Full Length Research

Effects of dietary L-carnitine supplementation on growth performance and survival rate in common carp (*Cyprinus carpio* Linneaus 1758)

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The aim of present study (60 days) was to evaluate the effect of dietary L-carnitine on growth performance and survival rate of Common Carp (*Cyprinus carpio*) via supplementation with Biomar. According to body length and weight, 180 common carp (average weight 13.21±2.5g) were divided into 4 groups (three replicates for each group). The L-carnitine was used in three concentrations 500 (T1), 1500 (T2) and 2500 (T3) mg/Kg-1 of diet (Biomar). The common carp in experimental treatments were fed of the three levels of L-carnitine with 5 percent body weight (3 times a day). The fish in control treatment was fed on not supplemented Biomar. The growth factors of fishes fed on L-carnitine were compared to those fishes in control treatment that fed of unsupplemented Biomar. The results clearly showed that animal fed the L-carnitine had significantly increased final body weight in comparison to control treatment. The maximum of final body weight (FBW) and Specific growth rate (SGR) were observed in treatment of T3 (P>0.05) followed by T2. There were no significantly different between T1 and control group in this compare (P>0.05) however T1 showed better result in grow performance than control group. Also in survival rate the treatments had no significantly different to each other (P>0.05).

Key words: *Cyprinus carpio*, L-carnitine, growth performance, survival, Iran.

INTRODUCTION

Carnitine is the collective term for a number of compounds that include D- and L-carnitine, acetyl-L-carnitine, and propionyl-L-carnitine. Only one form (L-carnitine, but not D-carnitine) is biologically active, i.e., of use to the body. Carnitine plays an important role in fat metabolism: It is required for the breakdown of fatty acids into usable forms. Fatty acids are a major energy source for working muscles, and it has been suggested that increasing the availability of carnitine will increase its rate of absorption and breakdown (via oxidation) in the body’s cells. Proposed ways in which carnitine may enhance performance include improved oxidation of fatty acids in the muscles, altered regulation of glucose, increased production of acylcarnitine (important for carnitine effectiveness), and the ability of muscles to resist fatigue (Wachter et al., 2002). While levels of L-carnitine in the bloodstream respond to supplementation, the amount of carnitine in muscles, cellular production of carnitine, and physical performance do not appear to do so. Recent data, however, suggest that the reserves of carnitine available for use by the muscles can be manipulated both

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through exercise and dietary consumption (Stephens et al., 2007).

L-carnitine is a water-soluble quaternary amine that occurs naturally in microorganisms, plants and animals (Bremer, 1983) and 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 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 energy available for growth (Dikel et al., 2010).

The researchers (Dikel et al., 2010; Ji et al., 2009; Nekoubin et al., 2012), have been studying to replace animal protein sources with proteins derived from plant material or some feed additives for stimulate to the growth. One of these additives is L-carnitine which can increase lipid catabolism and might also lead a protein sparing effect (Dikel et al., 2010; Nekoubin et al., 2012), pointed out that the improvement of vitamin C metabolism by Spirulina as feed supplement eventually activated lipid metabolism through L-carnitine metabolism. Several enzymes are involved in the lipid and L-carnitine metabolism process. For instance, L-carnitine palmitol transferase, 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; Ozorio, 2009). So far, a relatively small amount of work has been done on the effects of L-carnitine on muscle fatty acid composition of fish.

Past studies have shown that L-carnitine has growth promoting effect on a number of fish species sea bass (Santulli and Damelio, 1986), African catfish (Torreele et al., 1993) and red sea bream (Chatzifotis et al., 1997). Furthermore, Dikel et al. (2010), Nekoubin et al. (2012) suggested that L-carnitine may increase the growth rate of carp. Contrary to the above observation a clear effect of L-carnitine on growth of rainbow trout was not observed (Chatzifotis et al., 1997; Rodehutscord, 1995). On the other hand, inclusion of different levels of L-carnitine in diet has negligible or even negative effects on growth in warm water (Chatzifotis et al., 1997; Ozorio, 2001) and cold water species (Chatzifotis et al., 1996).

Although it is not clear how L-carnitine affects fish growth it is generally assumed that L-carnitine stimulates fatty acid oxidation and protein sparing action of lipids. Thus the improvement in protein utilization results in an increase in growth.

The L-carnitine pool in fish is derived both from endogenous synthesis and diet, L-carnitine is synthesized from lysine and methionine. The carbon and nitrogen atoms of L-carnitine come from the amino acid lysine while the N-methyl groups come from the S-methyl group of methionine (Bremer, 1961). The objective of this experiment was to evaluate the effects of dietary L-carnitine on growth performance and body composition of Cyprinus carpio.

MATERIALS AND METHODS

The L-carnitine was prepared from the LONZA LTD Company (Sweden). Also formulate diet was provided by aquatic foods company in sari (Iran). Nutrient compositions of experimental diets are given in Table 1. Proximate composition of diets was carried out using the Association of Official Analytical Chemists (A.O.A.C, 2000) methods. Protein was determined by measuring nitrogen (N×6.25) using the Kjeldahl method; Crude fat was determined using petroleum ether (40–60 Bp) extraction method with Soxhlet apparatus and ash by combustion at 550°C.

This experiment was conducted in a completely randomized design with four treatments (three L-carnitine levels and a control), and three replicates per treatment for a total of twelve fiberglass tanks (each with a capacity of 60 liters). Common carp (initial weight: 13.21±2.5 g) were obtained from the Institute of Fish Hatchery in Gorgan, Iran. The density of fish per tank was 15 fish. Common carp in control and experimental treatments were fed 7 percent of their body weight for 3 times a day (8.00, 16.00 and 24.00). The control treatment was fed without supplemented formulate diet. Water quality parameters of input water to rearing system were monitored each week throughout the experimental period. The water temperature was 19.46±1.23°C, pH was 7.85±0.26 and water oxygen level was maintained above 7.65 ± 0.55 mg L-1 during the experiment an electrical air pump (by a single filtration unit).

The fish were weighed individually at the beginning and at the end of the experiment. Before distributing fish to the experimental tanks (the beginning of exogenous feeding), 60 fish were sampled from the holding tank for biometry. At the end of experiment, 15 fish from each tank were sampled and the final weight and length of body were measured. Growth parameters of fish were calculated based on the data of biometry of common carp.

One-way ANOVA and Duncan’s multiple range tests were used to analyze the significance of the difference among the means of treatments by using the SPSS18 program.

RESULTS AND DISCUSSION

Growth performance of Common carp fed the diets containing different dietary L-carnitine levels for 60 days are presented in Table 2.

There were no external symptoms of infection or mortality during the experiment. The results clearly showed...
Table 1. Nutrient composition of experimental diets (%).

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>37-40</td>
</tr>
<tr>
<td>Lipid</td>
<td>10-12</td>
</tr>
<tr>
<td>moisture</td>
<td>8-9</td>
</tr>
<tr>
<td>Ash</td>
<td>10-12</td>
</tr>
<tr>
<td>Vitamin</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Growth parameters of Common carp (Cyprinus carpio) in experimental treatments (trial 1-3) and control.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>T1</th>
<th>T2</th>
<th>T13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsupplemented</td>
<td>supplemented</td>
<td>supplemented</td>
<td>supplemented</td>
</tr>
<tr>
<td></td>
<td>L-carnitin</td>
<td>L-carnitin with 500 mg/kg</td>
<td>L-carnitin with 1500 mg/kg</td>
<td>L-carnitin with 2500 mg/kg</td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>13.21±2.5</td>
<td>13.21±2.5</td>
<td>13.21±2.5</td>
<td>13.21±2.5</td>
</tr>
<tr>
<td>Final body weight (g)</td>
<td>17.31±0.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.6±0.27&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.01±0.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.99±0.34&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Body weight increased (g)</td>
<td>4.1±0.53&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.39±0.43&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.8±0.49&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.78±0.57&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Specific growth rate for weight (% BW day&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>0.45±0.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.47±0.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.51±0.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.62±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>condition Factor</td>
<td>2.37±0.68&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.01±0.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.98±0.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.04±0.26&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Survival Rate (%)</td>
<td>94.289±4.28</td>
<td>94.289±4.28</td>
<td>96.18±2.18</td>
<td>98.09±2.18</td>
</tr>
</tbody>
</table>

that the L-carnitine had beneficial effects on the growth parameters on Common Carp, and the maximum final body weight (FBW) (18.99±0.34g) and specific growth rate (SGR) (0.62±0.01% body weight/day), were observed in treatment T3 (supplemented L-carnitine with 2500 mg/kg), and that has significantly different from other treatments (P<0.05). The lowest final body weight and Specific growth rate observed in T1 (supplemented L-carnitine with 500 mg/kg) but it has no significant different to the control group (P>0.05).

Effects of L-carnitine treatments on growth performance of Common carp resulted significantly difference than each other and control treatment (P<0.05) and the growth parameters had significantly affected by addition of L-carnitine to the rearing tanks.

To date, the major of the studies have been conducted on fish in early life stages; because it is believed that higher growth rate at this stage needs the carnitine levels higher than its synthesis in the body. It seems that some factors such as age, diet composition and species metabolic requirements affect the fish response to dietary L-carnitine supplementation (Ozorio, 2001).

Effects of L-carnitine on aquaculture have been investigated by researchers, clearly showed that the L-carnitine had beneficial effects on the growth parameters (Chatzifotis et al., 1996; Santulli and Damelio, 1986), these results agree with our findings, although fish and crustaceans may respond differently to L-carnitine and some of researches have not shown any positive effects on growth parameters or any promising results on the cultural condition. For instance, Chatzifotis et al (1996), found that treatment of rainbow trout with L-carnitine has not any significant increase growth. These results disagree with our findings. Similar finding were observed by Rodehutscord (1995), in using L-carnitine on rainbow trout. Also Nekoubin et al (2012) reported that L-carnitine had not any significantly effect in growth performance in Rutilus firsti kutum.

There are many studies about L-carnitine effects on others animals and human for example: the effect of L-carnitine on performance in Japanese Quail (Panahi et al., 2011), on semen characteristics of chilled rabbit (El-Nattat et al., 2011) and adipocytokines and lipid profile in obese women (Alshammari, 2011).

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REFERENCES


Official methods of analysis. EUA.