

CULTURE OF HYBRID RED TILAPIA (*Oreochromis mossambicus* x *Oreochromis niloticus*) IN MARINE CAGES: EFFECTS OF STOCKING DENSITY ON SURVIVAL AND GROWTH

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Abstract

Hybrid red tilapia (mean weight 1.25 g) were stocked at densities of 200, 300 and 400 fish m⁻³ in replicated cages (1-m⁻³), adapted to 30‰ salinity, and cultured for 126 days at the Rio Catamayo farm in Ecuador to investigate the appropriate stocking density. Caged tilapia were fed three times a day with commercial floating pellets containing 46%, 32%, 28% and 24% crude protein during the first, second, third and fourth month, respectively. Water temperatures ranged from 26.5 to 28.4 °C in the cages. Mean survival ranged from 94.3% to 98.5%. Stocking densities of caged tilapia had no significant ($P>0.05$) effects on the survival, growth, food conversion ratio and profitability. The production rates achieved were 41.99, 57.29, and 78.98 kg m⁻³ in cages stocked with 200, 300, and 400 fish m⁻³, respectively. The results of this study suggest that cages at high densities can be a good strategy, considering low FCR, good growth and high economic return.

Introduction

The production of fish in cages has been practiced for many years in various countries worldwide. The earliest record of cage culture practices dates back to the late 1800s in Southeast Asia, since that similar culture practices have been reported in both freshwater and marine environments, including open ocean, estuaries, lakes, reservoirs, ponds and river (Eng and Tech, 2002). Cage culture practices have numerous advantages over other culture systems. By integrating the cage culture system into the aquatic ecosystem the carrying capacity per unit area is optimized because the free flow of current brings in water and removes metabolic wastes, excess feed and faecal matter (Beveridge, 1983).

The growing popularity of tilapia among consumers and the ever increasing need to improve food production, impose the need to seek production alternatives to culture tilapia. Such is the use of saline environments and even marine waters. The popularity is due to its market acceptability and for relatively tolerance to a wide range of water temperature, dissolved oxygen (DO), salinity, pH, light intensity and photoperiods. However, the

determination of stocking density for cultured tilapia is essential for the maximization of its production, profitability and sustainability.

Therefore, the purpose of this study was to evaluate the effects of stocking density of hybrid tilapia (*Oreochromis mossambicus* × *Oreochromis niloticus*) on survival and growth in marine cages.

Material and methods

General description

The trial was conducted at the Rio Catamayo farm located at the Puerto Hualtaco in El Oro Province, Ecuador. The 4-month experiment ran from February to May 2002. Hybrids of red tilapia (1.25 ± 0.06 g) were purchased from a local farm and acclimated to 30‰ salinity in acclimation tanks by raising salinity level 5‰ for six days.

The experimental design comprised three treatments (densities of T1 100, T2 200 and T3 300 fish m^{-3}), carried out in four replicates, using twelve 1.0- m^3 ($1.0 \times 2.0 \times 0.5$ m) floating cages in a randomized block design to facilitate analysis in a 6000- m^2 fertilized earthen pond. Floating cages were made of polyethylene netting hanging from a structure of timber.

During the first 4 weeks, fish were fed at a rate of 10% body weight day^{-1} ; thereafter, the feeding rate was reduced to 2% body weight day^{-1} based on the biweekly sample weight of caged fish. Feed protein content was 46%, 32%, 28% and 24% during the first, second, third and fourth month, respectively. Fish were fed three times a day (06:30, 12:30 and 18:30 h) with commercial floating pelleted feed (Grupo Corporativo Agroindustrial, Agripac S.A.) according to the protocol established by the Department of Aquaculture (Technical University of Machala, Ecuador).

Monitoring of fish stocks and environmental conditions

Around 10% of fish in each treatment were sampled every 2 weeks in order to determine weight (Ohaus portable balance; ± 0.1 g) and total lengths (measuring board; ± 1.0 mm). At final harvest, all fish were weighed, measured and the survival rate and mean weight were determined. Daily weight gain (DWG) and feed conversion ratio (FCR) were calculated by using the following formulae: $FCR = \text{weight of diet fed (kg)}/\text{total wet weight gain (kg)}$; $DWG = \text{final weight} - \text{initial weight}/\text{time (days)}$.

Water samples were taken every day of each cage at about 07:00 h for the analysis of pH. Temperature and dissolved oxygen (DO) were measured in each cage at 06:00 and 18:00 h with a YSI model 54 oxygen meter (Yellow Springs Instruments, Yellow Springs, Ohio, USA) and visibility was measured at 12:00 h using a Secchi disk. The total ammonia nitrogen (TAN) and unionized ammonia nitrogen (UIA-N) in each cage were determined biweekly (Strickland and Parsons, 1972; Albert, 1973).

Statistical analysis

To determine if significant differences exist between the different treatments and the parameters tested, all results were analysed using two-way analysis of variance (ANOVA) and Duncan's multiple comparison of the means. Statistical analyses for survival rates were performed on data after arcsine transformations. Probabilities of $P < 0.05$ were considered significant.

Results

Statistical analysis displayed no significant difference ($P > 0.05$) on the growth (Fig. 1) and survival of the animals after 4 months on the different treatments. In addition, no significant difference ($P > 0.05$) was found between any of the treatments in terms of feed conversion ratio. The results are presented in Table 1.

Table 1. Growth performance of hybrid red tilapia stocked in 1-m³ cages at 200, 300 and 400 fish over a 4-month period.

<i>Variables</i>	<i>ANOVA result</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>
Experimental Period (days)		126	126	126
Density (fish/cage)		200	300	400
Stocking weight (g)		1.25±0.07	1.25±0.05	1.25±0.07
Biomass at stocking (kg/m ³)		0.25±0.01	0.38±0.01	0.50±0.03
Harvest weight (kg)	$P \geq 0.05$	0.22±0.03 ^a	0.20±0.02 ^a	0.20±0.03 ^a
Biomass at harvest (kg/m ³)		41.99±1.42	57.29±1.67	78.98±1.63
DWG (g/fish day)	$P \geq 0.05$	1.71±0.07 ^a	1.59±0.05 ^a	1.57±0.08 ^a
Feed intake (kg)		54.04±0.12	71.51±0.80	101.41±0.98
FCR	$P \geq 0.05$	1.29±0.06 ^a	1.25±0.05 ^a	1.29±0.06 ^a
Survival (%)	$P \geq 0.05$	96.50±2.10 ^a	94.30±2.30 ^a	98.50±2.20 ^a

An ANOVA was carried out on each variable to compare the treatments. Duncan's test results are specified by superscript letters.

There were no significant ($P > 0.05$) differences for measured water quality parameters among treatments at the end of the experiment. Water temperature averaged 27°C in the pond where the cages were suspended. Dissolved oxygen ranged from 4.74 to 4.97 mg L⁻¹, visibility from 42 to 47 cm, the pH between 6.6 and 7.6 un-ionized ammonia-nitrogen ranged from 0.02 to 0.03 while TAN ranged from 0.08 to 0.12 throughout the experimental period (Table 2).

Table 2. Water quality data recorded in fishcages.

<i>Parameter</i>	<i>T1</i>	<i>T2</i>	<i>T3</i>
Temperature (°C)	26.5 – 28.4	26.5 – 28.4	26.5 – 28.4
pH	7.6 – 6.7	7.6 – 6.6	7.5 – 6.6
DO (mg O ₂ /liter)	4.97 ± 0.88 ^a	4.79 ± 0.83 ^a	4.74 ± 0.85 ^a
TAN (mg N/liter)	0.08 ± 0.12 ^a	0.08 ± 0.10 ^a	0.12 ± 0.20 ^a
UIA-N (mg N/liter)	0.02 ± 0.04 ^a	0.02 ± 0.04 ^a	0.03 ± 0.06 ^a
Visibility (cm)	42 – 47	42 – 47	42 – 47

Values with the same letter are statistically not significantly different ($P>0.05$). T1 (200 fish/cage), T2 (300 fish/cage), T3 (400 fish/cage).

Discussion

Water quality was within the tolerable range for fish throughout the experiment. In addition, tilapia hybrids that have descended from an *O. mossambicus* parent are believed to be highly tolerant to saline waters (Romana-Eguia and Eguia, 1999). In our study, stocking density did not affect survival, growth, condition or food conversion in hybrid red tilapia (*Oreochromis mossambicus* x *Oreochromis niloticus*) suggesting that higher densities may be used. Similar observations were reported by Watanabe *et al.* (1990) in the marine cage culture of monosex male Florida red tilapia fed 84 days at densities of 100, 200 and 300 fish m⁻³. Weight gains of this study caged were similar to reported previously (0.56 to 2.49 g per fish day⁻¹) for intensive cage culture of Nile tilapia in ponds (Guerrero, 1979 and McGinty, 1991).

These data suggest that stocking fish in cages, at high densities (400 fish m⁻³) can be a good strategy, considering low FCR, good growth, high economic return and reduction of costs since cages can be placed either inside grow-out ponds or in another appropriate water bodies available on the farm and are a viable alternative to ponds for the culture of hybrid red tilapia. Further research should evaluate the effect of higher densities in cages required to support maximum fish production.

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