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ORIGINAL ARTICLE

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Chlorella vulgaris meal improved growth performance, digestive enzyme activities, fatty acid composition and tolerance of hypoxia and ammonia stress in juvenile Pacific white shrimp *Litopenaeus vannamei*

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Abstract

This study was conducted to investigate the effectiveness of fish meal substitution by *Chlorella vulgaris* meal in the diet of Pacific white shrimp, *Litopenaeus vannamei*. Experimental diets contained varying levels of fish meal (400, 300, 200, 100 and 0 g/kg) which was replaced by increasing levels of *C. vulgaris* (0, 97.2, 194.4, 291.6 and 388.8 g/kg). After 8 weeks of feeding trial, shrimp fed diet with 97.2 g/kg *C. vulgaris* showed significantly improved growth compared to other treatments including control. Similarly, shrimp fed diet with 97.2 g/kg *C. vulgaris* showed significantly higher amount of trypsin and amylase activities compared to other treatments. The contents of long-chain polyunsaturated fatty acids including eicosapentaenoic acid, docosahexaenoic acid and arachidonic acid were significantly higher in the whole body of *L. vannamei* fed with different levels of *C. vulgaris* compared to those of control group. After exposure to hypoxia, the survival rate of shrimp fed diets contained different levels of *C. vulgaris* was higher than that of control group, while no significant differences were observed in ammonia tolerance among treatments. In conclusion, this study indicated that fish meal can be completely replaced with *C. vulgaris* in the diet of juvenile *L. vannamei* with no adverse effects on the performance of shrimp.

KEYWORDS

enzyme, fatty acids, microalgae, performance, shrimp, stress

1 | INTRODUCTION

Shrimp aquaculture has increased rapidly within the last decades, and cultured shrimp continue to dominate international seafood markets (FAO, 2012). The Pacific white shrimp, *Litopenaeus vannamei* (Boone 1931), is an increasingly popular and important cultured shrimp species because of high survival, rapid growth in intensive culture systems, and disease tolerance (Iba, Rice, & Wikfors, 2014). To support the growing market for cultured shrimp, the demand for improved feeds has created a need for high-quality protein sources (Tacon & Forster, 2000). Fish meal is the preferred dietary protein source in the diet of many farmed fish and shrimp species owing to its substantial content of high-quality proteins, containing all the essential amino acids, vitamin content, palatability and unidentified growth factors (Majumdar, Deb, & Nath, 2014). However, fluctuating supply of fish meal and consequently, elevation of prices during the last decade encouraged the search for cheaper and sustainable protein ingredients to reduce or eliminate the use of fish meal in aquaculture diets (Atanasoff, 2014). In this regard, a large number of studies have been carried out to evaluate various alternate protein sources as partial or complete dietary replacement of fish meal in aquaculture (Zapata, Lazo, Herzka, & Teresa Viana, 2016; Trejo Escamilla, Galaviz, Flores Ibarra, Alvarez Gonzalez, & Lopez, 2016).

Microalgae are known to contain high amounts of important macronutrients including protein and lipid, and micronutrients comprising

