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Evaluation of different diets on the growth of normal and monosex GIFT tilapia (*Oreochromis niloticus* L.) in Bangladesh

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Abstract

A 4-month feeding trial was conducted in ponds to evaluate the different diets for the culture of normal and monosex GIFT tilapia (*Oreochromis niloticus*). Twelve experimental ponds each of 80 m^2 were divided into three treatments. Normal and monosex GIFT tilapia were assigned to each treatment in duplicate. Saudi Bangla tilapia feed, mixed feed and no feed but fertilization were considered as T_1, T_2 and T_3 respectively. The stocking density was 125 fingerlings/decimal. After four months of rearing T_1 showed significantly ($P<0.05$) higher mean final weight of 148.25±2.73 g and 197.20±3.62 g for normal and monosex GIFT tilapia respectively than those of T_2 and T_3. Among the treatments, T_1 also resulted in significantly ($P<0.05$) higher specific growth rate than T_2 and T_3. However, there was no significant difference in survival rate and food conversion ratio between T_1 and T_2 but in case of T_3 the survival rate was significantly ($P<0.05$) lower than T_1 and T_2. Again, the production of monosex GIFT tilapia was about 33% higher than that of normal GIFT tilapia. The net profit/ha generated from the 4 months culture period was calculated Tk. 67090.76, 38501.13 and 15906.8 for normal GIFT and Tk. 121578.34, 75026.25 and 29396.08 for monosex GIFT in T_1, T_2 and T_3 respectively. The results of the present study suggested that the culture of monosex GIFT tilapia is more profitable compared to normal GIFT tilapia and the use of Saudi Bangla tilapia feed is more economic than those of mixed feed and no feed but fertilization of the pond.

Keywords: Growth, GIFT tilapia, Diets

Introduction

With a population density of 1021 people/km^2 (CIA, The World Factbook-2006), land is an extremely scarce resource in Bangladesh. Agricultural production in Bangladesh needs to be increased substantially in order to satisfy the demand of the growing population and combat malnutrition and poverty. Providing sufficient food to the vast population will put increasing pressure on scarce natural resources of Bangladesh. Especially water and land need to be utilized more efficiently for healthy living and development of the population. Among the South-East Asian countries, Bangladesh abounds with hundreds and thousands of seasonal water bodies in the form of ditches, shallow ponds and road side canals etc. which retain water for 4 to 6 months where carps can not be cultured. Adoption of the GIFT strain of tilapia culture technology in these seasonal water bodies not only lead to an increase in the intake of animal protein in rural areas but can also generate income and employment opportunities for the poor farmers in Bangladesh. The introduction of tilapia in Bangladesh from Thailand was first initiated in 1954 with Mossambique species (*O. mossambicus* Peters) but did not attain popularity to the farmers due to early maturation and frequent breeding. The most significant landmark in aquaculture development was the development of a new and improved tilapia strain called GIFT (Genetically Improved Farmed Tilapia) with the assistance of UNDP and ADB. In on farm trials, the GIFT tilapia grew on an average of 60% better in growth and 50% in survival than normal farmed breeds (Sultana *et al.* 1997). In Bangladesh culture of GIFT tilapia (*O. niloticus*) in fresh water pond is getting popularity due to its higher market price and desirable features for aquaculture such as faster growth compared with any

other short cycled fish species in both perennial and seasonal ponds. Tilapia has good resistance to poor water quality and disease, tolerance to a wide range of environmental conditions, ability to convert efficiently the organic and domestic waste into high quality protein, rapid growth rate and tasty flavor (Balarin and Hallar, 1982).

The excessive reproduction of tilapia species leads to overcrowding, competition for available food and stunted the growth in aquaculture system. Many approaches for controlling reproduction have been tried. Since tilapia males grow faster than females, the culture of monosex male populations is preferable. Thus, the present study was undertaken to compare the growth performance and profitability of production of normal and monosex (male) GIFT tilapia (*O. niloticus*) in seasonal ponds under different feeding strategies.

Materials and Methods

The experiment was conducted in 12 experimental ponds situated in the Field Laboratory Complex, Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh, for a period of 4 months from May to August, 2006.

The experiment was carried out with three treatments viz.,T_1 providing Saudi Bangla tilapia feed, T_2 providing mixed feed (rice bran : mustard oilcake= 1:1) and T_3 no feed but fertilization was done. Two sets of experiment were conducted. One for normal GIFT and another for monosex GIFT tilapia was assigned in duplicate.

Twelve rectangular shaped experimental ponds each of 80 m^2 with an average depth of 1.0 m were used for the study. All ponds were prepared by completely drying by draining out the water and then ponds were treated with lime at the rate of 250 kg/ha. After 7 days, the ponds were filled with water. Three days after liming, the ponds were manured with cowdung at the rate of 1250 kg/ha and with urea and TSP at the rate of 50 kg/ha of each.

About one month old fingerlings of normal GIFT tilapia (*O. niloticus*) with mean initial weight of 3.60±0.18 g were collected from Freshwater Station, Bangladesh Fisheries Research Institute, Mymensingh and the fingerlings of monosex GIFT (*O. niloticus*) with mean initial weight of 3.62±0.20 g were collected from Reliance Aqua Farm, Trisal, Mymensingh. These fingerlings were brought to Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh using plastic polythene bags.

Different types of feed used in this study namely Saudi Bangla tilapia feed, rice bran and mustard oilcake were collected from Mymensingh local market. The analyzed proximate composition of experimental feeds are shown in Table 1.

The fingerlings were stocked after 7 days of pond fertilization. Each pond was stocked with 250 fingerlings at the rate of 125/decimal.

Table 1. Proximate composition (% dry matter basis) of the supplemental feeds used in the experiment

Components	Treatments	
	T_1 (Saudi Bangla tilapia feed)	T_2 (Mixed feed[2])
Dry matter	88.41	85.10
Protein	30.25	25.24
Lipid	7.30	10.30
Ash	15.18	15.20
Crude fiber	8.90	7.48
NFE[1]	38.37	41.78

[1]Nitrogen free extract (NFE) calculated as =100- % (protein + lipid + ash + crude fiber)
[2]Mixed feed contains rice bran and mustard oilcake (50:50)

To ensure preferable growth and production of fishes following management measures were taken:

Fertilization of the ponds was done weekly only in T_3 with cowdung, urea and TSP. Cowdung was applied as organic manure at the rate of 3 kg/decimal and urea and TSP were applied as inorganic fertilizer at the rate of 80 g and 40 g/decimal respectively. Both the organic and inorganic fertilizers were applied separately after dissolving them in water in a bucket and then spread over the pond surface manually.

Fish were fed twice daily at the rate of 10% of body weight at the beginning. The feeding rate was gradually reduced to 5%, 4% and 3% of the body weight for the last three months respectively. The feeding ration was adjusted during the fortnightly sampling of fish. The total amount of feed was divided into two equal rations for using at 10:00 and 17:00 hrs daily. Saudi Bangla tilapia feed was dispersed by hand broadcasting over the surface of water in a particular place. In case of mixed feed, 2kg of mustard oilcake was soaked into 5 liter tape water for 12 hrs and then 2kg of rice bran was mixed together and the chime made into small balls which were used in the ponds.

Fortnightly sampling of about 10% of stocked fish from each experimental pond was caught by using a seine net. The weight of sampled fish was recorded by using an electronic balance (Model EF-1-3k). The sample weight was used to adjust the feeding rate for the next fortnight.

The water temperature, dissolved oxygen, pH and transparency in the experimental ponds were monitored fortnightly between 10.00 to 11.00 hrs on the previous day of sampling. The water temperature of each experimental pond was recorded using a Celsius thermometer at a depth of approximately 10-12 cm from the surface. The dissolved oxygen (DO), pH and transparency of water were determined by DO meter (YSI, Model-58, USA), pH meter (Model-445, UK) and a Secchidisc respectively.

The proximate composition of diets was analyzed by following the AOAC (2000) standard method. Fish weight gain (g), specific growth rate (SGR %/day), food conversion ratio (FCR) and survival (%) were calculated according to Castell and Tiews (1980).

The data obtained during the study were statistically analyzed to see whether normal and monosex GIFT strain differ significantly on the basis of growth parameters, survival (%) and production (kg/ha). Student's t-test was employed to test the significance of difference among treatments. A significance level of $P < 0.05$ was used.

A simple economic analysis was performed to estimate the net profit in different treatments from monoculture of normal and monosex GIFT tilapia. The production cost was based on the Mymensingh whole sale market price for the inputs used. The cost of lime was Tk. 12/kg and each normal GIFT and monosex GIFT tilapia fry was Tk. 0.50 and Tk. 1.0 respectively. The cost of Saudi Bangla tilapia feed was Tk. 20.0/kg (market price).The ingredient of mixed feed was rice bran (50%) and mustard oilcake (50%) and their cost was Tk.10.0/kg and Tk.15.0/kg respectively. The selling price of tilapia was considered as Taka 70.00/kg. The cost of leasing of pond was not included. An additional 7.5% on total cost was included as operational cost (ADCP, 1983).

Results and Discussion

The overall mean values of water quality parameters viz. temperature, dissolved oxygen, pH and transparency under different treatments are presented in Table 2. Temperature varied from 26.33 to 32.57 ºC with mean value of 31.01±1.56 in T_1, 26.13 to 32.60 ºC with mean value of 31.05±0.53 in T_2 and 26.43 to 32.40 ºC with mean value of 30.98±0.55 in T_3, which were within the productive ranges for fish culture as reported by Hossain *et al.* (2004). Dissolved oxygen (DO) varied from 4.30 to 6.62 mg/l in T_1, 4.25 to 5.62 mg/l in T_2 and 4.10 to 6.19 mg/l in T_3 and the mean values were 5.49±0.19, 5.14±0.09 and 5.33±0.16 mg/l in T_1, T_2 and T_3 respectively. The values of DO recorded in the present study are strongly supported by Banerjee (1967). Slightly lower dissolved oxygen was found in the present study but this low dissolved oxygen level might have no negative effect since tilapia has high tolerance for low dissolved oxygen levels.

Table 2. Water quality parameters in three different treatments during the study period

Water quality parameters	T_1 (M±SE)	T_2 (M±SE)	T_3 (M±SE)
Temperature (°C)	31.01±1.56 (26.33-32.57)	31.05±0.53 (26.13-32.60)	30.98±0.55 (26.43-32.40)
Dissolved oxygen (mg/l)	5.49±0.19 (4.30-6.62)	5.14±0.09 (4.25-5.62)	5.33±0.16 (4.10-6.19)
pH	7.61±0.19 (6.37-9.65)	7.66±0.11 (7.11-9.16)	7.72±0.17 (6.27-9.18)
Transparency (cm)	36.29±1.26 (28.00-38.30)	29.20±0.81 (25.75-36.00)	27.71±0.86 (24.33-35.67)

Values are mean ± standard error

The pH values of pond water under different treatments were found to be alkaline and ranged from 6.37 to 9.65 with mean value of 7.61±0.19 in T_1, 7.11 to 7.66 with mean value of 7.66±0.11 in T_2 and 6.27 to 9.18 with mean value of 7.72±0.17 in T_3. According to Swingle (1967), pH 6.5 to 9.0 is suitable for pond fish culture which agreed to the present study. Michael (1969) and DoF (1996) reported that the suitable pH range for production is 7.3 to 8.4 and 6.5 to 8.5 respectively. The observed pH of water in the present study indicates that the experimental ponds were suitable for fish culture. The observed transparency ranged from 28.00 to 38.30 cm, 25.75 to 36.00 cm and 24.33 to 35.67 cm with mean values were 36.29±1.26, 29.20±0.81 and 27.71±0.86 cm in T_1, T_2 and T_3 respectively. According to Boyd, (1982) transparency values of about 15-40 cm are appropriate for fish culture, which are strongly supported in this result.

The mean final weight gain of normal GIFT was 144.65±2.71, 108.8±2.14 and 47.67±1.13 g and monosex GIFT was 193.58±3.59, 145.72±3.25 and 64.23±2.35 g in T_1, T_2 and T_3 respectively. The highest mean weight gain of normal and monosex GIFT tilapia was found in T_1 which was significantly (*P<0.05*) higher than T_2 and T_3. Hossain *et al.* (2005) reported a weight gain of about 106.34±3.59 g and 140.60±2.84 g of normal and monosex GIFT tilapia respectively, which was much lower that observed in the present study. However, the stocking size of fry used by Hossain *et al.* (2005) was much lower (0.16 g) than that used in the present study. In all treatments it was found that the growth of monosex GIFT was comparatively higher than those of normal GIFT tilapia. The growth of monosex GIFT was about 33% higher than the normal GIFT strain (Fig. 1).

The mean SGR values of normal GIFT were 3.09±0.02, 2.87±0.02 and 2.21±0.01 and monosex GIFT were 3.33±0.04, 3.09±0.03 and 2.44±0.02 in T_1, T_2 and T_3 respectively (Table 3). The highest SGR value of normal and monosex GIFT tilapia was found in T_1 which was significantly (*P<0.05*) higher than those of other treatments. Diana *et al.* (1996) obtained SGR value of 3.10 with *O. niloticus* in Thailand using feed and fertilizer. The difference of SGR values of the species *O. niloticus* in the present study is due to the temperature difference between regions and natural productivity of the ponds.

In the present study, Saudi Bangla tilapia feed and mixed feed were given in T_1 and T_2 respectively. So, the food conversion ratio (FCR) was calculated for normal and monosex GIFT tilapia in T_1 and T_2. The FCR values were recorded as 1.70±0.02 and 1.72±0.03 for normal GIFT and 1.61±0.05 and 1.65±0.06 for monosex GIFT in T_1 and T_2 respectively (Table 3). Statistically there was no significant (*P<0.05*) difference between the FCR values of normal and monosex GIFT tilapia in T_1 and T_2. Hossain *et al.* (2004) found FCR value for GIFT strain fed on formulated diet was 1.71 to 1.77 which is more or less similar to that observed in the present study.

Table 3. Growth parameters of normal and monosex GIFT tilapia (*O. niloticus*) in different treatments

Growth parameters	Fish species	T_1	T_2	T_3
Mean initial weight (g)	Normal	3.60±0.02	3.60±0.02	3.60±0.02
	Monosex	3.62±0.15	3.62±0.15	3.62±0.15
Mean final weight (g)	Normal	$148.25±2.73^c$	$112.40±2.15^b$	$51.27±1.15^a$
	Monosex	$197.20±3.62^c$	$149.34±3.30^b$	$67.85±1.18^a$
Mean weight gain (g)	Normal	$144.65±2.71^c$	$108.8±2.14^b$	$47.67±1.13^a$
	Monosex	$193.58±3.59^c$	$145.72±3.25^b$	$64.23±2.35^a$
Specific growth rate (%/day)	Normal	$3.09±0.02^c$	$2.87±0.02^b$	$2.21±0.01^a$
	Monosex	$3.33±0.04^c$	$3.09±0.03^b$	$2.44±0.02^a$
Food conversion ratio (FCR)	Normal	$1.70±0.02^a$	$1.72±0.03^a$	0.00
	Monosex	$1.61±0.05^a$	$1.65±0.06^a$	0.00
Survival (%)	Normal	$84.30 ± 1.51^b$	$81.36±1.21^b$	$73.67±1.06^a$
	Monosex	$87.10±1.18^b$	$83.40±1.43^b$	$75.0±1.42^a$
Production (kg/decimal)	Normal	$15.60±0.58^c$	$11.04±0.42^b$	$4.38±0.23^a$
	Monosex	$21.44±0.60^c$	$15.19±0.45^b$	$6.02±0.27^a$
Production (Kg/ha)	Normal	$3853.2±139^c$	$2726.8±117^b$	$1081.8±101^a$
	Monosex	$5295.6±197^c$	$3751.9±161^b$	$1486.9±118^a$

Mean values in the same row with different superscript letters (a, b, c) are statistically significant at *P<0.05*.
Values are mean ± standard error

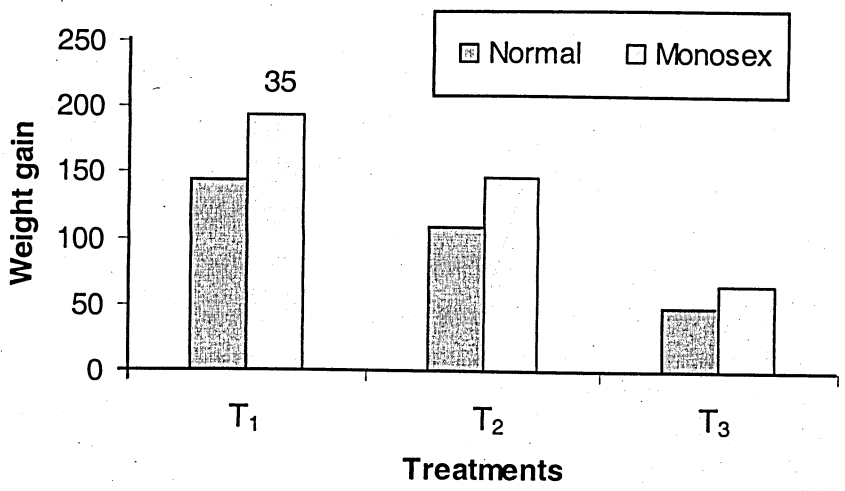

Fig. 1. Comparison of growth of normal and monosex GIFT tilapia in different treatments (T_1 providing Saudi Bangla tilapia feed, T_2 providing mixed feed (rice bran : mustard oilcake = 1 : 1 and T_3 no feed but fertilization was used)

The mean survival rate of normal GIFT was 84.30 ± 1.51, 81.36±1.21 and 73.67±1.06 % and of monosex GIFT was 87.10±1.18, 83.40±1.43 and 75.0±1.42 % in T_1, T_2 and T_3 respectively (Table 3). Significantly (*P<0.05*) higher survival rate was found in T_1 and T_2 for both normal and monosex GIFT tilapia than that in T_3. The survival (%) obtained in the present study was relatively higher than the survival recorded by Hossain *et al.* (2005). The higher survival (%) of fish in the present study might be due to the bigger size of fingerlings (3.6 g) were stocked.

The production of normal GIFT was 15.60±0.58, 11.04±0.42 and 4.38±0.23 kg/dec/4 months and monosex GIFT was 21.44±0.60, 15.19±0.45 and 6.02±0.27 kg/dec/4 months in T_1, T_2 and T_3 respectively (Table 4). Significantly (*P<0.05*) higher production was found in T_1 for both normal and monosex GIFT tilapia than those in T_2 and T_3. The extrapolated production in terms of kg/ha/4 months was 3853.2±139, 2726.88±117 and 1081.86±101 for normal GIFT and 5295.68±197, 3751.93±161 and 1486.94±118 for monosex GIFT in T_1, T_2 and T_3 respectively. The total production (kg/ha/4 months) obtained in the present study is similar to the production obtained by Hossain *et al.* (2004) and Veverica *et al.* (1998) for Nile tilapia.

A simple economic analysis was performed to estimate the net profit from this culture operation (Table 4). The cost of production was based on Mymensingh whole sale market price of year 2006-2007 in considering the inputs used. In the present study, the net profit generated from the 4 months culture period was calculated as Tk. 77925.4, 53804.6 and 21961.3/ha for normal GIFT and Tk. 131280.5, 78792.3 and 33721.6/ha for monosex GIFT in T_1, T_2 and T_3 respectively.

Table 4. Economic analysis of normal and monosex GIFT tilapia (*O. niloticus*) production in ponds for 4 months experimentation

Investment (Tk.)	T_1		T_2		T_3	
	Normal	Monosex	Normal	Monosex	Normal	Monosex
Pond preparation	300	300	300	300	300	300
Cost of fingerlings	250	500	250	500	250	500
Feed cost	2340	2808	1515	1969.5	-	-
Fertilizer cost	-	-	-	-	260	260
Operation cost	216.75	270.6	154.87	207.71	60.75	79.5
Total cost	3106.75	3878.6	2219.87	2977.21	870.75	1139.5
Production (kg/treatment)	62.41	85.78	44.16	60.76	17.52	24.08
Gross income from fish sale	4368.7	6004.6	3091.2	4253.2	1226.4	1685.6
Net profit (per treatment)	1261.95	2126.0	871.33	1275.99	355.65	546.1
Net profit/ ha/4 months	77925.4	131280.5	53804.6	78792.3	21961.3	33721.6

Sale price of tilapia = Tk. 70.00/ kg.
Leasing cost for pond is not included.
Operational cost is considered as 7.5% of total cost (ADCP, 1983)

The highest net profit was obtained in T_1 receiving Saudi Bangla tilapia feed than those of in T_2 and T_3 for both normal and monosex GIFT tilapia. On the other hand, monosex GIFT had significantly higher yield than that of normal GIFT. Faster growth of monosex tilapia has been related to the lack of energy expenditure in egg production and mouth brooding by females and lower energy expenditure on courtship by males (Macintosh and Little, 1995).

From the study, the economic analysis showed that T_1 gave the highest net profit. Some profits were also found in T_2 and T_3 but it was lower than that of T_1 and economically farmer may not get more benefit from T_2 and T_3. Therefore, among the treatments, T_1 gave the highest net return though the investment cost was higher and the production of T_1 was economically more profitable. The result of the present study also showed that the growth of monosex GIFT is significantly better (33%) than that of normal GIFT tilapia cultured in small seasonal ponds.

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