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Original Research Article

Assessing Production and Economics of Mono Sex Male Tilapia (*Oreochromis niloticus*) in Small Seasonal Ponds

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Abstract

The study was conducted to assess the production and economics of mono sex male tilapia (*Oreochromis niloticus*) reared in nine seasonal small ponds at Patuakhali Science and Technology University research farm for a period of three months during March to May 2019.The experiment was designed in three treatments (T) each with three replications. The ponds were drained, limed and fertilized with organic and inorganic fertilizers during preparation. The stocking density was 37050 fish/ha in all three treatments. After stocking the fish ponds were fertilized weekly with cowdung, urea and TSP. Supplementary feed was not given in T_1, but rice bran and mustard oilcake were given in T_2 and commercial pellet feed in T_3. Some water quality parameters were monitored at regular intervals and they were found within acceptable range for pond aquaculture. The survival rates were high (> 96%) in all treatments. Significantly highest production (5494.10 kg/ha in three months) was found in T_3 followed by T_2 (2392.23 kg/ha/3months) and T_1 (1048.93 kg/ha/3 months). Similarly, significantly highest net return (Tk. 206274.64/ha with benefit cost ratio of 2.01) was found in T_3 followed by T_2 (Tk.33100.47/ha with benefit cost ratio of 1.24) and T_1 (Tk. 8254.74/ha with benefit cost ratio of 1.11).

Keywords: Monosex male tilapia, Seasonal, Pond, Production, Bangladesh.

INTRODUCTION

Genetically Improved Farmed Tilapia (GIFT) strain, a synthetic strain of *Oreochromis niloticus* that was developed through selection of several generations from a base involving eight different strains of Nile tilapia (*O. niloticus*), was introduced in Bangladesh in July 1994 from Philippines [1].

The GIFT strain was reported to show an average 60% faster growth and 50% better survival at harvest than most commonly farmed strain [2, 3]. Tilapia has comparatively good market price, become marketable size in 3-5 months and requires low input cost. It is also preferred both by farmers and consumers due to its fast growth and tasty flesh. Tilapia can grow in a wide range of environmental condition and has good resistance to poor water quality and disease [4]. In Bangladesh, culture of tilapias has been promoted in small, seasonal ditches for poor marginal farmers [5, 6]. Fish farmers in rural areas can effectively utilize these seasonal water bodies for fish culture either for their subsistence or economical benefits. Tilapia, the most important aqua cultured species has been already named as the "food fish of the 21st century" [7] and has poultry broiler like growth with a short culture period. Mono-sex population of male tilapia was produced by treating fry with a synthetic male hormone 17α methyl testosterone at a treatment regime of 10 mg/kg food for 30 days. The healthy cultivation of tilapia depends on nutritional status and rearing environmental conditions [8]. Supplementary feed is one of the key inputs in fish culture to get high production. Feed cost generally constitutes the highest single operating cost in semi intensive farming operation [9]. Increased natural food produced in fish ponds through fertilization reduces the use of supplementary feeds that ultimately reduces the feed costs. In Bangladesh some relatively cheap indigenous agricultural by-products, such as, rice bran, wheat bran, mustard oilcake are being used for aquaculture. For proper growth of fish, animal protein supplement, growth promoting vitamins and micronutrients are essential. In recent years, pelleted commercial fish feeds have been marketed by different industries. These feeds are mainly used by medium to large farmers in commercial fish farms. For marginal resource poor farmers it is important to improve the

traditional fish culture system. Mono sex male tilapia is omnivorous and its production can be increased through partial feed supplementation. The present study was conducted to learn about the production and profitability of monosex male tilapia culture under different feeding strategies in seasonal small ponds.

MATERIALS AND METHODS

Experimental site and pond facilities

The experiment was carried out for a period of 92 days from 1 March to 31 May, 2019, in nine experimental ponds situated in the Field research farm, Faculty of Fisheries, Patuakhali Science and Technology University (PSTU), Dumki, Patuakhali. The ponds were equal in size (120 m^2) and similar in shape, depth and basin configuration.

Pond Preparation

The ponds were drained out completely and aquatic weeds were removed manually. Liming was done in all ponds at the rate of 1 kg/decimal. Three days after liming the ponds were manured with cowdung at the rate of 4 kg/decimal. One week after liming the ponds were filled with water and fertilized with urea and TSP at the rate of 100 g/decimal. TSP was soaked overnight, then urea and TSP were dissolved together and spreaded manually on pond water surface in the morning at 10 am with sufficient sunlight.

Collection of experimental fish and stocking

All the mono sex male tilapia fingerlings with mean initial weight of 4.55 ± 0.03 g were collected from a local fish vendor and were stocked at a rate of 150 fish/decimal (37500 fish/ha).

Experimental design and feeding

The experiment was carried out with three treatments each with three replications. Fertilization was done weekly in the ponds of all treatments at the same rate (cowdung,3 kg/decimal; urea, 40g /decimal and TSP, 40 g/decimal). Supplemental feeds were given in treatment-2 (T_2) (rice bran: mustard oilcake; 1:1) and in treatment-3 (T_3) (commercial pellet feed containing 32% protein). The feed was applied at the rate of 5% of the body weight of fishes at the beginning of the experiment, and then it was reduced to 4% after one month and 3% after two months. Feed was applied twice a day, half in the morning (9.00 am) and the rest in the afternoon (4.00 pm). The supplementary feeds, such as rice bran and mustard oilcake were given to the fish in dough form. For this purpose, mustard oilcake was soaked overnight, mixed with rice bran and small balls were made. The feeds were gently thrown over the ponds water on a particular site of the ponds regularly. Twenty percent of the total fish were sampled fortnightly by a seine net to monitor the fish growth and to adjust feeding rates. The weight of fish during sampling was measured by using a portable digital balance.

Water Quality Parameters

The water quality parameters such as temperature, dissolved oxygen (DO) and pH were recorded fortnightly. The temperature and dissolved oxygen of the ponds were determined by a DO meter (YSI, model 58, USA). Secchi disc visibility was measured using a Secchi disc at the time of water sampling. The water pH was recorded by a pH meter (Jenway, model 3020, UK). Integrated water sample of entire column was taken at fortnightly interval for analysis of chlorophyll-*a* [10].

Statistical Analysis

For data analysis a one-way ANOVA and DMRT were applied following Gomez and Gomez [11]. Computer analysis of the data was done by using the software SPSS (Statistical Package for Social Science) version 20.0 Significance was assigned at 0.05% level.

Economic Analysis

An economic analysis was conducted to estimate the net profit from different treatments. The analysis was based on local market prices for harvested fish and all other items. The costs of fingerlings, fertilizer and supplemental feeds are shown in Table-3. The cost of leasing ponds was not included in the total cost. An additional 7.5% on total cost was included as operational cost [12]. The net return was measured by deducting the gross cost from the gross return per decimal. The benefit cost ratio was also measured as a ratio of net benefit to gross cost.

RESULTS

Water Quality Parameters

The water quality parameters measured during the experimental period is furnished in Table-1 and found that the water quality parameters were within the expectable range among the treatments for pond aquaculture and only significant differences were found among the treatments regarding transparency and Chlorophyll-*a* (Table-1).

Table-1: Mean (± SD) values and ranges (in parentheses) of water quality parameters of experimental ponds under three treatments during the study period

Parameters	Treatments	Level of

	T_1	T_2	T_3	Significance
Temperature (ºC)	30.96 ± 0.53	31.08 ± 0.47	31.03 ± 0.55	NS
Transparency (cm)	24.62 ± 0.84b	30.29 ± 0.81b	37.28 ± 1.28a	*
Dissolved oxygen(mg/l)	5.37 ± 0.15	5.16 ± 0.08	5.46 ± 0.17	NS
pH	7.74 ± 0.18	7.64 ± 0.13	7.62 ± 0.16	NS
Chlorophyll-*a* (µg/l)	129.67±15.76b	156.57 ± 39.72b	248.95± 55.33a	*

Mean values with different superscripts in the same row are significantly different (p<0.05); NS-Non significant; * Significant

Growth and Production Performances

The growth performance of mono sex male tilapia in terms of initial weight, final weight, weight gain, specific growth rate, feed conversion ratio, survival rate and total production is shown in Table-2. Mean weight gain of mono sex male tilapia ranged between 23.58 and 148.50 g and there was a significant variation (p<0.05) among the treatments (Table 2). The mean weight gain was significantly higher (p<0.05) in T_3 (146.69 g) than in T_1 (24.72 g) and T_2 (60.19 g). Significantly highest (p<0.05) SGR value (1.98) was recorded in T_3 and the lowest (1.21) in T_1 (Table-2).

Table-2: Growth and production of mono sex male tilapia observed in different treatments during the experimental period

Parameters	Treatments		
	T_1	T_2	T_3
Initial weight (g)	4.55 ± 0.03	4.55 ± 0.03	4.55 ± 0.03
Final weight (g)	29.27±1.16c	64.74 ± 1.18b	151.24± 1.79a
Weight gain (g)	24.72±1.14c	60.19 ± 1.16b	146.69± 1.81a
% Weight gain (g)	643.29±19.54c	1422.85 ± 15.65b	3223.95± 24.04a
SGR (% day)	1.21 ± 0.02c	1.47 ± 0.01b	1.98 ± 0.02a
FCR	-	1.71 ± 0.01	1.36 ± 0.03
Survival rate (%)	96.76 ± 1.15	97.10 ± 1.25	98.05 ± 0.57
Production (kg/pond/3 months)	12.74±1.15c	28.29 ± 1.14b	66.73 ± 1.17a
Total production (kg/ha/3 months)	1048.93±11.55c	2392.23 ± 9.52b	5494.10± 11.55a

Mean values with different superscripts in the same row are significantly different (p<0.05

The FCR was 1.71 and 1.36 in T_2 and T_3 respectively. The survival rate ranged between 96.76 to 98.05 % and there was no significant difference (p>0.05) among the treatments. The production of mono sex male tilapia in terms of kg/ha/3 months was highest (5494.10 kg) in T_3, followed by T_2 (2392.23 kg) and T_1 (1048.93 kg) and they were significantly (p<0.05) different (Table-2). A simple economic analysis showed that T_3 generated the highest benefit or net return of Tk. 2,06,274.64/ha/3 /ha/3months and Benefit Cost Ratio (BCR) of 2.01 followed by Tk. 33100.4/ha/3 months and BCR value of 1.24 in T_2 and Tk. 8254.74/ha/3 months and BCR value of 1.11 in T_1 (Table-3).

Table-3: Economic analysis of mono sex male tilapia (*O. niloticus*) production in ponds reared for 3 months

Components	Treatments		
	T1	T2	T3
Expenditure (Tk/pond)			
Fingerlings cost	450	450	450
Feed cost	-	793.00	1,620.00
Lime cost	120.00	120.00	120.00
Cow dung	110.0	85.00	55.00
Urea	50.00	50.00	35.00
TSP	65.00	55.00	45.00
Operational cost	60.00 ± 1.20	116.00 ± 1.14	174.38 ± 0.58
Total expenditures (Tk/pond)	855.24 ± 1.13c	1,719.72 ± 1.16b	2,499.39±2.79a
Income			
Gross return (Tk/pond)	955.50 ± 5.75c	2121.75 ± 1.17b	5004.75±1.15a
Net return (Tk/pond)	100.26± 0.58c	402.03 ± 1.15b	2505.36±1.15a
Net return (Tk/ha)	8254.74 ± 0.58c	33100.47± 2.31b	206274.64±57.74a
BCR (Benefit Cost Ratio)	1.11 ± 0.01	1.24 ± 0.03	2.01 ± 0.05

Mean values with different superscripts in the same row are significantly different (p<0.05)
Sale price of mono sex male tilapia = Taka 75.00/ kg.
Leasing cost for pond is not included.
Operational cost is considered as 7.5% of total cost (ADCP, 1983).

DISCUSSION

The rearing experiment of mono sex male tilapia was conducted during March to May when the environmental temperature was very suitable for aquaculture. The surface water temperature of the ponds ranged from 30.96 to 31.58ºC. Hossain *et al.*,

[13] reported that conditions are highly suited for raising tilapia between March and May when temperature varies from 25°C to 35°C.

DoF [14] reported that the range of suitable dissolved oxygen for fish culture would be 5–8 mg/l. In the present study dissolved oxygen concentration ranged from 5.22 to 5.63 mg/l. DO content in the present study was slightly lower. This might be due to the measurement of DO at morning (10.00 am). However, this low DO level might have not any negative effect since tilapia has high tolerance to environmental fluctuation. The pH of water in the experimental ponds ranged between 7.74 ± 0.18 and 7.62 ± 0.16 which is considered suitable as suggested by some other authors [15, 14].

Transparency ranged from 23.78 to 38.56 cm and the mean values were 24.62, 30.29 and 37.28 cm in T_1, T_2 and T_3 respectively. The variation in transparency was due to plankton production and rain induced turbidity. Similar transparency values were recorded by Latif *et al.*, [16]; Wahab *et al*., [17].

The mean chlorophyll-*a* values recorded in the present study were 129.67, 156.57 and 248.95 µg/l in T_1, T_2 and T_3 respectively. The highest chlorophyll-*a* values was found in T_3 that might be due to higher concentration of phytoplankton in the ponds. The lower mean value was observed in T_1 that might be due to the grazing pressure of fish in natural food because supplemental feed was not given in that treatment.

In this study, mean weight gain of Mono sex male tilapia were 24.72 g, 60.19 g and 146.69 g and percent weight gain were 643.29, 1422.85 and 3223.95% in T_1, T_2, T_3 respectively. From the study, it is found that mean weight gain and percent weight gain were significantly higher in T_3 than T_2 and T_1. This is due to utilization of natural foods in the ponds as well as the use of supplementary pellet feed. Lower value of mean weight gain and percent weight gain in T_1 was due to no use of any supplementary feed. Hussain *et al.*, [1] reported a weight gain of about 128g for GIFT strain in on-farm ponds for a culture period of 6 months fed rice bran at 5-6% of their body weight. Considering the 3 months culture period in the present study compared to 6 months period by Hussain *et al.*, [1], mono sex male tilapia in the present study performed better. This difference in the growth might be related to feed & fertilizer supplied in the ponds and the time/ season of the experiment. Hussain *et al*., [1] conducted the experiment from January to May which covered part of the winter season when growth of fish is generally slow.

In this study, Specific Growth Rate (SGR) value of mono sex male tilapia was 1.21, 1.47 and 1.98% in T_1, T_2 and T_3 respectively. The highest SGR value in T_3 was due to high protein and energy content of the diet compared to other treatments. Green [18] obtained a higher SGR value of 2.03 with tilapia in Honduras using feed and fertilizer. Hossain *et al.* (2004) also observed SGR values of GIFT tilapia ranged from 2.04 to 2.30 fed on formulated diet. The lower SGR values of mono sex male tilapia (*O. niloticus*) in the study might be due to the protein and energy content of the diet and natural productivity of the ponds.

The Food Conversion Ration (FCR) values found in T_2 and T_3 were 1.71 and 1.36 respectively. Hossain [19] found FCR value of GIFT tilapia fed rice bran and commercial tilapia feed as 2.07 and 1.84. The variation in FCR values might be due to difference in quality of food given. The survival rate of the fishes were high and ranged between 96.76 and 98.05%. Similar higher survival of mono sex male tilapia was recorded by Hossain *et al*., [20] and DoF [14]. The higher survival of fish in the study might be related to the relatively larger size of fingerlings (4.55 g) stocked and care during the rearing period.

The total production of fishes was 1048.93, 2392.23 and 5494.10 kg/ha/3months in T_1, T_2 and T_3 respectively, and varied significantly among the treatments. The highest production found in T_3 might be due to high protein quality supplementary-pelleted feed and large quantity of natural food available in the pond during the study period, and this production is more or less similar to the findings of Hossain *et al.*, [20] and Hossain [19]. Boyd [21] reported that feeding plus fertilization can increase fish production over that possible with fertilization alone. Gupta *et al*., [22] reported that tilapia production of 3554.76 kg/ha in treatment receiving supplementary feed than 1510.71 kg/ha in fertilized ponds for 6 months. Green *et al.*, [23] reported yields ranged from 1274 to 2929 kg/ha/145 days. The difference in total production found by different authors might be due to the variation in productivity of the ponds, variation of rearing season and cultural periods along with other factors.

The net return and benefit cost ratio was higher in T_3 where pellet feed was used. Possibly the feed (rice bran + oil cake) given in T_2 could not fulfill the nutritional requirement of the fishes in that treatment as a result the fish production, net income and benefit cost ratio was lower. As no food was given in T_1 so the production was very low in that treatment.

The research findings revealed that pellet feed having nutritional requirements in good form than other two treatments resulting high production and net income.

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