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Evaluation of dietary protein level on selected parameters of immune and antioxidant systems, and growth performance of juvenile *Litopenaeus vannamei* reared in zero-water exchange biofloc-based culture tanks

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ABSTRACT

The biofloc technology was proposed as a sustainable solution to culture shrimp with low protein feeds even in intensive systems, which can effectively control water quality under negligible water exchange and sustain healthy culture of shrimp. This study was conducted to evaluate the effects of four dietary protein levels (20%, 25%, 30% and 35%) on selected parameters of immune and antioxidant systems, and growth performance of *Litopenaeus vannamei* juveniles reared in zero-water exchange biofloc-based intensive culture tanks for a period of 7 weeks. Good water quality was maintained with the promotion and development of biofloc through sucrose addition during the feeding experiment. At the end of the experiment, the total hemocyte count in the hemolymph, phagocytic activity of the hemocyte, and antibacterial activity and bacteriolytic activity in the plasma of shrimp showed no significant differences ($P > 0.05$) among the four treatments with four dietary protein levels. The shrimp in the treatment with 20% dietary protein level had the lowest total antioxidant capacity (T-AOC) in both the plasma and the hepatopancreas, and the lowest reduced glutathione/oxidized glutathione (GSH/GSSG) ratio in the plasma. No significant differences were found in the antioxidant status (in terms of T-AOC, superoxide dismutase activity, GSH level and GSH/GSSG ratio in the plasma and the hepatopancreas) of shrimp fed with 25%, 30% and 35% dietary protein levels. Furthermore, except for the suboptimal growth performance of shrimp in the treatment with 20% dietary protein level, the growth (in terms of final weight, weight gain and specific growth rate) and feed conversion rate (FCR) of shrimp in treatments with 25%, 30% and 35% dietary protein levels showed no significant differences ($P > 0.05$). Mean survival rates were above 85%, with no significant differences ($P > 0.05$) among the four treatments with four dietary protein levels. The results of this study demonstrated that, when juveniles of *L. vannamei* were reared in zero-water exchange biofloc-based intensive culture tanks, dietary protein level can be reduced from 35% to 25% without affecting survival, growth, FCR, and physiological status of immune response and antioxidant capability, indicating that the promoted biofloc could contribute to the protein nutrition and physiological health of cultured shrimp.

1. Introduction

The application of biofloc technology (BFT) in shrimp aquaculture has gained great attention recently because it offers a practical solution to effectively control water quality under negligible water exchange and improves shrimp growth performance, thus achieving efficient and healthy culture of shrimp (Avnimelech, 2012; Crab et al., 2012; De Schryver et al., 2008; Stokstad, 2010; Xu and Pan, 2013). In heterotrophic biofloc-based shrimp culture systems, the driving force is dense populations of active heterotrophic bacteria which can be promoted by increasing the C/N ratio of feed input and assimilate the waste nitrogen from culture water resulting in the production of new microbial biomass (cellular proteins) (Avnimelech, 2006; Crab et al., 2007; Ebeling et al., 2006). As the microbial communities develop, bioflocs are formed from heterogeneous aggregates of microorganisms and organic particles (De Schryver et al., 2008; Hargreaves, 2006). As a supplemental food source available for cultured shrimp, the biofloc can be consumed and provide a significant fraction of protein demand (Ballester et al., 2010; Burford et al., 2004; Crab et al., 2010; Wasielesky et al., 2006; Xu et al. 2012). Some studies suggested that using low protein feeds in biofloc-based culture systems could also achieve good survival and growth performance of cultured shrimp (Ballester et al., 2010; Megahed, 2010; Moss, 2002; Wasielesky et al., 2006). With biofloc supplementing the inadequate portion of protein intake, the proper use of low protein feed can reduce dietary fishmeal inclusion, thus reducing the cost of feed and improving the efficiency of production.

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