

EFFECT OF DIFFERENT LEVELS OF ZINC ON GROWTH PERFORMANCE AND GONADOSOMATIC INDEX OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FEMALES

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Abstract

The present experiment was conducted at the Central Laboratory for Aquaculture research in order to investigate the optimum growth performance, survival rate and gonadosomatic index of (*Oreochromis niloticus*) females reared in glass aquaria as affected with different levels of zinc.

The experimental system consisted of 18 experimental glass aquaria (80×40×50 cm). Each aquarium was stocked with 10 of (*O. niloticus*) females, which fed diets with different levels of zinc 0.0, 10, 25, 50, 75 and 100 mg / kg diet, respectively.

The results indicated that there were significant differences in growth performance among zinc levels feed. The averages of final body weight, weight gain and daily weight gain showed that the highest results were obtained from the level 25 mg Zn / kg diets followed in a decreasing order by 50, 75, 100 and 0.0 mg Zn (the control) levels.

The survival rate at 25 mg Zn / kg diets was the highest results than other treatments.

The highest value of gonadosomatic index (2.14) was obtained from level of 50 mg Zn / kg diets than other treatments.

The present results found that the optimal growth performance, survival rate and gonadosomatic index of (*Oreochromis niloticus*) females fingerlings was obtained from level of 25 mg Zn / kg diets.

INTRODUCTION

Zinc is an essential element for living organisms, being an indispensable cofactor for the normal activity of many enzymes, such as DNA and RNA polymerases, which act in protein synthesis (Hayashi *et al.* (2001)). While severe zinc deficiency causes growth impairment and anorexia. A marginal zinc deficiency causes depression of the immune response (Cousins. 1996) and it was found that zinc is essential for normal growth, reproduction, and wound healing (Stahl *et al.* 1989a). More than 200 different enzymes require zinc for maximum catalytic activity, including carbonic anhydrase, alkaline phosphatase, alcohol dehydrogenase, acid phosphatase, lactic dehydrogenase, carboxypeptidase, and superoxide dismutase (Thompson *et al.* 1989).

Zinc is an essential micronutrient that plays a crucial role in many cellular processes involving transcription, enzyme structure and activity. Protein interactions

and even cell signaling (Vallee and Falchuk, 1993). Zinc is involved in antioxidant defense (Bray and Bettger, 1990) and in maintaining membrane integrity (Bettger and O. Dell, 1981). However, zinc may become toxic if accumulated at high levels and many proteins are therefore involved in zinc homeostasis (Hogstrand and Wood, 1996).

The dietary zinc requirement has been determined for several fish species. The requirement values reported were 15 to 30 mg Zn / kg diets for rainbow trout and common carp (Ogina and Yang, 1978) and 20 mg Zn / kg diets for Channel catfish (Gatlin and Wilson, 1983), Blue tilapia (*Oreochromis aureuse*) which require 20 mg zinc / kg diet (McClain and Gatlin, 1988) and for Nile tilapia was 30 mg zinc/kg purified diet for maximum weight gain and suitable zinc levels in bones and blood (Eid and Ghonim, 1994).

Zinc uptake is significantly correlated to increasing GSI (Thompson, *et al.*, 2002). The aim of this work is to investigate the optimum growth performance, survival rate and gonadosomatic index of *Oreochromis niloticus* females reared in glass aquaria affected by different levels of zinc.

MATERIALS AND METHODS

The present experiment was conducted at the Central Laboratory for Aquaculture Research, to investigate the optimum growth performance, survival rate and gonadosomatic index of (*Oreochromis niloticus*) females fingerlings reared in glass aquaria affected by different dietary levels of zinc.

The experimental system consisted of 18 experimental glass aquaria (80×40×50 cm). Each aquarium was stocked with 10 (*O. niloticus*) females with an average initial weight ranging from 25.30 to 29.9 gm.

A total number of 180 *Oreochromis niloticus* females were used in this experiment. *Oreochromis niloticus* females were stocked in glass aquaria and fed on the experimental diets containing different levels of zinc as follow (0.0, 10, 25, 50, 75 and 100 mg / kg feed). Each treatment was represented in three replicate.

The *Oreochromis niloticus* females were fed on diet containing of 25.23 % protein twice / daily. The ingredients of the diet were 28.5 % egg white, 38.5 % starch, 8 % mixture of oils, 20 % cellulose, 2 % zinc free mineral mixture, 2 % vitamin and 1 % CMC (carboxy methyl cellulose). The ingredient and the proximate analyses of the diet are illustrated in Table (1).

Each aquarium was supplied with compressed air via an air-stone from air pumps (Boss 9500. Germany). Well-aerated water supply was provided from a storage fiberglass tank. Water level in each glass aquarium was kept at 40 cm depth.

All aquaria were drained and cleaned every day during experimental period. Water temperature and dissolved oxygen concentration were measured by using YSI model 58-oxygen meter (Yellow Springs Instrument, Yellow Springs, OH. USA). Total ammonia and nitrite were measured once weekly using a DREL. 2000 spectrophotometer (Hach. Loveland. CO. USA). Total alkalinity and chloride were monitored using the titration method, and pH was monitored using an electronic pH meter (pH pen. Fisher Scientific. Cincinnati. OH. USA). Average of water quality parameters were: water temperature 22 °C, dissolved oxygen 5.1 mg / l, total ammonia 0.2 mg / l, nitrite 0.05 mg / l, total alkalinity 182 mg / l, chlorides 550 mg / l and pH value was 7.6 all water quality parameters were within the acceptable levels for tilapia. At end of experiment the ovaries were removed and weighed for calculation of the GSI.

Table 1. Composition of the experimental diet for Nile tilapia (*Oreochromis niloticus*) female fingerlings reared in glass aquaria.

Ingredients	%
Egg white	28.5
Starch	38.5
Mixture oil	8
Cellulose	20
Zinc-free mineral mix	2
Vitamin mixture	2
Carboxymethyl cellulose (CMC)	1
Total	100

Proximate analysis	%
Moisture	9.70
Protein	25.23
Lipids	8.27
Ash	8.60
Fiber	19.2
NFE	28.00
Zinc (ppm)	1.00

Growth response was calculated as a follows:

Condition factor (k) = $100 (Wt/L^3)$. Where Wt is fish body weight (g). L is total length (cm), according to Hengsawat *et al.* (1997).

Weight gain (g fish) = mean final body weight – mean initial body weight

Feed conversion ratio (FCR) was estimated according to Berger and Halver, (1987) as follow: Dry feed intake (gm) / total weight gain (gm).

Gonadosomatic index (GSI) was estimated as = $100 (\text{weight of gonads} / \text{total body weight})$.

Statistical analysis:

The data were analyzed by analysis of variance. Duncan's Multiple Range test was applied to final body weight, body length, condition factor, weight gain, daily weight gain, survival rate and gonadosomatic index. All statistics were carried out using Statistical analysis systems (SAS, 2004).

RESULTS AND DISCUSSION

Growth performance of *Oreochromis niloticus* female fingerlings.

Averages of final body weight was affected by different levels of zinc in Nile tilapia females as illustrated in Table (2) the mean final body weight in different treatments of *Oreochromis niloticus* females fed diets containing levels of zinc of 0.0, 10, 25, 50, 75 and 100 mg of zinc /kg diet for 9 weeks were 37.40 ± 1.0 , 37.58 ± 1.02 , 45.27 ± 1.33 , 45.90 ± 1.33 , 40.67 ± 0.86 and 39.73 ± 0.63 , respectively. Analysis of variance showed a significant difference between final body weight of *Oreochromis niloticus* females treated with 25 mg zinc / kg diet and other treatments.

Final weight gain and daily weight gain of Nile tilapia (*Oreochromis niloticus*) females fed on the basal diet (2 mg Zn / kg) were significantly lower than those fed diets containing the different levels of zinc (10 – 100 mg Zn / kg diet). Weight gain and daily weight gain of *Oreochromis niloticus* females fed diets containing different levels of zinc 0.0, 10, 25, 50, 75 and 100 mg Zn / kg diet were (10.14 ± 0.06 , 12.28 ± 0.06 , 19.11 ± 0.006 , 16.00 ± 0.057 , 13.80 ± 0.05 and 13.77 ± 0.04) and (0.13 ± 0.0 , 0.16 ± 0.0 , 0.24 ± 0.003 , 0.21 ± 0.003 , 0.18 ± 0.0 and 0.18 ± 0.0), respectively. The highest results were obtained from the level of 25 mg Zn / kg diet followed in a decreasing order by 50, 75, 100 and 0.0 mg Zn (the control). Statistical analyses of weight gain and daily weight gain showed a significant difference between all treatments and the control group. The present results are in agreement with Satoh *et al.*, (1987), Apines *et al.*, (2001) and Ebrahim, (2005) they found significantly lower values with the control diets (0.0 mg Zn) when compared with those fed diets supplemented with different levels of zinc (Table 2).

Relative growth rate: As indicated in table (2) there were significant differences between level of 25 mg Zn / kg diets and other treatments when *Oreochromis niloticus* females fed diets supplemented with different levels of zinc. The highest value was obtained from 25 mg Zn / kg diet (73.42 ± 3.86) and lowest value was obtained by 0.0 mg Zn / kg diet (37.31 ± 1.67) in relative growth rate.

Results of Table (2) illustrate the FCR values as affected by different levels of zinc (0, 10, 25, 50, 75 and 100 mg Zn / kg diet). The results revealed that FCR was improved at level of 25 mg Zn / kg diet than other treatments, for (*Oreochromis niloticus*) females fingerlings. The results are in agreement with Ebrahim, (2005) who found that improve in FCR at level of 30 mg Zn / kg diets than all other treatments.

Table 2. Effect of different levels of zinc in diet on growth performance of female (*Oreochromis niloticus*) fingerlings females reared in glass aquaria.

Mg Zn / kg diet	Initial weight. (gm)	Final weight. (gm)	Final length (cm)	K. Factor	Avg. weight gain	Avg. D.Wt. gain	RGR %	FCR
0.0	27.27	37.40± 1.01b	13.33± 0.16c	1.58± 0.02a	10.14± 0.06e	0.13± 0.0e	37.31± 1.67c	6.19l 0.27a
10	25.30	37.58± 1.02b	13.50± 0.11cb	1.53± 0.04a	12.28± 0.06d	0.16± 0.0d	48.70± 1.89b	4.83± 0.19bc
25	26.17	45.27± 1.33a	14.53± 0.31a	1.48± 0.05a	19.11± 0.006a	0.24± 0.003a	73.42± 3.86a	3.43± 0.16d
50	29.90	45.90± 1.33a	14.23± 0.20ab	1.59± 0.023a	16.00± 0.057b	0.21± 0.003b	53.69± 2.07b	5.13± 0.20b
75	26.87	40.67± 0.86b	14.10± 0.23ab	1.45± 0.04a	13.80± 0.05c	0.18± 0.0c	51.46± 1.36b	4.78± 0.04bc
100	25.97	39.73± 0.63b	13.57± 0.24cb	1.59± 0.05a	13.77± 0.04c	0.18± 0.0c	53.10± 1.55b	4.50± 1.48c

Means with the same letter in the same column are not significant differences at ($P < 0.05$).

Survival rate of females *Oreochromis niloticus* fingerlings ranged from 90 – 100 %. The results indicated that there were no significant differences among the tested dietary treatments, at the same time there were significant differences between them and those treated with (0.0, 10 and 100 mg Zn / kg diet). In the present study the survival rate at 25 mg Zn / kg diets was the best result and more economical than other treatments. The results are in agreement with the results obtained by Eid and Ghonim, (1994) and Ebrahim, (2005) who reported that, high mortality has usually been associated with zinc deficiency in fish.

Gonadosomatic index (GSI) of Nile tilapia females fed on the diets on different levels of zinc are presented in table (3). It could be noticed that the gonadosomatic index for different levels of zinc concentration (0.0, 10, 25, 50, 75 and 100 mg Zn / kg diet) were 1.44, 1.51, 1.82, 2.14, 1.89 and 1.95, respectively. The highest value of gonadosomatic index was obtained by level 50 mg Zn / kg diets. Analysis of variance

showed no significant difference in GSI among fish treated with (10, 25, 75 and 100 mg Zn / kg diet), at the same time there were significant difference between them and groups that treated with 50 mg zinc / kg diet in the average of final gonadosomatic index of *Oreochromis niloticus* females.

The present results recommend adding 25 mg Zn/ kg diet to obtain the highest growth performance, survival rate and adding 50 mg Zn/ kg diet to obtain the highest gonadosomatic index.

Table 4. Effect of different dietary zinc levels on survival rate and gonadosomatic index of (*Oreochromis niloticus*) fingerlings females reared in glass aquaria.

Mg Zn / kg diet	Initial weight	Final weight	Survival rate	Weight of Gonads (g)	GSI
0.0	27.27	37.40±1.01b	90.00± 0.0b	0.54± 0.09e	1.44± 0.23b
10	25.30	37.58±1.02b	90.00±0.0b	0.57±0.11d	1.51±0.26ab
25	26.17	45.27±1.33a	100.00±0.0a	0.83±0.08a	1.83±0.13ab
50	29.90	45.90±1.33a	100.00±0.0a	0.99±0.107b	2.14±0.17a
75	26.87	40.67±0.86b	100.00±0.0a	0.77±0.05c	1.90±0.139ab
100	25.97	39.73±0.63b	90.00±0b	0.77±0.07c	1.95±0.18ab

Means with the same letter in the same column are not significant differences at (P < 0.05).

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تأثير مستويات مختلفة من الزنك على أداء النمو ودليل المناسل لإناث البلطي النيلي
المرباه في أحواض زجاجية

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المعمل المركزي لبحوث الثروة السمكية بالعباسة - مركز البحوث الزراعية - وزارة الزراعة -
الدقي - الجيزة

أجريت هذه الدراسة بالمعمل المركزي لبحوث الثروة السمكية بالعباسة أبوحماد شرقية. لمعرفة كفاءة أداء النمو المثلى ومعدل الإعاشة ودليل المناسل عند معاملة إصبيجات إناث أسماك البلطي النيلي بمستويات مختلفة من الزنك. كالتالي: ٠ و ١٠ و ٢٥ و ٥٠ و ٧٥ و ١٠٠ ملجم زنك لكل كجم عليقة كل معاملة ٣ مكررات بأحواض زجاجية كل حوض خزن به ١٠ أسماك من إناث البلطي النيلي. دلت النتائج على وجود اختلافات معنوية في أداء النمو، متوسط للوزن النهائي، والوزن المكتسب ومعدل النمو اليومي سجلت أعلى النتائج المتحصل عليها من الأسماك المعاملة بالمستوى ٢٥ ملجم زنك لكل كجم عليقه يليها في المستويات ٥٠ و ٧٥ و ١٠٠ ملجم زنك لكل كجم عليقه ثم المجموعة الضابطة. معدلات الإعاشة للأسماك عند المستوى ٢٥، ٥٠، ٧٥ ملجم زنك لكل كجم عليقه كانت أفضل عن باقي المعاملات الأخرى. دلت النتائج أيضا أن أفضل قيمة لدليل المناسل كانت (٢,١٤) سجلت عند الأسماك المعاملة بالمستوى ٥٠ ملجم زنك لكل كجم عليقه عن باقي المعاملات الأخرى. تخلص الدراسة إلى أن معدلات النمو المثلى ومعدلات الإعاشة ودليل المناسل لإناث البلطي النيلي كانت عند المستوى ٢٥ ملجم زنك لكل كجم عليقه.