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Health & Welfare

Dietary sodium butyrate improves performance of Pacific white shrimp

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Organic acid improves balance of intestinal bacterial flora and performance of shrimp grown in different systems

Testing was performed in biofloc tanks as well as clearwater systems.

The emergence of bacterial diseases such as early mortality syndrome, caused by a strain of *Vibrio parahaemolyticus,* has caused negative impacts on the production of marine shrimp. With the use of antibiotics in animal production prohibited in many countries due to environmental problems and the selection of resistant bacteria, the industry has sought new feed additives to improve the nutrition and health of aquatic animals.

The use of organic acids and their salts in animal production has gained attention in recent years. These additives may promote benefits to cultured animals that include inhibiting pathogenic bacteria in the gastrointestinal system, development of highly available energy, increased absorption of macro- and micronutrients in diets and, therefore, greater productivity. Among the organic acids, sodium butyrate deserves special attention. In swine and poultry production, studies have shown benefits from dietary supplementation with butyrate, such as increased weight gain, feed efficiency and immunological parameters, along with benefits for intestinal mucus. However, despite its current commercial use in aquaculture, studies of sodium butyrate's effects in marine shrimp diets have been limited.

Shrimp performance in Clearwater

With the financial support of the Brazilian Ministry of Fisheries and Aquaculture and the Financier of Studies and Projects, the authors conducted studies at the Universidade Federal de Santa Catarina in Brazil to evaluate the potential use of sodium butyrate as a feed additive for Pacific white shrimp (*Litopenaeus vannamei)* in different culture systems.

Four diets were evaluated for a clearwater system: a control diet without supplementation and three diets containing sodium butyrate at concentrations of 0.5, 1.0 or 2.0 percent. The treatments were evaluated in triplicate, totaling 12 experimental units.

Each experimental unit was populated with 150 shrimp with an average weight of 2.5 grams, resulting in a density of 12 shrimp per square meter. The experimental units consisted of 6,000-L fiberglass tanks with aeration and heating systems that maintained 29.0 ± 0.4 degrees-C. The tanks also had a water-exchange system that supported daily exchange up to 50 percent of the tank volume.

After 50 days of culture, shrimp fed diets supplemented with sodium butyrate presented final weights 9.9 and 16.1 percent higher than those for the shrimp fed the control diet. Shrimp that received the diet supplemented with 2.0 percent sodium butyrate also showed higher survival, feed efficiency and productivity (Table 1).

Silva, Growth performance of L. vannamei, Table 1

Treatment	Final Weight (g)	Survival (%)	Feed Efficiency	Yield (kg/ha)
Control	9.3 ± 0.9^{a}	88.7 ± 0.6^{a}	0.53 ± 0.03^{a}	992 ± 89^{a}
Butyrate 0.5%	10.6 ± 0.2^{b}	92.3 ± 1.5^{ab}	0.59 ± 0.01^{ab}	1,176 ± 5^{b}
Butyrate 1.0%	10.3 ± 0.1^{b}	89.3 ± 0.6^{ab}	0.55 ± 0.01^{ab}	1,100 ± 0^{b}
Butyrate 2.0%	10.8 ± 0.5^{b}	93.0 ± 1.4^{b}	0.61 ± 0.01^{b}	1,237 ± 23^{b}

Table 1. Growth performance of L. vannamei cultured in clearwater with dietary supplementation of sodium butyrate at different concentrations.

Shrimp performance in biofloc system

Eight experimental units of 800-L volume were stocked with 200 shrimp with an average weight of 3.9 grams, maintaining an initial density of 250 shrimp per cubic meter. The units had 4 square meters of bottom and side surface and 2 square meters of additional artificial substrate in order to increase the well-being and comfort of the animals.

In addition, the units had aeration and heating systems, and a water clarifier to maintain the total solids concentration between 400 and 600 mg/L. The treatments consisted of shrimp fed a diet supplemented with 2 percent sodium butyrate and shrimp fed a control diet without supplementation.

After 42 days of cultivation, shrimp given the diet supplemented with sodium butyrate had higher survival and, consequently, higher productivity. However, no difference in weight gain or feed efficiency was observed between the treatments (Table 2).

Silva, Growth performance of L. vannamei, Table 2

Treatment	Final Weight (g)	Survival (%)	Feed Efficiency	Yield (kg/ha)

Control	13.3 ± 0.3	76.5 ± 0.5[a]	0.45 ± 0.05	25,400 ± 1,500[a]
Butyrate 2%	13.3 ± 0.5	81.6 ± 2.8[b]	0.46 ± 0.06	27,110 ± 460[b]

Table 2. Growth performance of L. vannamei cultured in biofloc systems with dietary supplementation of 2% sodium butyrate.

Effects against *vibrio* species

The antimicrobial effects of sodium butyrate against three strains of *Vibrio (Vibrio harveyi, V. alginolyticus* and *V. anguillarum*) were evaluated in vitro in microplates at pH values of 6 and 7. The sodium butyrate had an antimicrobial effect against all three *Vibrio* strains. At pH 6, the minimum inhibitory concentrations were between 7.5 and 15 mM, whereas at pH 7, total inhibition was observed between the concentrations of 30 and 120 mM.

In vivo bacterial counts of *Vibrio* species were performed in shrimp cultured in clearwater and biofloc (Figs. 1 and 2). In clearwater culture, dietary supplementation of sodium butyrate at 0.5 to 2.0 percent showed reductions of 95.3 to 98.4 percent in *Vibrio* counts in the shrimp's intestines. In the biofloc system, the shrimp fed diets supplemented by 2 percent sodium butyrate had a decrease of 92.3 percent.

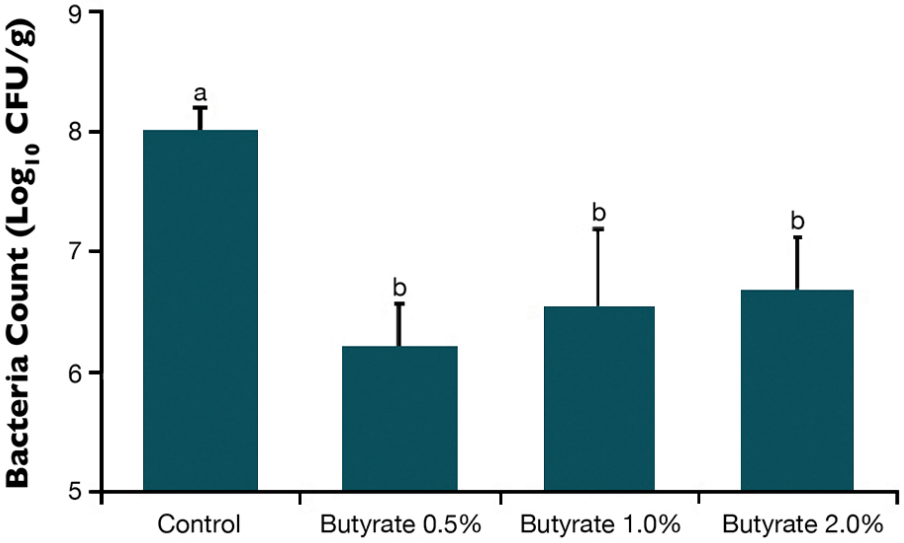

Fig. 1: *Vibrio* species counts in the intestines of *L. vannamei* cultured in clearwater with dietary supplementation of sodium butyrate at different concentrations.

Fig. 2: *Vibrio* species counts in the intestines of *L. vannamei* cultured in biofloc systems with dietary supplementation of 2% sodium butyrate.

Perspectives

The authors believe that sodium butyrate has the potential to be used as a feed additive for *L. vannamei*, improving the balance of intestinal bacterial flora and performance of marine shrimp grown in different systems.

However, further assessments of the effects of dietary supplementation with butyrate, in physiological and morphostructural alterations in the digestive tracts of marine shrimp, are needed to better understand the action mechanisms of this feed additive. In addition, since the organic salts are highly water-soluble, coated forms of organic salts should be evaluated to improve efficacy, as well as the use of lower concentrations in the diets.

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