

Survival and Growth Potential of Genetically Male Tilapia (GMT) Fry in Flow Through System Under Different Dietary Protein Concentrations

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Abstract.- Study was conducted to evaluate the survival and growth potential of genetically male tilapia (GMT) in flow through system under different dietary protein concentrations. The fish was kept in cemented rectangular tanks @ 59 fish fry/ tank in mixed sex (XX/XY) culture system and 27 fish fry/tank in mono sex culture (super males YY). Each treatment group in mixed sex had two replicates while mono sex had one replicate. Artificial feeds containing 30%, 35% and 40% crude protein were applied at 4% fish wet body weight twice a day to mixed sex while 35% and 40% to super males. The results of mixed sex were analyzed using one way ANOVA while mono sex was compared by using t-test. Results of mixed sex indicated significantly higher ($P > 0.05$) final body weight, net weight gain, percent weight gain in 40% compared to 30% and 35% feeds. Feed conversion ratio (FCR) and specific growth rate (SGR %) were 1.21 and 4.83, respectively for 30%, and 1.24 and 3.59, respectively for 35% feeds and were significantly different compared to 1.33 and 3.23, respectively, for 40% feed in mixed-sex culture. The survival rate was 43% in 30%, 83% in 35% and 68% in 40% feeds for mixed sex. In the case of mono-sex culture (YY), results indicated significantly higher ($P > 0.05$) values with 40% feed for final body weight, net weight gain, percent weight gain and SGR compared to that of 35% feed. The FCR values in 40% feed (3.65) was significantly different from that of 35% feed (4.74). Survival rate of YY was 100% in 35%, while 81% in 40% feed. In conclusion mono sex (YY) GMT fry outperformed than mixed sex under both treatments of 35% and 40% crude protein in flow through system.

Key Words: GM tilapia, specific growth rate, artificial feeds, feed conversion ratio, *Oreochromis niloticus*.

INTRODUCTION

Aquaculture is being called the next agricultural revolution due to its potential of generating the great changes in the production of fish products. Among aquaculture products tilapia (*Oreochromis niloticus*) has significant share in providing animal protein and income in every region of the world (Sosa *et al.*, 2005). It is currently ranked second only to carps in global production and is likely to be the most important cultured fish in the 21st century (Ridha, 2006). Farmed tilapia production throughout the world increased dramatically in recent years, from 383,654 mt in 1990 to 2,326,413 mt in 2006 (FAO, 2007).

Tilapia grows and reproduces in a wide range of environmental conditions and tolerates stress induced by handling (Tsadik and Bart, 2007). Major problem in tilapia culture is that females grow slower than males because of early sexual maturation that diverts energy from growth to reproduction. The most effective solution to this problem is to produce and grow only male fish. There are a number of ways to control reproduction in mixed-sex population. One of these is the culture of all-male tilapia (Phelps and Popma, 2000). Moreover, sex-specific differences in growth were significant in *O. niloticus* where males grow significantly faster, larger and more uniform in size than females (Bwanika *et al.*, 2007).

Due to rapid growth of population, industrialization and climatic changes in Pakistan and in South Asia the quality and quantity of water resources are deteriorating at an alarming rate. Indian major carps which are the main stay of

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aquaculture in sub-continent and are under great danger due to water problems. Fish farmers are looking towards tilapia and importing genetically improved farmed tilapia (GIFT) strain from Thailand since 2010. Now a day's all progressive farmers are used to prefer GIFT culture compared to Indian major carps. Genetically male tilapia (GMT) is another useful alternative and advantages over GIFT due to its fertility and ability to produce all males and great potential of growth. Through the application of relatively simple genetic manipulations, the University of Wales Swansea and its collaborators have developed an innovative and robust new genetic technology for producing all- or nearly all-male progeny in the Nile tilapia (Mair *et al.*, 1997). This technique was known as the "YY male technology" and takes the form of a breeding programme to produce novel males with YY genotypes instead of the usual XY male genotype. These YY males are known as "super males" and have the unique property of siring only genetically male progeny. These progeny are termed GMT and are normal males.

The dietary protein requirements of several species of tilapia have been estimated to range between 20% and 56% (El-Sayed and Teshima, 1991). Most studies are confined to fry and young tilapia, although the major part of the feed is used during grow-out (Siddiqui *et al.*, 1998). Preparation of artificial feed is one of the major constraints in Pakistan both for Indian major carps and tilapia strains. Few companies have started their business recently to produce pelleted feed for tilapia (*Oreochromis niloticus*) on commercial scale. Keeping in view the above mentioned facts this study was planned to explore the survival and growth potential of this new strain (GMT) under different protein concentrations.

MATERIALS AND METHODS

Experimental site and test species

The study was conducted at Research and Training Facilities, Department of Fisheries and Aquaculture, UVAS, Ravi Campus, Pattoki, Pakistan in cemented tanks under intensive rearing condition for 60 days. GMT was experimental fish for this study. Experimental fish mentioned below

with different genomes were procured from FishGen Company's commercial fish hatchery located at Central Luzon State University, Philippines. The fish under study have following genomes: XX females, XY males; and YY super males

Experimental setup

The experimental fish was kept in cemented circular tanks for one week and fed 30% pelleted floating feed in quarantine condition. After one week the experimental fish was put in cemented rectangular tanks @ 59 fish fry/ tank in mixed sex culture system (XX/XY) and 27 fish fry/tank in mono sex culture (super males YY). A total of eight tanks were used having equal dimension 3.66m x 0.76m x 0.91m, respectively. Each treatment group had two replicates (Table I). Tube well water was used and water level was maintained in tanks about 0.76m /tank with continuous supply of freshwater from turbine. Oxygen supply was given through mechanical air blower.

Table I.- Experimental setup.

	Sex	Replicates	
		Dietary protein level	Stocking density
Tank 1	XX/XY	30%	59
Tank 2	XX/XY	30%	59
Tank 3	XX/XY	35%	59
Tank 4	XX/XY	35%	59
Tank 5	XX/XY	40%	59
Tank 1	XX/XY	40%	59
Tank 6	YY	35%	27
Tank 8	YY	40%	27

Feed formulation

Feed ingredients such as fish meal, soybean meal, maize gluten (60%), rice polish, wheat bran, sunflower meal and nutrimix (Vit. A, D3, E, K, B1, B2, B6, B12, biotin, pantothonic acid, niacin, folic acid, copper sulphate, cobalt carbonate, iron sulphate, manganese oxide, sodium selenite, potassium iodide, zinc oxide, lysine, methionine. Bruce Veterinary Products Drv. Product Origin Malaysia and Pak Care International Company)

were used for the preparation of powdered artificial feeds containing 30%, 35% and 40% crude protein (CP) (Table II). Feeds were given at 4% fish wet body weight twice a day at 9:00 a. m. and 3:00 p.m.

Table II.- Feed composition and formulation.

Feed ingredient	D1 (CP%)	D2 (CP%)	D3 (CP%)
Fish meal	10 (5.4)	13 (7.0)	16 (8.6)
Soybean meal	15 (5.3)	20 (7.1)	20 (7.1)
Maize gluten (60%)	16 (9.6)	22 (13.2)	31 (18.6)
Rice polish	25 (3.5)	16 (2.2)	12 (1.70)
Wheat bran	23 (3.8)	18 (3.0)	13 (2.1)
Sunflower meal	10 (2.7)	10 (2.7)	7 (1.9)
Nutrimix	1 (-)	1 (-)	1 (-)
Total	100 (30)	100 (35.2)	100 (40.0)

CP, crude protein.

Growth parameters

Growth parameters such as total body weight and total body length were monitored at the time of stocking and subsequently every fortnightly, while other parameters were calculated by using following equations:

Net weight gain (NWG) = Final weight (g) - Initial weight (g)

Percent weight gain (PWG) = Final body weight (g) - Initial body weight (g) x 100/ Initial body weight

Specific growth rate % (SGR) = Final body weight - Initial body weight) x 100/ No. of days of experiment

Feed conversion ratio (FCR) = Feed intake (g) / Wet weight gain (g)

Physico-chemical parameters

Water quality parameters like temperature, pH, DO, EC, salinity and TDS were monitored on daily basis using standard methods as described by APHA (1998), and were measured with the help of digital meters, whereas, nitrates were determined on fortnightly basis with spectrophotometer ((IRMECO UV-Vis Spectrophotometer, Model: U2020).

Statistical analysis

The data was analyzed by completely randomized design (CRD) using one way Analysis

of Variance (ANOVA) technique (Steel *et al.*, 1997) using Minitab software packages version 1.5.

RESULTS

Fish growth studies

In mix sex culture survival rate was 43% in 30% CP level, 83% in 35% CP level and 68% in 40% CP level while in mono sex culture 100% in 35% CP level and 81% in 40% CP level (Table III). The statistical analysis of mixed sex culture (XX/XY) using one way ANOVA indicated significant ($P < 0.05$) differences among all the treatment group for final body weight, NWG and PWG (Table III). The fish fed 40% CP showed significantly higher final body weight, NWG and PWG compared to 30% and 35% CP levels (Table III). SGR values showed similar pattern and were found significantly higher in 40% compared to 30% and 35%, respectively (Table III). FCR values recorded under three CP levels 4.83, 3.59 and 3.23 in 30%, 35% and 40% were found significantly different (Table III).

The results of mono sex (YY) using t-test indicated significant ($P > 0.05$) differences between final body weight, NWG, PWG, SGR and FCR among two treatment groups. Survival of fish was 100% in 35% CP level while 81% in 40% CP level (Table IV). Fish fed with 40% CP level showed significantly ($P < 0.05$) higher weight gain than 35% CP level (Table III).

Comparison of growth in terms of fortnightly average increase in length and weight of mono sex (YY) was found significantly higher ($P < 0.05$) than mixed sex (XX/XY) under both treatments 35% and 40% CP (Fig. 1).

Physico-chemical parameters

The results of physico-chemical parameters during current study were observed in acceptable range for the best growth of this species. There was no significant numerical difference seen except in DO where in treatment 35% mixed sex group showed numerically higher 6.4 mg/L dissolved oxygen concentration compared to other groups 30% and 40% (Table IV). The values of nitrates ranged from 0.0012-0.0014 mg/L and were found in acceptable range (Table IV).

DISCUSSION

The study was conducted to investigate the survival and growth potential of GMT tilapia in intensive rearing condition under different artificial feed containing 30%, 35% and 40% CP levels. The survival rate was observed higher with 35% CP in both mixed and mono culture followed by 40% CP levels and lowest in 30%. This higher survival rate might be due to increasing level of protein contents in the experimental diets. However, various studies revealed that stocking density (Narejo *et al.*, 2007; Aksungur *et al.*, 2007; Moradyan *et al.*, 2012), higher protein contents (Abdel-Tawab, 2012) and sex/strain (Perschbacher, 2007) has significant effects on the survival and growth of fish larvae in intensive rearing conditions. Mono sex (YY) group achieved significantly higher weight gain and length than mixed-sex (XX/XY) strain of tilapia under both treatments 35% and 40% CP level. Faster growth of mono sex (YY) tilapia during current studies might be related to its genetic makeup, higher protein contents and lack of energy expenditure in breeding than local/mixed strains. Previous studies on Nile tilapia during mono sex culture revealed similar results where they reported significant increase in individual growth of the experimental fish under various feeding levels (Mair *et al.*, 1997; Dan and Little, 2000; Little *et al.*, 2003). The results of final body weight, NWG, PWG, SGR% and FCR for all the treatments of mixed sex culture as well as in mono sex culture showed significant differences during current study which are comparable with the findings of Perschbacher (2007) who worked on genetically-improved stocks and strains of tilapia in recirculating aquaculture system (RAS) using GMT, Nile tilapia (*Oreochromis niloticus*), and mixed sex Nile tilapia, to measure the response of (32% protein). They reported that GMT fish outperformed mixed sex fish and were found 25% larger than mixed sex on both feed sources (natural and artificial).

The results of Physico-chemical parameters of water quality were found within optimum range for mixed sex culture and mono sex culture of GMT. No significant differences were observed for temperature, TDS, salinity and nitrates while dissolved oxygen at 35% level showed significant

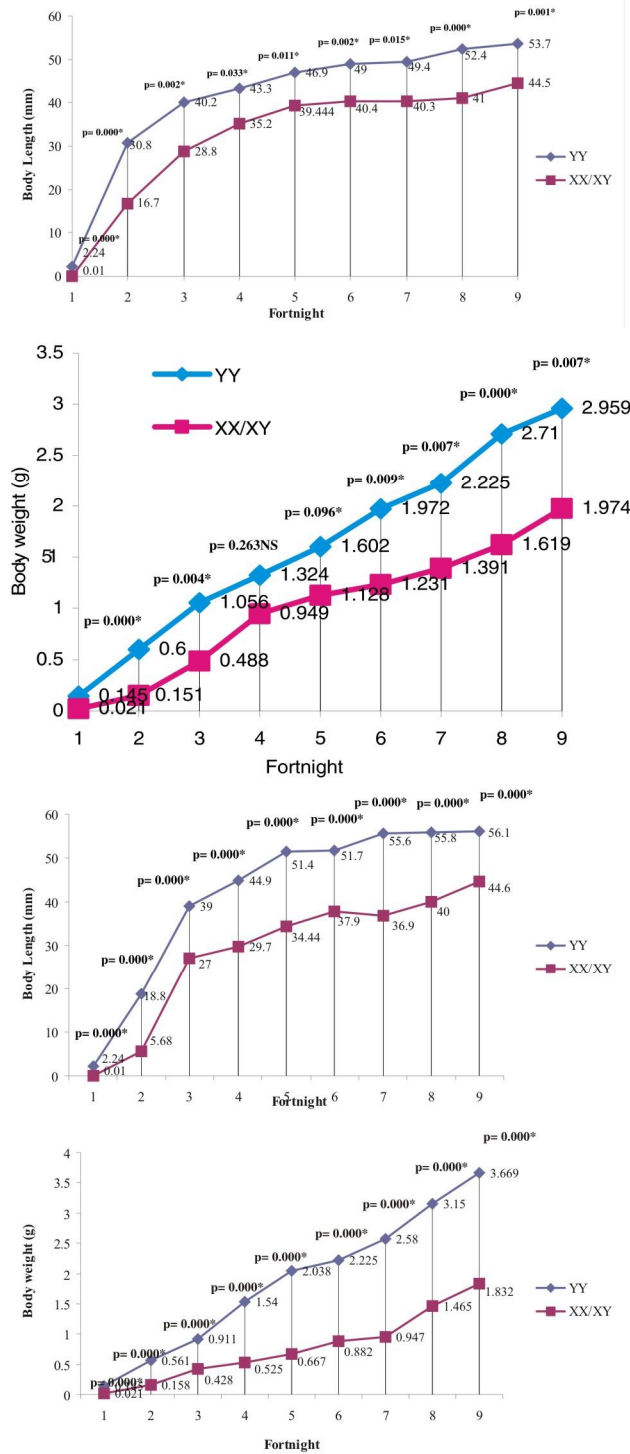


Fig. 1. Fortnightly average increase body length (A, C), weight (B, D) of mono sex (YY) and mixed sex culture (XX/XY) under 35 (A, B) and 40% (C, D) CP level.

Table III.- Growth parameters of GMT fry under 30%, 35% and 40% CP level in mixed sex (XX/XY) and monosex (YY) cultures. Means \pm SD are of two replicates n = 2. Mixed sex (XX/XY) culture.

Parameters	30%	35%	40%	P(t=0)
No. of fish stocked	118	118	118	---
Survival %	43	83	68	---
Initial weight (g)	0.02 \pm 0	0.02 \pm 0	0.02 \pm 0	-
Final weight (g)	3.17 \pm 0.50 ^b	3.54 \pm 0.05 ^b	5.13 \pm 0.20 ^a	0.0352
Net weight gain (g)	3.15 \pm 0.50 ^b	3.52 \pm 0.05 ^b	5.11 \pm 0.21 ^a	0.0352
% weight gain (%)	15783.33 \pm 2518.10 ^b	17600 \pm 25 ^b	25566.66 \pm 1040.83 ^a	0.0352
Specific growth rate (%)	1.21 \pm 0.041 ^b	1.24 \pm 0.006 ^b	1.33 \pm 0.01 ^a	0.0377
Feed conversion ratio	4.83 \pm 0.05 ^a	3.59 \pm 0.1 ^b	3.23 \pm 0.15 ^c	0.0247

*Figures with different superscripts are significantly different ($P > 0.05$)

Table IV.- Average physico-chemical parameters of mixed-sex (XX/XY) and mono-sex (YY) GMT tilapia cultured under various feeding levels.

Parameters	XX/XY			YY	
	30%	35%	40%	35%	40%
Temperature ($^{\circ}$ C)	27.2	27.2	27.1	27.2	26.4
DO (mg/L)	4.0	6.4	4.3	4.9	4.2
TDS (mg/L)	1009.0	1007.9	1012.6	1009.9	999.2
Salinity (ppt)	1.0	1.0	1.0	1.0	1.0
Nitrates (mg/L)	0.0013	0.0013	0.0014	0.0012	0.0013

difference compared to 30% and 40% CP level. Evidently not clear but it might be due to higher metabolic rate, higher growth of fish and efficient consumption of artificial feed that utilizes more oxygen compared in 30% and 40%.

CONCLUSION

In conclusion it has been observed that monosex (YY) GMT strain performed significantly better in terms of growth under 40% CP followed by 35% CP feed under intensive rearing condition.

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