SGR was computed after Brown (1957) as follows:

$$\text{SGR (\%/day)} = \frac{\ln w_2 - \ln w_1}{T_2 - T_1} \times 100$$

where, $W_1$ = initial live body weight (g) at time $T_1$ (day) and $W_2$ = final live body weight (g) at time $T_2$ (day).

At the end of the experiment, the survived fish were counted and weighed individually and the data were utilized for consequent analyses. Survival rates were estimated on the premise by counting the number of fish harvested (no. of fish harvested/no. stocked X 100). Production of fish was calculated by multiplying the average final weight of fish by the aggregate number and was expressed as kg / ha.

**Data Analysis**

Data were analyzed by the computer software MS Excel version 2007 as descriptive values such as mean and percentage. Data on growth was analyzed by computer software SPSS version 20.0 (Statistical Package for Social Science) using student's t-test at 5% level of significance.

## Results

**Growth**

Results of different growth and production parameters are shown in Table 2 and Fig. 2. Mean weight gain in $T_1$ and $T_2$ were 671.60 g and 509.80 g, respectively. Higher growth in terms of weight gain (g) was observed in $T_1$ compared to $T_2$. Though the weight gain of fishes in $T_1$ was apparently higher than that of $T_2$ but there was no significant difference ($p<0.05$) between the treatments. The percent weight gain was also obtained higher in $T_1$ compared to $T_2$. In both the treatments the survival rate was found 100% as the fish were larger in size. Both FCR and SGR were found better in $T_1$ than $T_2$.

**Water Quality Parameters**

The data of various physico-chemical parameters (mean values) of water of two experimental ponds are presented in Table 3. The minimum temperature in both the ponds was almost similar and found to be 22.0°C in January and the maximum of 32.6°C in April. The maximum value of dissolved oxygen (7.2 mg $l^{-1}$) was recorded in October and the minimum (4.8 mg $l^{-1}$) in February. The pH values of the two experimental ponds were also always found to be more or less in the optimum level. In both the treatments, the maximum pH 8.5 was recorded in July and the minimum pH 6.5 in June.

**Table 2. Growth, survival, and production of *T. tor* during the study period**

| Treatment | Mean weight gain (g) | Percent Weight gain | Production (kg/ha/year) | | SGR (%day$^{-1}$) | Survival rate (%) | FCR |
|---|---|---|---|---|---|---|---|
| | | | Gross production | Net production | | | |
| **1** | 671.60 | 55.03 | 2807.06 | 995.31 | 1.39 | 100 | 4.72 |
| **2** | 509.80 | 42.14 | 2557.78 | 755.52 | 0.10 | 100 | 5.26 |

**Table 3. Month-wise (August 2015 to July 2016) physico-chemical parameters of water in the two experimental ponds**

| Month | Treatment 1 | | | | Treatment 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | Temperature (ºC) | | DO (mg $l^{-1}$) | pH | Temperature (ºC) | | DO (mg $l^{-1}$) | pH |
| | 9.00 am | 14.00 pm | | | 9.00 am | 14.00 pm | | |
| August, 2015 | 27.2 | 27.6 | 6.9 | 7.0 | 27.0 | 27.6 | 6.8 | 7.1 |
| September, 2015 | 28.4 | 31.1 | 5.2 | 8.0 | 28.8 | 31.6 | 5.6 | 8.1 |
| October, 2015 | 29.0 | 29.7 | 7.2 | 8.0 | 29.0 | 29.7 | 7.2 | 8.0 |
| November, 2015 | 26.3 | 28.5 | 7.0 | 7.8 | 26.3 | 28.5 | 7.0 | 7.8 |
| December, 2015 | 22.9 | 23.5 | 5.2 | 8.4 | 23.1 | 23.9 | 5.2 | 8.4 |
| January, 2016 | 22.0 | 21.5 | 5.0 | 7.4 | 22.0 | 22.5 | 5.0 | 7.4 |
| February, 2016 | 25.8 | 29.1 | 4.8 | 7.8 | 25.2 | 29.9 | 4.8 | 7.8 |
| March, 2016 | 26.4 | 29.5 | 5.4 | 7.1 | 26.2 | 29.5 | 5.5 | 7.2 |
| April, 2016 | 29.2 | 31.9 | 5.9 | 7.7 | 29.5 | 32.6 | 6.0 | 7.7 |
| May, 2016 | 28.1 | 31.3 | 6.6 | 7.9 | 27.8 | 30.9 | 6.6 | 8.2 |
| June, 2016 | 28.8 | 32.1 | 5.5 | 6.5 | 28.6 | 31.5 | 5.7 | 6.8 |
| July, 2016 | 28.8 | 30.1 | 5.6 | 8.4 | 28.1 | 31.0 | 5.7 | 8.5 |

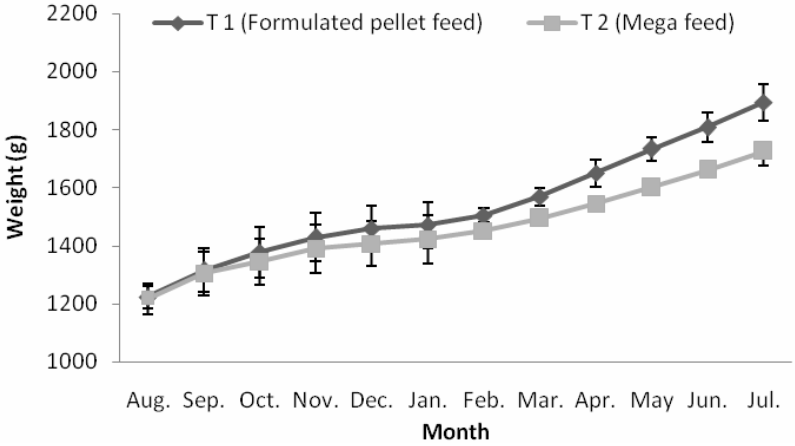


Fig. 2. Mean increase in weight (g) of *T. tor* during 12 months of rearing with two supplementary feeds

## Discussion

### Growth and Survival

In the present study, *T. tor* showed impressive growth and mean weight gain as 671.60 g and 509.80 g in $T_1$ and $T_2$, respectively. This steady-state growth of fish may be occurred due to the presence of high protein in feed, specially in $T_1$. In both feeds, fishmeal was used as the main source of protein. Similar finding was reported by Bista *et al*. (2002) where *T. putitora* showed a faster growth from the administration of feed containing high proportion of animal origin ingredients. However, there is no concrete data on the dietary protein requirements of mahseer for pond culture system. In the present study, fish showed better growth with feed containing around 37% protein which is in agreement with Joshi *et al.* (1989) who reported 35% crude protein as the best for growth and feed efficiency of *T. putitora*. Bazaz and Keshavanath (1993) and Misieng *et al.* (2011) found the optimum dietary protein level for growth of *T. tambroides* fingerlings to be 40%. Sunder *et al*. (1998) reported better growth, survival and feed conversion with 45.4% crude protein for *T. putitora* which is similar to the findings of Islam and Tanaka (2004).

In the present study, the SGR (% $day^{-1}$) of *T. tor* was higher (1.39) in $T_1$ than $T_2$ (0.10). Higher SGR with commercial pelleted feed containing high protein percentage was also reported by Akram and Swapna (2014), Lone and Lone (2014), Sawhney and Gandotra (2010), Islam and Tanaka (2004), and Islam *et al.* (2002). Islam and Tanaka (2004) reported SGR of 1.86±0.14 using 35% protein containing feed for putitor mahseer, which is close to the present findings. Misieng *et al*. (2011) reported low SGR (0.51 ± 0.08) by using feed containing 40% protein for *T. tambroides* fingerlings and suggested that SGR improves with increasing dietary protein from 30% to 50%. Chatta *et al*. (2015a and 2015b) found SGR of *T. macrolepis* in polyculture with other carps as 1.59 ± 0.00 and 1.09 ± 0.08 with 12.5% and 25% protein containing feed respectively, which is similar (1.39) to present findings at 36.67% protein level. It is evident from the studies that protein percentage does not seem to have any clear relationship with SGR in different species of *Tor*. It is also difficult to draw any conclusion as the size of stocked fish; feeding frequency and culture duration were also not similar in the reported data regarding this genus.

The FCR values of 4.72 and 5.26 in $T_1$ and $T_2$, respectively as obtained in the present study were little higher than many of the cultivable species. But these values are almost half of those obtained by Chatta *et al*. (2015a) on *T. macrolepis* fed 43% protein containing feed. They also reported an increasing trend in FCR with increasing ration size from 4-6% body weight. Sawhney and Gandotra (2010) observed average FCR of *T. putitora* fry as 13.39 at 30% protein level which is more than double of the present study. In another case, Islam (2002) obtained FCR of 5.28 for *T. putitora* when sustained with supplementary feed containing 30% protein under a semi-intensive culture system which is pretty much like to present findings. The possible cause of increased FCR in present research may be the feed digestibility incompetence of fish as De Silva and Davy (1992) suggested that digestibility had an imperative role to lower the value of FCR by efficient food utilization. Low FCR can be achieved by high digestibility, smaller ration size and proper use of feed (Rahman *et al*. 2006, Misieng *et al*. 2011). There were also some possibilities of wastage of feed. The digestibility in turn, depends on daily feeding rate, its frequency, and the type of food used (Chiu *et al*. 1987). The wastage of food might also lead to poor feed utilization and higher FCR. Akram and Swapna (2014) conducted a study on *T. tor* fry by using 25%, 35%, and 40% protein containing pelleted feed and found the FCR as 1.3 ± 0.02, 1.12 ± 0.03, and 0.82 ± 0.02, respectively. These findings differ from the present study which might be due to size variation of fish at stocking.

In both the treatments of the present investigation, the survival rate was found to be 100% as the fish were larger in size. Hundred percent survival of *T. tor* in pond was very encouraging and almost similar to the findings of Mohan and Basade (2005), Misieng *et al*. (2011) and Chatta *et al*. (2015b) who reported very high survival rates of masheer. Itreflects that this species can equally survive in pond water in Bangladesh. On the contrary, Islam *et al.* (2002) reported comparatively lower survival (83.8-89.4%) of *T. putitora* fingerlings in outdoor culture system in Bangladesh.

### Water Quality Parameters

Water temperature is considered as an important factor for fish growth, and according to Aminul (1996), water temperature ranged between 25 to 35 ºC is suitable for fish culture. The water temperature throughout the present experimental period was found within the suitable range. The highest temperature (32.6º**C**) was recorded in the month of April due to relatively high intensity of sunlight and absence of cloud in the sky and the lowest 22.0º**C** was recorded in January. The mean temperature varied from 26.05 ºC to 31.05 ºC from February to October and that was varied from 22.25 ºC to 27.4 ºC during November to January in $T_1$ and $T_2$, respectively. The average increment of body weight was recorded as 630.10 g and 477.0 g from February to October whereas only 40.50 g and 32.80 g increment was recorded during the rearing period of November to January in $T_1$ and $T_2$, respectively. Bista *et al*. (2002) observed that low water temperatures have been the cause for slow growth of fingerlings of *T. putitora* wherein fingerlings of 19-23g attained 44g in 6 months. They also suggested that mahseer growth response could be increased with increasing water temperature and this is common with many other cyprinids. In polyculture system of *T. putitora* with Indian major carps, mean weight gained by *T. putitora* was more than 560g during

the culture period of 10 months where mean temperature was 29.4ºC (Rahman *et al*. 2005). Ogale (1997) recorded the water temperature between 24 and 28º**C** during monoculture of *T. putitora* in ponds at Lonavla, India with pelletized feed. In another study in the village ponds near Lonavla, India, *T. khudree* showed an outstanding growth of 600–900 g after 1 year (Basavaraja, 2011). However, stocking density, size of stocked fish and details of feeding in this study were not mentioned. Chatta *et al.* (2015a and 2015b) found the water temperature to range from 25°C to 31.5º**C** in polyculture system with the combination of *T. macrolepis* with *L. rohita*, *C. catla*, *C. mrigala*, *C. idella*, and *H. molitrix* in Pakistan.

In addition to temperature, fluctuation of DO concentrations might be attributed to alteration in the rate of photosynthesis caused by altering cloudy and sunny weather of the monsoon and also due to variation in the rate of oxygen consumption by fish and other animals through respiration (Boyd, 1982). The dissolved oxygen values during the experimental period were within the productive range in both treatments according to the statement of Jhingran (1991) and Wahab *et al*. (1995, 1996). In the present study, the values of pH fluctuated between 7.0 and 8.4, and 7.1 and 8.5 in $T_1$ and $T_2$, respectively which was more or less similar to the pH values suggested by Hora and Pillay (1962), Swingle (1967), and Rahman *et al*. (2007).

## Conclusion

This is the first attempt of domestication and evaluation of the culture potential of critically endangered *T. tor* in earthen pond monoculture system in Bangladesh. In wild though it is a slow growing cold water species, growth and survival rate was found very impressive in this experiment. However, trials with large size fish in small pond and treatments without replication have been considered as the main limitations of this experiment. Considering the limitations further research on dietary protein requirement, feeding frequency, and feeding rate of fingerlings or juveniles in large grow-out facility will help in resolving the growth-related issues and artificial breeding of captive reared *T. tor*. This intervention will play a crucial role in helping protection of this critically endangered species and thus restore its populations in the wild.

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