Effects of Increased Salinity on the Growth and Survival of Genetically Improved Farmed Tilapia (GIFT) (Oreochromis niloticus)

Clarita D. Bidad[1]

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Abstract

This study was conducted to determine the growth and survival of GIFT fry/fingerlings reared in a 150-liter concrete ponds with salinities of 5, 10, 15 ppt respectively. Results revealed that GIFT fry at salinity level of 15 ppt exhibited growth superiority (4.03 cm length; 5.94 g weight) followed by the fry exposed to 10 ppt salinity (3.64 cm; 5.24 g weight). Slow growth was manifested among the fry under 5 ppt salinity level (3.27 cm length; 4.61 g weight).Analysis of variance (ANOVA) revealed significant difference in both the lengths and weights of the fry. T-test results showed that the significant difference in length existed between the fry under treatments 5 ppt and 15 ppt while significant variation in weight occurred between the fry exposed to 5 ppt and 15 ppt and between 10 ppt and 15 ppt. Complete survival (100 %) was obtained at 5 ppt and only 93 % at 10 ppt and 15 ppt. However, no significant difference existed in these salinity levels at 0.05 level of significance. Results of this study indicate that the growth of GIFT is affected by the salinity of rearing water. The ideal salinity ranges from 10 ppt to 15 ppt.

Keywords and Phrases: *salinity level, genetically improved farmed tilapia (GIFT), Oreochromis niloticus, part per thousand (ppt).*

Introduction

Since recorded history began, Filipinos have been known as fish consumers. Fish as a food item is as essential as rice. Breakfast is never complete without fish whether it be fresh, dried, smoked or canned. Considerably, fish and fishery products remained the cheapest source of high-quality protein for the millions of the Filipino people especially those living in the rural areas who cannot afford to buy meat, eggs or milk.

The high demand for fish makes it imperative to device some ways to meet peoples' needs protein in their diet. Fish culture as an important activity, switch to high fish yields because of the rarity of fish in the open sea.

A variety of Nile tilapia called GIFT (Genetically Improved Farmed Tilapia) has been developed because it has many strong culinary attributes, fast growing and can survive in a salty water environment.

[1] Extension Director, Jose Rizal Memorial State University – Dipolog Campus, Dipolog City

As a potential culture species, there is a need to develop viable culture environment for larval rearing and grow out of GIFT to meet the demand for fry and fingerlings and augment the unstable supply of protein materials for the increasing population. Knowledge of growth and survival of fish per unit culture facility is then deemed necessary for efficient tilapia farming management.

Statement of the Problem

This study determined the effects of increased salinity on the growth and survival of Genetically Improved Farmed Tilapia (Oreochromis niloticus) exposed to 5 ppt, 10 ppt and 15 ppt salinity levels.

Specifically, this study attempted to attain the following objectives:

1. Determine the growth increment of the GIFT (Oreochromis niloticus) fry exposed to 5ppt, 10 ppt and 15 ppt salinity in terms of length and weight;

2. Test the significant difference in the growth increment of the GIFT (Oreochromis niloticus) exposed to 5ppt, 10 ppt and 15 ppt salinity levels in terms of length and weight;

3. Determine the percent survival of GIFT (Oreochromis niloticus) exposed to 5 ppt, 10 ppt and 15 ppt salinity levels; and

4. Test the significant difference in the percentage survival of GIFT exposed to 5 ppt, 10 ppt and 15 ppt salinity levels.

Research Design

A one month old GIFT fry ranging from 3.5 to 4.3 cm in total length were utilized in the study. They were grown in a 150-L concrete ponds with salinity of 5, 10, 15 ppt respectively. Each experimental salinity was replicated three times. These were arranged randomly using the Latin Square Design. The ponds were constructed in the area where only diffused light could enter to minimize rapid evaporation of water. To prevent salinity change due to the evaporation and dilution with rain water and objects falling into the pond a striped sack was used to cover it. Commercial feeds were given twice a day equal to 10 % of the body weight of the fish. Measurement of growth increment was determined every fifteen days and water change was done every two weeks.

	A	B	C
A	A	B	C
B	B	C	A
C	C	A	B

Figure 1 The Experimental Set-up for the Effect of Increased Salinity on the Growth and Survival of GIFT Using Latin Square Design.

Statistical Treatment

Descriptive statistics such as mean and standard deviation were used to describe the generated mean lengths and weights of 5 GIFT fry exposed to three different salinity levels (5,10, 15) and trials (1,2,3).

Analysis of variance (ANOVA) was used to test the significant differences in lengths and weights of GIFT exposed to three salinity levels. Mean values were further analyzed using t-test for samples of unequal sizes in order to compute the significance of these differences. Level of significance of all tests was $P<0.05$.

Materials and Methods

Dilution of Seawater to the Desired Salinity. The water in the pond was obtained by diluting seawater with freshwater taken from the artesian well. Mixing was done thoroughly in a 20-liter plastic container. The water salinity was determined using an automatic refractometer. The mixture was transferred to the pre-labeled aquaria through siphoning and was stabilized 24 hours prior of the stocking of the fish.

Stocking of the Fry. A one-month old GIFT fry hatched and grown in aquaria with zero ppt salinity were used in the study. The fry were acclimatized to pond water salinity 5, 10, 15 ppt at a gradual change of salinity of 5 ppt per day for one week to avoid fish shock. After one week the fry were transferred to a pre-labeled 150-liter concrete pond at temperature of 29-30 º C and pH ranging from 6.3 – 7.5. Each pond was stocked with 5 GIFT fry with a total length ranging from 3.4 cm to 4.3 cm and initial weight ranging from 0.5 g to 1.1 g. Their reactions to the new environment were monitored daily.

Water Management and Maintenance. Water in the pond was totally replaced every two weeks by siphoning. The water parameters like salinity, temperature and pH were monitored daily.

Feeds and Feeding. The fish were fed morning and afternoon with commercial feeds equal to 10 % of the body weight. Uneaten foods and metabolic wastes were removed from the ponds by siphoning.

Measurement of Growth and Survival. Growth increment in terms of length and weight and survival were taken every 15 days for two months. Fish length was measured from the anterior most projecting part of the head up to the farthest tip of the caudal fin, when caudal fin rays were pressed together. The weight of the fish was determined using a triple-beam balance in which the fish was placed in a pre-weighed beaker with pond water. The growth increases were calculated by subtracting the initial mean weights and total lengths from those subsequently taken every 15 days. The fingerlings percent of survival was determined by the actual number of fish in every rearing pond.

Results and Discussion

The growth of the GIFT fry in terms of length under 5ppt, 10 ppt and 15 ppt was measured every 15 days for two months. Data are presented in Figure 2. As shown, the GIFT fry reared at 5 ppt and 10 ppt show almost equal mean of length as compared to the fry at 15 ppt salinity level. At one month rearing, still the fry exposed to 5 ppt and 10 ppt exhibited higher growth increase than the fry at 15 ppt. On day 45, mean value for length was higher in 10 ppt than in 15 ppt. There was slow growth of fry grown in 5 ppt. At two months rearing, increase in length was observed to be higher at 15 ppt than at 10 ppt. The fry at 5 ppt treatment still displayed the lowest growth increase. Results suggest that the fry were slowly adjusting to the higher environmental salinity.

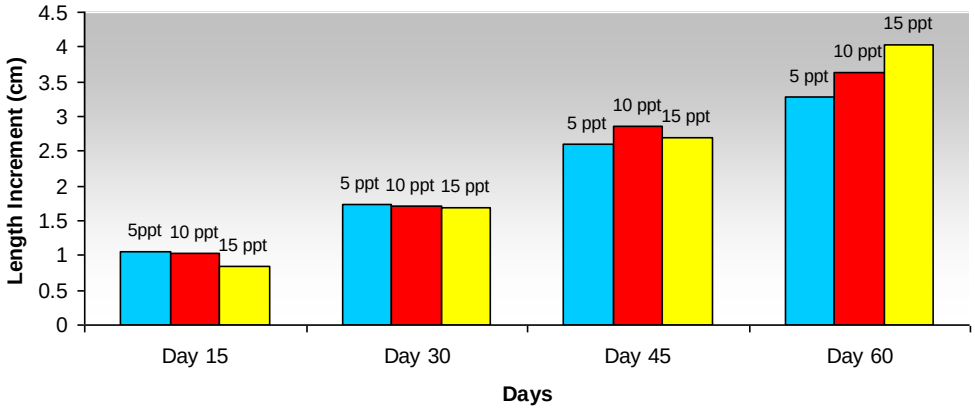

Figure 2 Increase in Length (cm) of GIFT Fry Every 15 Days for Two Months at 5 ppt, 10 ppt. and 15 ppt.

The effects of the increased salinity in weight of GIFT fry as measured every 15 days for two months were shown in Fig. 3. As depicted, slow growth was shown by the fry at 15 ppt than at 10 ppt and 5 ppt. On day 30, the GIFT fry at 5 ppt and 10 ppt still displayed almost equal mean weight as compared to the fry at 15 ppt. However, on the 45 days, weight increase was lower at 5 ppt than at 15 ppt.

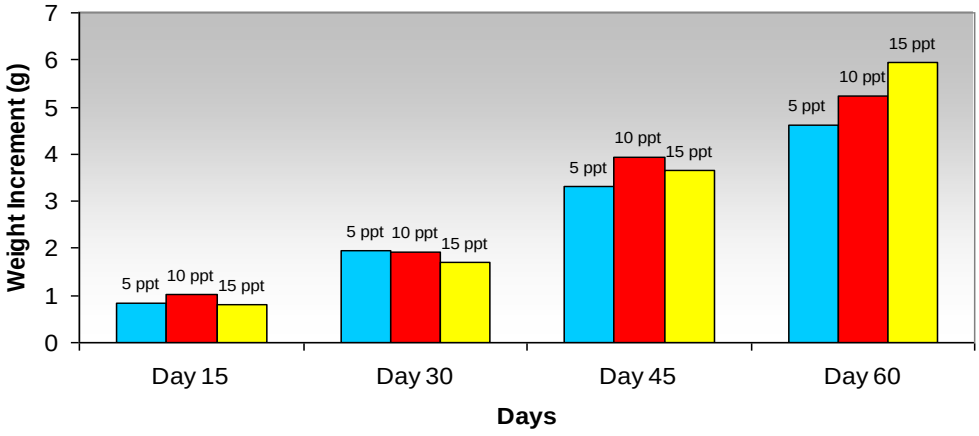

Figure 3 Increase in Weight (g) of GIFT Fry Every 15 Days for Two Months at 5 ppt, 10 ppt and 15 ppt.

High increase was shown at treatment 10 ppt. At two months rearing, increase in weight was higher at 15 ppt than at 10 ppt. Slow growth was observed at 5 ppt. This appears that the GIFT fry seem to gradually develop adaptation to 15 ppt salinity. Apparently, a better growth can be attained after two months of exposure.

The mean lengths and weights generated from the three trials of each treatment were subjected to statistical analysis of variance (ANOVA) to determine precisely the significant differences. Results are reflected in Table 1. It appeared that the length and weight of the fry at 5 ppt illustrated insignificant difference. However, significant variation existed in the length of the fry exposed to 10 ppt and 15 ppt. and non in the weight. The differences were further verified by the t-Test method. The results of the test conducted are presented in Table 2. Data show that the computed values in length from day 15 to day 45 in all experimental salinities manifest insignificant difference. The computed values (0.1073, 3.48, 2.70) are less than the critical value (3.89). It could mean that the growth of the fry is not affected by the rearing water. But on day 60, variation in length affirmed significant difference since the computed value of 8.372 was higher than the critical value of 3.89.

Table 1 ANOVA Values of the Lengths and Weights of GIFT Fry after 60 Days

Source of Variation	Sum of Squares		df (Degree of Freedom)	MSS(Mean Sum of Squares)		$F_{computed}$		$F_{critical}$	Description
	Length	Weight		Length	Weight	Length	Weight		
A (5ppt)									
Between Column	0.228	0.15	2	0.114	0.07	0.43	0.07	3.89	Length: No significant difference
Within Column	3.168	13.15	12	0.264	1.1				Weight: No significant difference
Total	3.396	13.29	4						
B (10ppt)									
Between Column	1.465	1.45	2	0.733	0.725	4.06	1.43	3.98	Length: Significant difference
Within Column	1.984	5.579	12	0.18	0.507				Weight: No significant difference
Total	3.449	7.029	4						
C (15ppt)									
Between Column	0.853	0.79	2	0.426	0.395	2.08	3.98	3.98	Length: Significant difference
Within Column	2.26	2.954	11	0.205	0.236				Weight: No significant difference
Total	3.112	3.384	13						

However, t-test result on Table 2 verified whether significant variation in lengths and weights existed between the fry treated under the three experimental salinities. As revealed, mean lengths and weights of GIFT fry under 5ppt and 10 ppt were insignificant.

Significant variation was evident between the fry exposed to 5 and 15ppt. On the other hand, the length of fry between salinities of 10 and 15 ppt showed no variation but the difference in weight was significant.

Table 2 T-test on the Lengths and Weights of GIFT Fry After 60 Days.

Pair/Treatment	t computed		t critical		Description
	Length	Weight	Length	Weight	
A & B (5&10 ppt)	0.152	1.803	1.86	1.86	No significant difference
A & C (5 &15 ppt)	16.297	3.614	1.86	1.86	There is significant difference
B & C (10 & 15 ppt)	0.136	2.434	1.86	1.86	L* No significant difference W▪ There is significant difference

The effect of the experimental salinities on the survival of GIFT fry at the end two months rearing is reflected in Fig. 4. There was 100 percent survival of the fish in all salinity levels within the 45 day-rearing period. But at the end of two months only the experimental treatment of 5 ppt achieved 100 % survival while the other two treatments 10 ppt and 15 ppt respectively attained 93 % survival. Statistical test using ANOVA disclosed the absence of significant difference (p=0.05) in the survival of the fish at 5ppt, 10 ppt and 15 ppt. Therefore, GIFT can thrive in any of the specified salinity level and the single death of fish at 10 and 15 ppt can be attributed to fish stress due to handling and the measuring process.

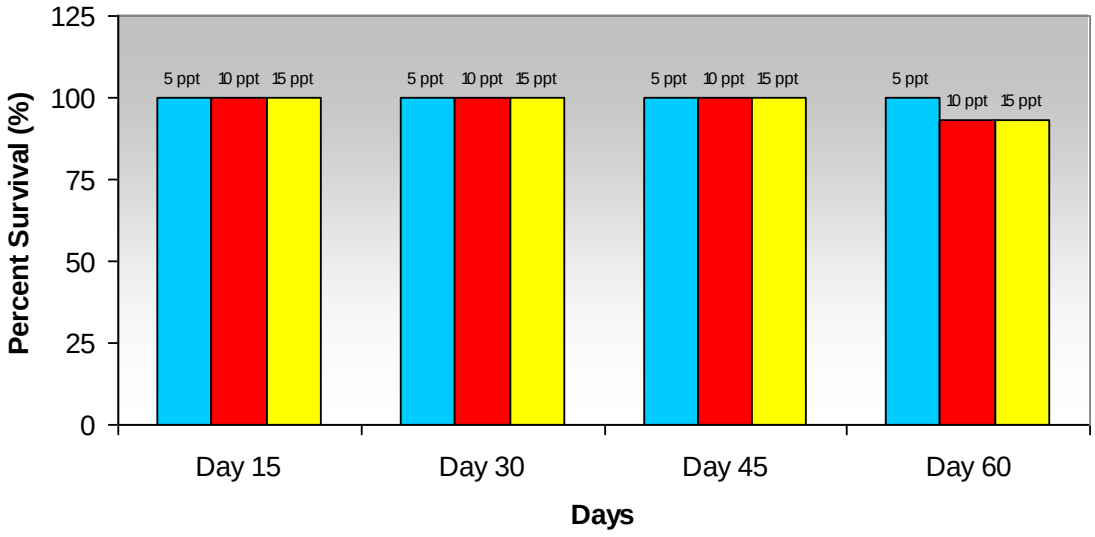

Figure 4 Percentage of survival of GIFT fry every 15 days for two months at 5ppt, 10 ppt and 15 ppt.

The growth and survival of GIFT were better at environmental salinities ranging from 10 ppt to 15 ppt. These results agreed with the findings of Kamal and Mair(2005); Ridha (2008) Nugon (2003) that Tilapia (O. niloticus) is more moderate in its tolerance to saline condition and dies at salinities more than 20 ppt. These salinity levels enable the organisms to keep themselves in osmotic balance (Garcia- Ulloa et. al 2001) as cited by

Ridha (2008). The absence of osmotic stress allowed maximum distribution of energy to grow and kept osmoregulation of the body fluids going on smoothly. Nevertheless, it is remarkable to make that the dilute salt solution with a salt concentration of 5 ppt exposed the fish to osmotic stress, thus, affecting its osmoregulatory function. However, the three experimental salinities did not appear to give adverse effect on the survival of the fish, hence, favorably allow the fish to thrive and attain good survival. The lack of survival difference reflects relatively greater degree of adaptation of the fish to the environmental salinity of the water.

Conclusions

The following conclusions were drawn based on the findings of the study:

1. GIFT tilapia exposed to environmental salinity of 15 ppt achieved higher growth increase in terms of length and weight than those exposed to 5 ppt and 10 ppt. salt solution.

2. There is significant difference in the lengths and weights of GIFT fry exposed to 5 ppt, 10 ppt and 15 ppt salinity levels at two-month rearing period. That GIFT fry exposed to 15 ppt salinity level showed greater growth compared to the fry exposed to 5 ppt and 10 ppt salinity levels.

3. The survival of GIFT tilapia exposed to 5 ppt is higher than at 10 ppt and 15 ppt salinity levels.

4. The survival of GIFT tilapia exposed to 5 ppt, 10 ppt and 15 ppt salinity levels has no significant difference; that is, GIFT's survival is not affected by the three salinities.

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