Zagazig J. Agric. Res., Vol. 41 No. (5) 2014 1035-1046

Zagazig Journal of Agricultural Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

GROWTH PERFORMANCE, FEED UTILIZATION AND BLOOD COMPONENTS OF NILE TILAPIA (*Oreochromis niloticus*) AS AFFECTED BY DIETARY ENERGY LEVELS AND ZINC SUPPLEMENTATION

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ABSTRACT

The study was conducted at the Department of Animal Production, Agriculture Faculty, Zagazig University and the practical work was carried out at Central Laboratory for Aquaculture Research, Abbassa, Sharkia, Egypt. The experiment was carried from August to November, 2012. Fish were divided into twelve groups, each group was stocked into 3 aquaria and each one contains 10 fish. The fish of the first four groups were fed the diet containing 4113 Kcal/kg diet (normal energy level), the second four groups were fed the diet containing 4337 Kcal/kg diet (medium energy level) and the other four groups were fed on the diet containing 4559 Kcal/kg diet (high energy level). Within each dietary energy level, fish groups were fed diets supplemented with vitamin zinc to supply 0, 25, 50 and 75 mg/kg diet. The non significant differences between the experimental groups for initial live body weight indicated that the groups at the beginning of the experiment were homogenous. Live body weight, daily gain, relative growth rate and feed conversion of Nile tilapia fish was affected insignificantly with dietary energy level. Daily weight gain of fish increased in fish fed high and medium energy levels by 5.69 and 0.19%, respectively. The energy levels on fish diets did not affected the mortality rate. Serum total protein, albumin, globulin, urea-N, creatinine, ALT and alkaline phosphatase insignificantly affected with dietary energy level, while AST and total lipids affected significantly ($P<0.001$ or 0.01). Moisture, crude protein and ether extract content of the fish flesh increased with increasing dietary energy level. Final live body weight increased by 7.19, 9.20 and 13.23%, respectively in fish fed diets supplemented with 25, 50 and 75 mg zinc/kg diet, when compared with fish fed diet without zinc supplementation. The same figures for daily weight gain were 9.65, 12.28 and 17.54 %, respectively. Also, feed conversion at 0-14 weeks of the experimental period improved by 3.62, 8.72 and 8.95%, respectively. Fish groups fed diet supplemented with 75 mg zinc/kg diet recorded higher growth rate and the best feed conversion. Serum total protein, albumin, globulin, serum creatinine, alkaline phosphates and lipids significantly ($P<0.001$ or 0.05) affected with zinc supplementation in Nile tilapia feed, while serum urea-N, AST and ALT insignificantly affected. Ether extract percentages of the flesh significantly ($P<0.001$) affected by dietary zinc supplementation, on the other hand crude protein, moisture and ash insignificantly affected. Moisture, crude protein and ether extract content of the fish flesh increased with increasing dietary zinc level supplementation. Interaction between dietary energy level and zinc supplementation insignificantly affected feed intake, feed conversion ratio and all studied blood components. Supplementation fish diets with 50 or 75 mg zinc/kg diet could be recommended, since it showed the highest final weight and body gain weight and the best feed conversion.

Key words: Energy level, zinc supplementation, growth, feed conversion, blood components, body composition.

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INTRODUCTION

Aquaculture is considered today an important source of production for meeting the worlds increasing demand for animal protein. Aquaculture development projects are being initiated in many parts of the world especially in the developing countries. Tilapia are mainly freshwater fish inhabiting shallow streams, ponds, rivers and lakes and less commonly found living in brackish water (FAO, 2012).

Fish under farming conditions are mostly fed pre-set amounts of a single feed type so that the fish cannot compensate feed intake for the eventual lack of a particular nutrient or for energy content, which may lead to reduced growth. Thus, predicting the feed ration close to the voluntary feed intake level of fish as a function of diet composition and culture conditions is essential to maximize growth rate and feed use and also to minimize feed wastage in the aquatic environment. This requires a better understanding of the dietary, physiological and environmental factors affecting feed intake and their underlying mechanisms (Saravanan *et al.*, 2012).

Ayyat *et al.* (2009) found that the live body weight and daily gain of Nile tilapia fish insignificant were affected due to increasing in dietary energy level. The best final live body weight and daily gain were obtained in fish group reared during summer season and fed diet with high or normal energy level. Also, Ramezani (2009) reported that the energy content of diets not affect any growth related parameter such as feed conversion ratio, specific growth rate and protein efficiency ratio. There was not interaction between protein and energy levels in the growth related parameters, suggesting the effect of protein on the growth parameters in Caspian brown trout (*Salmo trutta caspius*) did not depend on energy levels of diet. El-Sayed and Teshima (1992) reported that, at dietary protein levels from 30 to 40%, Nile tilapia fish growth and survival rates were significantly improved by increasing dietary energy from 300 to 500 kcal GE/100 g at 45% protein, the best growth and feed utilization were achieved at 400 kcal/100 g diets.

Zinc is an essential element, many functions are recognized such as it is an essential part or a cofactor for a number of enzymes including carbonic anhydrase, carboxypeptidase, superoxide dismutase, lactate dehydrogenase, phosphatase and glutamate dehydrogenase (NRC, 1993). As a component of carbonic anhydrase, zinc play a role in binding carbon dioxide in teleost cells, combining it with water to form carbonic acid and releasing carbon dioxide from capillaries at secondary lamellae of gills. Also, carbonic anhydrase is important in maintaining acid-base balance in renal tubule cells. As a cofactor of the protein-splitting enzyme carboxypeptidase, zinc has a key role in protein digestion (Sorensen, 1991). The zinc requirement of young rainbow trout and carp is 15 to 30 mg/kg of diet (Ogino and Yang, 1978 and 1979), wherease blue tilapia require 20 mg/kg of diet (McClain and Gattin, 1988). Dietary protein source, phytic acid and form of zinc and calcium affect zinc absorption and use in fish (Hardy and Shearer, 1985; Wekell *et al.*, 1986; Satoh *et al.*, 1987 and 1989; McClain and Gattin, 1988). The bioavailability of zinc in fishmeal is inversely related to the tricalcium phosphate content. This is presumably caused by absorption of zinc into insoluble calcium phosphate complexes in the intestine that are passed through the gut unabsorbed and excreted (Satoh *et al.*, 1987).

The objective of the present study was to investigate the effects of energy level in the diets and zinc supplementation on growth performance, feed efficiency, blood components and body composition of growing Nile tilapia fish.

MATERIALS AND METHODS

The study was conducted at the Department of Animal Production, Agriculture Faculty, Zagazig University and the practical work was carried out at Central Laboratory for Aquaculture Research, Abbassa, Sharkia, Egypt. The experiment was carried from August to November, 2012.

Fingerlings Nile tilapia fish (*Oreochromis niloticus*) averaged about 3.699±0.003 g was used in this study. The fish were stocked in thirty six glass aquaria (70 × 40 × 60 cm) supplied with fresh aerated tap water. Fish were divided into twelve groups, each group was stocked into 3 aquaria and each one contains 10 fish. The fish of the first four groups were fed the diet 1, which containing 4113 Kcal/kg diet (low energy level), the second four groups were fed the diet 2, which containing 4337 Kcal/kg diet (medium energy level) and the third four groups were fed on the diet 3, which containing 4559 Kcal/kg diet (high energy level). The chemical compositions of the diets are shown in Table 1. Within each dietary energy level, fish groups were fed diets supplemented with vitamin zinc to supply 0, 25, 50 and 75 mg/kg diet. Fish were fed three times daily at 9:00, 14:00 and 19:00 clock at a feeding rate of 3% of body weight per day. The total duration of the experimental feeding trial was 14 weeks.

Fish wastes were siphoned out and 30% of the water in each aquarium was removed daily and replaced with fresh new water. Fish were individually weighed to the nearest 0.1 g at the beginning of the experiment and biweekly intervals throughout the experimental period. Feed conversion was calculated as the quantity of feed required to obtain one unit growth during the experimental period, according to Berger and Halver (1987). Blood samples were taken from the caudal vein from randomly selected three fish in each group. The blood samples were centrifuged at 3000 RPM for 20 min to separate the serum. Total protein, albumin, urea-N, creatinine, serum transaminase enzymes (AST; aspartate amino transferase and ALT; alanine amino transferase), Alkaline phosphatase and total lipids were measured in blood serum by colormetric methods using commercial kits. Proximate chemical compositions of experimental diets and fish body were determined according to AOAC (1980).

The obtained data were statistically analyzed by factorial experiment (Snedecor and Cochran, 1982) as the following model: $Y_{ijk} = \mu + E_i + Z_j + EZ_{ij} + e_{ijk}$ Where, μ is the overall mean, E_i is the fixed effect of i^{th} dietary energy level (1,..3), Z_j is the fixed effect of j^{th} dietary zinc supplementation level (1,.......4), EZ_{ij} is the interaction effect of i^{th} dietary energy level and j^{th} dietary zinc level and e_{ijk} is the random error. Differences between treatments were statisticaly tested by Duncan''s multiple range test (Duncan, 1955).

Table 1. Composition and chemical analysis of the experimental fish diets used (on dry matter basis)

Ingredients (%)	Low energy level (Diet 1)	Medium energy level (Diet 2)	High energy level (Diet 3)
Fish meal (herring)	16	16	16
Soya bean meal	34	35	37
Yellow corn	26	25	25
Wheat bran	17	13	7
Sunflower oil	2	6	10
Vitamin mix(1)	1	1	1
Minerals mix(2)	2	2	2
Carboxymethyl cellulose	2	2	2
Chemical analysis:			
Crude protein (%)	31.85	31.68	31.73
Crude fiber (%)	3.71	3.31	2.76
Ether extract (%)	6.01	9.79	13.56
Ash (%)	5.72	5.52	5.26
Gross energy(kcal/kg)	4113.6	4337.2	4559.2
Metabolizable energy (ME) (3)	2879.5	3036.0	3191.4

(1) Each one kg of vitamin mixture contained: Vit. A 72000 IU, Vit.B1 6 mg, Vit.B3 12000 IU, Vit.B6 9 mg , Vit.B12 0.06 mg, Vit. E 60 mg, Vit. K 12 mg, Pantothenic acid 60 mg, Nicotinic acid 120 mg, Folic acid 6mg , Biotin 0.3 mg and Choline chlorides 3 mg.

(2) Each one kg of Minerals mixture contained: Zinc 1.23 g, Manganese 930 mg, iron 630 mg , Copper 105 mg , Iodin 10.5 mg, Selnium 2.1mg .

(3) ME was calculated from gross energy as 70% (NRC, 1993).

RESULTS AND DISCUSSION

Growth Performance

The non significant differences between the experimental groups for initial live body weight indicated that the groups at the beginning of the experiment were homogenous. Live body weight, daily gain and relative growth rate of Nile tilapia fish were insignificantly affected with dietary energy level at the whole of the experimental periods (Table 2). Live body weight of fish increased by 4.301 and 0.462%, respectively, at fish group fed high and medium energy level when compared with the low once at the final experimental period. Daily weight gain of fish increased in fish fed high and medium energy levels by 5.69 and 0.19%, respectively, at the 0-14weeks of the experimental periods as compared with those fed at the low energy diet. From the obtained results, growth rate of Nile tilapia fish slightly affected with the energy level in diets. Ayyat *et al.* (2009) found that the live body weight and growth rate of Nile tilapia fish insignificantly affected as increasing in dietary energy level. The best final live body weight and daily gain were obtained in fish group reared during summer season and fed diet with high or low energy level. Also, Ramezani (2009) reported that the energy content of diets does not affect any growth related parameter

Dietary zinc supplementation affected significantly ($P<0.001$, 0.01) live body weight, daily gain and relative growth (Table 2). Final live body weight increased by 7.19, 9.20 and 13.23%, respectively in fish fed diets supplemented with 25, 50 and 75 mg zinc/kg diet, when compared with fish fed diet without zinc supplementation. The same figures for daily weight gain were 9.65, 12.28 and 17.54%, respectively. Fish groups fed diet supplemented with 75 mg zinc/kg diet recorded higher final body weight. The same trend was also observed by Ayyat *et al.* (2004), who reported that live body weight and daily gain weight of Nile tilapia increased significantly ($P<0.001$) as affected with zinc supplementation in the diets. Zinc is essential for normal growth of the farmed fish (Prasad 1979 and Stahl *et al.*, 1989). The significant improvement in growth performance of fish fed diets supplemented with zinc may be attributed to the sufficient zinc to increase the activity of enzymes of zinc-metalloenzynes, which stimulate the synthesis of body protein and improvement of growth rate (Freeman 1983). Sorensen (1991) reported that, zinc is a cofactor of the protein-splitting enzyme carboxypeptidase, zinc has a key role in protein digestion.

Interactions between dietary energy levels and dietary zinc supplementation levels insignificantly affected live body weight, daily gain and relative growth (Table 2).

Feed Efficiency

Feed intake and feed conversion insignificantly affected with the dietary energy level. Feed intake slightly increased with the increasing in energy level in Nile tilapia diets (Table 2). Feed conversion slightly improved with the increasing in energy level in Nile tilapia diets. Fish fed the high dietary energy level recorded lower feed conversion with 3.42% than those fed the low energy diet. The same trend was obtained by Ayyat *et al.* (2009), who reported that the feed intake and feed conversion insignificantly affected with dietary energy levels.

Daily feed intake and feed conversion ratio significantly ($P<0.01$) affected with zinc supplementation at all experimental periods, except at 8-12 and 12-14 weeks insignificantly affected (Table 2). Feed conversion at 0-14 weeks of the experimental period improved by 3.62, 8.72 and 8.95%, respectively in fish fed diets supplemented with 25, 50 or 75 mg zinc/kg diet, when compared with fish fed diet without zinc supplementation. Fish fed diets supplemented with 75 mg zinc recorded the best feed conversion than the other experimental groups. The same trend was observed by Ayyat *et al.* (2004) who found that zinc supplementation in Nile tilapia fish diets improved feed conversion during the whole experimental period.

Interactions between dietary energy levels and zinc supplementation levels insignificantly affected feed intake and feed conversion ratio during the all experimental periods (Table 2).

Table 2. Body weight, feed conversion and mortality rate of Nile tilapia fish as affected by dietary energy levels, zinc supplementation and their interactions

Items	Initial weight (g)	Weight at 14 weeks (g)	Daily gain at 0-14 weeks (g)	Relative growth at 0-14 weeks	Daily feed intake at 0-14 weeks (g)	Feed conversion at 0-14 weeks	Mortality rate (%)
Effect of dietary energy levels							
Low	3.698±0.004	15.787±0.325	0.123±0.003	123.872± 1.155	0.262±0.003	2.135±0.038	3.333
Medium	3.699±0.004	15.860±0.324	0.124±0.003	124.112±1.248	0.265±0.002	2.154±0.038	1.666
High	3.698±0.005	16.466±0.287	0.130±0.002	126.475±1.041	0.267±0.003	2.062±0.043	3.333
Sigificance	NS	NS	NS	NS	NS	NS	----
Effect of zinc supplementation (mg/kg diet)							
0 mg	3.693±0.006	14.932±0.172^{b}	0.114±0.001^{b}	120.639±0.673^{b}	0.256±0.002^{c}	2.236±0.030^{c}	2.222
25 mg	3.695±0.005	16.005±0.257^{a}	0.125±0.002^{a}	124.870±0.999^{a}	0.270±0.001^{ab}	2.155±0.033^{ab}	0.000
50 mg	3.705±0.004	16.306±0.310^{a}	0.128±0.003^{a}	125.795±1.148^{a}	0.261±0.003^{bc}	2.041±0.053^{bc}	4.444
75 mg	3.701±0.004	16.908±0.369^{a}	0.134±0.003^{a}	127.977±1.288^{a}	0.273±0.003^{a}	2.036±0.036^{a}	4.444
Sigificance	NS	**	**	***	**	**	-----
Interaction between dietary energy levels and zinc supplementation							
Low energy level							
0 mg	3.685±0.010	14.715±0.068	0.112±0.000	119.878±0.283	0.251±0.006	2.232±0.072	3.333
25 mg	3.704±0.006	15.788±0.338	0.123±0.003	123.938±1.292	0.267±0.003	2.169±0.036	0.000
50 mg	3.700±0.010	15.846±0.166	0.124±0.001	124.273±0.481	0.262±0.003	2.116±0.054	3.333
75 mg	3.702±0.002	16.800±1.044	0.133±0.010	127.399±3.617	0.268±0.007	2.026±0.107	6.666
Medium energy level							
0 mg	3.694±0.012	14.739±0.202	0.112±0.002	119.818±1.085	0.256±0.003	2.278±0.032	3.333
25 mg	3.696±0.012	15.944±0.598	0.125±0.006	124.576±2.372	0.270±0.002	2.173±0.090	0.000
50 mg	3.708±0.007	16.001±0.771	0.125±0.007	124.512±2.978	0.263±0.006	2.108±0.081	0.000
75 mg	3.701±0.004	16.757±0.530	0.133±0.005	127.545±1.818	0.273±0.003	2.057±0.057	3.333
High energy level							
0 mg	3.699±0.013	15.342±0.427	0.118±0.004	122.221±1.520	0.261±0.004	2.200±0.058	0.000
25 mg	3.684±0.001	16.283±0.507	0.128±0.005	126.095±1.863	0.272±0.004	2.123±0.053	0.000
50 mg	3.708±0.006	17.072±0.292	0.136±0.002	128.600±0.904	0.258±0.010	1.899±0.098	9.000
75 mg	3.701±0.015	17.167±0.465	0.137±0.004	128.986±1.657	0.278±0.007	2.027±0.030	3.333
Sigificance	NS	NS	NS	NS	NS	NS	------

Means in the same column within each classification with different letters differ significantly ($P<0.05$).

Within each dietary energy level, zinc supplementation in tilapia fish feed improved feed conversion. Fish fed the high energy diet and supplemented with 50 mg zinc/kg diet recorded the best feed conversion than the other groups. Such significant improvements in feed conversion are due to that zinc is essential in metabolism (Banerjee, 1987)

Mortality Rate (%)

Effect of dietary energy level on mortality rate did not take the graded trend. Fish group fed the medium energy diet recorded the lower mortality rate; 50.1% lower than the other experimental groups (Table 2). The obtained results indicated that the energy levels on fish diets did not affect the mortality rate.

Effect of dietary zinc supplementation on mortality rate did not take the graded trend. Fish group fed diet supplemented with 25 mg zinc/kg diet recorded the lower mortality rate (0.0%), while fish fed diet supplemented with 50 or 75 mg zinc/kg diet recorded the higher mortality rate (Table 2). Zinc plays a role in immune function (Solomons, 1998 ; Prasad, 1995). Whereas growth and survival rate of fish were reduced by dietary zinc or calcium deficiency (Scarpa and Gatlin, 1992). Eid and Ghonim (1994) reported that Nile tilapia fish fed the lowest levels of supplemental zinc (0 and 5 mg Zn/kg diet) had high mortality, while the levels over 30 mg/kg diet showed reduced mortality rate

Effect of the interactions between dietary energy levels and zinc supplementation levels on mortality rate did not take the graded trend. Within each dietary energy level, fish group fed diet supplemented with 25 mg zinc/kg diet recorded the lower mortality rate. Fish group fed high energy diet and supplemented with 50 mg zinc/kg diet recorded the higher mortality rate than the other experimental groups (Table 2).

Blood Components

Serum total protein, albumin, globulin, urea-N, creatinine, total lipids, ALT and alkaline phosphatase insignificantly affected with dietary energy level, while AST affected significantly ($P<0.001$ or 0.01) (Tables 3 and 4). Fish fed the high energy diet recorded higher level of serum total protein, albumin, and globulin by 3.59, 5.52 and 1.00% than the fish group which fed low energy diet, the same figures for the medium energy diet were 2.42, 2.31 and 2.58%, respectively. Also, serum urea-N, creatinine, ALT, AST, alkaline phosphatase and lipids slightly increased with increasing dietary energy level. On the other hand, Ayyat *et al.* (2009) reported that the plasma albumin concentration decreased in fish group fed high energy diet.

Serum total protein, albumin, globulin, serum urea-N, serum creatinine, alkaline phosphatase and lipids significantly ($P<0.001$ or 0.05) affected with zinc supplementation in Nile tilapia feed, while AST and ALT insignificantly affected (Tables 3 and 4). Serum total protein increased by 3.92, 11.34 and 20.43%, respectively, in fish group fed diets supplemented with 25, 50 and 75 zinc/kg diet, when compared with the fish group fed diet without zinc supplementation. The same trend was obtained in serum albumin, which increased by 5.15, 11.74 and 27.80%, respectively. Serum creatinine increased by 5.31, 9.04 and 17.06%, respectively. The same trend was obtained in serum alkaline phosphatase, which increased by 10.45, 24.59 and 58.86%, respectively. Increasing serum total protein and AST concentrations may be attributed due to the increasing of protein syntheses in the liver and related with improving the metabolism rate. Ayyat *et al.* (2009) reported that serum total protein, albumin, creatinine and AST significantly ($P<0.001$ or 0.05) increased with increasing zinc level in fish diet, while ALT significantly decreased.

Interactions between dietary energy levels and zinc supplementation levels insignificantly affected all studied blood components (Tables 3 and 4). Within each dietary energy level, zinc supplementation in tilapia fish diet increased serum total protein and albumin concentrations.

Body Composition

Ether extract percentages of the flesh significantly ($P<0.001$) affected by dietary energy levels, on the other hand crude protein, moisture and ash insignificantly affected (Table 5).

Table 3. Serum total protein and its fractions, urea-N and createnine in blood of Nile tilapia fish as affected by dietary energy levels, zinc supplementation and their interactions

Items	Total Protein (g/100 ml)	Albumin (g/100 ml)	Globulin (g/100 ml)	Urea-N (mg/100 ml)	Createnine (mg/100 ml)
Effect of dietary energy levels					
Low	4.955±0.118	2.860±0.097	2.094±0.051	3.707±0.075	0.919±0.019
Medium	5.075±0.124	2.926±0.079	2.148±0.057	3.870±0.040	0.970±0.025
High	5.133±0.136	3.018±0.110	2.115±0.055	3.832±0.074	0.974±0.027
Sigificance	NS	NS	NS	NS	NS
Effect of zinc supplementation (mg/kg diet)					
0 mg	4.640±0.101^{c}	2.640±0.043^{c}	2.000±0.070^{b}	3.670±0.102^{b}	0.885±0.021^{c}
25 mg	4.822±0.041^{c}	2.776±0.046^{c}	2.045±0.043^{ab}	3.805±0.033^{ab}	0.932±0.023^{bc}
50 mg	5.166±0.040^{b}	2.950±0.046^{b}	2.216±0.046^{a}	3.781±0.064^{ab}	0.965±0.018^{b}
75 mg	5.588±0.109^{a}	3.374±0.097^{a}	2.214±0.053^{a}	3.957±0.069^{a}	1.036±0.025^{a}
Sigificance	***	***	*	*	**
Interaction between dietary energy levels and zinc supplementation					
Low energy level					
0 mg	4.470±0.173	2.520±0.056	1.950±0.125	3.603±0.237	0.851±0.041
25 mg	4.850±0.028	2.783±0.101	2.066±0.088	3.800±0.076	0.903±0.026
50 mg	5.100±0.057	2.876±0.069	2.223±0.113	3.616±0.101	0.960±0.035
75 mg	5.400±0.208	3.263±0.220	2.136±0.031	3.810±0.180	0.961±0.018
Medium energy level					
0 mg	4.833±0.192	2.733±0.044	2.100±0.175	3.783±0.092	0.913±0.023
25 mg	4.700±0.076	2.683±0.060	2.016±0.092	3.800±0.076	0.916±0.024
50 mg	5.200±0.100	3.030±0.070	2.170±0.030	3.913±0.057	0.963±0.037
75 mg	5.566±0.240	3.260±0.142	2.306±0.097	3.986±0.071	1.090±0.032
High energy level					
0 mg	4.616±0.148	2.666±0.072	1.950±0.076	3.623±0.226	0.890±0.050
25 mg	4.916±0.044	2.863±0.059	2.053±0.077	3.816±0.044	0.976±0.063
50 mg	5.200±0.057	2.943±0.102	2.256±0.099	3.813±0.114	0.973±0.035
75 mg	5.800±0.057	3.600±0.076	2.200±0.125	4.076±0.046	1.058±0.046
Sigificance	NS	NS	NS	NS	NS

Means in the same column within each classification with different letters differ significantly ($P<0.05$).

Table 4. Serum AST, ALT, alkaline phosphatase and lipids in blood of Nile tilapia fish as affected by dietary energy levels, zinc supplementation and their interactions

Items	AST (IU)	ALT (IU)	Alkaline phosphatase (IU)	Lipids (mg/dl)
Effect of dietary energy levels				
Low	22.016±0.428[b]	13.066±0.250	8.380±0.478[b]	3.185±0.111
Medium	23.125±0.360[a]	13.083±0.145	8.973±0.485[a]	3.220±0.129
High	23.616±0.302[a]	13.383±0.159	9.117±0.505[a]	3.234±0.126
Sigificance	**	NS	***	NS
Effect of zinc supplementation (mg/kg diet)				
0 mg	22.855±0.639	13.600±0.209	7.146±0.133[d]	2.735±0.048[a]
25 mg	22.588±0.409	13.122±0.191	7.893±0.128[c]	3.015±0.032[b]
50 mg	22.888±0.471	13.044±0.150	8.903±0.217[b]	3.324±0.050[c]
75 mg	23.344±0.362	12.944±0.276	11.352±0.170[a]	3.776±0.048[d]
Sigificance	NS	NS	***	***
Interaction between dietary energy levels and zinc supplementation				
Low energy level				
0 mg	20.766±0.762	13.900±0.351	6.916±0.103	2.773±0.121
25 mg	21.466±0.548	12.966±0.425	7.476±0.189	3.026±0.049
50 mg	22.000±0.152	12.966±0.272	8.120±0.073	3.213±0.052
75 mg	23.833±0.744	12.433±0.669	11.010±0.119	3.726±0.090
Medium energy level				
0 mg	23.900±0.964	13.000±0.251	7.083±0.084	2.683±0.088
25 mg	23.200±0.360	13.066±0.338	8.220±0.115	3.046±0.050
50 mg	22.766±0.970	13.133±0.366	9.216±0.145	3.310±0.030
75 mg	22.633±0.611	13.133±0.384	11.373±0.402	3.840±0.049
High energy level				
0 mg	23.900±0.351	13.900±0.264	7.440±0.351	2.750±0.057
25 mg	23.100±0.793	13.333±0.328	7.983±0.077	2.973±0.078
50 mg	23.900±0.888	13.033±0.233	9.373±0.269	3.450±0.115
75 mg	23.566±0.504	13.266±0.352	11.673±0.251	3.763±0.121
Sigificance	NS	NS	NS	NS

Means in the same column within each classification with different letters differ significantly (P<0.05).

Table 5. Body composition of Nile tilapia fish as affected by dietary energy levels, zinc supplementation and their interactions

Items	Moisture (%)	Crude protein (%)	Fate (%)	Ash (%)
Effect of dietary energy levels				
Low	74.711±0.343	60.608±0.408	6.247±0.167[b]	24.041±0.370
Medium	74.870±0.347	59.512±0.834	6.145±0.187[b]	24.374±0.254
High	74.679±0.336	58.992±0.881	6.785±0.245[a]	24.080±0.308
Sigificance	NS	NS	***	NS
Effect of zinc supplementation (mg/kg diet)				
0 mg	74.612±0.443	60.735±0.288	5.614±0.070[c]	24.118±0.393
25 mg	75.188±0.287	60.064±1.112	6.073±0.117[b]	24.043±0.376
50 mg	74.780±0.412	58.552±1.068	6.842±0.195[a]	23.957±0.333
75 mg	74.433±0.401	59.465±0.669	7.041±0.206[a]	24.542±0.351
Sigificance	NS	NS	***	NS
Interaction between dietary energy levels and zinc supplementation				
Low energy level				
0 mg	74.436±0.998	61.113±0.264	5.743±0.086	24.296±0.990
25 mg	75.283±0.409	61.263±0.213	5.870±0.040	23.986±0.842
50 mg	74.423±0.772	59.346±1.093	6.770±0.417	23.743±0.557
75 mg	74.703±0.771	60.710±1.105	6.606±0.188	24.140±0.968
Medium energy level				
0 mg	73.916±0.762	60.883±0.391	5.430±0.094	24.503±0.490
25 mg	75.150±0.288	61.046±0.104	5.866±0.164	24.200±0.180
50 mg	75.870±0.413	56.326±2.739	6.406±0.158	24.043±0.888
75 mg	74.543±0.884	59.793±0.647	6.880±0.342	24.750±0.462
High energy level				
0 mg	75.483±0.384	60.210±0.743	5.670±0.127	23.556±0.622
25 mg	75.133±0.857	57.883±3.350	6.483±0.103	23.943±0.969
50 mg	74.046±0.589	59.983±1.084	7.350±0.185	24.086±0.442
75 mg	74.053±0.666	57.893±1.294	7.636±0.273	24.736±0.456
Sigificance	NS	NS	NS	NS

Means in the same column within each classification with different letters differ significantly ($P<0.05$).

Moisture, crude protein and ether extract content of the fish flesh increased with increasing dietary energy level. The same trend was obtained by Ayyat *et al.* (2009) who reported that increasing dietary energy level increased the crude protein, ether extract and dry matter content, while the ash level was decreased.

Ether extract percentages of the flesh significantly ($P<0.001$) affected by dietary zinc supplementation, on the other hand crude protein, moisture and ash insignificantly affected (Table 5). Moisture, crude protein and ether extract content of the fish flesh increased with increasing dietary zinc level supplementation. The results of Zhao *et al.* (2011) showed that the composition of tilapia carcass was also found to be influenced by various levels of dietary zinc. Ayyat *et al.* (2004) reported that fish body composition did not affect significantly with dietary zinc supplementation.

Fish carcass components insignificantly affected by the interactions between dietary energy levels and zinc supplementation (Table 5).

In conclusion, supplementation Nile tilapia fish diets with 50 or 75 mg zinc/kg diet with high energy level could be recommended, since it showed the highest final weight and body gain weight and the best feed conversion.

REFERENCES

AOAC (1980). Official methods of analysis, 13th Ed. Association of Official Analytical Chemists, Virginia.

Ayyat M.S., F.S. Abbas, S.M. Sharaf and H.I. El-Marakby (2004). Growth performance, feed utilization and blood components of Nile tilapia *Oreochromis niloticus* as affected by dietary protein source and zinc supplementation. J. Egyptian Academic Soc. Environ. Develop., (B- Aquaculture), 5 (1): 1-15.

Ayyat, M.S., H.I. El-Marakby, F.M. Abbas, S.M. Sharaf and S.M. Hamdey (2009). Effect of dietary energy level and water temperature on growth performance of Nile tilapia (*Oreochromis niloticus*). Egyptian J. Nutr. and Feeds, 12 (3; Special Issue): 905-918.

Banerjee, G.C. (1987). Animal Husbandry. 6th Edition, Published by Mohan Prinzlani, Oxford.

Berger, A. and J.E. Halver (1987). Effect of dietary protein, lipid and carbohydrate content on the growth, feed efficiency and carcass composition of striped bass (*Morone saxatitis*) fingerlings. Aquaculture, 18: 345-356.

Duncan, D.B. (1955). Multiple range and multiple F-test. Biometrics, 11:1-42.

Eid, A.E. and S.I. Ghonim (1994). Dietary zinc requirement of fingerling *Oreochromis niloticus*. Aquaculture, 119 (2-3): 259-264.

El-Sayed, A.M. and S.I. Teshima (1992). Protein and energy requirements of Nile tilapia, *Oreochromis niloticus*, fry. Aquaculture, 103 (1): 55-63.

FAO (2012). Year Book of Fishery and Aquaculture Statistics, fisheries and aquaculture department food and agriculture organization of the united nations, Rome Italy, 239.

Freeman, B.W. (1983). Physiology and biochemistry of the domestic fowl. 4th Ed., Academic Press, New York and London, 181.

Hardy, R.W. and K.D. Shearer (1985). Effect of dietary calcium phosphate and zinc supplementation on whole body zinc concentration of rainbow trout (*Salmo gairdneri*). Candian J. Fishery Aquatic Sci., 42: 181-184.

McClain, W.R. and D.M. Gattin (1988). Dietary zinc requirement of *Oreochromis aureus* and effects of dietary calcium and phytate on zinc bioavailability. J. World Aquaculture Sci., 19: 103-108.

NRC (1993). Nutrient Requirements of Fish. National Academy Press, Washington, D.C.

Ogino, C. and G.Y. Yang (1978). Requiremnet of rainbow trout for dietary zinc. Bull. Jpn. Soc. Sci. Fish., 44: 1015-1018.

Ogino, C. and G.Y. Yang (1979). Requiremnet of carp for dietary zinc. Bull. Jpn. Soc. Sci. Fish., 45: 967-969.

Prasad, A.S. (1979). Clinical, biochemical, and pharmacological role of zinc. Annual Review of Pharmacol. and Toxicol., 20: 393-426.

Prasad, A.S. (1995). Zinc: an overview. Nutr., 11: 93-99.

Ramezani, H. (2009). Remove from marked records effects of different protein and energy levels on growth performance of caspian brown trout, *salmo trutta caspius* (Kessler, 1877). J. Fishery and Aquatic Sci., 4 (4): 203-209.

Saravanan, S., J.W. Schrama, A.C. Figueiredo-Silva, S.J. Kaushik, J.A.J. Verreth and I. Geurden (2012). Constraints on energy intake in fish: the link between diet composition, energy metabolism, and energy intake in rainbow trout. PLOS ONE, 7(4): 34-37.

Satoh, S., T. Takeuchi and T. Watanbe (1987). Availability of rainbow trout of zinc contained in white fish meal and various zinc compound. Bull. Jpn. Soc. Sci. Fish., 53: 595-599.

Satoh, S., W. Poe and R.P. Wilson (1989). Effect of supplemental phytate and/or tricalcium phosphate on weight gain, feed efficiency and zinc content in vertebrae of channel catfish. Aquaculture, 80: 155-161.

Scarpa, J. and D.M. Gatlin (1992). Effects of dietary zinc and calcium on select immune functions of channel catfish. J. Aquat. Anim. Health., 4 (1): 24-31.

Snedecor, G.W. and G.W. Cochran (1982). Statistical methods. 6th Ed. The Iowa State Univ., Press Ames, USA.

Solomons, N.W. (1998). Mild human zinc deficiency produces an imbalance between cell-mediated and humoral immunity. Nutr. Rev., 56: 27-28.

Sorensen, E.M.B. (1991). Metal poisoning in fish. CRC Press Inc., 2000 Corporate Blvd., N.W., Boca Raton, Florida, 33431, Library of Congress Card Number 91-7175, USA.

Stahl, J.L., M.E. Cook, M.L. Sunde and J.L. Greger (1989). Enhanced humoral immunity in progeny chicks fed practical diets supplemented with zinc. Appl. Agric. Res., 4: 86-89.

Wekell, J.C., K.D. Shearer and Jr.E.J. Cauglitz (1986). Zinc supplementation of trout diets: Tissue indicators of body zinc status. Progress Fish Culture, 48: 205-212.

Zhao, H.X., J.M. Cao, X.H. Liu, X. Zhu, S.C. Chen, H.B. Lan and A.L. Wang (2011). Effect of supplemental dietary zinc sources on the growth and carbohydrate utilization of tilapia Smith 1840, *Oreochromis niloticus* X *Oreochromis aureus*. Aquaculture Nutr., 17: 64.72.

تأثير كلا من مستوى الطاقة في العليقة وإضافة الزنك على مظاهر النمو والاستفادة من الغذاء وتأثيره على مكونات الدم في أسماك البلطي النيلي

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تمت هذه الدراسة بقسم الإنتاج الحيوانى، كلية الزراعة، جامعة الزقازيق، والتجربة العملية والتحليلات المعملية أجريت فى المعمل المركزى لبحوث الثروة السمكية بالعباسة، محافظة الشرقية، مصر، التجربة أجريت فى الفترة من شهر أغسطس لشهر نوفمبر ٢٠١٢، تم توزيع الأسماك إلى إثنى عشر معاملة وكل معاملة تحتوى على ٣ مكررات وكل مكررة تحتوى على ١٠ سمكات، تم تغذية أول ٤ معاملات على عليقة تحتوى على طاقة تقدر بـ ٤١١٣ كالورى/كجم (منخفضة الطاقة)، أما الأربع مجموعات الثانية تم تغذيتهم على عليقة تحتوى على طاقة تقدر بـ ٤٣٣٧ كالورى/كجم (متوسطة الطاقة) والأربع مجموعات الثالثة تم تغذيتهم على عليقة تحتوى على طاقة تقدر بـ ٤٥٥٩ كالورى / كجم (عالية الطاقة)، وداخل كل مجموعة من مستويات الطاقة تم إضافة أربع مستويات من الزنك وهى صفر، ٢٥، ٥٠، ٧٥ ملجرام/كجم علف، وجد أن الفروق غير معنوية بين المجموعات التجريبية لوزن الجسم الحي في بداية التجربة وكانت متجانسة، تأثر الوزن الحي الجسم، معدل الزيادة اليومي، ومعدل النمو النسبي والتحويل الغذائي فى الأسماك البلطي النيلى معنوياً بمستوى الطاقة الموجود فى العليقة، زاد معدل زيادة الوزن اليومي في الأسماك التى تغذت على مستويات عالية ومتوسطة الطاقة بنسبة ٥,٦٩ و٠,١٩% على التوالي، مستويات الطاقة فى عليقة السمك لم تؤثر على معدل الوفيات، البروتين الكلي في الدم، والألبيومين والجلوبيولين واليوريا، الكرياتينين، ALT والفوسفاتيز القلوية لم تتأثر معنويا مع مستوى الطاقة فى العليقة، في حين أن AST والدهون الذائبة تأثرت معنوياً، الرطوبة والبروتين الخام ومستخلص الأثير المستخلص من لحم السمك يزيد مع زيادة مستوى الطاقة فى العليقة، زاد وزن الجسم الحى النهائي بمعدل ٧,١٩ ، ٩,٢٠ و ١٣,٢٣%، على التوالي في الأسماك التى تغذت على عليقة تحتوى على ٢٥ و ٥٠ و ٧٥ ملجم من الزنك/كجم غذاء بالمقارنة مع الأسماك التي تغذيت بدون إضافة الزنك، وكانت نفس الأرقام لزيادة الوزن اليومية ٩,٦٥، ١٢,٢٨ و ١٧,٥٤% على التوالي، وأيضاً معدل التحويل الغذائى تحسن بنسبة ٣,٦٢، ٨,٧٢ و٨,٩٥% على التوالي. مجموعات الأسماك التى تغذت على عليقة بها٧٥ ملجم من الزنك/كجم علف سجلت أعلى معدل نمو وأفضل تحويل غذائى، البروتين الكلي في الدم، والألبومين، الجلوبيولين، الكرياتينين في مصل الدم، الفوسفاتيز القلوية والدهون تأثر معنويا مع إضافة الزنك في تغذية أسماك البلطي النيلى، في حين أن اليوريا، AST وALT لم تتأثر معنوياً، نسبة الدهون زادت معنويا مع إضافة الزنك في تغذية الأسماك، وعلى الجانب الآخر البروتين الخام، والرطوبة والرماد لم تتأثر معنوياً، كما لوحظ أن هناك زيادة في الرطوبة والبروتين الخام ومستخلص الأثير المحتوى من اللحم السمك مع زيادة مستوى الزنك فى العليقة، التداخل بين مستوى الطاقة فى العليقة وإضافة الزنك لم يؤثر معنويا فى كمية العلف المأكول، ونسبة التحويل الغذائي وجميع مكونات الدم التي شملتها الدراسة، العلائق المضاف إليها ٥٠ أو ٧٥ ملجم زنك/كجم علف مع مستوى الطاقة المرتفع يمكن التوصية بها، لأنها أظهرت أعلى النتائج فى الوزن النهائي والزيادة في وزن الجسم وأفضل تحويل غذائى.

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