Received: 23 October 2016 | Revised: 29 March 2017 | Accepted: 30 March 2017

DOI: 10.1111/are.13379

ORIGINAL ARTICLE

WILEY Aquaculture Research

# Partial and total replacement of fish meal by marine microalga *Spirulina platensis* in the diet of Pacific white shrimp *Litopenaeus vannamei*: Growth, digestive enzyme activities, fatty acid composition and responses to ammonia and hypoxia stress

Somayeh Pakravan[1] | Arash Akbarzadeh[1,2] | Mir Masoud Sajjadi[3] | Abdolmajid Hajimoradloo[4] | Farzaneh Noori[5]

[1]Department of Fisheries, Faculty of Marine Science and technology, University of Hormozgan, Bandar Abbas, Iran

[2]Department of Modern Technologies, Mangrove Forest Research Centre, University of Hormozgan, Bandar Abbas, Iran

[3]Department of Fisheries, University of Gilan, Rasht, Iran

[4]Department of Fisheries, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

[5]Urmia lake Research Institute, University of Urmia, Urmia,Iran

**Correspondence**
Arash Akbarzadeh, Department of Fisheries, Faculty of Marine Science and technology, University of Hormozgan, Bandar Abbas, Iran.
Email: akbarzadeh@ut.ac.ir

## Abstract

In the this study, we evaluated the effect of replacement of fish meal by a marine microalgae *Spirulina platensis* on growth, digestive enzyme activities, fatty acid composition and responses to ammonia and hypoxia stress in Pacific white shrimp *Litopenaeus vannamei* (2.6 ± 0.2 g). Experimental diets contained *S. platensis* at 0%, 25%, 50%, 75% and 100% replacement levels. After 8 weeks of feeding trial, growth parameters and proximate body composition were not significantly different among treatments ($p > .05$). Amylase and lipase activities did not show any significant differences between control group and other experimental diets ($p > .05$), while activities of trypsin and chymotrypsin were significantly higher in shrimp fed diet with 50% substitution of microalgae compared to control group. Fatty acid contents, particularly polyunsaturated fatty acids (PUFAs) including arachidonic acid (ARA), docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), were significantly higher in control diet compared to other experimental diets. On the contrary, the majority of fatty acids including the contents of PUFAs in the whole body of *L. vannamei* fed with different levels of *S. platensis* were significantly higher compared to those of control group. After 48-h exposure to ammonia, survival per cent was not statistically different between all groups ($p > .05$), but in hypoxia challenge, the survival per cent of control group was significantly less than that of treatments fed diets contained *S. platensis* ($p < .05$). Altogether, our results demonstrated the effectiveness of *S. platensis* as a reliable protein source for substitution of fish meal in shrimp aquaculture.

KEYWORDS

long-chain polyunsaturated fatty acids (LC-PUFAs), microalgae diet, Shrimp, stress

## 1 | INTRODUCTION

Pacific white shrimp, *Litopenaeus vannamei*, is an economically important farm-raised shrimp due to its great economic value, rapid growth rate and tolerance of a wide range of salinities and temperatures (Huang et al., 2015). In 2010, it accounted for 71.8% of world production of all farmed marine shrimp species (FAO 2012). 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

  