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Growth Performance and Body Composition of Pikeperch (*Sander lucioperca*) Fingerlings under Dietary L-Carnitine

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Abstract

Growth performance, food efficiency and body composition of pikeperch (*Sander lucioperca*) were investigated with 1 or 2 g/kg L-carnitine added to the diet. Control diet did not contain L-carnitine. Two hundred pikeperch fingerlings (1.63 g, mean weight) were stocked in each 1 m3 concrete tank and fed equally 6 meals per day for 6 weeks. Higher increment in body weight (5.92 ± 0.37 g), the highest specific growth rate (3.75 ± 0.17) and food efficiency (98.04 ± 4.56), the highest crude protein (64.53 ± 0.84), the lowest crude lipid (21.59 ± 0.23) and significant ($P<0.05$) lowering in food conversion ratio (1.02 ± 0.05) were obtained with 2 g/kg L-carnitine diet. The greatest survival rate (84.88 ± 0.92) occurred when fingerlings were fed with 1 g/kg L-carnitine. Both treatments with L-carnitine showed lesser rate of cannibalism than in control (1.25± 0.09). Use of dietary L-carnitine improved growth performance and body composition of pikeperch fingerlings.

Keywords: *Sander lucioperca, L-carnitine, Protein, Lipid, Food efficiency.*

1. Introduction

L-carnitine (β-hydroxy-γ-*N*-trimethylaminobutyric acid) is a water-soluble quaternary amine and plays an important role in lipid β-oxidation to facilitate the importation of activated long-chain fatty acids into mitochondria and the accompanying intermediate compounds out of the mitochondrial matrix (Rebouche and Seim, 1998; Harpaz, 2005). It has also been suggested that L-carnitine supplementation may stimulate the protein-sparing action by increasing the energy derived from lipids (Ozorio et al., 2005). Because of its role in lipid metabolism in fish, dietary L-carnitine supplementation has been found to enhance protein synthesis and promote growth performance (Ozorio, 2001).

Increased fatty acid oxidation via L-carnitine mediation is accompanied with decrease in essential amino acids catabolism. The advantage of dietary L-

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carnitine supplementation for growth performance is related to optimum dietary utilization as well as inhibition from lysine and methionine catabolism (Torreele, 1993). During the past decade, some reports have indicated that L-carnitine improved the performance of species, such as hybrid striped bass (Twibell and Brown 2000), beluga sturgeon (Mohseni et al., 2008), black sea bream (Ma, et al., 2008) but did not affect growth performance of rainbow trout fry and fingerlings (Rodehutscord, 1995; Chatzifotis et al., 1997), Atlantic salmon, Harpaz et al. (1999), European sea bass, (Santulli and D`Amelio, 1986) and tilapia (Yang et al., 2009).

Pikeperch (Sander lucioperca), is one of the most commercially important species of indigenous ichthyofauna of the Caspian Sea (Sattari et al., 2003) and is a valuable species for aquaculture because it grows rapidly and has good flesh quality and high commercial value (Zakes, 1997). Because of importance of pikeperch, as an aquaculture species, and in light of scarce information on its growth performance and body composition under dietary L-carnitine, this investigation was undertaken with pikeperch (*Sander lucioperca*) fingerlings.

2. Materials and Methods

This experiment was performed with two treatments and control in triplicates, in 9 tanks of 1000 L volume (with dimensions of 0.8 × 0.8 × 1 m) with completely randomized design (Baranek, 2007). Each tank contained a volume of 400 L of water with proper aeration. The water inlet with a flow rate of 5-6 L/min, created a slight circulation current in the tank. The initial stocking rate was 2 fish/l, (same size and from same stock) (Bodis, 2007). Light intensity was 50 lux for 24 h in rearing saloon (Zakes, 1997). (Table 1).

The pond cultured pikeperch fingerlings (initial mean weight of 1.63 g were transported to tanks and acclimated for 10 days. Then, each of 9 tanks received the basic diet (Bio optimal France) with pellet size of 1.5 mm for first half of rearing period and 2.2 mm for second half of rearing period. Treatment tanks were supplemented with either 1 or 2 gkg^{-1} of L-carnitine diet (TreatmentS B and C, respectively) for 6 weeks. Control tanks were not supplemented. The fingerlings were hand-fed from 8:00 AM to 8:00 PM with formulated diet 6 times a day. Feeding rate was 4-5% of fish biomass for all groups. Water physico-chemical parameters were monitored during experiment (Table 2).

Table 1: Formulation and proximate composition of experimental diets (% of Dry Matter)

Pellet size (mm)	1.5-2.2
Ingredient (%)	
Fish meal	48
Fish oil	11
Concentrate*	9
Maize gluten	8
Soya cake	7
Field peas	6
wheat	6
wheat gluten	5
Chemical composition	
Crude protein (%)	45.61
Crude lipid (%)	17.45
Fiber (%)	1.52
Ash (%)	10.53
Gross energy	22.1

*Concentrate (pea proteins, krill meal, hydrolyzed fish, vitamins and minerals, antioxidant (ethoxyquin), lecithin, yeas extract).

Table 2: Physical and chemical parameters of water during the period of experiment

Physico- chemical parameters	Duration of experiment (weeks)					
	1	2	3	4	5	6
Water temperature (ºC)	24.62 ± 0.43	24.72 ± 0.86	25.63 ± 0.96	26.23 ± 1.12	26.35 ± 0.59	26.32 ± 0.73
Dissolved O_2 (mg/L)	7.43 ± 0.68	7.29 ± 0.62	7.70 ± 0.22	6.86 ± 0.27	6.71 ± 0.69	7.01 ± 1.31
pH	8.16 ± 0.19	8.37 ± 0.22	7.92 ± 0.08	8.13 ± 0.15	8.26 ± 0.30	8.28 ± 0.24

Data are mean and standard deviations.

Every 7 days, 20 fish from each tank (60 individuals per treatment) were randomly captured and their length measured to ±0.1 mm accuracy. Fingerlings were weighted collectively from day 0 to day 14, and individually from day 21 to day 42. The number of sampled fingerlings was taken into account for calculation of survival rate. Body weight index (BWI), average daily growth (ADG), specific growth rate (SGR), condition factor (CF), food conversion ratio (FCR), food efficiency (FE), survival rate (SR) and cannibalism were assessed as follows (El-Husseiny et al, 2008):

Weight gain (g) = $(W_f - W_i)$

Average daily growth (ADG, %) = $100\ (W_f - W_i)\ T^{-1}$

Specific growth rate (SGR, % day^{-1}) = $100\ (LnW_f - LnW_i)\ \Delta T^{-1}$

Condition factor (CF) = $100 \times W_f \times (L_f)^{-3}$

Feed conversion ratio (FCR) = $W_{TFS} \times AWG^{-1}$

Feed efficiency (FE) = $(FB - IB)\ TFC^{-1}$

Counted mortality (%) =$100\ (Nd+Nc)\ Ni^{-1}$

Survival rate =$100\ (N_f - N_i)$

Cannibalism (%) =$100\ (Nc+Nm)\ Ni^{-1}$

where W_i and W_f are the initial and final body weights (g), W_{TFS} is the weight of the total feed supplied (g)T = duration of experiment (days), L = final body length (cm), Ni = initial number of fingerlings, Nf= final number of fingerlings, Nd=number of dead fish without signs of cannibalism, Nc = number of dead fish due to cannibalism, Nm=number of missing fish at the counting (end of experiment), C = Cannibalism, ΔT=duration of the experiment (days), TFC the total food consumption (g), IB the initial biomass (g), FB the final biomass (g).

Fish samples were analyzed for proximate composition according to AOAC (1992). Ten fish from each tank of experimental treatments were taken for chemical analysis of body composition. Sampled fish were killed and the viscera were removed and the carcasses stored at -18°C in fridge for chemical analyses. Moisture content (at 105°C for 24h), crude protein content (Kjeldahl apparatus, Gerhardt, Königswinter, Germany. Nitrogen* 6.25), crude fat content (extraction with petroleum ether by Soxhlet apparatus, Behr, Düsseldorf, Germany) and ash (incineration at 550°C for 6 h) of the samples were determined according to AOAC (1992). Results are given as mean and standard deviations. Normality of data was tested by Shapiro-Wilk's test. Data were subjected to one-way ANOVA and significant difference between the treatments was determined by Duncan's test. The values of $P<0.05$ were considered significantly different. All analyses were performed using statistical software SPSS (version, 16).

3. Results

The results of growth performance of pikeperch fingerlings fed by control and experimental diets are presented in Table 3. Average fish fingerlings weights were 5.93 for control and 6.14 and 7.52 g for supplemented diet treatments 1 and 2 gkg^{-1}, respectively. Daily specific growth rates were significantly ($P<0.05$) higher in treatment C than either control or treatment B at the end of experiment. The final condition factor of fingerlings showed no significant differences between treatments and control. at the end of feeding trial. Food conversion ratio was significantly ($P<0.05$) lower in treatments B and C than in control. Treatment C showed the lower FCR than in control during the experiment. The highest food efficiency was found in fingerlings fed Basic+2 g/kg L-carnitine (treatment C). Survival rate did not differ significantly between treatments. Results of the body compositions of pikeperch maintained on various treatments are presented in Table 4. Significantly ($P<0.05$) lower content of carcass total lipid was observed in fish fed diets B and C than in control. The highest and the lowest content of carcass crude protein and crude lipid were observed in fish fed with treatment C., There was also no significant difference in ash dry weight between the treatments and control ($P>0.05$). Except for weight gain, ADG and SGR, there was no significant difference between treatments B and C and control for other parameters (Table 3).

Table 3: Effects of different diets on growth indices of pikeperch fingerlings at the end of experiment

Parameters	Treatments		
	Control (A)	Basic + 1g/kg L-carnitine (B)	Basic + 2g/kg L-carnitine (C)
Initial weight (g)	1.63 ± 0.26 [a]	1.54 ± 0.47 [a]	1.60 ± 0.51 [a]
Final weight (g)	5.93 ± 0.66 [b]	6.14 ± 0.42 [b]	7.52 ± 0.69[a]
Weight gain (g)	4.30 ± 0.28 [b]	4.60 ± 0.46 [b]	5.92 ± 0.37 [a]
ADG (%)	11.04 ± 1.49 [b]	10.73 ± 1.65 [b]	12.89 ± 1.63 [a]
SGR (% per day)	3.09 ± 0.05 [b]	3.16 ± 0.14 [b]	3.75 ± 0.17 [a]
Initial length (mm)	5.98 ± 0.52 [a]	6.03 ± 0.31 [a]	6.11 ± 0.13 [a]
Final length (mm)	9.38 ± 0.67 [a]	9.29 ± 0.91 [a]	10.02 ± 0.25 [a]
Initial CF	0.74 ± 0.07 [a]	0.70 ± 0.09 [a]	0.70 ± 0.08 [a]
Final CF	0.72 ± 0.09 [a]	0.76 ± 0.14 [a]	0.74 ± 0.18 [a]
FCR	1.31 ± 0.08 [a]	1.28 ± 0.11 [a]	1.02 ± 0.05 [a]
FE	76.33 ± 4.65 [b]	78.16 ± 5.24 [b]	98.04 ± 4.56 [a]
Survival rate (%)	83.50 ± 1.26 [a]	84.88 ± 0.92 [a]	84.21 ± 1.34 [a]
Cannibalism (%)	1.25± 0.09 [a]	1.14 ± 0.11 [a]	1.03 ± 0.14 [a]

Values (mean ± SD) of the same row with different letters indicate significant differences (P<0.05).

Table 4: Mean and standard deviation (±) of Body composition of pikeperch fingerlings fed diets With varying dietary treatments

Duration of experiment (Day)	Treatments	Body Composition (%)*			
		Moisture	Crude protein	Crude lipid	Crude ash
1	Control	76.45 ± 0.55[a]	59.23 ± 0.76[a]	20.84 ± 1.31[a]	11.23 ± 0.49[a]
	B	76.43 ± 0.74[a]	58.41 ± 0.82[a]	21.32 ± 0.78[a]	10.49 ± 0.71[a]
	C	75.76 ± 0.75[a]	58.67 ± 0.79[a]	21.36 ± 0.83[a]	10.67± 0.68[a]
42	Control	74.15 ± 0.71[a]	60.96 ± 0.94[b]	25.39 ± 0.52[a]	10.79 ± 1.17[a]
	B	76.54 ± 1.02[a]	62.48 ± 1.06[ab]	23.63 ± 0.47[ab]	11.09 ± 0.65[a]
	C	75.67 ± 0.68[a]	64.53 ± 0.84[a]	21.59 ± 0.23[b]	11.33 ±0.83[a]

Values (mean ± SD) of the same column with different letters indicate significant differences (P<0.05).
*Crude protein, crude lipid and crude ash are based on percent of dry matter. The nitrogen-free extractives (NFE) compose the remainder of the body composition.

4. Discussion

The present study demonstrated that the addition of L-carnitine in different levels to diet improves the growth performance of pikeperch and the better results were found in treatment C (2 g/kg L-carnitine). The increased growth of pikeperch (Table 3) as a result of L-carnitine application may be attributed to the increased energy availability due to a rise in fatty acid oxidation. Although, results in this investigation are in close agreement with results of Torreele et al (1993) on African catfish, Santulli and D`Amelio (1986) on European sea bass, Chatzifotis et al (1995) on red seabream, Jayaprakas et al (1996) on Tilapia (*Oreochromis mossambicus*), Keshavanath and Renuka (1998) on Rohu (Indian major carp), Becker et al. (1999) on hybrid tilapia (Oreochromis niloticus×Oreochromis aureus), Twibell and Brown (2000) on hybrid striped bass (Morone chrysops×M. saxatilis), Mohseni et al (2008) on beluga sturgeon and Ma et al (2008) on black sea bream and Jalali Haji-abadi et al (2010) on Rainbow trout, they disagree with results reported for Channel catfish (Burtle and Liu, 1994), Rainbow trout (Rodehutscord, 1995; Chatzifotiz

et al. 1997), Atlantic salmon (Ji et al. 1996), Cichlid ornamental (Pelvicachromis pulcher) (Harpaz et al. 1999), Hybrid tilapia (Oreochromis niloticus Oreochromis aureus) (Schlechtriem et al. 2004).

The body composition analyses showed that the addition of L-carnitine increased the crude protein and reduced the crude lipid content in pikeperch (Table 4). This may be because supplementation of L-carnitine results in an acceleration of fatty acid oxidation and improved nitrogen retention (Ji, et. Al., 1996). L-carnitine is most concentrated in tissues that use fatty acids as their primary dietary fuel, such as skeletal and cardiac muscles. In this regard, L-carnitine plays an important role in energy production by chaperoning activated fatty acids (acyl-CoA) into the matrix for and accompanying intermediate compounds out of the mitochondrial matrix to prevent their accumulation. Carnitine-acylcarnitine translocase is responsible for the transport of carnitine and its esters across the inner mitochondrial membrane. It can help to prevent the accumulation of fatty acids in tissues, and thus the ratio of muscle to fat in the body rises (Wei-guo et al., 2012). Furthermore, OzőRio (2001) concluded that 1g kg1 L-carnitine supplementation in the diet of African catfish raised the concentration of some amino acids in muscle tissue and as consequence increased fatty acid oxidation rather than amino acid combustion for energy. Our results are in close agreement with findings of Santulli and D`Amelio (1986) on European sea bass, Torreele et al (1993) on African catfish, Burtle and Liu (1994) on channel catfish fingerling, Ji, et al (1996) on Atlantic salmon and Ma et al (2008) on black seabream.

Differences among studies may be related to the fish size (Rodnick and Williams 1999), dietary composition and feed processing (Schuhmacher and Gropp 1998), possible species effects, fish developmental stage, environmental conditions and the section body used for analysis, whole body (Rodehutscord, 1995) versus fish fillet (Ji et al. 1996; Jalali Haji-abadi et al. 2010). According to the results of this research, use of L-carnitine through addition in the diet is recommended for improving growth of pikeperch fingerlings and a dose of 2 g/kg L-carnitine in the diet is recommended for the best results on growth performance and body composition.

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