

Effect of Sampling Frequency on the Growth and Survival of Nile *Tilapia Oreochromis niloticus* in Hapas'

REMEDIOS B. BOLIVAR

*Freshwater Aquaculture Center
Central Luzon State University
Nueva Ecija 3120, Philippines*

HERNANDO L. BOLIVAR and AMBEKAR E. EKNATH

*International Center for Living Aquatic Resources Management
MCPO Box 2631, Makati, Metro Manila 0718, Philippines*

Abstract

Five sampling frequencies: weekly (S1), every two weeks (S2), every three weeks (S3), monthly (S4) and initial and final sampling only (S0) were used to investigate the effect on growth and survival of Nile tilapia *Oreochromis niloticus*. The study was conducted in ten 1-m³ hapas suspended in a 500-m² fertilized pond following routine sampling procedure over a 140-day period without supplementary feeding.

The highest mean body weight was observed in S0 (76.74 g) while the lowest in S1 (38.82 g). The observed differences on the mean final body weights were significant among treatments ($P < 0.01$). A 25-50% growth depression of Nile tilapia was observed in this study. The stress-induced effects of frequent sampling resulted in slower growth of fish in hapas.

There were no significant differences on the number of fish surviving among treatments. The highest survival was 97% observed in S2, while the lowest, 65%, was obtained in S3. Significant variation in sex ratios was observed only in S1 and S3 ($P < 0.05$). There were more females than males in these treatments, however, no differential effects of sampling frequency on the sexes were noted.

Introduction

Sampling of fish at periodic time intervals is useful in looking at trends on growth, maturity, reproduction or conditions of health under natural or culture environments. Sampling methods in experimental units like hapas or cages often require lifting the net, scooping out a certain number of fish and holding the fish out of the normal culture environment for a period of time until the fish are

*ICLARM Contribution No. 1063.

weighed and measured. In ponds, repeated seining is done to get the number of fish samples required from a population; while tanks or aquaria may need draining. While it is essential to obtain data for certain purposes, the stress-related effects of these procedures may affect growth rate and other traits in fish (Mazeaud et al. 1977) which may confound results of experiments.

There is lack of standardized methods for fish sampling in aquaculture experiments and no literature available indicating a standard time interval for monitoring growth of fish. In nutrition research, for instance, the sampling intervals used are variable.

This experiment was part of the pre-project studies to standardize methods under the collaborative research project on Genetic Improvement of Farmed Tilapias (GIFT). The objective of this study was to investigate the effect of sampling frequencies on growth and survival of *Oreochromis niloticus* in hapas.

Materials and Methods

Ten 1-m³ net hapas were each stocked with a random sample of 30 fish from a full-sib family averaging 0.88 g in weight. The hapas were arranged in two columns (at five hapas per column) and installed in the middle of a 500-m² earthen pond. The pond was fertilized every two weeks using inorganic (16-20-0) and organic (chicken manure) fertilizers at the rate of 100 kg•ha⁻¹ and 1 t•ha⁻¹, respectively. No supplementary feeds were given. Five sampling frequencies were used: weekly (S1), every two weeks (S2), every three weeks (S3), monthly (S4) and initial and final sampling only (S0). Each treatment was replicated twice.

The routine sampling procedure included lifting the hapas, collecting all the fish, and putting them in aerated water. Anesthetic (Quinaldine) was used to minimize fish movement during measurement. Fish were blot-dried to remove excess water on the body before individual weights were recorded at every sampling period.

Final body weights and survival were analyzed according to the following generalized linear model (GLM):

$$Y_{ijkl} = a + F_i + R_j + S_k + eijkl \quad \dots \text{model 1}$$

where:

- Y_{ijk} is the final body weight/survival
- a is a constant
- F_i is the effect of the i th sampling frequency
- R_j is the effect of the j th replication
- S_k is the effect of k th sex
- $eijkl$ is the random error.

For analysis within sexes, S_k was deleted from the above model (model 2). Differences in sex ratio were analyzed using the chi-square test.

Results

Survival and Sex Ratios

There were no significant differences in the number of fish surviving among treatments. The highest survival was 97% observed in S2; the lowest, 65%, was obtained in S3, while the rest gave 95% survival (Table 1). The low survival in S3 was due to the accidental escape of some fish in one of the replicate hapas towards the end of the experiment. The male to female ratio differed significantly from 1:1 only in S1 and S3 ($P < 0.05$). The sex ratio in S2, S4 and S0 were not significantly different from 1:1.

Table 1. Percentage overall survival, males and females and sex ratio of Nile tilapia *Oreochromis niloticus* in five sampling frequencies.

Treatments	Survival (%)			Sex ratio	
	Overall	Males	Females	Male	: Female
S1	95	35	65	1.00	: 1.85*
S2	97	55	45	1.23	: 1.00 ^{ns}
S3	65	31	69	1.00	: 2.25*
S4	95	53	47	1.11	: 1.00 ^{ns}
S0	95	51	49	1.03	: 1.00 ^{ns}

*Significantly different from 1:1 ($P < 0.05$)

^{ns} Not significant

Growth

The least square means (LSM) of final body weights and body weights of males and females, according to models 1 and 2, are presented in Table 2. The marginal mean squares (MS) from the GLM model for various fixed effects are presented in Table 3. Except for the treatment x sex interaction effect, the MS for all other effects in the model were significant ($P < 0.01$). This indicated no differential effects of sampling frequency on the sexes. The highest mean final body weight of fish was obtained in S0, and the lowest in S1. Males were significantly heavier than females in all the treatments. The trend in final body weights of males and females was similar to the overall mean body weights.

Table 2. Least square means and standard errors (in parentheses) of final body weight of Nile tilapia *Oreochromis niloticus* according to models 1 and 2 in five sampling frequencies. (Means in columns with the same superscript are not significantly different at $P > 0.05$).

Treatments	Mean weight (g)		
	Overall	Males	Females
S1	38.82 ^a (1.45)	40.66 ^a (2.34)	36.99 ^a (1.72)
S2	50.46 ^b (1.38)	55.82 ^{bc} (1.86)	45.11 ^b (1.86)
S3	57.04 ^c (1.84)	56.99 ^c (3.03)	57.09 ^{cd} (2.05)
S4	56.87 ^c (1.39)	60.60 ^{cd} (1.92)	53.15 ^d (2.02)
S0	76.74 ^d (1.39)	81.72 ^e (1.98)	71.71 ^e (1.94)

Table 3. Degrees of freedom (df), marginal mean squares (MS) and F values for the fixed effects in the model.

Effects	df	MS	F Value
Treatments	4	10,411.3	94.5*
Replicates	1	1,513.6	13.7*
Sex	1	2,456.9	22.3*
Treatment * sex	4	223.6	2.0 ^{ns}

*Significant at $P < 0.01$.

^{ns}Not significant.

Discussion

About 25-50% growth depression on Nile tilapia caused by frequent sampling was observed in this study. The greatest difference on final body weight was obtained between S1 and S0, and the least between S3 and S0. These marked differences on growth were probably caused by stress of handling which have physiological effects on fish (Miles et al. 1974; Mazeaud et al. 1977; Adedire and Oduleye 1983; Matty 1985; Kutty 1986). Another influence of stress is on tilapia nutrition. Fish (1960) as cited by Balarin (1979) reported that handling *Sarotherodon mossambicus* tended to reduce the acid concentration of the digestive juices. This would imply that stressed fish digest food less efficiently (Balarin 1979). Mabaye (1971), again as cited by Balarin (1979), did not note any significant difference between growth rates of 'handled' and 'non-handled' fish, although the former generally tended to have lower growth rates.

Fish sampling is essential in growth and nutrition studies which may require data on fish biomass at certain periods to determine growth curves or to adjust the amount of experimental feeds. A glance at 15 nutrition studies on tilapia in aquaria, tanks or cages in the literature showed weekly and every two weeks as the most common fish sampling intervals which means, based on the results of this study, a possible confounding effect between stress and the experimental diet on the growth rates of fish.

One limitation of this work was that the experiment was done in hapas. Fish sampling in ponds by seining to capture fish can be more stressful and complex because it tends to disturb the whole pond ecosystem. The sampling practice in ponds needs similar investigation.

Sampling every three weeks was adopted in the early stages of the GIFT project because more data points were needed to describe the growth performance of the different strains of tilapia. After this study, fish sampling was done at stocking and at harvest in subsequent growth testing.

Acknowledgments

This study forms part of the collaborative research project on Genetic Improvement of Farmed Tilapias (GIFT), co-financed by the Asian Development Bank (RETA 5279) and the United Nations Development Program/Division for

Global and Interregional Programs (INT/88/019). We thank Prof. Tereso A. Abella and Dr. Hans Bentsen for making helpful comments and suggestions on the manuscript.

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