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Comparative Study on the Breeding Performance of Two Different Strains (XY Male and YY Male) of Nile Tilapia (*Oreochromis niloticus*)

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Keywords: *Oreochromis niloticus , yy male,xy male, breeding performance.*

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Comparative Study on the Breeding Performance of Two Different Strains (XY Male and YY Male) of Nile Tilapia (*Oreochromis niloticus*)

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Keywords: Oreochromis niloticus, yy male, xy male, breeding performance.

I. Introduction

The Nile tilapia, Oreochromis niloticus (Linnaeus) is widely cultured species in many tropical and subtropical countries of the world (Lin *et al.,* 2008; Authman *et al.,* 2009).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). It is one of the popular and commercial species which fulfills the animal protein demand of people where wild capture fisheries are being depleted because of their faster growth rate, tolerance to harsh environment, ease of breeding and culture technique (Mandal *et al.,* 2009; Palipoch *et al.,* 2011). Major problems in tilapia culture arethe reduction of growth rates of females due to their early sexual maturity that diverts energy from growth to reproduction and the excessive reproduction that leads to various sizes of small fish production and overcrowding condition (Lèveque, 2002; Chakraborty *et al.,* 2011). The most effective solution to this problem is to produce, grow and culture all-male tilapia because males grow significantly faster, larger and more uniform in size than females (Bwanika *et al.,* 2007). In 1994 Bangladesh Fisheries Research Institute (BFRI) imported GIFT (Genetically Improved Farmed Tilapia) Tilapia for research of genetic improvement by a project of World Fish Center. Nowadays all progressive farmers are used to prefer GIFT culture compared to Indian major carps for more profit. Another alternative is GMT (Genetically male tilapia) which is useful and advantages over GIFT due to its fertility and ability to produce all males resulting great potential of growth. This genetic technology for producing all- or nearly all-male progeny in the Nile tilapia is known as the "YY male technology" and the producing YY male progeny are known as "super males" (Mair *et al.,* 1997). Thus, the main objective of this study was to find out more desirable and profitable strain between two different strains of (XY Male and YY Male) of Nile Tilapia (Oreochromis niloticus) by comparing their breeding performance.

II. Materials and Methods

Two different strains of tilapia such as: SRT (Sex Reversed Tilapia) and GMT (Genetically Male tilapia) were selected for the experiment.

a) Experimental site and species

The study was conducted in Bismillah Agro production hatchery of NoakhaliSadar in Noakhali district, Bangladesh (Fig. 1). Two different strains of tilapia – GIFT (Genetically Improved Farmed Tilapia) and GMT (Genetically Male tilapia) were experimental species. The fish under study have following genomes: XX females, XY males; and YY super males. In this study, the breeding of YY supermale and BFRI XY male were occurred with BFRI XX females separately in Bismillah Agro production hatchery.

b) Collection of brood fish

The YY supermale was collected from Philippine and GIFT brood fishes were collected from BFRI, Mymensing. The average arrival size of imported 50 fry

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of YY male was 11mm (0.1 g) which were reared for 3.5 months uptoattaining 200-250g as average size.The average arrival size of BFRI XY and XX tilapias were 22mm and 3 g which were reared for 3 months upto attaininganaverage size of 120 g.Six Experimental hapaswhich were similar in shape and size, with an area of 5m x 6m x 2 m hapasof 1.5-mm mesh size were used for stocking of the three strains.

c) Stocking of brood fish in experimental hapas

Amongtotal 252 broods, 42 were YY supermale, 42 were GIFT XY male and the rest 168 were GIFT XX female broods and the stocking ratio was 1:2 (male: female). In this study two treatments were T1 (XY male) and T2 (YY male) and each had three replicates (Table 1).

Table 1: Experimental setup

Treatment Category	Replication	Number of Tank	Sexes	Stocking density
T1(XY Male)	R1	Tank 1	XX/XY	36
	R2	Tank 2	XX/XY	36
	R3	Tank 3	XX/XY	36
T2(YY Male)	R1	Tank 4	XX/YY	36
	R2	Tank 5	XX/YY	36
	R3	Tank 6	XX/YY	36

Figure 1 : Image from Google Earth showing the location of Bismillah Agro production Hatchery

d) Brood stock test study

Comparative study was conducted to assess the maturation time of XX female broods. 30 GIFT females crossed by two types of male brood (XY male and YY male) were randomly selected for gonad weight test. The each sample was dissected after applying anesthetics and gonads from each sample were wiped out intact. Only the mature ovaries were selected for weight test. The mature ovaries were weighed by a sensitive electrical balance.

e) Fecundity test Study

Fecundity is the egg producing capability of the female fish. Fecundity is calculated by actual counting and volumetric methods. For fecundity estimation, Gonads were collected by cutting the abdomen of female fish. These gonads were placed in the 10% formalin solution, which helped to harden the eggs. As a result eggs were separated and were counted.

f) Comparative egg fertilization rate

Comparativeegg fertilization rate was found by counting the viable eggs. 30 GIFT femaleswere randomly selected from each treatment. Fertilized eggs were collected from the mouth of the sampled females. For calculating percent fertilization, eggs were carefully taken on a petridish containing water and the number of fertilized and unfertilized eggs were counted under a binocular microscope (x 10) (Adebayo, 2006).Ratio of the average collected eggs and eggs present in the gonad represent the egg fertilization rate.

Fertilization Rate = (Number of fertilized eggs / Total number of eggs counted) x 100

g) Comparative hatching rate

Adult female mouths were checked for eggs every seven days. The fertilized eggs were collected from the female mouths and kept in the incubation jars for hatching. Hatching period was 65-72 hours. About 10000 eggs were placed in each hatching tray. After

hatching, the number of hatchlings within each batch was carefully counted and the hatching rate was calculated using the following equation according Adebayo (2006).

Hatching Rate = (Number of eggs hatched / Total number of eggs in a batch) x 100

h) Comparative larval survival rate study

The hatchlings from two different strains of tilapia were kept in six different nursery hapas and were observed for 21 days to count the larval survival rate. Survival rate was estimated by following equation (Adebayo, 2006).

Survival Rate = (Number of hatchlings alive upto larvae stage / Total number of hatchings) x 100

i) Comparative larval growth observation

Larval growth was observed for 28 days in order to measure the length and weight. 30 different larvae were randomly sampled from each treatment.

j) Sex determination study

Finally the rate of male obtained from these comparative treatments and replications were observed. This determination was done by using two techniques:

Aceto-carmine technique: Microscopic examination on the gonads was performed by staining the gonad of the fish. 30 females were randomly sampled and sacrificed for collecting gonad. Collected gonads were mounted on a glass slide and few drops of aceto-carmine stain are added.

The gonad mounts are examined under a compound microscope. The male gonad is composed of fine granular like structure of spermatogonia and the female is characterized with the structure of circular oogonia. The technique proved to be efficient.

Manual sexing: This technique is based on the number of opening in the urinogenital papillae. The male were sorted out by finding a single opening where the female was sorted by finding two separate openings. The accuracy of this method ranges from 80% to 90% (Penman and McAndrew, 2000).

III. Results and Discussion

a) Average Total length observation

Average total lengthwas measured by using scale and gauge. The highest average length was found in YY male than XY male and XX female at three months-May (22.1±2.60 cm), June (23.5±3.18 cm) and July (25.6±0.322 cm) (Fig. 2). It was found from three different replications for each month that the total length were increased with the time (from May to July, 2012).The highest length of YY male, XY male and XX female were found in July (25.6±0.322 cm, 25.4±0.73 cm and 23.7±2.63 cm respectively) and lowest in May (22.1±2.60 cm, 18.5±0.36 cm and 17.8±1.45 respectively).

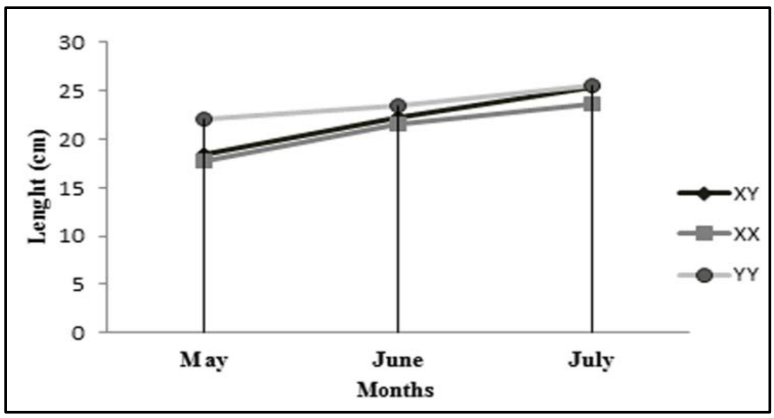

Figure 2 : Monthly variation in length of XX, XY and YY tilapia

Legend to Figure 2 : The highest average length was found in YY male than XY male and XX female during whole rearing periods (from May to July).

b) Average weight observation

Average total weightwas measured by using electrical balance. The highest average weight was found in YY male than XY male and XX female at three months-May (105.7 g), June (115.4 g) and July (129.6 g) (Fig. 3). As like as the length, the total weight of these fishes were increased with the time (from May to July, 2012).The highest weight of YY male, XY male and XX female were found in July (129.6 g, 110.2 g and 115.4 g respectively) and lowest in May (105.7 g, 75.2 g and 70.3 g respectively). Khan et al. (2014) reported that 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.

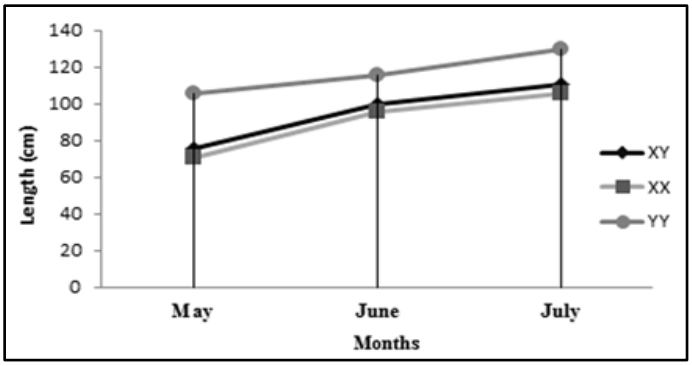

Figure 3 : Monthly variation in weight of XX, XY and YY tilapia

Legend to Figure 3: The highest average weight was found in YY male than XY male and XX female during whole rearing periods (from May to July).

c) Gonad weight and fecundity in GIFT female

Approximately, 752.7 eggs were counted when the gonad weight was 3.45 gram in average from the R1 replication. During the R2 replication approximately 769.8 eggs were counted and the gonad weight was 3.57 in average. In R3 replication the average numbers of eggs were 801.7 and the gonad weight was 3.61 gram in average (Table 2). It was found that the fecundity of XX female increases with the increasing weight of the gonad. Highest eggs production was seen during July with the higher weight of the gonads. Velasco (2003) reported that the fecundity fluctuates widely from a few hundred to several thousand eggs, depending on the size and age of the female. It is reported that as the weight of GIFT strain Oreochromisniloticus increases to a range of 180-498 g, the number of eggs decreases. It means that absolute fecundity in this species is inversely correlated with the weight of sexually mature females.

Table 2 : Relationship between gonad weight and fecundity in GIFT tilapia

No.	R1		R2		R3	
	Gonad weight (g)	Number of eggs	Gonad weight (g)	Number of eggs	Gonad weight (g)	Number of eggs
1.	3.25	735	3.48	791	3.45	775
2.	3.75	810	3.25	718	3.39	759
3.	3.15	710	3.09	675	3.54	785
4.	3.38	723	3.20	712	3.48	754
5.	3.50	794	3.78	823	3.75	851
6.	3.98	834	3.53	797	3.68	791
7.	3.91	825	3.42	784	3.78	868
8.	3.34	710	4.03	820	3.43	765
9.	3.05	685	3.99	798	3.52	791
10.	3.18	701	3.93	780	4.12	878
Average	3.45	752.7	3.57	769.8	3.61	801.7

d) Comparative egg fertilization rate observation

The higher average egg fertilization rate (83%) was found in YY crossed GIFT tilapia. On the other hand, the average estimated egg fertilization rate in XY crossed GIFT tilapia was 77% (Table 3). According to Dey (2000), the GIFT strain showed about 15 - 25% higher yield than the genetically superior existing strains introduced in 1978 and 1988, the hybrid strain of China, and the Chitralada strain of Thailand respectively.

Table 3 : Comparative egg fertilization rate in GIFT tilapia crossed by XY male and YY male

Treatment Category	R1	R2	R3	Average
T1 (XY male)	78%	75%	77%	77%
T2 (YY male)	82%	81%	85%	83%

e) Comparative hatching rate observation

The higher averagehatching rate was found in eggs of YY male crossed GIFT tilapia (47.66%)than XY male crossed GIFT tilapia (46%)(Table 4).Edwin and Ronald (1988) suggested that greater mechanical stress on the egg membrane may result in premature hatching. Therefore, it seems possible that the observed egg mortality was likely to have been associated with mechanical injuries making the eggs susceptible to bacterial or fungal infection. One of the main advantages which artificial incubation offers is the possibility of reducing egg losses compared with maternal incubation (Shamsuddinet al., 2012). However, in nature, oral incubation is a gentle and delicate process. Eventually, in this study, the eggs were kept in continuous circulation in artificial incubation. Although the incubators provide a somewhat smooth and gentle surface, this agitation could cause mechanical stress on the eggs which could result in physical damage to the eggs. Hatching jar was used for the hatching of the eggs.

Table 4 : Comparative hatching rate in GIFT tilapia crossed by XY male and YY male

Treatment	Replication	Number of fertilized eggs	Hatched egg	Hatching rate	Average Hatching rate
T1 (XY male)	R1	20350	9768	48%	46%
	R2	21211	9548	45%	
	R3	22127	9957	45%	
T2 (YY male)	R1	22800	10944	48%	47.66%
	R2	23666	10649	45%	
	R3	24100	11568	48%	

f) Comparative larval survival rate observation

The higher averagelarval survival rate was found in YY male derived larva (85%) rather than XY male derived larva (72.3%) tilapia (Table 5).

Table 5 : Comparative larval survival rate in GIFT tilapia crossed by XY male and YY male

Treatment	Replication	Hatched egg	Survived larva up to 21 days	Survival rate	Average Survival rate
T1 (XY male)	R1	9768	7326	75%	72.3%
	R2	9548	6684	70%	
	R3	9957	7169	72%	
T2 (YY male)	R1	10944	9302	85%	85%
	R2	10649	9318	87.5%	
	R3	11568	9486	82%	

g) Comparative larval growth observation

It was found the growth of YY male derived larvae were higher than XY male derived larvae. The average length of YY male derived larvae in 3rd, 15th and 28th days were 1.4, 3.69 and 11.6 mm respectively which were higher than XY male derived larvae (1.033, 3.01 and 9.7 mm respectively) (Fig. 4). The average weight of YY male derived larvae in 3rd, 15th and 28th days were 0.0126, 0.53 and 1.03 g respectively which were higher than XY male derived larvae (0.0116, 0.327and 0.59 g respectively) (Fig. 5).

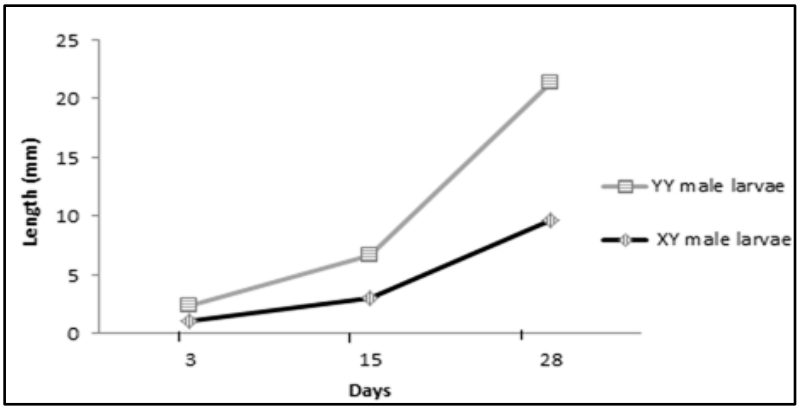

Figure 4 : Comparative length rate of XY and YY male derived larvae

Legend to Figure 4: The average length of YY male derived larvae in 3rd, 15th and 28th days were higher than the length of XY male derived larvae.

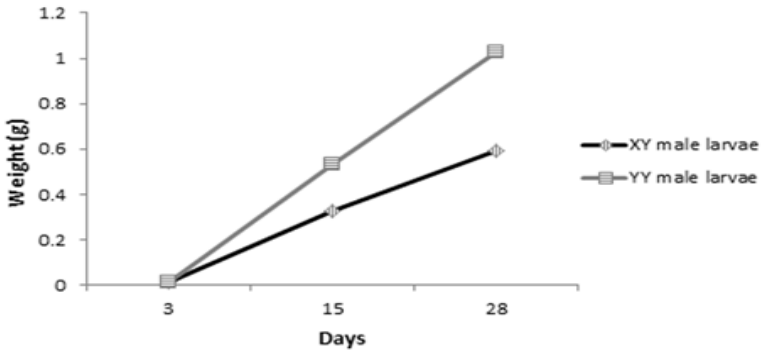

Figure 5 : Comparative weight rate of XY and YY male derived larvae

Legend to Figure 5: The average weight of YY male derived larvae in 3rd, 15th and 28th days were higher than the weight of XY male derived larvae.

h) Percent (%) of male tilapia

Aceto-carmine squash method was used to carry the sex determination study along with manual sexing technique. In the present study, 100% male population was obtained from the YY male crossed GIFT tilapia whereas only 50% male population was obtained from the XY male crossed GIFT tilapia.

IV. Conclusion

Farming of the tilapia has a great potential in Bangladesh and it will be a prime culture species in the near future for freshwater and brackish water ecosystems. The way tilapia aquaculture is expanding at small, medium to commercial scale; it will not be long before the tilapia contributes to the bulk of aquaculture production. It will also be a major source of employment. It can be confidently said that in the near future Bangladesh will be one of the leading countries in Asia in tilapia production.

V. Acknowledgement

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