Effects of Initial Age Variation on Survival, Growth, and Growth Variation of Florida Red Tilapia Fry During Sex-reversal in Brackishwater Tanks

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ABSTRACT

Two rearing strategies for Florida red tilapia were compared at the Caribbean Marine Research Center (CMRC) tilapia hatchery on Lee Stocking Island, Bahamas. A segregative approach where free swimming fry (FSF) were raised separately to fry obtained from eggs and non-swimming fry (ENS) was compared to a mixed treatment containing equal numbers of FSF and ENS (FSF/ENS-mix). Survival, growth, and growth variation were compared over a 30-day period.

Significant differences ($P < 0.05$) were observed among all treatments (FSF, ENS, FSF/ENS-mix) for percent survival and feed conversion ratio (FCR). ENS showed highest survival (76.8%) and lowest FCR (1.14), FSF showed intermediate survival (59.2%) and FCR (1.33), and FSF/ENS-mix showed lowest survival (38.5%) and highest FCR (1.70). Specific growth rate (17.1-17.8% increase in body weight daily) did not differ significantly among treatments.

Coefficient of variation of body weight was used as an indicator of growth variation among treatments. At the end of the trial coefficient of variation for body weight of the FSF/ENS-mix (62%) treatment was significantly higher than values for FSF (51%) and ENS (50%).

Previous CMRC hatchery procedure has been to mix FSF with ENS fry during sex-reversal. However, using a segregative approach produced superior survival, reduced feed costs (through lower feed conversion ratios) and reduced population heterogeneity.

INTRODUCTION

At the Tilapia Hatchery of the Caribbean Marine Research Center (CMRC) (Ernst, 1989) on Lee Stocking Island, Exuma Cays, Bahamas, emphasis is on developing and testing hatchery management strategies for brackish water culture of Florida red tilapia fry. Fry availability for experiments is often limited. The procedure in these cases is to mix naturally incubated free swimming fry (FSF) with artificially incubated fry obtained from eggs and non-swimming fry (ENS). Fry survival has been variable despite seemingly identical rearing conditions, ranging from 34 to 74%. An alternative is a segregative approach where free swimming fry and fry emerging from the incubators are reared separately. The objective of this study was to compare fry

survival, growth and growth variation among uniform age and mixed-age Florida red tilapia during hormone-induced sex reversal in brackish water.

MATERIALS AND METHODS

This study was conducted from May 21-June 24, 1991 using Florida red tilapia: descendant of hybtid *Oreochromis urolepsis honorum* (female; normal coloration) and *O. mossambicus* (male: red mutant strain) (Behrends *et al.*, 1982). To determine the effect of initial age variation on culture performance, post-yolksac stage fry were stocked into rearing tanks under three different age compositions and survival and growth were compared for 30 days. The treatments were (1) fry collected at the free-swimming stage (FSF), (2) fry collected as eggs and non-swimming fry (ENS), and (3) a mixed age group consisting of equal numbers of FSF and ENS (FSF/ENS-mix). Five replicates of each treatment were randomly assigned to fifteen 530-1 cylindroconical tanks connected to a central biofilter.

Seed consisting of a mixture of FSF and ENS were collected from broodstock over a period of two days (Ernst et al., 1991). ENS were separated from FSF and placed in upwelling incubators until yolksac absorbtion. Under all treatments, fry were stocked gravimetrically at a density of 7/1 (3700 per tank), with the FSF/ENS- treatment tanks receiving 3.5 fish/1 (1850) of each type.

A growth trial was started one day after all tanks were stocked. An initial sample of two hundred fish from each tank were individually weighed. Fish were subsequently sampled on day 15 (100 fry) and on day 30 (400 fry). Total weight of fish in each tank was also determined on day 30.

Fish were hormonally sex-reversed by feeding Zeigler trout starter (50% crude protein) treated with 17 alphaethynyltestosterone (60mg/ kg diet) (Guerro, 1975) for the duration of the study. Salinity was maintained between 10 and 14 ppt and a nine hour light, 15 hour dark photoperiod was maintained by fluorescent light. Each tank was supplied with aeration. Dead fish were removed and enumerated twice daily. Water quality parameters remained within acceptable ranges during the trial (ranges: NH_3-N 0.005-0.737 mg/l NO_2-N 0.02-3.8 mg/l, pH 7.92-8.29, dissolved oxygen 3.4-6.6 mg/l).

A completely randomized experimental design was employed. Analysis of variance was used to determine if differences existed among treatment means for initial and final weight, survival, feed conversion ratio, observed mortality, daily weight gain, specific growth rate and initial and final coefficient of variation of body weight. Percentage data were normalized by arcsin transformation prior to analysis. Where significant differences were indicated, Duncan's new multiple range test was used to identify differences between treatment means.

RESULTS

Mean per cent survival was significantly different ($P<0.05$) among all treatments (Table 1). Segragated treatments (ENS and FSF) had higher survival than the mixed treatment (FSF/ENS-mix). The ENS treatment showed highest survival (76.8%) followed by the FSF treatment (59.2%) and the mixed treatment (38.5%). Observed mortality was significantly higher ($P<0.05$) in the FSF and FSF/ENS-mix treatments (7.97 and 7.50% respectively) than the ENS treatment (3.5%).

Table 1. Mean survival, growth, and growth variation parameters for Florida red tilapia fry in three age treatments (mean ± standard error of five replications)[1].

TREATMENT[2] PARAMETER	100% ENS	100% FSF	FSF / ENS - mix
Init. wt. (mg)	9.2 + 0.3	15.1 + 0.5	12.8 + 0.9
Final wt. (g)	1.25 + 0.04	1.80 + 0.08	1.87 + 0.04
Survival (%)	76.8 + 4.2	59.2 + 2.8	38.5 + 1.6
FCR (dry/wet)[3]	1.14 + 0.08	1.33 + 0.04	1.70 + 0.05
SGR (%bw/d)[4]	17.5 + 0.1	17.1 + 0.2	17.8 + 0.3
DWG (g/d)[5]	0.044 + 0.001	0.064 + 0.003	0.067 + 0.001
Init. CV[6] (%)	20 + 0.01	39 + 0.01	43 + 0.01
Final CV (%)	50 + 0.02	51 + 0.02	62 + 0.01
OM[7] (%)	3.50 + 0.46	7.97 + 1.04	7.50 + 0.63

[1] Means in the same row with same superscipt are not significantly different ($P < 0.05$).
[2] Treatments are 100% eggs and non-swimming fry (100%ENS), 100% free swimming fry (100%FSF) and an equal numeric mixture of FSF and ENS (FSF / ENS - mix).
[3] FCR = Feed Conversion Ratio = Dry weight feed fed/wet body weight gain.
[4] SGR = Specific Growth Rate = ln final mean body weight - ln initial mean body weight/days in trial *100.
[5] DWG = Daily Weight Gain = Final mean body weight - initial mean body weight/days in trial.
[6] CV = Coefficient of Variation for body weight = standard deviation/mean * 100.
[7] OM = Observed Mortality = (100 - (100*(initial number - observed mortality) / initial number)).

Mean FCR was significantly different ($P<0.05$) among treatments (Table 1). Segregated treatments showed superior feed conversion ratios (1.14 for ENS and 1.33 for FSF) to the mixed treatment (1.70). Specific growth rate (range 17.1 to 17.8%/day) did not differ significantly among treatments ($P<0.05$) (Table 1). However, mean daily weight gains in the FSF and FSF/ENS-mix treatments (0.064 and 0.066 g/day respectively) were significantly higher ($P<0.05$) than the ENS treatment (0.044 g/day) (Table 1).

Coefficients of variation for initial body weight were significantly different ($P<0.05$) among treatments (Table 1). The mixed treatment had the greatest size variation (43%) followed by the FSF (39%) and the ENS (20%) treatments. Coefficient of variation for body weight at the end of the trial was significantly higher ($P<0.05$) in the mixed treatment (62%) than the segregated treatments (51% and 50% for the FSF and ENS respectively).

DISCUSSION

Segregative rearing of free swimming fry eggs and non-swimming fry produced superior survival and feed conversion in Florida red tilapia fry. Survival was inversely related to initial size variation (i.e. coefficient of variation for body weight).

Cannibalism has been documented previously in Florida red tilapia and other tilapia species. Watanabe *et al.* (in preparation) observed higher survival in Florida red tilapia fry fed continuously over fry fed intermittently. Higher survival was attributed to reduced cannibalism in the continuously fed fry. Uchida and King (1962) documented *Oreochromis mossambicus* fry 18-36 mm in length devouring siblings half their length. Pantastico *et al.* (1988) showed that cannibalism in *O. niloticus* became more intense as size differences between fish increased. Given the disparity between observed and actual mortalities in the present study, it is likely cannibalism contributed substantially to mortality in treatments with high size variation.

Macintosh and De Silva (1984) reported cannibalism in the first feeding stages of *O. mossambicus* and *O. niloticus* x *O. aureus* hybrid fry to be inversely related to level of feeding. Watanabe *et al.* (1991) showed that artificially incubated fry (ENS) survived better than naturally incubated FSF. This was attributed mainly to availability of prepared diets to artificially incubated ENS during the transition from endogenous to exogenous feeding, whereas free swimming fry (FSF) were dependent on food in the broodtanks. Results of the present study suggest that differences in survival between the segregated treatments may also be related to greater canibalism in the free swimming fry treatment.

A segregative approach to rearing Florida red tilapia fry has beneficial hatchery management implications. Survival of segregated fry was superior to that of the mixed treatment. Increased survival improved feed utilization, cut

feed costs, and resulted in more homogenous populations. Segregating fry did not alter growth rate and required minimal extra labor.

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