

The effects of dietary vitamin C on mucosal immune responses and growth performance in Caspian roach (*Rutilus rutilus caspicus*) fry

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Abstract This study was conducted to investigate the effects of different levels of dietary vitamin C on some skin mucus immune parameters, mucus antimicrobial activity and growth performance of Caspian roach (*Rutilus rutilus caspicus*) fry. Six hundred sixty Caspian roach (1.4 ± 0.02 g) fry were allocated to 12 tanks (55 fish per tank), and triplicate groups were fed diets containing 0, 1,000, 1,500 and 2,000 mg kg⁻¹ vitamin C for 60 days. At the end of the trial, the epidermal mucus protein level, alkaline phosphatase and antimicrobial activity against two gram-positive bacteria (*Streptococcus faecium* and *Micrococcus luteus*) and gram-negative bacteria (*Escherichia coli* and *Serratia marcescens*) as well as growth performance were measured. The results demonstrated that feeding on vitamin C significantly elevated skin mucus alkaline phosphatase and protein levels compared to the control group ($P < 0.05$). However, lysozyme activity was undetectable in both the vitamin C-fed roach fry and the control group. Skin mucus antimicrobial activity was increased following vitamin C administration, and the bacterial growth inhibition zones were significantly elevated in vitamin C-fed roach ($P < 0.05$). Similar results were obtained

in case of the minimum inhibitory concentration of skin mucus. Also fish fed the control diet had a significantly lower weight gain, specific growth rate and condition factor compared to the other treatments ($P < 0.05$). These results revealed that dietary vitamin C beneficially affects the skin mucus immune parameters and growth performance of Caspian roach fry.

Keywords Vitamin C · *Rutilus rutilus* · Skin mucus · Immune response · Growth performance

Introduction

The Caspian roach is a commercially valuable species in the Caspian Sea. This species is now considered a threatened species because of overfishing and destruction of spawning grounds (Soleimani et al. 2012). Restocking and artificial culture up to marketable size have been developed by the Iranian Shilat Organization to reduce pressure on natural Caspian Sea populations. The elevation of disease resistance, stimulation of immune responses and improvement of growth performance through administration of feed additives such as vitamins, minerals, and pro- and prebiotics are of great importance in commercial aquaculture of the Caspian roach, especially in sensitive periods (i.e., larvae and fry culture) (Hoseinifar et al. 2013).

Vitamin C or L-ascorbic acid (AA) is one of the best known feed additives and plays an essential

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