EFFECT OF SELENIUM SUPPLEMENTATION ON GROWTH PERFORMANCE, BODY COMPOSITION, ANTIOXIDANT ENZYMES AND SERUM COMPONENTS OF NILE TILAPIA FISH

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ABSTRACT

Twelve weeks feeding experiment was conducted to evaluate the effect of dietary selenium (selenomeshionine) supplementation of Nile tilapia fingerlings diets on growth performance, body composition and Se eontent of the whole body tissue, serum antioxidant enzymes & serum components. Selenomethione was added to the basal diet (32.18 CP% and 3020 Kcal DE/kg) to supply 0.0, 0.20, 0.25 and 0.50 mg Se/kg and 0.25 mg Se + 200 mg vit. E/kg. Each diet was fed to a group of Nile tilapia fingerlings (no=32) of mean initial weight 14.21 ± 0.18g reared in10 aquaria of 70 L water capacity (2 replicates / each group).The aquaria were supplied with declorinated tap water and continuous air pumping. Body weight (BW), body weight gain (BWG), feed consumption and feed conversion ratio (FCR) were calculated biweekly. At end of the experiment, blood samples were taken from each group for serum preparation for determination of the antioxidant enzymes glutathione peroxidase (GPx), reduced glutathione (GSH), catalase (CAT), superoxide dismutase (SOD) and malondialdhyde (MDA). Also, serum total protein, albumin, uric acid, createnine levels and activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were analyzed as well. Fish (n=6) from each group were freshly minced and stored frozen till analyzed for proximate chemical composition and Se content. Selenium supplementation has significantly increased BW, BWG and FCR for the fish groups fed diets supplemented with 0.5 mg Se/kg or 0.25 mg Se + 200 mg vit. E/kg. Likewise, the fish group fed the diets supplemented with 0.2 or 0.25 mg Se/kg had higher BWG than the fish group fed the basal Se-unsupplemented diet. Selenium supplementation of the basal diet significantly increased the activities of serum GPx, GSH, CAT & SOD. The higher values of the antioxidant enzymes were reported for the fish fed the 0.50 mg Se or 0.25 mg/Se + 200 mg vit. E/Kg. The values reported for MDA were reduced for the fish groups fed the Se supplemented diets. There were no marked changes in the serum levels of total protein, albumin and globulin. Also, Se supplementation did not affect the serum level of metabolites & enzymes (ALT & AST) which indicate that the levels of Se supplementation in the present study did not disturb

the liver & kidney functions. From the results of the current study it could be concluded that Se content of the basal diet was not sufficient to obtain maximal growth of Nile tilapia fingerlings and Se or Se & vit. E supplementation could be advisable for optimal growth, increasing serum activities of antioxidant enzymes & maintaining the serum levels of the liver and kidney biochemical indicators.

However, Se supplementation increased Se residue in the whole-fish body tissue which could be a critical finding that must be considered.

INTRODUCTION

Selenium (Se) is an essential trace element for all animals including fish. It has been found to be an integral component of glutathione peroxidase (GPx). The activity level of this enzyme in plasma or liver is indicative for Se supply to the organism. The enzyme GPx protects cell membrane from oxidative damage by destroying hydrogen peroxide and hydroperoxides employing reducing equivalents from glutathione. Selenium deficiency generally resultes in growth depression, low feed efficiency and high mortality **(Watanabe et al., 1997)**. Mortality noted in salmon fry fed Se-deficient diet was prevented by feeding a diet containing 0.1 mg Se/Kg and 500 IU vitamin E/Kg. **Bell et al. (1985)** reported that GPx activity in the liver of rainbow trout was reduced when Se level was low in the diet (0.06 mg/Kg) and that the effect was more pronounced when less vit. E was provided. Also, **Hilton et al. (1980)** recorded maximum GPx activity in plasma of rainbow trout when the diet contained from 0.15-0.38 mg Se/Kg.

Fish derive Se from both diet & water and high levels of Se (40-130 µg/L) in water are toxic. Also the uptake of Se through gills is very efficient and the minerals are stored in various tissues **(Watanabe et al., 1997)**. Selenium is available from various feed ingredients and other Se-containing compounds. Fish meal and marine by-products are considered as feed ingredients that provide adequate Se to fish, but plant feeds vary widely in their Se content **(NRC, 1993)** however, the availability of Se from fish meals are considered to be lower than that of plant feeds **(Bell and Cowey, 1989)**. Even though the comparative availability of Se is poor, fish meal based diets generally provide sufficient Se to satisfy the nutritional requirement of fish **(NRC, 1993)**. However, it has been shown that for dietary Se, the margin between the nutritive requirement at levels normally present in feed ingredients and the toxic threshold in the diet is narrow **(Hodson and Hilton, 1983)**. High levels of Se in the diet have toxic effects, resulting in reduced growth, feed efficiency and increased fish mortality while prolonged intake of 3 mg Se/Kg diet was detrimental **(Hilton et al., 1980)**. Yet, several studies concluded that Se supplementation to fish diets improves growth & feed efficiency. It has been stated in the NRC for warmwater fish that Salmon fish obtained the best growth rate at level of 0.15 mg Se/Kg diet irrespective of Vit. E content of the diet and for Channel catfish is 0.25 mg/Kg and for Rainbow trout is 0.3 mg/Kg but the requirement was not determined in Common carp and for Tilapia the requirement from Se was not tested yet **(NRC, 1993)**.

Recently, in several studies, fish diets

were supplemented with high levels of Se (up to 6 mg/Kg diet) to improve growth performance and provide some protection against oxidative stress and histopathological lesions indueed by eyanobaeterial cells eontaining mierocystinins **(Jos et al., 2005; Atenico et al., 2008; Atenico et al., 2009)** or heavy metals, such as cadmium & copper distributed in aquatic environment **(Sampaio, 2004; Lin and Shiau, 2005 & 2007; Abdel-tawwab and Wafeek, 2010)** in Nile tilapia and other fish species. Nevertheless, the authors eoncluded that further studies are needed to test the effieiency, practical and healthy levels of supplementation of this antioxidant (Se).

Consequently, the purpose of this study is to investigate the effeet of dietary Se (from selenomethionine) supplementation at 0.2, 0.25 & 0.5 mg/Kg and 0.25 mg Se+200 mg vit. E on growth performance and whole body composition of Nile tilapia fingerlings. The effects of dietary Se level & vit. E supplementation on concentration of serum metabolites and antioxidant enzymes were also investigated.

MATERIALS & METHODS

The experiment was carried out over 112 days using Nile tilapia fingerlings with 14.21 ±0.18 g of average initial weight in 10 rectangular glass aquaria of approximately 70 L capacity at the Fish Feeding Lab, Dept. of Nutrition and Nutritional Deficiency Diseases, Faculty of Veterinary Medicine, Mansoura University, Egypt. In the pre-experiment period, 20 fish were randomly allocated to each aquarium and acclimatized to the experimental conditions with feeding normal basal diet eontaining 32% CP & 3020 Kcal DE/Kg and supplemented with minerals & vitamins premix to eover the reeommended levels for 2 weeks. The fish were weighed and then redistributed based on average equal BW in each of the 10 aquaria and the no. of fish/ aquarium was reduced to 16 fish. The aquaria were supplied with tap water treated for declorinization. Fish were maintained under natural light with photoperiod ranged from 12-13 light hour/day throughout the study. Eaeh aquarium was continuously aerated with 2 air stones from different air pumps, water temperature was recorded daily and ranged from 25-29°C throughout the experiment. All aquaria were cleaned daily by siphoning off accumulated waste materials approximately about 1/3 of water in each aquarium was siphoned daily along with excrement and replaeed with equal volume of aerated deehlorinized fresh water to maintain water volume and properties throughout the experiment.

Experimental diet:

Experimental basal diet (Table 1) was supplemented with organic selenium (selenomethion-ine) at 0.0, 0.2, 0.25, 0.50 mg Se/Kg & 0.25 mg Se + 200 IU Vit. E/Kg. Feed was offered at 3% of body weight (BW) daily in 2 meals/day at 9:00 am & 2:00 pm. Amount of feed offered was adjusted every 2 weeks based upon total weight of fish per each aquarium. Feed quantities for eaeh aquarium (2/group/ day) were weighed for the eorresponding group in small plastic bags (12 bags for each aquarium/2 weeks) and were used daily to record daily feed consumption. The five dietary treatments were, 1) experimental basal control diet (Se unsupplemented diet), 2) Se supplement at 0.2 ppm, 3) Se supplement at 0.25 ppm, 4) Se supplement at 0.50 ppm and

5) Se supplementation at 0.25 ppm + 200 mg vit. E/kg diet.

Diet preparation:

Feed ingredients were weighed at predetermined levels (%) for cach Kg diet, mixed through a feed mixer for 5 min. and then the amount of Se supplement was added and mixed well for 5 min. The weighed, mixed diets were supplied with 20 g gelatin (dissolved in boiled water at 400 ml/Kg diet) then pelleted in a pelleting machine (4-mm pellet diameter), left to full dryness, collected in paper bags, packed in plastic bags & kept in refrigerator until used.

Measurements & biochemical analysis:

Body weight (BW), body weight gain (BWG), feed consumed, feed conversion ratio (FCR), were calculated biweekly. Blood samples (n = 6 fish for each group) were collected randomly from each aquarium using a hypodermic syringe from the caudal vessels. The collected blood was left to clot in the refrigerator, centrifuged at 3000 rpm for 15 min. then serum was collected & stored at -20°C until used for determination of serum metabolites and antioxidant enzyme activities.

The activities of the antioxidant enzymes, serum enzymes and serum components were assayed in the fish serum using chemically prepared test kits and after the methods described by the produeers, Glutathione Peroxidase (GPx) activity was assayed by the method of **Paglia and Valentine (1967)** with modification according to **Lawrence and Burke (1978)**. The activity of serum catalase (CAT), superoxide dismutase (SOD) and reduced glutathione (GSH) were determined colorimetrically according to **Cohen et al (1970); Winterbourn et al. (1975) and Buetler et al. (1963)** respectively. Malondialdehyde (MDA) was determined according tc **Draper and Hadley (1990)**. Aetivities o aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determincd colorimetrieally according to **Reitman and Frankel (1957)**. Level of the serum components total protein & albumin, urie acic and createnine were measured calorimetrically as described by **Henry (1964); Barham and Trinder (1972) and Henry (1974)**, respectively.

Proximate Chemical Analysis:

Samples from the experimental basal diet and the whole-fish body reprcsented each experimental fish group were analyzed for proximate chemical composition (moisture, crude protein, EE and ash) and selenium content according to the methods of the **AOAC (1990)**. Digestible energy (DE) contents of the ingredients were figured out from feed composition tables for warmwater fish **(NRC, 1993)**.

At the end of the experiment, 6 fish from each group (3 from each aquarium) were randomly sampled and prepared for determination of Se content according to the method described by **Tinggi (1999)** by hydride generating atomic absorption spectrophotometer (2-5000, Hitachi Ltd., Tokyo, Japan).

Statistical Analysis:

The obtained data were statistically analyzed of variance (ANOVA) to test the effect of Se supplementation treatments and Duncan's Multiple Range test was used to compare

between means at P≤0.05 as described by **Snedecor & Cochran (1967)**.

Results & Discussion

Effects of Se supplementation (0.0, 0.2, 0.25 and 0.50 mg/Kg) or Se (0.25 mg) plus vitamin E (200 IU/Kg) on body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) are presented in table 2. Selenium supplementation at different levels with or without vitamin E has signifieantly improved BW and BWG during the rearing period from 1-4 weeks. FI was a reflection of improved BWG. Also, FCR (1.29) was better for the fish group fed the high Se diet (0.50 mg/Kg) followed by the group fed Se + vit. E (1.44) compared to 1.84 for the Se-unsupplemented group fed the basal diet. Similarly, the results reported for the rearing period from 4-8 weeks showed the same trends of increased BW & improved FCR of the fish groups fed the Se supplemented diets, in spite of decreasing the differences between FCR of the different fish groups (1.74 Vs 1.8 to 1.9). No differenees were deteeted in BWG between the fish groups fed the Se supplemented diets (0.25, 0.5 mg Se or 0.25 mg Se + vitamin E 200 IU/Kg) at the 8th week of the experiment.

The data concerning BWG & FI during the period from 8-12 weeks of the experiment showed that the fish groups mostly consumed less diet relative to their body weight, the figured amount was near to 2.5% of the achieved body weight. Less feed intake may be due to the increase in water temperature in the aquaria. The reeorded degree of temperature during this period ranged from 27.5 to 29.0°C. Decreased FI due to rise in water temperature in fish has been demonstrated in Tilapia **(NRC, 1993)**.

At the end of the experiment there was no significant difference in final body weight of the fish groups fed diets either supplemented with 0.5 mg Se/Kg or 0.25 mg Se + vit. E 200 IU/Kg also, Se supplementation at 0.2 or 0.25 mg Se/Kg improved BW when compared with the unsupplemented basal diet. Improved BWG & FCR due to dietary Se supplementation has been reported in different fish species **(Lin and Shiau, 2005),** in Grouper fish with 0.7 mg Se/Kg) and in Nile tilapia as well at 1.4 mg Se/Kg (Abdel-Tawwab and Wafeek, 2010).

The impact of Se and vit. E on performance & physiological parameters of Nile tilapia has been evaluated for 100 days, three levels of vit. E (100, 200 & 400 mg/Kg) with two levels of Se (0.50 and 1.0 mg/Kg) plus two treatments, no supplements and 0.50 & 0.25 mg/Kg of vit. E & Se (control diet), respeetively were experimented **(Sampaio, et al., 2004).** The author concluded that the results of the eontrol diet which covers the nutritional requirements reeommended by the **NRC (1993)** for Vit. E & Se or these of the other treatments (vit. E & supplements at different levels) for the parameters weight gain, feed conversion, survival rate and hematological parameters were not different (P> 0.05), as well as lack of supplementation versus nutritional requirements.

With the same concept, **Huang and Huang (2004)** supplemented basal diet of juvenile hybrid tilapia with 0 to 300 IU vit. E/Kg for 14 weeks and reported that growth perfor-

manee of fish fed diets containing 0 to 40 IU vit. E/Kg was significantly lower than those fed higher vit. E (>80 IU/Kg) diets. Feed conversion and protein efficiency ratio followed similar trends as growth performance. Also, induced lipid peroxidation in muscle & liver of fish fed diets containing 0-40, 10 vit. E/Kg was significantly greater than those fed diets containing higher Vit. E (> 80 IU/Kg). Tissue vit. E and liver glutathione level increased with increasing dietary vit. E.

Alternatively, **Huang et al. (2004)** conducted a feeding trial in juvenile hybrid tilapia (O. nilotica X O.aureus) to evaluate the effect of vit. E content (0, 50, 100, 200, 450 and 700 mg α-toehopherol acetate /Kg diet) for 14 weeks on growth and lipid peroxidation in muscle and liver. The results showed that there was no significant difference in weight gain, feed conversion ratio and protein efficiency among the fish groups. Protein content of whole body of fish fed diet containing the lowest vit. E level was the lowest. Moreover, lipid peroxidation values were highest in muscle and liver of the fish group fed the α-tochopherol acetate unsupplemented diet. The authors concluded that dietary vit. E supplementation increased the oxidation capacity of Tilapia tissues against lipid peroxidation.

Supplementation of the basal control diet with Se at levels 0.25, 0.50 mg/Kg or 0.25 mg + 200 IU vit. E/Kg significantly elevated the concentration of serum glutathione peroxidase (GPx) and reduced glutathione (GSH) (Table 3). Nevertheless, 0.2 mg Se/Kg supplemented to the basal diet did not significantly increase the level of serum GPx. Similarly, supplementing the normal basal diet with Se or Se & vit. E significantly redueed the serun level of malondialdhyde (MDA). In the fisl group fed the diet supplemented with Se & vit. E the reduction in serum level of MD/ was clearly marked (Table 3). It has been con cluded that serum level of MDA can be use as a biomarker of lipid peroxidation **(Sheu e al., 2003; Lin and Shiau 2007)**. The reduc tion in the concentration of MDA in the fisl groups fed Sc (0.25, 0.50) or Se+ vit. E sup plemented diet suggested that dietary Se sup plementation decreased oxidative damage ir fish tissues and such levels of supplementa tion are dietary sufficient.

Supplementation of the basal diet with 0.5 mg Se/Kg or 0.25 mg Se + vit. E (200 IU/Kg inereased the serum level of catalase (CAT while, lower level of supplementation (0.2 or 0.25 mg Se/Kg) did not activate the serum levcl of CAT in comparison with the fish group fed the basal diet. The results also showed that Se supplementation of the basal diet with or without Vit. E significantly increased serum levels of superoxide dismutase (SOD), the highest levels were recorded for the fish groups fed both the diet supplemented with 0.50 mg Se or 0.25 mg Se + 200 IU vit. E/Kg (Table 3).

Higher levels of GPx, GSH, CAT & SOD activities in liver & kidney of fish fed Se-supplemented diets were reported in several fish species such as Rainbow trout **(Hilton et al., 1980)**, Atlantic salmon **(Bell et al., 1987)**, in Grouper fish **(Lin and Shiau 2005 & 2007)** and in Nile tilapia as well **(Atencio et al., 2009; Abdel-Tawab and Waffek, 2010)**. Though, the amount of Se supplemented to the fish diet used by the last authors was

much variable (1.5 to 6.0 mg/Kg diet) than the supplemented levels (0.2 to 0.5 mg/Kg) in our study.

Selenium has shown to have a pro-oxidant effect with increased kidney lipid peroxidation (LPO) values and liver & kidney GPx activities in Nile tilapia fish fed diets supplemented with 1.5, 3.0 & 6.0 mg Se/g **(Atencio et al., 2009)**. The results showed that the protective role of Se is depending on the level of Se supplement and the biomarker considered. The authors concluded that the level of Se supplementation must be therefore carefully selected to provide beneficial effects to avoid potential negative consequences.

Serum, tissues and liver tissue of MDA is an indicator for lipid peroxidation (LPO). Lipid peroxidation is a serious problem for biological materials containing unsaturated fatty acids. This is particularly important for aquatic animals since they normally contain greater amount of polyunsaturated fatty acids (PUFA) (both n-3 & n-6 fatty acids) than other species. Therefore, diets of Nile tilapia must contain a proper amount of a potent biological antioxidant that can protect biomembranes and lipid containing PUFA against attack of oxygen free radicals, such as vit. E components (α-γ tochopherols) & Se. Nevertheless, many studies have shown that the requirements of Tilapia and other fish species are variable **(Satoh et al., 1987; Schwarz et al., 1988; Roem et al., 1990; Shiau and Shiau, 2001; Huang et al., 2004; Sampaio et al., 2004). Confirming these findings, Huang et al. (2004) and Huang and Huang (2004)** brought to a close that dietary vit. E supplementation increased the antioxidant capacity of Tilapia tissues against lipid peroxidation.

Since the function of GPx is to eliminate peroxides through oxidation of GSH, vit. E supplementation which followed by high concentration of vit. E in the liver would expected to increase the antioxidant power of the biological systems, thus reducing the consumption of GSH. Therefore, GSH increased when dietary vit. E increased. Also, **Gabrielsen and Opstvedt (1980)** demonstrated that Se availability (relative to Se in selenite = 100%) in feeds for restoring blood serum GPx activity in Se-depicted chicks was in fish meal 48.0 - 34.1%, soybean meal 17.5%, corn gluten meal 25.7% and in selenomethionine 78.3%.

From the present results it could be concluded that in spite of presence of Se in the basal diet (0.6 mg/Kg) which covers Se requirement of Nile tilapia in the concept of the **NRC (1993)** recommendations, over supplementation of Se in the selenomethionine form improved the activity of GPx, GSH and other antioxidant enzymes (CAT & SOD) and decreased the level of MDA which may reflect the low availability & insufficieney of Se present in the feed ingredients. This finding agrees with the earlier results of **Bell and Cowey (1989)** that the availability of Se from fish meal, soybean meal & corn is low.

Supplementation of the basal diet with Se or Se & vit. E did not significantly affect ($P>0.05$) the levels of total serum proteins in Nile tilapia fish (Table 4). Significant increase was observed in the total proteins and albumin levels of the fish group supplemented with 0.25 mg Se/Kg diet. Also, the level of

serum globulin was significantly elevated in the fish group fed the diet supplemented with 0.25 mg Se+ 200 IU vit. E/Kg (Table 4).The data presented in table 4, also showed that the serum level of uric acid markedly increased in the fish groups supplemented with Se (0.2 & 0.5 mg) or Se + vit. E. On the other hand, feeding the Nile tilapia fish Se or Se + vit. E supplemented diet for 14 weeks did not affeet the serum level of ALT or AST, a finding that may refleet healthiness of internal organs (liver & kidney).

Reviewing the data presented in table 5 showed that there were no significant ($P<0.05$) changes in the percentage of dry matter, crude protein, erude fat (ether extract) & ash of the whole body of Nile tilapia fish fed the basal control diet supplemented with Se (0.2, 0.25 & 0.50 mg Kg^{-1}) or 0.25 Se + 200 mg vit. E Kg -1diet. However, the data showed that Se supplementation significantly increased Se content of the whole body tissue of fish, the increment of Se content was gradual with the Se supplemented to the basal diet. Increase of Se residues in the whole body tissue due to gradual levels of dietary Se supplementation has been reported **(Lin and Shiau, 2007)** in grouper fish & in Nile tilapia **(Abdel-Tawab and Waffek, 2010)**. On the other hand, **Abdel-Tawab and Waffek (2010)** found that dietary organic Se supplementation (1.04 & 5.54 mg/Kg) of Nile tilapia fingerlings significantly affects all fish body constituents except moisture content & showed that crude protein & total lipids in fish body decreased, whereas ash content increased significantly.

Selenium supplementation improves body growth through synthesis of glutathione peroxidase (GPx) the antioxidant enzyme which protects the tissues against oxidative stress. Oxidative stress occurs when reactive oxygen substances (ROS) overwhelm the cellular defense and damage protein, membranes and DNA **(Kelly et al., 1998)**. Reactive oxygen substances generated in tissues are effectively scavenged by the antioxidant defense system that in aquatic organisms eomprise specific antioxidant enzymes, sueh as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), glutathione reductase (GR), reduced glutathione (GSH) and the vitamins (E, A & C) and carotenes **(Atencio et al., 2009)**. The activity of extracellular and cytosolic forms of GPx to produce oxidized glutathione (GSSG) and water is dependent upon the essential trace element Se **(Maier and Knight, 1994)**. Moreover, the essential nutrient Se proteets against oxidative stress by being a part of GPx constituted by four subunits & each subunit contains one Se atom **(Batcioglu et al., 2002)**. Furthermore it is a component of deiodinase & thioredoxin reductase, which are involved in DNS synthesis, oxidative stress defense and protein repair **(Arner and Holmgren, 2000)**. It is also well known that Se has potent cytotoxic effects by reacting with sulphydryl groups to produce biologically active ROS **(Spallholz et al., 2004)**. As a nutrient, the dietary Se requirement for fish is 0.1 to 0.7 mg/Kg dry diet and its beneficial effects are firmly established **(Lin and Shiau, 2005; Atencio et al., 2009)**. Conversely, at dietary level of only 7-30 times of the Se required (>3 mg/g) Se become toxic **(Lemly, 1997)**. Hence, regulation of optimal dietary level of Se appears to be critical for protection of tissues from H_2O_2 induced oxidative damage and maintaining overall

health **(Palchaudhuri et al., 2001)**.

From the results of the current study it could be concluded that Se content of the basal diet is insufficient for maximal growth of Nile tilapia fingerlings and Se or Se & vit. E supplementation could be advisable for optimal growth, increasing serum activities of antioxidant enzymes & maintaining the serum levels of the liver and kidney biochemical indicators. However, Se supplementation increased Se residue in the whole-fish body tissue which could be a critical finding that must be considered.

Table1. Ingredients & nutrient composition of the experimental basal diet used in feeding of Niletilapia fingerlings during the experiment (*14 weeks*).

Corn, yellow	**33.55**	**Crude protein %**	**32.18**
Wheat bran	**10.00**	**DE (Kcal/Kg)****	**3020**
Soybean meal	**21.75**	**Ether extract %**	**6.10**
Fish meal, herring	**21.75**	**Crude fibers %**	**5.24**
Fish oil	**2.00**	**Selenium content (mg/Kg)**	**0.60**
Corn oil	**2.00**		
Berseem hay meal	**5.00**	**Calcium %**	**0.88**
Mineral &Vitamin premix*	**1.00**	**Phosphorus %**	**0.41**
Dicalcium phosphate	**1.00**		

* Trace minerals & vitamins premix prepared to cover the levels of the microminerals & vitamins for Tilapia fish as recommended by the **NRC (1993)**.
Selenium free mineral mixture (mg/Kg diet): Cu 3, Mn 15, Fe 150, I 1.1 & Zn 30.
Vitamins premix (IU or mg/Kg diet); vit.A 4500, vit.D 500, vit.E 50, vit K 20, riboflavin 6, niacin 28, B_{12} 0.01, pantothenic acid 10, choline 500, biotin 150, folacin 2, vit. B_6 6, thiamin 2, myoinsitol 400 & vit.C 100.
Dietary supplemental Se (mg/Kg) at levels 0.0, 0.2, 0.25, 0.50 & 0.25 + 200 IU Vit. E.

** DE(Kcal/Kg) values are calculated from the feed composition tables, Nutrient requirement of fish (NRC 1993)

Table 2: Growth performance of Nile tilapia fingerlings fed basal diet (*32.18% CP & 3020 Kcal DE/Kg*) supplemented with different levels of selenium for *14* weeks.

	Basal diet	Se supplementation (mg/Kg diet)			
	0.60mg Se/Kg	**0.20**	**0.25**	**0.50**	**0.25+Vit.E**
Experimental period					
Initial BW (g)	14.22±0.31	14.19±0.23	14.20±0.26	14.22±0.24	14.21±0.25
1-4 weeks					
BW (g)	19.54^{c}±0.31	21.24^{b}±0.28	21.44^{b}±0.34	23.90^{a}±0.32	22.25^{b}±0.35
BWG (g)	5.32	7.05	7.24	9.66	8.04
F. consumption(g)	9.80^{b}±0.25	10.95^{a}±0.28	11.10^{a}±0.28	12.50^{a}±0.18	11.60^{a}±0.26
FCR	1.84	1.55	1.53	1.29	1.44
1-8 weeks					
BW (g)	27.10^{c}±0.28	29.88^{b}±0.33	30.90^{b}±0.39	34.94^{a}±0.42	32.25^{b}±0.35
BWG (g)	7.56	8.64	9.46	11.04	10.00
F. consumption(g)	14.80^{a}±0.33	16.06^{b}±0.37	16.40^{b}±0.41	19.20^{a}±0.25	18.00^{a}±0.42
FCR	1.96	1.85	1.73	1.74	1.80
8-12weeks					
BW (g)	36.43^{c}±0.35	40.35^{b}±0.37	41.58^{b}±0.37	45.74^{a}±0.36	42.10^{b}±0.38
BWG (g)	9.33	10.47	10.68	10.90	9.85
F. consumption(g)	17.46^{b}±0.39	19.01^{a}±0.43	19.55^{a}±0.34	20.74^{a}±0.31	19.10^{a}±0.49
FCR	1.89	1.82	1.83	1.90	1.94
12-14weeks					
Final BW (g)	42.10^{c}±0.51	47.08^{b}±0.46	48.20^{b}±0.53	52.90^{a}±0.48	50.08^{a}±0.36
BWG (g)	5.67	6.73	6.62	7.17	6.98
F. consumption(g)	11.00^{b}±0.38	12.25^{ab}±0.24	12.25^{ab}±0.20	13.00^{a}±0.35	12.60^{ab}±0.38
FCR	1.94	1.82	1.85	1.81	1.81
Total BWG (g)	**27.88**	**32.89**	**34.00**	**38.68**	**35.87**
Total FCR	**1.90**	**1.77**	**1.74**	**1.69**	**1.71**

Vitamin E supplemented at 200 mg/Kg.

^{a,b,c} means in the same row with different superscripts are statistically different at ($P<0.05$).

Body weight=BW Body weight gain=BWG Feed conversion ratio=FCR

Table 3: Effect of selenium supplementation on serum levels of antioxidant enzymes of Nile tilapia fingerlings fed the basal diet for 14 weeks.

Parameters	Basal diet	Se supplementation (mg/Kg diet)			
	0.60mg Se/Kg	0.20	0.25	0.50	0.25+Vit.E*
GPx (mU/ml)	287.35^{b} ±17.24	320.47^{b} ±23.19	416.36^{a}±34.86	439.82^{a} ±36.74	410.66^{a} ± 27.15
GSH (mg/dl)	1.487^{d} ±0.073	2.347^{c} ±0.026	3.820^{b}±0.031	4.223^{a} ±0.217	3.190^{b} ± 0.191
CAT (U/L)	431.27^{b} ±71.90	367.75^{c} ±43.82	569.70^{a}±72.41	544.85^{a} ±32.71	382.35^{c} ± 29.75
SOD (U/ml)	278.41^{c} ±21.30	447.30^{b} ±28.70	620.00^{a}±38.9	654.80^{a} ±41.6	533.73^{b} ± 38.2
MDA(µmol/L)	0.933^{a} ±0.028	0.713^{b} ±0.047	0.644^{b} ±0.038	0.540^{c} ±0.120	0.538^{c} ± 0.130

^{a,b,c} means in the same row with different superscripts are statistically different at (P<0.05).
GP_x= Glutathione peroxidase GSH= Reduced glutathione CAT= Catalase
SOD= Super oxide dismutase MDA= Malondialdhyde

Table 4: Effect of selenium supplementation on the biochemical serum components (Mean ± SD) of Nile tilapia fingerlings fed the experimental diets for 14 weeks.

Parameters	Basal diet [1]	Se supplementation (mg/Kg diet)			
	0.60 mg Se/Kg	0.20	0.25	0.50	0.25+Vit.E[2]
Total Protein (g/dl)	4.16 ±0. 25	4.20 ± 0.22	4.63 ± 0.25	4.27 ± 0.24	4.26 ± 0.23
Albumin (g/dl)	2.61^{b} ±0.23	2.55^{b} ± 0.28	3.05^{a}± 0.28	2.80^{a}± 0.26	2.37^{b} ± 0.21
Globulin (g/dl)	1.55^{b} ±0.27	1.65^{b} ± 0.18	1.58^{b}± 0.31	1.47^{b}± 0.31	1.89^{a} ± 0.26
Uric acid (g/dl)	0.71^{c} ±0.23	1.48^{a} ± 0.51	1.08^{b} ± 0.87	1.93^{a} ± 0.85	1.88^{a} ± 0. 34
Creatinine (g/dl)	0.90 ±0.29	0.80 ± 0.33	1.00 ± 0.27	1.00 ± 0.25	1.13 ± 0.23
ALT (IU/L)	25.16 ±3.70	25.72 ± 2.53	26.26 ±3.27	26.50 ±4.89	26.43 ± 3.47
AST (IU/L)	39.50 ±2.10	42.84± 3.24	43.45 ± 4.60	43.63 ± 3.45	44.82 ± 2.98

^{ab} means in the same row with different superscripts are statically different (P<0.05).
[1] Basal diet containing 0.60mg Se/Kg
[2] Vitamin E supplemented at 200 mg/kg diet

Table 5: Effect of selenium supplementation level on proximate chemical composition and Se content of whole body of Nile tilapia fingerlings fed basal diet for 14 weeks

	Basal diet	Se supplementation[1] (mg/Kg diet)			
Parameters	**0.60mg Se/Kg**	**0.20**	**0.25**	**0.50**	**0.25+Vit.E**
Dry matter (%)	24.10	24.82	24.61	23.97	24.21
Crude protein (%)	14.86	15.12	14.81	14.87	15.01
Crude fat (%)	4.	5.29	5.39	4.09	4.46
Ash (%)	4.31	4.25	4.22	4.89	4.72
Se content* (µg/g)	0.61^{d} ±0.09	0.70^{c} ±0.18	0.73^{bc} ±0.21	1.11^{a} ±0.19	0.80^{b} ±0.011

*mcg/g of whole body tissue on wet weight
1=0.2, 0.25, 0.50 mg Se/Kg as selenomethionine supplements to the basal control diet.
Mean ± SE (n= 3x2=6 samples for each group)

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الملخص العربى

تأثير إضافة السيلينيوم على معدلات النمو، مكونات الجسم، الإنزيمات المضادة للأكسدة وبعض مكونات مصل الدم فى أسماك البلطى النيلى

ط. ب/ عـلا عرمـه أ. د/ طـــارق محمـــد
أ. د/ عبدالناصر بكر أ. د/ عبدالهادى عرمه

أجريت هذه الدراسة لمدة 14 إسبوع على إصبعيات أسماك البلطى النيلى عددها 160 ومتوسط وزنها 14.21±0.18 جم لدراسة تأثير إضافة السيلينيوم العضوى للعلائق على معدلات النمو والتحويلات الغذائى والاستجابة الفسيولوجية والمكونات الكيميائية للجسم (المادة الجافة، البروتين، الدهون، والأملاح المعدنية) ونشاط الإنزيمات المضادة للأكسدة وبعض مكونات مصل الدم، أضيف السيلينيوم للعليقة الأساسية (32.18% بروتين و 3020 كيلو كالورى طاقة مهضومة/كجم علف) بنسبة 0.5,0.25.0.2,0 ملجم وأيضاً 0.25+200 ملجم فيتامين هـ ليكون 5 مجموعات فى 10 أحواض زجاجية سعة كل منها 70 لتر متوفر بها كل الظروف الملائمة للنمو، أعدت العلائق المستخدمة لتغذية الأسماك فى صورة حبيبات قطرها 4 ملم وغذيت عليها الأسماك بنسبة 3% من وزن الجسم وتم وزن الأسماك مرة كل إسبوعين، تم قياس معدلات النمو (وزن الجسم - النمو المطلق) واستهلاك العلف ومعامل التحويل الغذائى، وأخذت عينات الدم من كل مجموعة لتجهيز مصل الدم لقياس مستوى الإنزيمات المضادة للأكسدة وبعض مكونات مصل الدم، وقد أخذت عينات عشوائية من كل مجموعة فى نهاية التجربة لقياس المكونات الكيميائية للجسم على أساس المادة الجافة.

وأدت التجربة إلى النتائج التالية : إن إضافة السيلينيوم (0.5 أو 0.25+200 ملجم فيتامين هـ) أدى إلى تحسن فى وزن الأسماك، معدل النمو، استهلاك العلف ومعامل التحويل الغذائى وزيادة ترسيب السيلينيوم فى الجسم وزيادة نشاط الإنزيمات المضادة للأكسدة بينما لم يحدث تأثير ملحوظ فى مكونات مصل الدم (البروتين والألبيومين والجلوبيولين) مما يدل على أن زيادة السيلينيوم لم تضر بوظائف الكبد والكلى وخلصت هذه الدراسة إلى أن كمية السيلينيوم التى تحتوى عليها العليقة الأساسية ليست كافية للحصول على أفضل مستوى للنمو لأسماك البلطى النيلى ومن الأفضل إضافة السيلينيوم أو السيلينيوم مع فيتامين هـ لتحسين النمو وزيادة نشاط الإنزيمات المضادة للأكسدة وبعض مكونات مصل الدم.