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Effects of bioflocs on growth performance, digestive enzyme activity and body composition of juvenile *Litopenaeus vannamei* in zero-water exchange tanks manipulating C/N ratio in feed

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ABSTRACT

A 30-day feeding experiment was conducted to investigate the effects of promoted bioflocs on growth performance, feed utilization, digestive enzyme activity and whole body composition of *Litopenaeus vannamei* juveniles (average 6.95 ± 0.22 g) in zero-water exchange culture tanks. Two bioflocs treatments and one control were evaluated: Bioflocs-based tanks with two levels of C/N ratio (15, 20) by addition of carbohydrate referred to as 'CN15' and 'CN20', and clear water tanks operated with water exchange and without addition of carbohydrate referred to as 'Control'. Each group consisted of quadruplicate tanks (125 L) and each tank contained 28 shrimp (equivalent to shrimp density of 224 individuals and biomass of ~1.56 kg per cubic meter of water volume). Original concentrated bioflocs were collected from an indoor bioflocs-based shrimp culture pond, and inoculated into all bioflocs-based tanks with the same amount (0.5 mL L^{-1} bioflocs volume) just before stocking shrimp. Sucrose was applied as a source of carbohydrate and added separately to the CN15 and CN20 treatment tanks in addition to the applied feed (35% crude protein), so as to raise the C/N ratio of the feeds input (feed and sucrose) to 15 and 20 and subsequently promote the development of bioflocs. The monitoring of water quality parameters showed that they all remained within recommended levels for shrimp culture in the three groups. At the end of the experiment, survival rates of the shrimp were above 90%, with no significant differences among the three groups ($P>0.05$); and the growth (in terms of final weight, weight gain and specific growth rate) of the shrimp in both bioflocs treatments were significantly better ($P<0.05$) than that obtained in the control while the feed conversion rate was significantly lower ($P<0.05$). An overall enhancement in protease and amylase activities of the shrimp in both bioflocs treatments was observed, though the effect of the bioflocs on each enzyme activity performed inconsistently among different digestive tissues: digestive gland, stomach and intestine. Proximate composition analysis showed that the crude lipid and ash contents of the shrimp in both bioflocs treatments tended to increase. The bioflocs collected from both bioflocs treatments showed good prime nutritional values and appropriate extracellular enzymes activities. The crude protein and crude lipid contents ranged from 27.3% to 31.6% and 3.7% to 4.2%, respectively; and protease and amylase activities ranged from 10.7 to 14.4 μmol min^{-1} g^{-1} TSS and 293.5 to 335.5 μmol min^{-1} g^{-1} TSS, respectively. The results from this study suggest that the promoted bioflocs can improve growth performance and feed utilization of the cultured shrimp, probably through providing a supplemental food source and enhancing feed digestion and utilization.

1. Introduction

The bioflocs technology is a sustainable technique used in zero-water exchange shrimp culture systems (Avnimelech, 2008; Crab et al., 2007; De Schryver et al., 2008). Dense and active heterotrophic microorganisms are manipulated so as to control water quality mainly by the immobilization of ammonium into microbial biomass (Avnimelech, 2006; Crab et al., 2007). As the microbial community develops, bioflocs (microbial flocs) are formed containing heterogeneous mixture of microorganisms and organic particles (De Schryver et al., 2008; Hargreaves, 2006). Relatively high C/N ratio in feed (10 to 20) was recommended for the establishment of bioflocs in such a system (Asaduzzaman et al., 2008; Avnimelech, 1999; Ballester et al., 2010; Hargreaves, 2006). As the C/N ratio of most of the artificial feeds used in intensive aquaculture systems is around 10, adding carbohydrates (e.g. sugar) in addition to the regular feed can be a practical way to increase the C/N ratio, thereby promoting the development of bioflocs within the systems (Asaduzzaman et al., 2008; Avnimelech, 1999; De Schryver et al., 2008). Several studies

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