



Improved digestion and initial performance of whiteleg shrimp using organic salt supplements

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Abstract

Organic acids or their salts are promising feed additives for aquatic animals to improve growth performance. We determined the effect of supplementing diets with sodium salts (formate, acetate, lactate, propionate, butyrate, fumarate, succinate and citrate) on trypsin and chymotrypsin activities, *in vitro* digestibility and zootechnical performance in the whiteleg shrimp (*Litopenaeus vannamei*). Shrimp trypsin and chymotrypsin activity increased in the presence of acetate and propionate and decreased in the presence of lactate and citrate. The highest *in vitro* protein digestibility of the experimental diets, using shrimp enzymes, was obtained for diets containing fumarate and succinate, which was significantly greater than the control diet (no supplements). In a growth trial, the highest final weights were in shrimp fed diets supplemented with fumarate, succinate, butyrate and propionate, increasing 53%, 46%, 38% and 29%, respectively, compared to the control. Shrimp that were fed diets with fumarate digested more feed and had a feed conversion ratio 23% higher than the control shrimp. Shrimp survival did not differ among treatments. We concluded that organic salts in the diet modify digestive enzymatic activity and *in vitro* protein digestibility of whiteleg shrimp. Fumarate, succinate, butyrate and propionate have potential as feed additives for *L. vannamei*.

KEY WORDS: enzymatic activity, *in vitro* digestibility, *Litopenaeus vannamei*, organic acids, sodium salts, zootechnical performance

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Introduction

Organic acids or their salts are one form of feed additive used in cultivating aquatic animals because they inhibit bacteria, contribute to nutrition, are components in several metabolic pathways for generating energy and improve digestibility of major nutrients (Lückstädt 2008; Defoirdt *et al.* 2009; Ng & Koh 2011) and growth performance (Goosen *et al.* 2011).

In the first studies using organic salts in aquafeeds (Ringo 1991; Ringo *et al.* 1994), a 10 g kg⁻¹ lactate feed supplement for the Arctic char (*Salvelinus alpinus*) increased growth and feed efficiency. In rainbow trout (*Oncorhynchus mykiss*), a supplement of 10 g kg⁻¹ sodium diformate (NaDF) increased digestibility of proteins, lipids and amino acids (Morken *et al.* 2011). Digestibility of plant proteins improved in Atlantic salmon, *Salmo salar* (Storebakken *et al.* 2010), when diets were supplemented with 12 g kg⁻¹ potassium diformate (KDF) and digestibility of fat increased when diets were supplemented with 10 g kg⁻¹ KDF (Lückstädt & Schulz 2008). In contrast, Atlantic salmon receiving a supplement of 12 g kg⁻¹ KDF did not influence nutrient digestibility (Morken *et al.* 2012) and neither did a blend of 12.6 g kg⁻¹ sodium butyrate and 9.4 g kg⁻¹ sodium formate improve growth rate or use of feed of rainbow trout, *Oncorhynchus mykiss* (Gao *et al.* 2011).

Studies of organic acids and their salts as supplements for shrimp are limited. Lückstädt (2008) reported the existence of only two studies that were not published in scientific journals. In one of them, adding 5 g kg⁻¹ sodium