# Evaluating the growth performance of all male sex reversal and mixed ser tilapia *(Oreochromis niloticus)* cultured in earthen ponds in Binh Phuo province, Vietnam

**Loi N. Nguyen[1*], Dang H. Nguyen[1], Nam B. Nguyen[1], Nhung T. H. Nguyen[2], & Hien T. Nguyen[2]**

[1]Faculty of Fisheries, Nong Lam University, Ho Chi Minh City, Vietnam

[2]Agricultural Service Center of Binh Phuoc Province, Binh Phuoc, Vietnam

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***Corresponding author**

Nguyen Ngoc Loi

Email:
17116076@st.hcmuaf.edu.vn

**ABSTRACT**

The study was conducted to evaluate the growth performance, survival rate and yield of all male sex reversed and mixed sex Nile tilapia (Oreochromis niloticus) cultured in earthen ponds for 180 days. The reversed sex and mixed sex fingerlings (mean weight 7.43 ± 0.35 g) was randomly stocked in six earthen ponds (1,000 $m^2$/pond). The stocking density maintained was 5 fish/$m^2$. The stocked fish were fed a commercial pellet feed containing 35% crude protein. The feeding rate was adjusted according the size of fish, 5% at the beginning to 3% at harvest. Water environment parameters including dissolved oxygen (DO) (4.3 ± 0.8 mg/L), temperature (30 ± 0.7°C), NH3 (0.18 ± 0.2 mg/L), and pH (6.9 ± 0.5) were always within the appropriate range for the normal growth and development of tilapia. The growth rate of sex reversed tilapia was significantly higher ($P < 0.05$) than that of mixed tilapia throughout the experiment. The harvest weight and length of reversed sex tilapia were 410.5 ± 5.15 g and 25.48 ± 0.48 cm, respectively, and were significantly higher than that of mixed sex tilapia ($P < 0.05$). The survival rates and feed conversion ratio (FCR) of mono and mixed sex were 90.1% and 89.9%, respectively, but no significant differences were observed ($P > 0.05$). The relationship of fish lengths and weights expressed by power function revealed that the slope of the length weight regression lines was normal for reversed sex (2.72) and mixed sex Tilapia (2.93) with the high correlation coefficient (> 0.9). The findings of this study demonstrate that reversed sex tilapia has better growth performance compared to mixed sex tilapia. Therefore, reversed sex fingerlings should be used in commercial farming to increase tilapia production.

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## 1. Introduction

Nile tilapia, Oreochromis niloticus is one of the most important freshwater fish species in world aquaculture accounting for the second highest production in the world after carp (Admassu, 1996; Coward & Bromage, 1998). It is widely cultured in many tropical and subtropical countries around the world (Boyd & Tucker, 1998). Tilapia belongs to the Cichlidae family and was introduced from Africa (Gómez et al., 2015) and provides important economic and social benefits to rural communities (Jiménez-Badillo, 2006). Its fast growth rate, high tolerance to adverse environmental conditions, use of a variety of available feeds, ease of reproduction, disease resistance and consumer acceptance have made it be a commonly selected species for farming (Wohlfarth et al., 1983; Bahnasawy, 2009). However, one of the major constraints of tilapia farming with mixed-sex population is inherent high reproductive capacity resulting from early maturity, highly developed parental care, and multiple spawning cycles. Under favorable conditions they continue to reproduce, offspring will compete for food sources with the initially stocked fingerlings, resulting in stunted growth and unmarketable fish (Lévêque, 2002; Babiker & Ibrahim, 2006). Therefore, the need for monosex tilapia for intensive farming of this fish is an urgent requirement. Currently in the world, there are many all-male tilapia production techniques being used based on the treatment of male sex hormones in fry at a stage where they have not yet had sexual differentiation. Direct masculinization of tilapia using hormones is the most common method to produce unisexual males. Therefore, the objective of this study was to compare and evaluate the growth and productivity of unisex tilapia and mixed tilapia.

## 2. Material and Methods

### 2.1. Origin of experimental fish

Two groups of fish in the experiment including mixed sex (MS) and reversed sex (HR) were produced at provincial breeding center for freshwater aquaculture of Binh Phuoc province, Vietnam. The fry less than 14 days old were collected from the same brood stock, in which 50% of the fry were reversed sex by immersed in 17α - methyltestosterone for 2 h, while the remaining 50% were not treated with hormones. Fry of two groups were reared separately in the hapas (4 m x 4 m x 1 m) set in a pond until they reached experimental size.

### 2.2. Grow-out performance analysis

Fingerlings (7.1 ± 0.2 g; 6.5 ± 0.2 cm) of mixed sex and reversed sex were randomly sampled from the nursery hapas and stocked into six earthen ponds (1000 $m^2$), having three replicates of each with same stocking densities of 5 fish/$m^2$ at the experimental farm for aquaculture, Faculty of Fisheries, Nong Lam University. The fishes were fed twice a day on a commercial floating pelleted feed (Brand Tilapia feed, Cargill), with approximately 35% of crude protein, at a feeding rate of 3 - 5% of body weight daily, adjusted biweekly based on sample mean weight. Throughout the grow-out period (180 days), all water parameters (temperature, pH and dissolved oxygen) were closely monitored once a week. Growth parameters such as average weight gain (AWG), daily weight gain (DWG), specific growth rate (SGR), feed conversion ratio (FCR), survival rate were calculated as follows:

AWG (g/fish) = average final weight (g) – average initial weight (g)

DWG (g/day) = (Average final weight (g) – Average initial weight (g))/experimental period (day)

SGR (%/day) = (ln final weight (g) – ln initial weight (g)) X 100/experimental period (day)
FCR = feed intake (g)/ weight gain (g)

Survival rate (%) = final number of fish × 100/ initial number of fish

**2.3. Statistical analysis**

The data were expressed in terms of mean ± standard deviation. All growth parameters were statistically analyzed using SPSS version 16.0 in which data were subjected to one-way ANOVA and Duncan's multiple range test (DMRT) was used to determine the significant differences between the means at 5% level of significance.

**3. Results and Discussion**

During the experiment, the physical and chemical parameters of ponds water were ranged within the appropriate range for normal growth and development of Nile tilapia (Table 1). Water temperature is one of the most important environmental factors affecting fish physiological responses of growth and feed utilization. The water temperature in the experiment was ranged from 29 - 31°C, but there were not statistical differences among experimental ponds. El-sayed & Kawanna (2008) stated that the optimal temperature for growth and reproduction was between 22°C to 32°C. The ideal DO level for tilapia farming is 4 - 5 mg/L. Dissolved oxygen in this study fluctuated between 4.3 ± 0.8 mg/L (mixed sex) and 4.4 ± 0.9 mg/L (reversed sex). There was not statistical difference in the dissolved oxygen concentration experimental ponds. The pH values of ponds were varied from 6.5 to 8.0 throughout experiment. The water mean values of total ammonia nitrogen concentrations of pond water were 0.17 ± 0.15 mg/L (mixed sex) and 0.19 ± 0.12 mg/L (reversed sex), but there was not statistical different among ponds.

**Table 1.** Physico-chemical parameters of pond water during the experimental period

| Parameter | Mixed sex | Reversed sex |
|---|---|---|
| Water temperature (°C) | 29.9 ± 0.7 | 30.0 ± 0.6 |
| pH | 6.7 ± 0.5 | 6.9 ± 0.5 |
| Dissolved oxygen (mg/L) | 4.3 ± 0.8 | 4.4 ± 0.9 |
| Ammonia (mg/L) | 0.17 ± 0.15 | 0.19 ± 0.12 |

*All data are presented as mean ± SD.*

Experimental results showed that although the initial weight was the same, the growth of reversed sex tilapia was significantly higher than that of mixed sex tilapia in all growth measurement times ($P < 0.05$). The results also indicated that the average harvest weight of reversed sex fish was 410.5 ± 5.15 g, while the weight of mixed sex fish was 315.9 ± 4.09 g (Table 2). Many studies have also found that male reversed sex fish have higher growth rates and harvest weights than mixed sex fish (Little et al., 2003; Chakraborty et al., 2011). Dagne et al. (2013) noted that male mono-sex tilapia showed significantly higher growth rate (weight, length, DWG, SGR) than mixed-sex group ($P < 0.05$).

**Table 2.** The weight gain (g) and length (cm) of mono sex and mixed sex tilapia at different time interval

| Growing day | Weight (g) | | Length (cm) | |
|---|---|---|---|---|
| | Reversed sex | Mixed sex | Reversed sex | Mixed sex |
| 1 | 7.02 ± 0.21[a] | 7.15 ± 0.19[a] | 6.38 ± 0.16[a] | 6.57 ± 0.18[a] |
| 30 | 35.10 ± 0.99[a] | 28.60 ± 1.76[b] | 9.49 ± 0.23[a] | 8.87 ± 0.25[b] |
| 60 | 66.00 ± 1.94[a] | 44.30 ± 1.42[b] | 13.53 ± 0.39[a] | 12.08 ± 0.34[b] |
| 90 | 133.4 ± 2.41[a] | 75.1 ± 1.54[b] | 19.01 ± 0.39[a] | 16.71 ± 0.26[b] |
| 120 | 238.3 ± 2.31[a] | 147.6 ± 1.43[b] | 21.02 ± 0.28[a] | 17.92 ± 0.36[b] |
| 150 | 287.3 ± 8.19[a] | 218.2 ± 5.98[b] | 23.96 ± 0.45[a] | 18.64 ± 0.35[b] |
| 180 | 410.5 ± 5.15[a] | 315.9 ± 4.09[b] | 25.48 ± 0.48[s] | 20.85 ± 0.38[b] |

*Values (mean ± standard deviation of data for triplicate groups) with different superscripts in the same row are significantly different (one-way ANOVA and Tukey test, P < 0.05).*

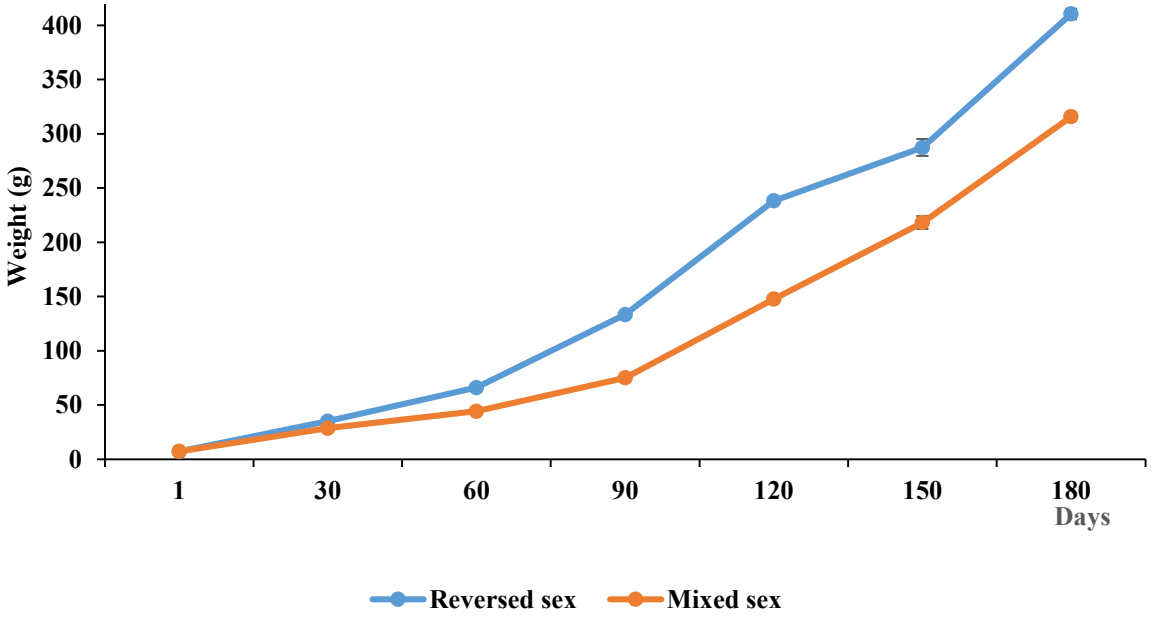


**Figure 1.** Growth trend in weight of reversed and mixed-sex tilapia throughout the experimental period.

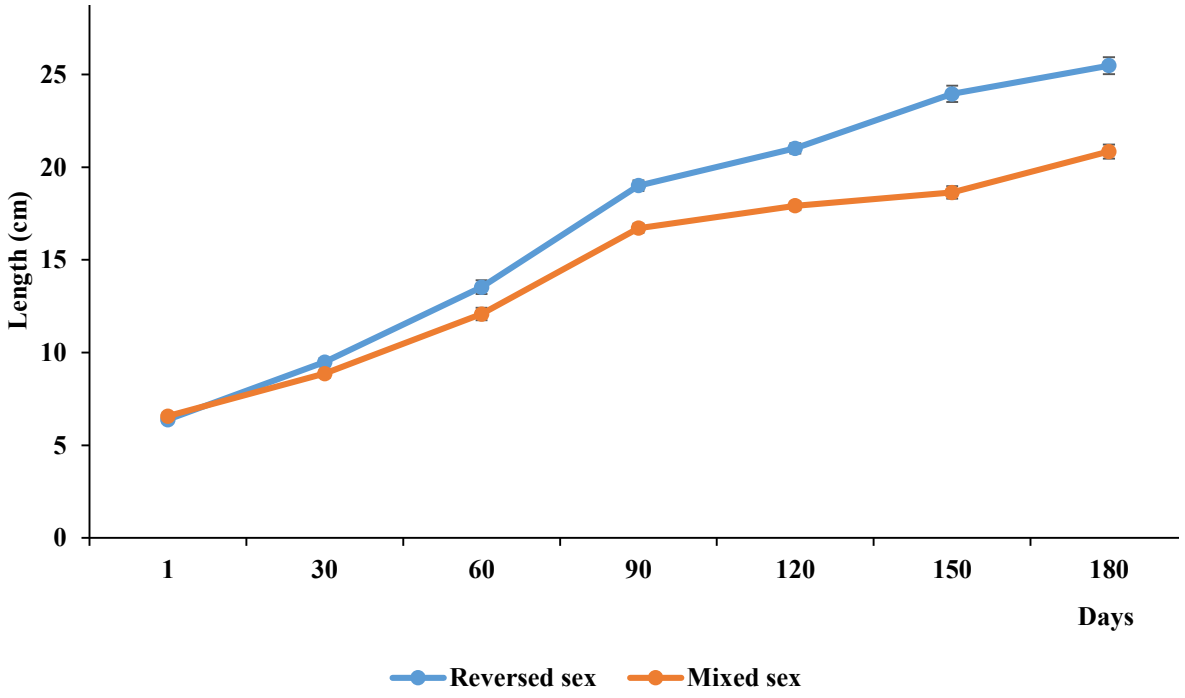


**Figure 2.** Growth trend in length of reversed and mixed-sex tilapia throughout the experimental period.

The average weight gain, daily weight and specific growth rate of reversed sex tilapia were 403.18 g/day, 2.08 g/day and 2.26%, respectively, which were significant higher than those of mixed sex tilapia ($P < 0.05$; Table 3). The higher growth rate of treated fish may be due to the anabolic effect of hormones to induce sex reversal in farmed tilapia (Jo et al., 1995). Mair et al. (1995) and Dan & Little (2000) reported that the anabolic effect of hormones showed an increase in growth rate of tilapia. Other studies have also shown that the higher average weight may be due to improved feed conversion efficiency of Oreochromis niloticus fry (Chakraborty & Samir, 2009; Dagne et al., 2013).

The FCR values of mixed sex group was higher than that of reversed sex group but the difference was not statistically significant difference. The FCR in this study was similar to the results of Islam et al. (2015) and Toguyeni et al. (1997) who reported that reversed sex male had a better feed conversion ratio than mixed sex tilapia.

The survival rate of reversed sex was slightly higher (88.4%) compared to mixed sex tilapia (86.2%) but the difference was not significantly different (Table 3). The survival rate of tilapia in this study was higher than the survival rate of tilapia in study of Nahiduzzaman & Awal (2023) varied between 73 and 78%, but lower than that in the study of Sultana et al. (1997) who recorded 95.75% and 81.25% for GIFT and existing Nile tilapia species, respectively. Several studies have demonstrated that 17 α-methyltestosterone has no negative impact on the survival of hormone-treated all male tilapia (Cruz & Mair, 1994).

**Table 3.** Data of stocking and harvest parameters of reversed-sex male and mixed-sex of Nile tilapia cultured in earthen ponds

| Growth parameters | Mixed sex | Reversed-sex male |
|---|---|---|
| Initial body weight (g) | 7.15 ± 0.19[a] | 7.02 ± 0.21[a] |
| Final body weight (g) | 315.9 ± 4.09[b] | 410.5 ± 5.15[a] |
| Initial total length (cm) | 6.38 ± 0.16[a] | 6.57 ± 0.18[b] |
| Final body weight (g) | 20.85 ± 0.38[a] | 25.48 ± 0.48[b] |
| Average weight gain (g/fish) | 308.70 ± 3.80[a] | 403.18 ± 4.93[b] |
| Daily weight gain (g/day) | 1.60 ± 0.02[a] | 2.08 ± 0.03[b] |
| Specific growth rate (%/day) | 2.10± 0.02[a] | 2.26 ± 0.02[b] |
| Feed conversion ratio | 1.54 ± 0.12[a] | 1.42 ± 0.07[a] |
| Survival (%) | 86.2 ± 1.8[a] | 88.4 ± 2.6[a] |

*Values (mean ± standard deviation of data for triplicate groups) with different superscripts in the same row are significantly different (one-way ANOVA and Tukey test, P < 0.05).*

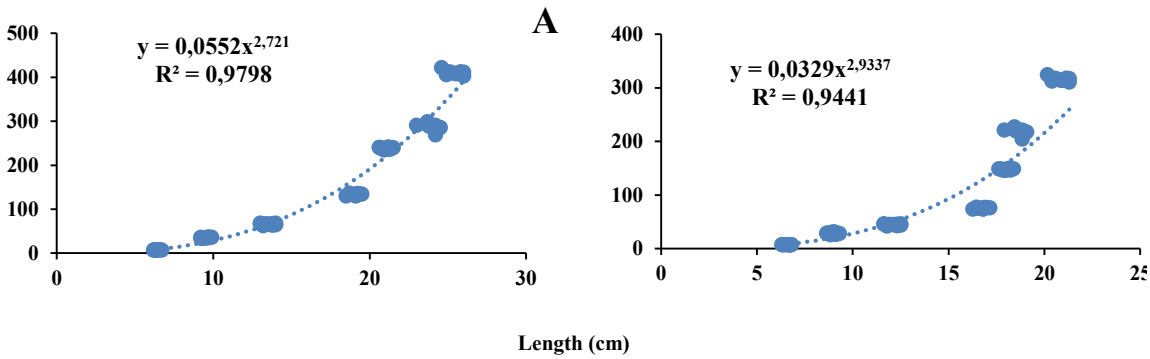


**Figure 3.** Length-weight relationships for (A) reversed sex male tilapia and (B) mixed sex population tilapia.

The relationship between length and fish weight expressed as an exponential function shows that the slope of the length-weight regression line is normal for reversed sex (2.72) and mixed sex tilapia (2.93) with high correlation coefficient (> 0.9; Figures 1, 2 & 3). Hopkins (1992) suggests that the slope of the length-weighted regression line when applying an exponential function should be between 2.5 and 3.5 with a high correlation coefficient (> 0.9) for farmed fish species.

## 4. Conclusions

The present findings indicated that reversed-sex tilapia had better growth rate than mixed-sex tilapia and had a low FCR, indicating that the sex-reversed tilapia is more viable for pond aquaculture compared to the mixed-sex tilapia.

## Conflict of interest

The authors have no conflicts of interest to declare.

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