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Effect of Dietary Vitamin C on Growth and Feeding Parameters, Carcass Composition and Survival Rate of Common Carp (*Cyprinus carpio*)

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Abstract: A 90-day feeding experiment was conducted to evaluate the influences of vitamin C (Ascorbic Acid, AA) on growth and feeding parameters, carcass composition and survival rate of Common Carp (*Cyprinus carpio*). Five semi purified diets supplemented with 0 (control treatment), 400, 800, 1200 and 2000 mg vitamin C/kg (treatment 1, 2, 3 and 4 respectively) dry diet that were fed to common carp fries (0.58±0.01 g) in triplicate groups. At the end of the experiment, growth and feeding parameters, carcass composition and survival rate of fries were evaluated. The average net weight gains were 6.82±0.09, 7.38±0.03, 8.20±0.03, 8.07±0.09 and 8.12±0.08 g/90 days, respectively, for fish fed diets 0, 400, 800, 1200 and 2000 mg vitamin C/kg. The fish fed diets containing less than 800 mg supplemental vitamin C/kg had significantly ($P<0.05$) reduced weight gain, feed efficiency and other nutritional indices compared to those fed diets supplemented with vitamin C at 800-2000 mg/kg. In vitamin C treatments the specific growth rate (SGR), food conversation efficiency (FCE) were increased significantly ($P<0.05$) and highest SGR was observed in treatment 4. There were no significant differences in survival rate observed between the treatments ($P<0.05$).

Key words: Common Carp · *Cyprinus carpio* · Vitamin C · Specific Growth Rate and Survival Rate

INTRODUCTION

Vitamin C is an essential vitamin for normal physiological functions in animals including fish [1]. Most teleosts are unable to synthesize ascorbic acid due to the lack of l-gulonolactone oxidase (EC 1.1.3.8) that is responsible for synthesis of vitamin C [2]. Therefore, an exogenous source of vitamin C is required in fish diets. Inadequate supply of dietary vitamin C usually results in a number of deficiency signs such as spinal deformation, impaired collagen formation, internal haemorrhaging and retarded growth [3]. The quantitative requirements for dietary vitamin C have been determined for several fish species and the recommended values ranged from 20 to 50 mg ascorbic acid kg^{-1} diet [4]. The requirement of vitamin C varies, to some degree, with fish species, size, diet and experimental conditions.

Vitamin C has been found to be one of nutrients correlating with fish immunity [5]. A number of studies have shown beneficial effects of vitamin C on immunological parameters, such as lysozyme and complement activities, phagocytic activity, respiratory burst [6] and enhanced resistance to stress and diseases [7]. However, immune enhancement was not observed in some other studies [8].

Ascorbic acid has been studied in fish due to its dietary essentiality, rapid degradation in feeds and metabolic functions such as antioxidant effects [9]. Ishibashi *et al*. [10] reported that ascorbic acid prevented parrot fish from intermittent stress under hypoxic conditions and that the hypoxic condition resulted in an increased requirement of ascorbic acid. Lower superoxide dismutase activity in fish compared to guinea pigs and primates may result in a higher demand for ascorbic acid supplementation in hyperoxic conditions [11]. Also in mammals able to synthetize its own vitamin C, beneficial effects of ascorbic acid were reported in pulmonary vesicles of mice when exposed to hyperoxia [12]. In rats, dietary supplementation of ascorbic acid protected against hyperoxia-induced oxygen damage and lipid peroxidation [13, 14].

The present study was designed to examine the effects of different dietary levels of ascorbic acid on growth and feeding parameters, carcass composition and survival rate of common carp (*Cyprinus carpio*).

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MATERIALS AND METHODS

The basal experimental diets were formulated with the commonly available ingredients (Table 1). The formula and analyzed proximate composition of the basal diet is shown in Table 1. Five graded levels of vitamin C (L-ascorbic acid, AA) at 0, 400, 800, 1200 and 2000 mg Kg^{-1} diets were included in the basal diet (AA was supplemented separately to the basal diet at the expense of wheat flour). The ingredients were grinded, milled, weighed, mixed and pelleted with meat mincer through a 0.8 mm diameter. After cold pelleting, the feeds were air dried and put in an air-tight container. All diets were stored at -20°C until fed.

All common carp (*Cyprinus carpio*) fry hatched from single egg mass were used in this experiment and acclimated to laboratory condition in two cement tanks (80 l capacity each) for 2 weeks by feeding a commercial carp diet.

The growth trial was conducted in 40^{-1} circular flow-through Fibre Reinforced Plastic (FRP) tanks ($\pi r^2 h$ = 3.14×222×26 cm^3) with flow rate of about 600 ml/min. The water quality parameters observed during the experimental period were; temperature (24.3±0.25°C), dissolved oxygen (7.05±0.10 mg/l), total hardness (103.5±0.35 mg/l as $CaCo_3$) and total alkalinity (111.2±0.42 mg/l as $CaCo_3$). Tanks were indoors and the light cycle was 12 h light-12 h darkness (12 L: 12 D). Stored ground water was used for rearing the fish. Aeration was provided from a 1.0-hp compressor to all the experimental tanks.

Table 1: Formulation and proximate composition of the basal diets (dry weight)

Ingredients (%)	
Fush meal	60.0
Barley meal	7.5
Whear flour	7.5
Corn meal	7.5
Soybean meal	7.5
Mineral mixture[a]	5.0
Olivel oil	2.0
Fish oil	3.0
Proximate composition (%)	
Moisture	13.4
Ash	11.5
Crude protein	38.7
Crude lipid	13.0

[a]Mineral mixture contains (mg/g mixture): Ca, 180000; P, 90000; Cu, 600; Zn, 300; Co, 300; I, 100; Co_3^{-2}, 100; Mg, 190000; Se, 1; Na, 60000; Mn; 200; Fe, 3000. Vitamin A, 500000 IU; Vitamin D3, 100000; Vitamin E, 100 mg

Ten fish were stocked randomly into triplicate tanks for each dietary group with near uniform biomass. All experimental fish were acclimated to the basal diet (no supplemental DL-a-tocopheryl acetate) for 1 week prior to start of the growth trial. All groups of fish were fed their respective diet at 5% of body weight initially and gradually reduced to maintain a level close to apparent satiation. Any uneaten food was collected 1 h after every feeding and the dry matter content was determined for both supplied and uneaten food [15]. Fish were weighed every fortnight and the daily rations adjusted accordingly. The daily ration was divided into two equal parts and fed at 0930 and 1700 h. The experiment was conducted for 12 weeks.

At the end of the 12-week feeding trial, fish were weighed and feed conversion ratio (FCR), feed conversion efficiency (FCE) specific growth rate (SGR), protein efficiency ratio (PER) and percent survival were calculated. Fish were anesthetized with 60 mg tricaine methane sulfate (MS 222)/l and examined externally and internally for vitamin E deficiency signs.

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 SPSS program.

RESULTS AND DISCUSSION

Levels of vitamin C significantly influenced weight gain of common carps (Table 2).

Weight gain increased with an increase in levels of vitamin C. SGR of fries also followed the similar pattern as observed with weight gain. Protein efficiency ratio (PER) was significantly higher in treatment 2 compared with other groups and lowest in control group (without supplementation of vitamin C). Lower feed conversion ratio (FCR) was observed in treatment 2. Survival rate of common carp did not differ among the treatments.

Carcass proximate and vitamin C content of fish fed the various diets are presented in Table 3.

The crude protein content was significantly ($P<0.05$) higher in fish in treatment 1 than those in treatment 3 and 4, but it did not differ from fish in treatment 2. There were no differences in lipid or ash content among the treatments.

Weight gain, with reduced values for fish fed the basal diet, increased with increases in dietary vitamin E up to the requirement level was observed. Increased ascorbate levels in tissues and increased dietary ascorbic acid levels show a linear relationship in many fish species [9].

Table 2: Response of common carp fry to the various test diets after 12 weeks of feeding

	Treatments				
Parameters	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Initial weight (g)	0.58±0.01	0.58±0.01	0.58±0.01	0.58±0.01	0.58±0.01
Weight gain (g/90 days)	6.82±0.09[c]	7.38±0.03[b]	8.20±0.03a	8.07±0.09[a]	8.12±0.08[a]
FCR	2.68±0.02[a]	2.65±0.01[ab]	2.58±0.01b	2.61±0.01[bc]	2.60±0.01[c]
FCE	0.37±0.01[b]	0.37±0.02[b]	0.38±0.01[a]	0.38±0.01[a]	0.38±0.02[a]
SGR (%/day)	2.87±0.09[c]	2.90±0.03[bc]	2.99±0.02[ab]	3.02±0.03[a]	3.07±0.02[a]
PER	1.02±0.01[c]	1.03±0.01[cd]	1.05±0.01[b]	1.04±0.01[ab]	1.04±0.01[ab]
Survival rate (%)	83.33±3.30	86.67±3.33	90.00±5.77	96.67±3.33	86.67±3.33

Groups with different alphabetic superscripts differ significantly at p<0.05 (ANOVA)

Table 3: Carcass composition (%) of common carp fries fed the test diets

	Treatments				
Parameters	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Moisture (%)	79.16±0.53	78.64±0.68	78.24±0.51	78.75±0.56	78.94±0.62
Crud protein (%)	58.34±0.29[ab]	59.21±0.29[a]	58.34±0.29[ab]	58.04±0.29[bc]	57.17±0.29[c]
Crud lipid (%)	12.99±0.29	13.21±0.15	13.53±0.22	13.17±0.18	12.52±0.23
Total ash (%)	15.58±0.15	15.65±0.12	15.57±0.10	15.61±0.09	15.55±0.12

Groups with different alphabetic superscripts differ significantly at p<0.05 (ANOVA)

The ascorbic acid requirement value by Common carps attained in this experiment was higher than those reported for *Oreochromis aureus* between 10 and 25 mg ascorbic acid who also examined juvenile hybrid tilapia, *Oreochromis niloticus x O. aureus* [16]. Also, the requirement based on growth performance in this study was higher than that for *Oreochromis spilurus* (100-200 mg ascorbic acid kg^{-1} diet) [17].

Vitamin C is an essential coenzyme in certain oxidative processes, including the oxidation of tyrosine and phenylalanine [18]. This probably explains the differences that occur in the percent body weight increase (PBWI) with respect to the vitamin C free and enriched groups [19]. Growth is a function of both the nutritional quality and the rate of consumption, among other things [20].

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