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The effects of *Lactobacillus acidophilus* as feed supplement on skin mucosal immune parameters, intestinal microbiota, stress resistance and growth performance of black swordtail (*Xiphophorus helleri*)



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ABSTRACT

The present study evaluates the effects of different levels of dietary *Lactobacillus acidophilus* as feed supplement on intestinal microbiota, skin mucus immune parameters and salinity stress resistance as well as growth performance of black swordtail (*Xiphophorus helleri*). One-thousand and eight hundred healthy black swordtail larvae (0.03 ± 0.001 g) were randomly distributed in 12 tanks (100 L) at a density of 150 fish per aquaria and fed different levels of dietary *L. acidophilus* (0 , 1.5×10^8 , 3×10^8 and 6×10^8 CFU g⁻¹) for 10 weeks. At the end of trial, there were significant differences among antibacterial activity of skin mucus in probiotic fed fish and control group ($P < 0.05$). Furthermore, the skin mucus protein level and alkaline phosphatase activity in control group were significantly lower than those of *L. acidophilus* fed fish ($P < 0.05$). Microbiological assessments revealed that feeding with probiotic supplemented diet remarkably increased total autochthonous bacteria and autochthonous lactic acid bacteria levels ($P < 0.05$). The results showed that dietary administration of *L. acidophilus* significantly elevated black swordtail resistance against salinity stress (i.e. survival %) ($P < 0.05$). Also, dietary administration of different levels of *L. acidophilus* improved weight gain, SGR, FCR compared to fish fed unsupplemented diet ($P < 0.05$). These results demonstrate beneficial effects of dietary *L. acidophilus* on mucosal immune parameters, intestinal microbiota, stress resistance and growth parameters of black swordtail and the appropriate inclusion is 6×10^8 CFU g⁻¹.

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1. Introduction

The economic importance of ornamental fishes causes increased interests for their artificial propagation and culture. Therefore, it is necessary to investigate various aspects of aquarium fish rearing such as growth performance, survival, immune response. Nowadays, nutritional manipulation of fish health is considered as one of the most important goals in ornamental fish culture plan [1]. The elevation of 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 [2–4]. Recently, administration of dietary probiotics have become common in aquaculture due to several advantages such as overcoming the limitations of antibiotics utilisation as well as increasing production rate by enhancing growth performance, immune response [5,6]. Probiotics are defined as the organisms and substances which contribute to the intestinal microbial balance and exerting numerous advantages in host [7]. Several species of lactic acid bacteria as well as yeast including *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Bacillus* sp., and *Saccharomyces cerevisiae* have been studied as probiotic in aquaculture [8,9]. It is now well-documented that *Lactobacillus* sp. can be considered as an important probiotic for elevation of fish growth performance and immune responses [10].

Considering the environmental condition and presence of opportunistic pathogenic organisms, the skin mucus plays a key

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