

Modulating gut microbiota and digestive enzyme activities of *Artemia urmiana* by administration of different levels of *Bacillus subtilis* and *Bacillus licheniformis*

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Received: 17 April 2011 / Accepted: 9 January 2012 / Published online: 28 January 2012
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Abstract The aim of this study was to evaluate the effects of *Bacillus subtilis* and *Bacillus licheniformis* on growth, gut microbiota, and digestive enzyme activities of *Artemia urmiana*. Three diets containing 10^2 (T₁), 10^4 (T₂), 10^6 (T₃) CFU of probiotics/g feed, and a control diet (C) without probiotic were used through a completely randomized design (treatments with triplicates). Twelve plastic tanks with the capacity of 60-l and density of 20 nauplii/ml were used and the trial continued for 15 days. Results showed that probiotics significantly increased the total length of *A. urmiana* ($P < 0.05$). Although the total aerobic gastrointestinal bacteria count showed no significant differences among the treatments, the total *Bacillus* count significantly increased in experiments ($P < 0.05$). The ratio of TCBS to total aerobic bacteria count was significantly lower in T₁ (0.31 ± 0.05), T₂ (0.27 ± 0.15), and T₃ (0.25 ± 0.05) compared to the control (0.76 ± 0.34) ($P < 0.05$). The probiotics were able to increase the protease and amylase activities ($P < 0.05$). No significant effect on lipase activity. The study determined T₂ and T₃ as the most effective treatments for improving growth, bacterial flora, and digestive enzyme activities. As less probiotic needed in T₂, using 10^4 bacteria per g diet is recommended for rearing *Artemia* up to the maturity stage.

Keywords Probiotics · *Artemia urmiana* · Growth · Microbiota · Digestive enzyme activity

Introduction

One of the main ways of transmission pathogenic bacteria to aquaculture systems is the use of live food including artemia. Controlling microbial communities in modern farming systems is necessary for increasing the productivity and preventing the spread of disease.

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