Bangladesh J. Fish. Res., 12(1), 2008: 35-40

Establishment of satellite nucleus of genetically improved farmed tilapia (GIFT strain) in Bangladesh

A.H.M. Kohinoor*, M.S. Islam, R.W. Ponzoni[1], N.H. Nguyen[1], S.U. Ahammed and M.G. Hussain
Bangladesh Fisheries Research Institute, Mymensingh 2201, Bangladesh
[1]WorldFish Center, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia.
*Corresponding author

Abstract
The aim of this study was to evaluate growth performance of the GIFT (Genetically Improved Farmed Tilapia) strain after one generation of selection for increased body weight at Bangladesh Fisheries Research Institute. Founder stock comprised of 30 families having 300 individuals of the GIFT strain were introduced from Malaysia through WorldFish Center in March 2005. The founder stock was reared in 100 m^2 hapa for three months and then individually tagged using Passive Integrated Transponder (PIT) at the weight between 30 and 40 g. After tagging, all the fish were communally grown out in pond until harvest. Breeding value for body weight was estimated using SAS and ASREML ranging from 4.17 to 9.70 g for males and 4.24 to 9.36 g for females. The best 40 females and 40 males from the founder stock were then selected to produce progeny of the first generation (F-1). From each family 25 female and 25 male fingerlings were sampled and tagged using PIT. A total of 2,000 tagged fish from 40 families were stocked in a pond (1000 m^2) for a continuation of the selection program. In addition, surplus fish after tagging were also reared together with progeny of the founder stock in cistern ecology for growth evaluation. The mean weight of the F-1 generation of GIFT fish was 7.2% greater than that of the founder population (non selected population).

Key words: Satellite nucleus, Genetically Improved Farmed Tilapia (GIFT)

Introduction

The last three decades have seen significant developments in farming of tilapias worldwide. In view of the increasing commercialization and continuing growth of tilapia industry, the commodity is not only the second most important farmed fish globally, next to carps but is also described as the most important aquaculture species of the 21st century (Shelton 2002). The fish is being farmed in about 85 countries worldwide, and about 98% of tilapia produced in these countries is grown outside their original habitats (FAO 2002). The main culture industries are in the Far East but they are increasingly being farmed in Caribbean, Latin America and recently, in temperate countries where

warm water through artificial means (thermal effluents or geothermal springs) are also available.

The development of Genetically Improved Tilapia (GIFT) technology that is based on traditional selective breeding as a means to improve commercially important traits of tropical farmed fish is a major milestone in the history of tilapia aquaculture (Azhar, *et al.* 2004). The GIFT was developed by WorldFish Center through several generations of selection from a base population involving eight different strains of Nile tilapia (Eknath *et al.* 1993 and 1998). Bangladesh Fisheries Research Institute (BFRI) received GIFT strain in 1994 and again 116 families in 1996 through WorldFish Center (Formerly ICLARM). In on-station and on-farm trials of BFRI, the GIFT strain was reported to show 35-57% superior growth than that of the existing strain of the country (Hussain *et al.* 2000). Further stock improvement of GIFT through mass selection was initiated in 1998. Through mass selection, six generations (F-1 to F-6) were produced. Through combined selection technology, the F-6 generation of GIFT strain achieved 33.7% growth over the existing GIFT strain. The rate of genetic gain in weight of fish was greater up to third generation but it decreased gradually after that and up to sixth generation. The reason behind such a decrease in genetic gain in particularly for body weight might have been the accumulation of inbreeding. Therefore, the genetic improvement strategy for GIFT was re-designed. Now the stock improvement program is being implemented through family selection protocol under the technical assistance of WorldFish Center. In this paper we report preliminary results of growth evaluation of F-1 generation of improved GIFT strain in Bangladesh.

Materials and methods

Stock improvement through family selection

Origin of stock

Founder stock comprised of 30 families having 300 individuals of GIFT Strain were introduced from Malaysia through WorldFish Center in March 2005. The founder stocks was reared in 100 m^2 hapa for three months. The fish were fed with SABINCO feed (28% crude protein) at the rate of 6% of estimated biomass. After three months rearing, the mean weight of female and male were 41.18±5.41 and 30.42±3.47g, respectively.

Tagging of founder stock

Then the female and male were tagged by using Passive Integrated Transponder (PIT). A PIT tag was injected into the peritoneal cavity of a fish and the number of tag was recorded. After tagging all the fish were transferred to a pond having 1000 m^2 area.

Rearing in pond

During rearing period, the fish were fed with supplementary feed six days in a week (28% crude protein) at the rate of 4-5% of estimated biomass. Fish were sampled at

fortnightly interval to assess the growth and feed adjustment. Water was supplied once in a week to maintain water depth at 1.0 meter. Pond was fertilized fortnightly with Urea and TSP at the rate of 12.5 and 25.0 kg/ha, respectively. After four months rearing, the fish were recaptured through seine netting and pond drying. The final body weight, sex and tag number of all harvested fish were recorded.

Estimation of breeding value

Breeding value was estimated for individual fish in a full pedigree, using SAS (SAS Inc, 1997) and ASREML (Gilmour *et al.* 1999).

Breeding in hapa

On the basis of breeding values of the founder stock, the best 40 males from 30 families were crossed with 40 best females (from 30 families) for the production of F-1 generation. For breeding, 40 breeding hapas ($1.0m^3$) were set up in a pond with bamboo poles. A pair of female and male breeders (1:1) was stocked in each breeding hapa. After 12 days of stocking, fertilized eggs were collected from brooding females. After that, collected eggs were transferred to the hatchery for incubation. Immediately after hatching, the larvae were shifted to a series of trays and were kept until their yolk sac resorption stage.

Nursing in hapa

After resorption stage, 300 fry from each family were transferred to 40 individual fine mesh nursery hapas (2.0 m^3) in pond. The progeny were fed with nursery feed containing 30% protein at the rate of 30% of estimated body weight. After 45 days nursing, the mean weight of the fry was 2.80 ± 0.42g.

Rearing in hapa

Subsequently, 150 fry from each progeny group were transferred to 40 individual rearing hapa (2.0 m^3 in size). Supplementary feed (Nursery feed) was applied in all the hapas at the rate of 15% of estimated biomass. After two months of rearing, the weight range of male and female were 36-43 and 28-32g, respectively.

Tagging

From each progeny group 25 male and 25 female fish were selected and tagged using Passive Integrated Transponder (PIT). Tagged fish from 40 families (2000 fishes) were stocked in a pond having $1000m^2$ area for communal rearing. Supplementary feed (25% crude protein) was supplied regularly at the rate of 6% of estimated biomass. After six months of grow-out in pond, the fish were harvested, and tag number, weight, sex, body depth were recorded. After harvesting, breeding values of F-1 generation were estimated from the complete data set, tracing back to the foundation population (F0).

Evaluation of Growth performances

This trial was conducted to compare growth performance between F-1 progeny of the selected fish (F-1 selected GIFT) and progeny of the non-selected population (founder stock) in cisterns (2.0 m^3) for a period of four months during April to July 2007. Progeny of the selected fish were produced from 40 single pair matings in separate hapas. Family rearing of the selection progeny was as described above. After tagging, surplus fish were sampled for this experiment. By contrast, the non-selected population (200 breeders) was stocked in a 300 m^2 pond for mass breeding. After 40 days of stocking, 6,000 fry were collected and reared in a 10m^3 hapa for a period of 3 weeks. From this population, fry samples were taken for growth evaluation. The initial mean weight of the selected fish and of the founder population (non selected population) were 2.95±0.65 and 2.65±0.82g, respectively. There were two treatments with three replicates. Before stocking the cisterns were cleaned and filled up with deep tube well water at the depth of 1.0 meter. Fry of GIFT strain were stocked at a density of 5 fish/m^3.

The fry of both treatments were fed twice a day in six days in a week with supplementary feed (28% crude protein) at 5-8% body weight. During grow out period, first and second months, feed was given at the rate of 8% and 7% of body weight, respectively, Then subsequently, 6% and 5% feed were given to the fish in the 3rd and 4th month, respectively. Fish sampling was done at monthly interval to assess the growth, and feeding ratio was adjusted on the basis of estimated weight of fish biomass. In every week cisterns were cleaned through siphoning and 80% water changed with deep tube well water. Average water depth was maintained in all the cisterns at 1.0 m during the experimental period. After four months rearing, all the fishes were harvested. After harvest, body weight was measured on individual fish. Statistical analysis was carried out to test significant differences in growth between the F1 generation fish and the founder stock.

Results and discussions

A total of 2000 fish (1000 males and 1000 females) of the first generation were harvested and measured of body weight in June 2007. General linear model analysis indicated that there was significant difference ($P<0.001$) in body weight between the two sexes, where the males were substantially heavier than the females (278 vs. 156 g) (Table 1). The effect of sex on size and growth is often found in aquaculture species (Ponzoni *et al.* 2005, Nguyen *et al.* 2007).

Table 1. Body weight of male and female

Sex	Number of records	Weight (g)
Male	1000	277.76±29.77
Female	1000	156.05±30.26

Therefore, the statistical model included sex as the fixed effect and the additive genetics of individual fish as the random term to estimate breeding values (EBV) of all animals in the pedigree. Based on EBV ranking, the best 70 females and 70 males from 40 families were selected to produce progeny for the second generation (F2). The EBV range for the selected males and females were 4.17- 9.70 g and 4.24-9.36 g, respectively (Table 2).

Table 2. Breeding values of selected male and female breeders

Sex	Number of animals	Breeding Values
Male	70	4.17 - 9.70
Female	70	4.24 - 9.36

The body weight data measured at different culture periods of the improved (selected) fish and founder stock (non selected population) are given in Figure 1. The initial mean weight was 30.23±0.41 and 31.70±0.60g for the improved (selected GIFT) and founder stock, respectively. Month wise sampling data showed that growth rate of the selected GIFT was always higher than the founder stock (Fig. 1). After four months rearing, the final cumulative mean weights were recorded at 168.67±3.51 and 157.33±2.52g for the selected and founder stock, respectively.

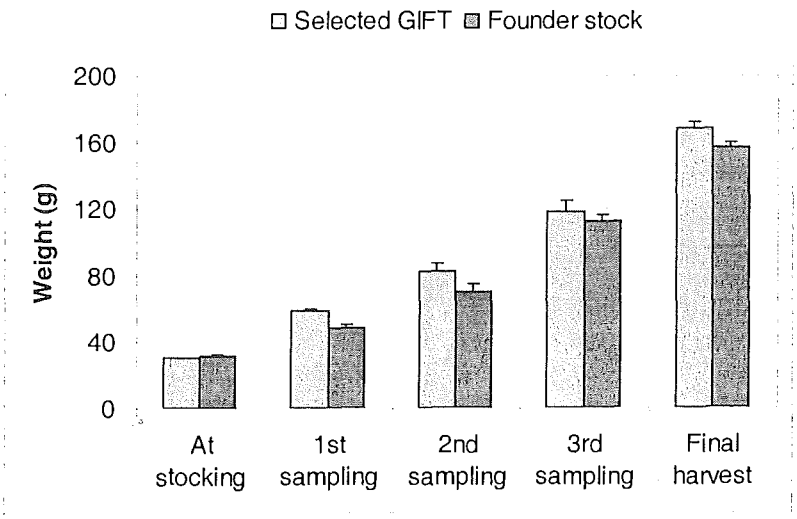

Fig. 1. Body weight of the progeny of the selected GIFT and founder stock over different culture periods.

Table 3 also presents net gain and daily gain for the F1 and founder stocks. The net gains for weight estimated for the selected GIFT was significantly ($P < 0.05$) higher than that of the founder stock (138.4 vs. 125.6 g). The final weight of the selected GIFT was 7.20% higher than that of the founder stock. In regard to survival rate, hundred percent survivals were obtained in both the stocks.

Table 3. Growth rate of the GIFT fish tested in cistern ecology at BFRI

Population	No of records	Net gain (g)	Daily gain (g)
Selected GIFT	30	138.43±3.40	1.15±0.03
Founder stock	30	125.50±3.30	1.04±0.02

To evaluate growth performance of the selected GIFT and founder population, the same ecological environment and culture condition were maintained where the selected GIFT and founder population representing more or less similar size were stocked at a density of 5 fish/m^2 and fed a formulated feed containing protein level 28% for 120 days. The results showed that the selected GIFT had a significant higher growth than the foundation stock, after one generation of selection. BFRI has initiated stock improvement program for GIFT through mass selection in 1998. Through mass selection, F-1 generation of GIFT showed 5% higher growth over average GIFT strain, which was introduced from ICLARM in 1994. Subsequent generations (F-2 to F-6) were produced in the same manner. Through combined mass selection technology, the F-6 generation of GIFT strain achieved 32.7% growth over existing GIFT strain (Annual Progress Report, 2007). In the present study, we applied family selection protocol, and an approximately 7.2% genetic gain was achieved after one generation.

References

Annual Progress Report, 2007. Annual Report 2003-04 and 2004-2005. Bangladesh Fisheries Research Institute, Mymensingh 2001. 136 p.

Azhar, H., R. Ponzoni, K. Nurhidayat, A.R. Masazurah and A.N. Roslina, 2004. Genetic selection of Farmed tilapia: the performance of the 9th generation of the GIFT strain in different farm environments. *Malaysian Fisheries Journal*, 3(2):74-80.

Eknath, A.E., M.M. Dey, M. Rye, B. Gjedre, T.A. Abella, R.C Sevillega, M.M Tayamen, R.A Reyes, H.B Bensten, 1998. Selective breeding of Nile tilapia in Asia. Paper presented in the 6th World Congress on Genetics Applied to Livestock Production, 11-16 January, 1998, University of New England, Armidale, Australia. 10 pp.

Eknath, A.E., M.M. Tayamen, M.S. Palada-de-Vera, J.C. Danting, R.A. Reyes, E.E. Dionisio, J.B. Capili, H.L. Bolivar, T.A. Abella, A.V. Circa, H.B. Bensten, B. Gjedre, T. Gjedrem, M. Rye, R.S.V. Pullin, 1993. Genetic improvement of farmed tilapias: the growth performance of eight strains of *O. niloticus* tested in different environments. *Aquaculture*, 111: 171-188.

FAO. 2002. Fishery Statistics. Aquaculture production. 90 (2).

Gilmour, A.R, B.R. Cullis, S.J. Welham, R. Thompson, 2002. Asreml reference manual. NSW Agriculture Biometric Bulletin No.3. Orange Agricultural Institute, Forest Road, Orange 2800 NSW Australia.

(Manuscript received 14 June 2008)