PERFORMANCE OF GROWTH AND SURVIVAL RATES OF*OREOCHROMIS AUREUS* JUVENILES DURING HARD WINTER CONDITION IN EGYPT

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Abstract

This study has aimed to investigate the growth and survival rates of *Oreochromis aureus* juveniles during hard winter conditions in Egypt. The study which was conducted at the Central Laboratory for Aquaculture Research (CLAR), Abbassa included three treatments (T1, T2 and T3). Three different weights of juveniles 0.4 ±SE 0.07, 0.67 ±SE 0.01 and 1.4 ±SE 0.08 g; T3,T2 and T1 respectively have been evaluated in concrete ponds and hapas at various water depth (70, 40 and 60 cm for T1,T2 and T3 respectively). Fish was randomly stocked at different densities 32 (T2), 22 (T1) and 12 (T3) fish/m^2.There was noticeable fluctuation in ambient water temperature were recorded during winter and the lowest water temperature was 8^{o}C.The survival rate was significantly different in concrete ponds (80.9, 10.3 %for T1 and T2 respectively) and hapas (32 % for T3). The highest growth rate 5.3 ± SE 0.45 g was recorded for concrete ponds and the lowest 1.4 ±SE 0.17 g for hapas. The condition factor was not significantly different among the ponds but significantly different between ponds and hapas. The correlation between initial weight and survival rate was 0.48, P<.0001 while it was -0.90595 P<.0001 between initial weight and no. of fish/m^2. Negative correlation was recorded (-0.30013, P<.0001) between depth of water and final weight.

Key words: Growth, survival, winter, *Oreochromis aureus* juveniles, size, correlation, condition factor, hapas and concrete ponds.

INTRODUCTION

Tilapias are African fish and Egyptian strains of tilapia were found the best in regard to growth rates compared to other African tilapias when introduced to many countries. Growth of tilapia in Egypt is restricted by cold season during the winter and significant mortalities were recorded in commercial fish farms leading to loss in the production and income. For that reason, cold tolerance is a trait of great economic importance in tilapia, as severe mortalities could occur during winters in temperate countries (Tave *et al.*, 1990; Sarig, 1993; Hsieh *et al.*, 2007; *Williams and Dasgupta, 2007*).

Long winters and low temperature has been reported to have negative effects on tilapia production in China whereas the production have dropped by as much as 80% as estimated by observers (*GLOBEFISH* 2008). Therefore, cold tolerance of tilapia is considered among the important production traits. Choosing a tilapia variety with better cold tolerance may reduce production costs through extending the growing season and reducing mortalities resulting from sudden temperature drop. Water temperature at which mortality begins should be highly considered in terms of cold tolerance in commercial tilapia production. In general, production systems would probably not be economically sustainable if mortality rates because of low temperature exceed 10% (Patricio, 2004). Cold tolerance in the tropical and subtropical tilapias (genus *Oreochromis*) is a trait of economic importance in temperate climates where growing seasons are 6–8 months long and over - wintering of stocks is a necessity (Behrends *et al.,* 1990). Cold tolerance of tilapia was quantified as cooling degree hours (Behrends *et al.*, 1996) Cold tolerance has increasingly become an important criterion for selecting a species in more northerly latitudes (Rakocy and McGinty, 1989). Tilapia growth rates are influenced by variety of factors such as sex, supplemental feeding, stocking density and similarly, by the declining of water temperature which noticeably affects their growth rate. In areas outside their natural range, the major limiting factor determining the possibility for establishment of tilapia populations is the normal minimum temperature during the coldest period of the year (Hargreaves, 2000).

The optimal temperature for the growth of most tilapiine species is 25–28 °C; reproduction stops at 22 °C and feeding below 20 °C (Wohlfarth and Hulata, 1983, Wohlfarth, *et al.*, 1983).

It is hard to estimate the lowest temperature tilapias can tolerate. The lower lethal temperature varies due to environmental effects, the history of individual fish and genetic effects. The variation of cold tolerance among and within species is correlated to their geographical distribution (Cnaani *et al.*, 2000).

Genetics variation in cold tolerance can be attributed to a number of factors, including test conditions, rate of temperature decrease and duration of exposure at low temperatures appear to affect tilapia survival significantly (Zale and Gregory, 1989; Starling *et al.*, 1995; Hargreaves, 2000).

Low lethal temperature ranged from 11 to 8.4 °C for the GIFT strain, from 9.8 to 7.4 °C for the Sudan strain and from 11 to 7.4 °C for the Egypt strain. The LD50 for low temperature among the three strains suggested that the GIFT line was less tolerant to low temperature than the other two strains and that there was no difference with respect to temperature tolerance between the Sudan and the Egypt strains (Sifa *et al.*, 2002).

Dan and Little (2000) assessed the performance of Nile tilapia *Oreochromis niloticus* (L.) broodstock of the Thai, GIFT, Egypt and Vietnam strains over- wintered in deep and shallow ponds, as well as in deep and shallow hapas suspended in a single deep pond for evaluation of the influence of over-wintering systems on the survival and growth rates of fish. Large (>1g) and small (<1g) tilapia seed were over-wintered in deep hapas-in-ponds for comparison of their performance. The survival rate of larger monosex tilapia fry was 54%, which was significantly (P <0.05) higher than that of smaller fry (33.4%).

The most appropriate way of enhancing cold tolerance of tilapia juveniles is by husbandry practices that increase pre-winter body weights (Charo-Karisa *et al.,* 2005).

The objective of current investigation was to study the growth, and survival rates of *Oreochromis aureus* juveniles under different depth of water and stocking density of in concrete ponds with different sizes and in hapas suspended in earthen ponds during hard winter condition in Egypt.

MATERIALS AND METHODS

Three experiments were conducted at the experimental station of the Central Laboratory for Aquaculture Research (CLAR) at Abbassa. Experimental fish of *O. aureus* were obtained from the hatchery of CLAR, which has originated from Ismailia Canal, one of the distributaries Nile River, about 75 Km northeast of Cairo.

In the experiment I (T1)

Juveniles of *O. aureus* were randomly stocked in small concrete ponds (size 2x2.5x1m) in triplicate and the depth of water was 70cm. The initial weight of O. *aureus* juveniles was 1.4 ±SE 0.08 g and stocking density was 22 juveniles fish/m^2

In the experiment II (T2)

O. aureus juveniles were randomly stocked at average weight of 0.67 ± 0.01 g in large concrete ponds (6x2x1m) whereas and depth of water was 40 cm. The stocking density of juveniles was 32 fish/m^2

In the experiment III (T3)

Six hundred juveniles of *O. aureus* were distributed randomly in three hapas (7x3x1 m) suspended in the earthen ponds and stocked with juveniles at average weight of 0.4 ±SE 0.07 g and stocking density was 12 fish/m^2 .

Condition factor

Condition factor was calculated according to Ricker, 1975 according to the formula:

$CF = 100W/L^3$

Where W= body weight and L= body length.

All experiments started on November 2007 and lasted until April 2008. Fish were fed artificial feed 25% protein in sunny days only.

Daily temperature was recorded using low and high thermometer.

From our experiences in the field during the winter and the bad condition in the road during the season, we measure the temperature, but we used the daily on line data for weather in Egypt as an indication to temperature form www.wunderground.com and comparing with field data.

Statistical Analysis

The analyses in this investigation were conducted using SAS software to calculate means, stander error and correlation coefficient. Analysis of variance by generalized linear model (GLM) were used and initial weight, depth of water and number the fish per meter were included in the model as factor affecting the growth and survival.

RESULTS

In this investigation, temperature regimes have witnessed suddenly drop during nights and during some coldly days. The differences of water temperature were very closely related to those of the air temperature and the lowest average and dropping were recorded in February (8^{o}C).

The results of the three experiments were summarized in table (1).

In the first experiment (T1), where the number of fish was 22/m^2 with 70 cm depth of water the survival rate was 80.9 % (SE± 1.52) .The final weight was 4.7 g (SE± 0.38) and the gain of weight was 3.3g.

The correlation between the initial weight and final weight was very low (r=0.04830, P>0.05), while the correlation between the survival and initial weight was negative (r=-0.01769, P>0.05); final weight and survival was also negative (r= -0.02666, P>0.05).

In the second experiment (T2) where the depth of water was 40 cm and the effects on temperature decline was higher and so on fish survival which reached 10.3 % (SE ± 0.52). The highest final weight and weight gain was recorded in this experiment. Negative correlation of final weight was recorded between both initial weight (-0.03338) and survival (-0.01305).

In the earthen ponds (1000 m^2) where the hapas were suspended (T3); the fluctuation of temperature and of winds in this area were more effect than that the concrete ponds.

In the third experiment the lowest growth recorded in hapas maybe as results of environmental stress resulting from cold storms in open areas and diseases infections. Negative correlation of initial weight was recorded between both final weight (-0.12147) and length (-0.04198).

For the three experiments the correlation between the initial weight and final weight, depth of water, and number of fish/ m^2 was very low. While the correlation was 0.48624 (P <.0001) between initial weight and survival. Negative correlation was reported for depth of water between the length, final weight, and number of fish/ m^2. The correlation between survival rate and initial weight, length, final weight, depth of water was positive while it was negative for number of fish/m^2

The condition factors were not significantly different between the ponds but varied significantly between ponds and hapas.

DISCUSSION

Cold winter is one of most important factor which affects the growth, survival and the production especially for cold sensitive fish as tilapias. The fluctuation and dropping of temperature during winter have been recorded in many countries. In this study the recorded water temperature and online temperature for weather in Egypt were very close to changes to reach lowest value in February. The same results was reported by Zakaria (2007) who revealed that the seasonal variations of the surface water temperature of Abu Qir Bay are very closely related to those of the air temperature and in February (winter), the lowest values of air temperature were observed.

From the results we can use the weather temperature as indication to dropping the temperature during winter.

The small size of juveniles was more sensitive to cold at lower water depth (40 cm). In this environment the fluctuation of temperatures during the day had more effect of water temperature in the different stoking densities and size.

The survival rate was higher for fish with initial weight 1.4 g reaching to 80.9%. These results are in full agreement with Patricio (2004) who reported high survival 90% at (8.2^{o}C) with rapid changes in temperature used for Egyptian (Lake Manzala) strain of blue tilapia (2 to 5 g). The survival was significantly different for sizes (1.4 and 0.4 g) and it was higher in deep water (70 cm) and lower in shallow water (40 cm); lower in hapas than ponds (deep water 70 cm) maybe as a results of environmental stress resulting from cold storms in open areas and diseases infection. These results are in contrast with Dan and Little (2000) who revealed that fry showed similarly high survival rates in deep and shallow ponds (97-100%) and there was no significant difference between fry in the two size classes. Also reported that the survival of Egyptian strain of Nile tilapia *Oreochromis niloticus* (L.) over wintered in deep and shallow hapas-in-ponds was significantly (P<0.05) higher than fish stocked in deep and shallow ponds.

The survival rate of larger fish was higher than smaller ones; which agrees with Hofer and Watts (2002) who reported that small fingerlings (average 5.8 g) are more susceptible to cold stress than larger fingerlings (average 9.6 g); Charo-Karisa *et al.*, 2005 who recorded that fish body weight had a highly significant effect on cold tolerance (P <0.0001). Smaller fish (<5g) were more susceptible to lower temperature than larger fish and Dan and Little (2000) who reported that the survival rate of larger monosex tilapia fry was 54%, which was significantly (P<0.05) higher than that of smaller fry (33.4%).

Atwood *et al.,* (2003) found that size to make a difference small fish were more susceptible to decreasing temperature than larger fish.

There was disagreement with Cnaani *et al.,* (2000, 2003) who recorded no correlation between cold tolerance and fish size; no correlation between body weight, standard length and cold tolerance.

The correlation between the initial weight and final weight, depth of water, and number of fish/ m^2 and cold was very low which came in the same line with Cnaani *et al.,* (2000) and Charo-Karisa *et al.,* (2004) who recorded low correlation on body weight, fish size but significant and Cold tolerance was significantly affected by genotype, size, aquarium, and condition factor (P= 0.0001); smaller fish were more vulnerable to cold stress. The lack of correlation between fish size and cold tolerance was also confirmed by Behrends *et al.* (1990) in fish of a similar size range.

There was significant difference in condition factor between the three experiments Charo-Karisa *et al.,* 2004 reported significant effect of condition factor on cold tolerance and fish condition or well-being has a large influence on growth, reproduction and survival of fish populations Lambert and Dutil, 2000.

It may be possible to improve commercial tilapia production under low temperatures by taking advantage of additive genetic variance (VA) in selecting the most cold-tolerant fish and It is possible to infer that certain crosses would be highly cold-tolerant and perhaps could develop populations in areas where temperatures decline below 10 C for short periods (Armas-Rosales, 2006).

Table 1. Mean (± SE) of the initial weight, final weight, weight gain, length, survival and condition factor of Juveniles *O. aureus* in the three experiments in concrete ponds and hapas

Stocking environment	Concrete pond		Hapas
Treatment	(Treatment 1) (T1)	(Treatment 2) (T2)	(Treatment 3) (T3)
Stocking density	22 fish/m^2	32 fish/m^2	13 fish/m^2
Depth of water (cm)	70	40	60
Initial weight (g)	1.4 ± 0.08	0.67 ± 0.01	0.4 ± 0.07
Final weight (g)	4.7 ± 0.38^{B}	5.3 ± 0.45^{A}	1.4 ± 0.17^{C}
Weight gain (g)	3.3^{B}	4.63^{A}	1^{C}
Length (cm)	5.6 ± 0.18^{B}	5.9 ± 0.21^{A}	3.9 ± 0.13^{C}
Survival	80.9 ± 1.52^{A}	10.3 ± 0.52^{C}	32 ± 1.1^{B}
K	2.5^{A}	2.6^{A}	2.0^{B}

- Means within row with different letter are significantly different (P<0.05)

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كفاءة معدلات النمو والحيوية لزريعة البلطى الاوريا خلال ظروف الشتاء القاصى فى مصر

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الهدف من هذة الدراسة هو دراسة معدلات النمو و الحيوية لزريعة البلطى الاوريا خلال ظروف الشتاء القاصى فى مصر

وقد تمت هذه الدراسة فى المعمل المركزى لبحوث الاسماك بالعباسة و قد شملت ثلاث تجارب لدراسة معدلات النمو والحيوية استخدمت فيها ثلاث معدلات من اوزان الزريعة بمتوسطات ٤و ، ١,٤ ،٠,٦٧ جرام للتجربة الثالثة والثانية و الاولى، تمت دراستها فى احواض خرسانية وهابات تحت ارتفاعات عمود مياه مختلفة (٧٠ و٤٠ و ٦٠ سم للتجربة الاولى والثانية والثالثة على التوالى) وكذلك كثافات مختلفة فى المتر المربع و هى ٣٢ سمكة فى المتر المربع (للتجربة الاولى) ٢٢ سمكة فى المتر المربع (للتجربة الثانية) ١٢ سمكة فى المتر المربع (للتجربة الثالثة)

قد لوحظ تذبذب وانخفاض فى درجات الحرارة اثناء فترة الشتاء فى درجات حرارة المياة لتصل الى اقل معدل ٨ درجات مئوية

قد سجل معدل الحيوية فروق معنوية بين الثلاث تجارب وقد كانت النتائج كالتالى ٨٠،٩٪ للتجربة الاولى و ١٠،٣ ٪ للتجربة الثانية بالاحواض الخرسانية و٪ ٣٢ للهابات.

كان اعلى معدل نمو اثناء التجربة قد سجل بالاحواض الخرسانية وهو ٥،٣ جرام بينما اقل معدلات النمو للثلاث تجارب كان للهابات وهو ١،٤ جرام

لم توجد اى فروق معنوية بين معامل الحيوية فى الثلاث تجارب وقد كان هناك ارتباط بين متوسط الوزن البدائى و معدل الحيوية (٤٨، .) بينما كان هناك ارتباط سالب بين متوسط الوزن البدائى وعدد الاسماك بالمتر المربع

كان هناك ارتباط سالب بين ارتفاع عمود المياه والوزن النهائى للاسماك