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GESIT tilapia: Indonesia's genetic supermales

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All-male tilapia result in more uniform culture populations and faster growth

Tilapia are a paradox in terms of reproduction. The relative fecundity of the *Oreochromis* genus is low, at 6,000-13,000 eggs/kg/spawn. But this is compensated for by the high survival of fry due to their large size at hatching, their large yolk reserves, the mouth-brooding maternal care given until the fry are 10mm or larger and frequent spawning.

Tilapia present some challenges to fish culturists. Most *Oreochromis* species reach sexual maturity within six to eight months of hatching at sizes often less than 100 grams. Under some conditions, they mature in less than five months at 20 to 30 grams.

Unless controlled, the fish continue to reproduce, and offspring compete with the initial stock for food, often resulting in stunted growth and unmarketable fish. Therefore, all-male monosex culture of tilapia is preferred because of males' fast growth and larger average size.



Two-month-old all-male tilapia exhibit faster growth performance than that of mixed populations.

All-male methods

Several techniques have been adopted to produce all-male tilapia, including manual sexing, hybridization, genetic manipulation and sex reversal through sex hormone administration. Human error in manual sexing can be high, and the method also wastes the females. The problems with hybridization are the difficulties in maintaining the pure parental stocks that consistently produce 100 percent male offspring and reduction in egg fertilization. The use of hormones to produce monosex fish has been limited or prohibited in some countries over market and/or environmental concerns.

Therefore, the production of genetically "supermale" tilapia YY has been suggested as the safest, most efficient and effective technology. When crossed with normal female (XX) fish, YY tilapia produce 98 to 100 percent male tilapia (XY) or genetically male tilapia (GMT). All-male tilapia result in more uniform culture populations and faster growth compared to mixed sex populations.

Indonesian tilapia research

In Indonesia, Nile tilapia (*Oreochromis niloticus*) are considered an important culture species by the Indonesian Ministry of Marine Affairs and Fisheries. They have high economic value and are popular with local fish farmers, who find them easy to farm in well-established culture technology. There is high demand for tilapia, both for export and domestic markets. In addition, the species holds high potential for large-scale production.

Considering the significance of tilapia, research on developing genetically male tilapia has been conducted on Nile tilapia in Indonesia since 2001. As outlined in Table 1, treatment with hormone resulted in XY females, which were then crossed with XY males to produce YY males. Further crossing and hormone treatment generated YY females and mass production of all-male YY fish.

Aliah, Development of YY male tilapia, Table 1

Time	Activity	Result
July-December 2001	Feminization through feeding diet containing estradiol from 10 days post-hatch for 30 days	120 females
January-June 2002	Feminized fish grow out Progeny test preparation to produce XY female	59 females 47 females
July-November 2002	Progeny test I – XY female crossed with XY male	3 XY females
December 2002-June 2003	XY female crossed with XY male to produce YY male; only YY and XY males selected for further steps	421 YY males + 28 XY males
June 2003-November 2004	XY female crossed with XY male; resulting fish then given feed containing estradiol to produce YY female	129 XX, XY and YY females
December 2003-July 2005	Progeny test II – XY crossed with YY male from XY to produce YY male	19 YY males – 9, 100% male, 10, ≥ 96% male
August 2004-October 2005	Progeny test III – YY, XY and XX females crossed with XY (normal male) to produce YY female	2 females
December 2004-October 2005	Progeny test III for female – YY, XY and XX	2 YY females
July 2005-October 2006	Multiplication of YY males through crossing YY male and YY female from progeny test	663 fish
July 2006-October 2006	Mass production of YY male; YY male crossed with YY female	All-male tilapia

Table 1. Development of YY male tilapia in Indonesia.

GESIT tilapia

Genetically supermale Indonesian tilapia (GESIT) were officially released on December 15, 2006, through the Indonesian Ministry of Marine Affairs and Fisheries. Over 100,000 GESIT fish were distributed to 22 provinces by 2008.

Based on reports from Cianjur, West Java, GESIT reach a size of 6 to 8 cm size 15 days faster than earlier tilapia lines. Other culturists reported that 100 kg of GESIT fingerlings resulted in 1,300 kg at harvest – double the regular harvest.

In Situbondo, East Java, the monosex fish have been cultured in abandoned shrimp ponds with 12 ppt salinity. At a density of 10 fish per square meter with 1- to 2-cm fish, GESIT reach 300 grams after 120 days with 60 percent survival and a feed-conversion ratio (FCR) of 0.8. In Subang, West Java, GESIT fry demand 30 percent higher prices than local fry. It takes 60 days for them to reach 10-g size with FCR of 1.1 to 1.2, compared to 75 days for local fry with 1.4 FCR.



The adoption of GESIT tilapia has reportedly led to double-size harvests.

GESIT crosses

Further research has been conducted to measure the survival and growth performance of fry from GESIT crossed with normal female tilapia (JICA strain) in hapa nets in 300-square-meter concrete ponds with aeration. The densities were 250 fish/hapa net with three replicates. The temperature was maintained between 23.6 and 25.4 degrees-C, and dissolved-oxygen levels were 2.8 to 4.8 ppm. pH varied 6.5 to 8.3, and ammonia content ranged 0.04 to 0.24 ppm.

After 70 days, GESIT x JICA reached 11.46 grams \pm 1.20 percent compared to JICA x JICA at 5.38 g \pm 1.51 percent. Fig. 1 shows the growth curve. The FCR for GESIT x JICA was 2.11 – lower than JICA x JICA's 3.04 after 70 days. Survival for GESIT x JICA was 82.8 \pm 1.1 percent, compared to JICA x JICA at 89.1 \pm 5.7 percent.

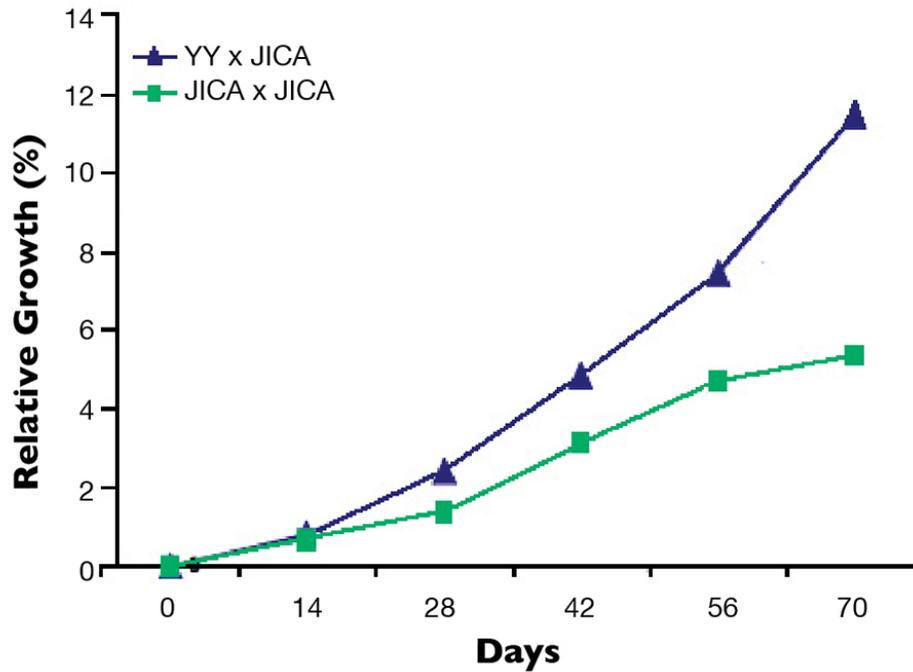


Fig. 1: Relative growth of YY male x JICA female and JICA male x JICA female crosses.

The GESIT x JICA cross resulted in 93.8 percent males, compared to 59.5 percent males for JICA x JICA.

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