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The Effect of Additive Vitamin C on Growth, Feed Conversion Ratio and Survival Rate of Rainbow Trout (*Oncorhynchus Mykiss*)

Shahab Notash

Department of Aquatic Disease and Hygiene, Tabriz Branch, Islamic Azad University, Tabriz, Iran.

Abstract: Rainbow trout are coldwater fish that have long been symbolic of clear, healthy mountain streams and lakes in North America. The main objective of present study was to survey on effect of additive vitamin C on growth, feed conversion ratio and survival rate of rainbow trout (Oncorhynchus Mykiss). In this study, 200 fingerling fishes weighting 3gr were achieved from farms and divided into the two identical groups. Group 1 (control group) were feed only with starter but group 2 (treatment group) in addition to starter were feed with vitamin C as additive at the dose of 500 mg/kg. At the end of the study, growth, feed conversion ratio and survival rate were measured. The results of present study showed that there is a significant difference among groups in weight gain, length and losses ($P<0.05$) but this significant value don't observed in Vitamin C consumption point of view ($P>0.05$). It is reasonable to assume that if the fish receives same amount of required feed contents (protein, fat, vitamin etc.) it would grow the same amount regardless of the source (liver, spleen, drosophila, dry feed ect.) as long as they are all digested. Therefore by choosing different feed, we are changing relative ratios of these basic feed components. One issue of aquaculture studies is to provide these feed components as cheap as possible and same quality protein or fat can be cheaper from one source than another. This point is one of the reasons why feed studies are necessary.

Key words: vitamin C, growth, feed conversion ratio, survival rate, rainbow trout (Oncorhynchus Mykiss).

INTRODUCTION

Rainbow trout are coldwater fish that have long been symbolic of clear, healthy mountain streams and lakes in North America. Because of their ability to thrive in hatcheries, rainbow trout have been introduced into much of the United States and now inhabit many streams and lakes throughout the country. The popularity of rainbow trout among anglers has placed it among the top five sport fishes in North America, and it is considered by many to be the most important game fish west of the Rocky Mountains. However, reduction of good quality trout habitat due to stream bank and upland soil erosion, loss of riparian vegetation, water diversion, logging and mining activities, and point and non–point source pollution from municipal development and agriculture have significantly reduced the distribution and abundance of rainbow trout. In addition, construction of dams, road crossings, and other structures impede the ability of rainbow trout to migrate upstream and down-stream, which is critical to successful completion of their life cycles. Consequently, nine different populations of steelhead (sea-run rainbow trout) have been added to the federal endangered species list. Implementing sound land management practices and stream and riparian improvements on private lands can help improve coldwater habitats used by rainbow trout and a host of other aquatic species (Durve and Lovell, 1982; Gabaudan and Verlhac, 1992).

The life history requirements of the species vary tremendously depending on where the trout lives and whether it spends its life entirely in freshwater, or migrates to the sea for several years of growth before returning to its freshwater birthplace to spawn. This leaflet will concentrate on the life history requirements of resident rainbow and redband trout, and the freshwater habitat needs of steelhead, collectively referred to here as rainbow trout (Lall et al., 1989; Hardie et al., 1991).

Fish are the most primitive vertebrates and are an important link between invertebrates and higher vertebrates. They possess the non-specific defense mechanisms of the invertebrates such as the phagocytic mechanisms developed by macrophages and granular leukocytes, but were also the first animals to develop both cellular and humoral immune responses mediated by lymphocytes. The main lymphoid organs of fish are the anterior kidney, the thymus and the spleen. In fish, nonspecific immunity is considered as the first line of defense and represents a considerable part of the immune response, in contrast to mammals (Liu et al., 1989; Roberts et al., 1995).

When a pathogen penetrates the body, the non-specific immune mechanisms may be sufficient to stop the infection. If not, the disease will develop and the specific immune mechanisms will also be involved. If the animal survives, it will be protected against re-infection by the same pathogen, owing to the development of a

Corresponding Author: Shahab Notash, Department of Aquatic Disease and Hygiene, Tabriz Branch, Islamic Azad University, Tabriz, Iran
E-mail: drshnotash@iaut.ac.ir

specific immunological memory. The immune memory in fish is less developed than in mammals (Lin and Shiau, 2005).

With the exception of perhaps two or three species, vitamin C biosynthesis does not occur in fish due to the lack of the last enzyme of the biosynthetic pathway: L-gulonolactone oxidase. Vitamin C must therefore be supplied via the feed. Major signs of ascorbate deficiency include reduced growth, scoliosis, lordosis, internal and fin haemorrhage, distorted gill filaments, fin erosion, anorexia and increased mortality (Wilson and Poe, 1973).

Because of its modes of actions, vitamin C is involved in several physiological functions including growth, development, reproduction, wound healing, response to stressors and possibly lipid metabolism through its action on carnitine synthesis. Further, as discussed later, vitamin C plays a significant role in the immune response and resistance to infectious diseases of fish, probably through its antioxidant properties (Abdolbaghian et al., 2010). Vitamin C has no coenzyme functions, unlike other water-soluble vitamins, but acts as a cofactor in many reactions involving hydroxylating enzymes:

Collagen synthesis: collagen is an important component of skin, bone, cartilage and endothelium of blood vessels. Therefore, these tissues will be damaged if the formation of collagen is impaired by insufficient vitamin C levels in the body. The hydroxylation of specific prolyl and lysyl residues of procollagen is catalysed by hydroxylases dependent upon ascorbic acid: hydroxyproline residues contribute to the stiffness of the collagen triple helix and bind carbohydrates to form intramolecular crosslinks which give the structural integrity of the collagen. Ascorbate deficiency also reduces complement activity (the complement component C1q is rich in hydroxyproline and hydroxylysine).

Catecholamine biosynthesis: the stress response is primarily controlled by the endocrine system via cortisol and catecholamines whose synthesis depends upon ascorbic acid-dependent hydroxylases. Ascorbic acid requirement is increased by stressful situations. It can compensate for the stress induced down regulation of the immune system (Halver, 2002).

Tyrosine metabolism: the active degradation of tyrosine is made via two oxidases which are vitamin C-dependent. In turbot, vitamin C- deficiency causes hypertyrosinemia and the excretion of tyrosine metabolites.

Metal ion metabolism: vitamin C interacts with several metallic elements of nutritional significance (selenium) and reduces the toxicity of metals such as cadmium, nickel, lead (the elements are transformed into their reduced forms, which are absorbed less and excreted more rapidly).

Protection of cells from oxidative damage and the regeneration of vitamin E in its metabolically active form.

Immune reactions: vitamin C affects immune functions in different ways (protection against free radical-mediated protein inactivation associated with the oxidative burst of macrophages, chemotaxis, stimulation of proliferative response and antibody production and interferon). Vitamin C helps to maintain the integrity of the immune cells through their protection from oxidation and within the cells (high amount of vitamin C stored in the immune cells) (Abdolbaghian et al., 2010).

The main objective of present study was to survey on effect of additive vitamin C on growth, feed conversion ratio and survival rate of rainbow trout (Oncorhynchus Mykiss).

MATERIALS AND METHODS

In this study, 200 fingerling fishes weighting 3gr were achieved from farms and divided into the two identical groups. The all culturing condition such as water temperature, food, O_2 and etc. was same between two groups. The temperature of water was 10˚C and was constant during the study. Group 1 (control group) were feed only with starter but group 2 (treatment group) in addition to starter were feed with vitamin C as additive at the dose of 500 mg/kg. At the end of the study, mentioned parameters were measured. Feed conversion ratio (FCR) was measured by following formula:

$$\text{FCR} = \frac{\text{Total consumed feed in a culture period}}{\text{Weight gain of whole fishes in a culture period}}$$

Results:

The results of present study showed that weight gain in control and treatment group was 5.35±0.15 and 7.31±0.24, so there is a significant differences among groups ($P<0.05$).

Also it has been revealed that there is a significant difference among groups from length point of view ($P<0.05$) (7.56±0.09 versus 8.73±0.15).

The losses rate in in control and treatment group was measured 10 versus 4.

But there is no significant difference among groups from Vitamin C consumption point of view ($P>0.05$) table 1.

Table 1: Data related to measured parameters during 1 month.

Parameters / Group	Weight gain	Length	FCR	Losses rate
Control	5.35±0.15	7.56±0.09	2.3	10
Treatment	7.31±0.24	8.73±0.15	1.2	4
p-value	P<0.05	P<0.05	P>0.05	P<0.05

Discussion and Conclusion:

Stress has numerous adverse effects on animal and human. It is known to influence the immunocompetence of fish, for example, gilthead sea bream (Sparus aurata) (Sunyer et al. 1995). Chased daily for 8 min with a hand-held net for a period of 16 days has been shown to suppress the number of lymphocytes, haemolytic activity, agglutination capacity and antibody titre, while plasma cortisol levels were elevated (Sunyer et al. 1995). Captivity for 3 days decreased phagocytic activity in the juvenile salmonids (Oncorhynchus tshawytscha) (Pegg et al. 1995), which was similar to rainbow trout in transport (Jeney et al. 1997). Vitamin C supplementation has been shown to compensate the lymphocytopenia because of lindane depression (Dunier et al. 1995), and partly alleviated the reduction of antibody response caused by high temperature (Pardue et al. 1985) and cold exposure (Gross 1988) in chicken. However, little information is available about the effect of vitamin C on anti-stress ability in reptiles and amphibians.

Abdolbaghian et al. (2010), studied angel fish fry (Pterophyllum scalare) fed with artemia and dry blood worm at temperatures 27, 29, 31°C and they investigated SGR and weight growth. Their study lasted 6 months and they found that both feed type and temperature affects growth. It is interesting that in their study even two degrees temperature difference had significant effects on growth. Shamsaie et al. (2007), studied effects of live feed (rotifers), dry feed (commercial) and mixture of them on white fish (Coregonus lavaretus) for a three months period. In the first month of the experiment, specific growth rate was highest (5.36%) in the live feed group. They also found that in the last month of the experiment, SGR was highest (3.73%) in the dry feed group. In the study, SGR for dry feed higher temperature group was 3.65% and SGR for live feed higher temperature group was found 3.28%.

There are reports of significant effects of different feed on survival rates of rainbow trout in the literature however. Especially in the juvenile period, death rate decreased significantly in the enterprises using natural feeds. For instance, Mathias et al. (1982) determined the death rate of juvenile rainbow trout as 2.23% for the group fed on commercial feeds and 0.93% for the group fed on live feeds. Kocaman et al. (1997) gave wet and live feeds to juvenile rainbow trout in their study and determined the highest survival rate as 97.5% in the groups fed on Artemia+dry feeds and spleen+dry feeds, however the lowest survival rate as 85% in the group fed on spleen. Feed conversion ratio was found statistically highly significant among the groups fed on dry, wet and live feeds in normal water and higher temperature groups ($p<0.01$).

Vitamins C (ascorbic acid, AA) and E (tocopherols) are strong antioxidants. These two vitamins have been extensively studied in fish nutrition (Halver, 2002), as well as in humans and other animals (Hamilton et al., 2000). Vitamin C plays an important role in growth and immunity of fish (Lin and Shiau, 2005). Most teleosts are unable to synthesize ascorbic acid due to the lack of L-gulonolactone oxidase (EC 1.1.3.8) which is necessary to convert L-gulonolactic acid to AA; therefore, an exogenous source of vitamin C is required in fish diet (Wilson and Poe, 1973).

In a study revealed that diets without ascorbic acid supplementation decreased the specific growth rate (2.59) of guppies and this is in accordance with studies conducted by Ai et al., 2004 who also observed declining specific growth rate with ascorbic acid deficient diet for seabass (Scophthalmus maximus).

It is reasonable to assume that if the fish receives same amount of required feed contents (protein, fat, vitamin etc.) it would grow the same amount regardless of the source (liver, spleen, drosophila, dry feed ect.) as long as they are all digested. Therefore by choosing different feed, we are changing relative ratios of these basic feed components. One issue of aquaculture studies is to provide these feed components as cheap as possible and same quality protein or fat can be cheaper from one source than another. This point is one of the reasons why feed studies are necessary.

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