

PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus*) FINGERLINGS FED DIETS CONTAINING DIFFERENT LEVELS OF L-CARNITINE

A.M.A. El-Hais

Department of Animal Production, Faculty of Agriculture, University of Tanta, Egypt

SUMMARY

This study was designed to evaluate the effect of dietary L-carnitine supplementation at different levels (0.0, 0.25, 0.50 and 1.0 %DM basis) on growth performance, feed utilization, body composition and some blood parameters of Nile tilapia, *Oreochromis niloticus*. Experimental diets were isonitrogenous and isocaloric (29.48 % CP and 4.55 kcal/GE/g in average). A total number of 120 Nile tilapia fingerlings with an average initial body weight of 5.93g/fish were randomly distributed into four treatment groups and stocked into 12 glass aquaria (70 liter each). Four experimental groups in triplicate aquaria were fed daily at a rate of 5, 4 and 3% of the body weight daily for the 1-4, 5-8 and 9-12 weeks, respectively. The results indicated that final body weight, weight gain, daily gain and specific growth rate for fish groups fed diets supplemented with L-carnitine were significantly ($P<0.05$) higher compared with the control group. In addition, the feed conversion ratio, protein efficiency ratio in treatments receiving L-carnitine were significantly better ($P<0.05$) than those fed the control diet. Concerning the influence of L-carnitine on the proximate composition of carcass, no significant differences ($P>0.05$) were observed among different treatments in carcass moisture, crude protein, lipid, ash and energy contents. Results showed that no significant differences ($P>0.05$) were observed among different treatments in plasma glucose, total protein and total lipids, but acted on improving each of the aspartate aminotransferase and alanine aminotransferase. In conclusion, the addition of L-carnitine in the diets, specially at level 1.0%, enhances the growth performance of Nile tilapia, *Oreochromis niloticus*, fingerlings.

Keywords: Feed additives; L-carnitine; Nile Tilapia; growth performance and feed utilization

INTRODUCTION

Nile tilapia, *Oreochromis niloticus* (L.), is an important species for freshwater aquaculture. Improving fish performance and disease resistance of cultured organisms are the major challenges facing fish culturists. Moreover, bacterial diseases are one of the limiting factors for fish culture including Nile tilapia.

L-carnitine (L- β -hydroxy γ -trimethyl aminobutyrate) is a water-soluble quaternary amine that occurs naturally in microorganisms, plants and animals (Bremer, 1983) and is synthesized from the essential amino acids lysine and methionine with the assistance of vitamin C and other compounds produced in the body (Rebouche, 1991). It functions as a cofactor for the transport of fatty acids into

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the mitochondrial matrix. Increased import of fatty acids into the mitochondria for oxidation has the potential to spare the catabolism of proteins for energy. Thus, animals fed diets with elevated L-carnitine contents may have more protein and energy available for growth.

Based on the role of carnitine in vertebrates, its supplementation in aqua feeds has been advocated for multifunctional purposes: (1) as a growth promoter; (2) providing protection against toxic levels of xenobiotics; (3) alleviating stress related to water temperature extremes; (4) inducing changes in muscle structure/texture related to higher levels of swimming activity and (5) enhancing reproduction (Harpaz, 2005).

Several studies on pigs, foals and broiler chickens have shown that growth performance was significantly improved by feeding dietary L-carnitine (Weeden *et al.*, 1991; Hausenblasz *et al.*, 1996 and Rabie *et al.*, 1997). Studies employing carnitine in fish have indicated growth improvement in sea bass (Santulli and D'Amelio, 1986), African catfish (Torreale *et al.*, 1993), carp (Becker and Focken, 1995) red sea bream (Chatzifotis *et al.*, 1995), white prawn (Jayaprakas and Sambhu, 1996) and hybrid sea bass (Twibell and Brown, 2000). On the other hand, inclusion of different levels of L-carnitine in diet has negligible or even negative effects on growth in warm water fish (Dzikowski *et al.*, 2001 and Schlechtriem *et al.*, 2004) and cold water fish species (Chatzifotis *et al.*, 1997 and Gaylord and Gatlin, 2000). These differences of results between species suggest that the effects of dietary carnitine supplements are associated with different factors such as age, fish size, experimental period, feed composition and levels of supplements.

The present study aimed to determine the effect of dietary supplementation of L-carnitine at different levels (control (0.0), 0.25, 0.50 and 1% DM basis) on growth performance, feed utilization, body composition and some blood parameters of Nile tilapia, *Oreochromis niloticus*, fingerlings.

MATERIALS AND METHODS

This study was carried out at the Wet Fish Laboratory, Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh University, Egypt.

Experimental fish:

Nile tilapia, *Oreochromis niloticus*, fingerlings were brought from a fresh water commercial farm in Motobas, Kafr El-Sheikh Governorate, Egypt. Prior to the start of the experiment, fingerlings were placed in a fiberglass tank and randomly distributed into glass aquaria to be adapted to the experimental condition until starting the experiment. Fish were fed on the control diet for two weeks, during this period healthy fish at the same weight were replaced instead of dead ones. All the experimental treatments were conducted under an artificial photo period equal to natural light/darkness period (12h light: 12h darkness).

Experimental Diets:

Four experimental diets were formulated to contain L-carnitine for tilapia fingerlings. Diet one (control diet without supplements); second to fourth diets were supplemented with L-carnitine at different levels (0.25, 0.50 and 1%), respectively. The basal and tested diets were formulated from the commercial feed ingredients. The dry ingredients were ground through a feed grinder to very small size (0.15 mm).

L-carnitine was obtained from Global Napi Pharmaceuticals Company 6th, of October city.

Experimental diets were formulated (Table 1) to be isonitrogenous and isocaloric (about 29.48% crude protein and about 454.60 kcal GE/100g diet). The ingredients were weighed and mixed by a dough mixer for 20 minutes to homogeneity of the ingredients. The estimated amount of oil components (sunflower oil) was gradually added (few drops gradually) and the mixing operation was continued for 20 minutes. The diets were pelleted through fodder machine and the pellets were dried under room temperature. The diets were collected, and stored in plastic bags in refrigerator at 4°C during the experimental period to avoid the deterioration of nutrients.

Table 1. Composition and proximate analysis of the experimental diets

Item	Diet ⁵ No (on DM basis, %)			
	D1 Control	D2	D3	D4
<u>Feed ingredients</u>				
Herring fish meal	12	12	12	12
Soybean meal	32	32	32	32
Yellow corn	36	35.75	35.50	35.00
Wheat bran	15	15	15	15
Sunflower oil	3	3	3	3
Vitamins and minerals premix ¹	2	2	2	2
L-carnitine	0	0.25	0.50	1.00
Total	100	100	100	100
<u>Chemical composition (% DM)</u>				
Dry matter	91.02	90.89	90.76	90.92
Crude protein	29.34	29.46	29.52	29.58
Ether extract	5.21	5.26	5.28	5.31
Crude fiber	4.21	4.24	4.22	4.25
Total ash	4.54	4.57	4.59	4.55
Nitrogen free extract	56.70	56.47	56.39	56.31
<u>Calculated energy value</u>				
GE (kcal/kg) ²	4543	4545	4547	4549
DE (kcal/kg) ³	3407	3409	3410	3412
P/E,mg/kcal ⁴	86.12	86.42	86.57	86.69

¹Vitamins and minerals premix at 2 % of the diet supplies the following per kg of the diet: 75000 IU Vit.A; 9000 IU Vit. D3 ; 150 mg Vit. E ; 30 mg Vit. K3 ; 26.7 mg Vit. B1; 30 mg Vit. B2; 24.7 mg Vit. B6 ; 75 mg Vit.B12; 225 mg Nicotinic acid ; 69 mg Pantothenic acid ; 7.5 mg Folic acid; 150 mg vit. C; 150 mg Biotin; 500 mg Choline chlorid 300 mg DL-methionine; 93 mg Fe; 11.25 mg Cu; 210 mg Zn; 204 mg Mn; 5 mg Se and Co 5 mg (Local market).

²GE (Gross energy) was calculated according to NRC (1993) by using factors of 5.65, 9.45 and 4.22 K cal per gram of protein, lipid and carbohydrate, respectively .

³DE (Digestible energy) was calculated by applying the coefficient of 0.75 to convert gross energy to digestible energy according to Hephher *et al.*, (1983).

⁴P/E (protein energy ratio) = crude protein x 10000 / digestible energy, according to Hephher *et al.* (1983).

⁵Treatments: T1 (control): 0% L-carnitine, T2: 0.25% L-carnitine, T3: 0.50% L-carnitine and T4: 1.0% L-carnitine .

Experimental design of rearing fish:

A total of 120 Nile tilapia, *Oreochromis niloticus*, fingerlings with an average initial body weight of 5.93g/ fish were randomly divided into four treatment groups and stocked into 12 glass aquaria (70 liter each). Three aquaria were assigned for each treatment.

Fresh tap water was stored in fiberglass tanks for 24h under aeration for dechlorination. One third of all aquaria were replaced daily. Five air stones were used for aerating the aquaria water. Fish feces and feed residues were removed daily by siphoning. Fish from each replicate were weighed at the start of each experiment and counted and weighted every two weeks throughout the experimental period (12 weeks).

Fish in all treatments were fed daily at a rate of 5, 4 and 3% of the body weight daily for the 1-4, 5-8 and 9-12 weeks, respectively. The feed amount was given three times daily (9 00, 1200 and 1500) in equal proportions, six days a week for 12 weeks. Fish were weighed biweekly and feed amounts were adjusted on the basis of the new weight.

Chemical analysis:

Proximate chemical analyses were made of diet ingredients and a sample of fish at the beginning and end of the experiment according to standard methods (A.O.A.C., 1992) for dry matter, crude protein, ether extract, crude fiber and ash. Gross energy (GE) contents of the experimental diets and fish samples were calculated using factors of 5.65, 9.45 and 4.22 kcal/g of protein, lipid and carbohydrates, respectively (NRC, 1993).

Measurements of water parameters:

Water samples were taken each two days for ammonia and pH analysis. Analytical methods were done according to the American Public Health Association (APHA, 1985). The pH values were determined by a digital pH-meter. Water temperature and oxygen level were measured daily at 8 o'clock by (Oxygen meter model 9070). In all treatments water quality parameters for water temperature ranged between 27 to 28.50°C, pH (7.3 to 8.2); dissolved oxygen (5.80 to 6.32 mg/L) and water ammonia (0.07 to 0.11 mg/L). All the water quality parameters were within the acceptable ranges for fish growth (Boyed, 1984).

Blood parameters:

Blood samples were collected at the end of the experiment, fish in each aquarium were weighed and 5 fish were taken randomly for blood sampling. The blood was collected using heparinized syringes from the caudal vein. Blood samples were centrifuged at 4000 rpm for 20 minutes to allow separation of plasma which was subjected to determine plasma total protein (Tietz, 1990). Blood plasma total lipids were determined according to the method of McGowan *et al.* (1983). Glucose concentration was determined according to Trinder (1969). Alanine aminotransferase (ALT) and activity of aspartate aminotransferase (AST) were determined by the methods of Young (1990).

Statistical analysis:

The obtained numerical data were statistically analyzed using SPSS (1997) for one-way analysis of variance. When F-test was significant, least significant difference was calculated according to Duncan (1955).

RESULTS AND DISCUSSION

Chemical composition of the experimental diets:

Experimental diets (Table 1) contained nearly similar levels of DM, CP, EE, CF, Ash, NFE, GE, DE and P/E ratio. The CP and GE content of experimental diets were around 29.48 % and 4.55 kcal/g, respectively. These values were within the range suggested for tilapia by Jauncey and Ross (1982) and NRC (1993).

Growth performance and survival rate:

Data in Table (2) show the growth performance and nutrient utilization efficiencies of Nile tilapia fingerlings fed diets containing L-carnitine. Statistical analysis showed no significant differences ($P > 0.05$) in initial body weight among the different experimental treatments, indicating the accuracy of randomization process among the experimental treatments.

It is clearly shown in table, 2 that, the groups of fish fed diets supplemented with different levels of L-carnitine had significantly ($P < 0.05$) higher growth values than the control diet (without supplements). However no significant differences were observed between fish groups fed diet supplemented with L-carnitine.

Results showed that, treatments T₃ to T₄ had statistically higher feed conversion ratios compared with the control diet ($P < 0.05$). The best conversion ratio (1.31 g feed/ g gain) was recorded for T₂ (1% supplementation of L-carnitine).

Table 2. Growth performance parameters of Nile tilapia (*O. niloticus*) fed on the experimental diets

Items	Treatments				± SE*
	T ₁ , Control	T ₂	T ₃	T ₄	
Initial weight, g/fish	5.90	5.93	5.92	5.95	0.06
Final weight, g/fish	30.00 ^b	31.07 ^b	36.14 ^a	37.60 ^a	0.68
Average total gain ¹ , g/fish	24.10 ^b	25.14 ^b	30.22 ^a	31.65 ^a	1.23
Average daily gain ² , g/fish/day	0.29 ^b	0.30 ^b	0.36 ^a	0.38 ^a	0.02
Specific growth rate ³ (SGR % /day)	1.94 ^b	1.97 ^b	2.15 ^a	2.19 ^a	0.09
Survival rate ⁴ , %	90	90	95	100	0.001
Feed intake (FI), g/fish	39.62	40.20	40.41	41.42	1.97
Feed conversion ratio ⁵ (FCR)	1.64 ^a	1.60 ^a	1.34 ^b	1.31 ^b	0.13
Protein efficiency ratio ⁶ (PER)	2.07 ^b	2.12 ^b	2.53 ^a	2.58 ^a	0.19
Protein productive value ⁷ (PPV,%)	31.83 ^b	33.04 ^b	39.23 ^a	41.21 ^a	2.14
Energy retention ⁸ (ER, %)	20.10 ^b	20.84 ^b	24.56 ^a	25.01 ^a	0.87

*Means in the same rows having different superscript letters were significantly different at 0.05 level.

* Standard error of the mean derived from the analysis of variance.

1. ATG (g/fish) = Average final weight (g) – Average initial weight (g).

2. ADG (g/fish/day) = [ATG (g)/experimental period (d)].

3. SGR (%/day) = 100(Ln final weight–Ln initial weight)/experimental period (d).

4. SR = 100[Total No of fish at the end of the experimental/Total No of fish at the start of the experiment].

5. FCR = DM Feed Intake (g)/Live weight gain (g).

6. PER = Live weight gain (g)/ Protein intake (g).

7. PPV (%) = 100 [Final fish body protein (g)–Initial fish body protein (g)]/crude protein intake (g).

8. ER % = 100 [gross energy gain / gross energy intake]

In general, fish fed diets supplemented with L-carnitine showed better feeding efficiency than those fed with control diet (without supplement). The protein efficiency ratio (PER), protein productive value (PPV %) and energy retention (ER %) were significantly higher in the groups fed diets containing L-carnitine than the control one (Table, 2). The lowest PER, PPV and ER values were recorded for the control treatment.

The results obtained from this study clearly point out that L-carnitine has a positive effect on growth rates and feed utilization of Nile tilapia fingerlings. Fish receiving L-carnitine level of 1% (T₄) in their diet showed the highest increase in growth rate and feed utilization. Similar studies on other tilapia species including Mozambique tilapia (*Oreochromis mossambicus*) (Jayaprakas *et al.*, 1996), hybrid tilapia *Oreochromis niloticus* × *O. aureus* (Becker *et al.*, 1999) and Nile tilapia (Abou-Seif, 2006 and Abdel-Fattah *et al.*, 2010) revealed that dietary L-carnitine supplementation resulted in improved growth rates and feed efficiency. Similar results have also been reported with several other species reared on diets supplemented with L-carnitine, including European sea bass (Santulli and D'Amelio, 1986), African catfish (*Clarias gariepinus*) (Torreele *et al.*, 1993; Ozorio *et al.*, 2001), red sea bream (Chatzifotis *et al.*, 1995), Indian major carp rohu (Keshavanath and Renuka, 1998); hybrid striped bass (Twibell and Brown, 2000).

In the current study, dietary L-carnitine may have indirectly increased carnitine synthesis and consequently promoted lipolysis activity. Thus, promoted lipolysis activity may have an effect on protein accumulation in tested fish. However, it was important for the objectives of the present trail to note that there was an obvious effect of L-carnitine on the growth and fatty acid composition. Several enzymes are involved in the lipid and carnitine metabolism process. For instance, carnitine palmitoyltransferase, as lipolysis enzyme, performs a function to exchange of coenzyme A for carnitine to facilitate the transfer of acyl groups into mitochondria for β -oxidation (Ji *et al.*, 2009).

A significantly higher feed conversion appeared in control group for fish fed with control diet (1.64) compared with T₂ (1.60); T₃(1.34) and T₄ (1.31). Supplementation with 1% L-carnitine saves 0.33 kg feed per kg body weight gain, which is 20% less than the feed required for the control group. This aspect is of practical importance for the fish culturist both from an ecological and economic point of view. The significant differences of FCR in the experiment, may suggest that the improved growth was related to feed consumption and better feed utilization efficiency. Therefore, the improved performance of Nile tilapia in the experiment with 1% L-carnitine supplementation is presumably due to the enhancement, caused by carnitine, of energy utilization from fatty acid oxidation (Torreele *et al.*, 1993 and Chatzifotis *et al.*, 1995). It has also been reported that L-carnitine facilitates the removal of short chain organic acids from the mitochondria, leading to freeing coenzyme A to participate in α -oxidation and tricarboxylic acid cycle pathways (Harpaz, 2005).

These findings have also been supported by Becker *et al.* (1999), who observed that low level supplementation of L-carnitine (150 mg kg⁻¹) for tilapia is effective but not the best supplementation level (300 mg kg⁻¹). Supplemental dietary L-carnitine showed positive effects in terms of growth rate and food conversion ratio of red sea bream (Chatzifotis *et al.*, 1995; 1996), tilapia (Jayaprakas *et al.*, 1996; Dikel *et al.*, 2003), European sea bass (Santulli and D'Amelio, 1986) and African catfish (Torreele *et al.*, 1993), hybrid striped bass (Twibell and Brown, 2000). In contrast

dietary carnitine did not affect weight gain of the channel catfish (Burtle and Liu, 1994), rainbow trout (Rodehutsord, 1995) or Atlantic salmon (Ji *et al.*, 1996). However, in the present study, growth rate and FCR of Nile tilapia fingerlings have been positively affected by L-carnitine administration. It is difficult to explain these conflicts because the mechanisms by which supplemental dietary L-carnitine may exert such beneficial effects in terms of growth performance are still little understood in fish. For these reasons, L-carnitine supplementations in fish have shown conflicting results even with the same species, like hybrid striped bass which reported by Twibell and Brown (2000) and Gaylord and Gatlin (2000).

In contrast, no effects of L-carnitine supplementation was reported in European sea bass (Dias *et al.*, 2001), Channel catfish (Burtle and Liu, 1994), Atlantic salmon (Ji *et al.*, 1996), Rainbow trout (Chatzifotis *et al.*, 1997), hybrid striped bass (Gaylord and Gatlin 2000 a,b), African catfish (Ozorio *et al.*, 2001 a and b) and hybrid tilapia *O. niloticus* × *O. aureus* (Schlechtriem *et al.*, 2004). The discrepancies in these results may have been due to the differences in culture conditions, diets composition and fish species and sizes.

Body composition:

The influence of different dietary L-carnitine levels on chemical composition of fish carcass is shown in Table (3). No significant differences ($P < 0.05$) were observed in dry matter, crude protein, ether extract, ash and energy contents. Also, fish at the start of the experiment had lower dry matter, crude protein, ether extract, ash and energy contents than at the end of the experiment. This result was in agreement with Saad *et al.* (2009).

These results suggest that L-carnitine supplementation plays a role in enhancing feed intake with a subsequent enhancement of fish body composition. The better feed intake in feed additives supplemented diets may have been due to increased fish appetite resulting in a higher feed intake and therefore improved growth. Moreover, due to the high feed intake and nutrient utilization, the deposited nutrients increased.

Table 3. Effect of L-carnitine on Nile tilapia body composition (% , on DM basis)

Items	Initial fish	Treatments				± SE*
		T ₁	T ₂	T ₃	T ₄	
Dry matter, %	21.42	26.33	26.54	26.26	26.17	0.27
Crude protein, %	54.10	55.44	55.81	56.58	58.32	2.42
Ether extract, %	16.35	18.24	18.42	18.80	18.01	1.34
Ash, %	11.47	12.47	12.73	12.80	12.25	1.22
Energy, Kcal/100g	537	544	544	547	548	3.87

*Means in the same rows having different superscript letters were significantly different at 0.05 level.

* Means of the standard error derived from the analysis of variance.

Biochemical blood parameters:

Results in Table (4) showed that, blood plasma glucose, total protein and total lipids, were not significantly affected ($P < 0.05$) by the different levels of L-carnitine. A slight decrease in plasma glucose and slight decrease in plasma total lipid were observed. These results suggested that fish health was improved when fed diets

supplemented with. Moreover, feed additives supplementation significantly ($P < 0.05$) decreased aspartate aminotransferase (AST) and alanine aminotransferase (ALT) values compared with control group (without supplementation). Biochemical analyses often provide vital information for health assessment and management of cultured fish (Cnaani *et al.*, 2004).

Table 4. Blood plasma parameters of Nile tilapia fed on the experimental diets

Items	Treatments				± SE*
	T ₁ , Control	T ₂	T ₃	T ₄	
Plasma glucose, mg/dl	57.75	57.54	56.78	56.54	0.40
Plasma total protein, g/dl	5.24	5.64	5.75	5.81	0.10
Plasma total lipid, g/dl	4.21	4.11	4.15	4.18	0.02
AST, U/dl	125 ^a	118 ^b	110 ^b	111 ^b	2.98
ALT, U/dl	55 ^a	43 ^b	42 ^b	40 ^b	1.21

*Means in the same rows having different superscript letters were significantly different at 0.05 level.

* Standard error of the mean derived from the analysis of variance.

This result agrees with Abdel-Tawwab *et al.* (2008) who investigated the use of commercial probiotic as a growth and immunity promoter for Nile tilapia, *Oreochromis niloticus*, since they found that biochemical parameters were improved in fish fed probiotic.

CONCLUSION

It can be concluded that the addition of L-carnitine in tilapia fingerlings diets improves fish growth and feed utilization. Based on these results, use of a 1% L-carnitine in tilapia fingerlings feeds is recommended to stimulate growth performance.

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إستجابة النمو لإصبعيات البلطي النيلي للتغذية على علائق محتوية على نسب مختلفة من الكارنيتين

عبد العزيز محمد عبد العزيز الحاييس

قسم الإنتاج الحيواني ، كلية الزراعة، جامعة طنطا

أجرى هذا البحث بمعمل بحوث الأسماك بقسم الإنتاج الحيواني بكلية الزراعة - جامعة كفر الشيخ وذلك لبحث تأثير أضافه أربعة مستويات مختلفة من الكارنيتين (صفر، ٠.٢٥ و ٠.٥ و ١.٠ %) على أداء النمو والإستفادة من الغذاء والعناصر الغذائية والتركيب الكيماوي لجسم الأسماك في نهاية التجربة وكذلك بعض مكونات الدم لأسماك البلطي النيلي . حيث تم تركيب أربعة علائق تجريبية متشابهة في نسبة البروتين (٢٩.٤٨%) والطاقة (٤.٥٥ ك كالورى/جم مادة جافة) - تم إستخدام عدد ١٢٠ من أصبعيات البلطي النيلي (بمتوسط وزن ابتدائي ٥.٩٣ جم/سمكه) وزعت عشوائيا على أربع معاملات في اثني عشر حوض زجاجي سعة كل منها ٧٠ لتر بواقع ثلاثة أحواض لكل معاملته وتم تخزين عشرة أسماك في كل حوض . وكانت معدلات التغذية اليومية تتم بنسبة ٥ و ٤ و ٣ % من الوزن الحي خلال الفترات من الأسبوع الأول إلى الرابع والخامس إلى الثامن والتاسع إلى الثاني عشر على الترتيب تبعاً لزيادة الأسماك في الوزن وذلك خلال فترة التجربة وهي اثني عشر أسبوعا . أظهرت نتائج التجربة أن أصبعيات البلطي النيلي التي تغذت على العلائق المضاف لها الكارنيتين أعطت أحسن النتائج في مقاييس النمو وكفاءة الإستفادة من الغذاء مقارنة بمجموعة المقارنة. بالإضافة إلى ذلك فإن كفاءة التحويل الغذائي ، كفاءة إستخدام البروتين قد تحسنت معنوياً في المعاملات المضاف إليها الكارنيتين مقارنة بمجموعة الكنترول. بالنسبة لتأثير الكارنيتين على التركيب الكيماوي لجسم الأسماك في نهاية التجربة فلم تكن هناك إختلافات معنوية بين المعاملات المختلفة في محتوى الجسم من الرطوبة والبروتين الخام والدهون والرماد وكذلك محتوى الطاقة . كما أظهرت النتائج عدم وجود إختلافات معنوية بين المعاملات المختلفة المضاف إليها الكارنيتين ومجموعة المقارنة . ولم يكن هناك إختلافات معنوية بين المعاملات بالنسبة لمحتوى بلازما الدم من الجلوكوز والبروتين الكلى والليبيدات كما حسنت أضافة الكارنتين من وظائف الكبد لأصبعيات البلطي النيلي .

تبين النتائج السابقة أن إضافه الكارنيتين بنسبة ١.٠ % فى علائق أصبعيات البلطي النيلي يؤدى الى تحسين النمو وزيادة الإستفادة من الغذاء وذلك تحت الظروف البيئية المماثلة لظروف التجربة.