1 Introduction

Bioflocs is a heterogeneous mixture of the microorganisms, particles, organic polymers and dead cells, etc. (Hargreaves, 2006). Among which, heterotrophic bacteria convert efficiently the ammonia nitrogen into the bacterial protein, which provides the supplementary feed for culture animals and reduces the nitrogen level in the culture system (De Schryver et al., 2008). In the closed aquaculture system, the growth of heterotrophic bacteria can be improved through managing C/N ratio such as feeding carbon-riched feed or adding carbohydrate directly into the culture medium (Avnimelech, 1999; Schneider et al., 2005). It has been reported that application of biofloc techniques in freshwater and seawater aquaculture system resulted in an increased production of tilapia (Avnimelech, 2006; Crab et al., 2009) and marine shrimps with lower feed input (Emerenciano et al., 2012; Zhao et al., 2012; Schveitzer et al., 2013).

Artemia inhabits the hypersaline environments such as inland salt lakes and coastal solar saltworks. As a major macroscopic representative in the saltponds, Artemia does not only play an important role in balancing saltpond biological system and improving salt production (Tackaert, 1987), but also provides an excellent live food for aquaculture (Sorgeloos et al., 2001). With the fast development of aquaculture and fluctuating cysts harvest from the wild, a controlled Artemia production in the saltpond biotope has been practiced recently. As a filter-feeding crustacean, Artemia accept all kinds of feed particles with size of less than 50 mm. And addition of extra carbon resource into the Artemia culture could efficiently increase the biofloc volume, and total Artemia biomass and cysts production (Ronald, et al., 2013; Sui et al., 2014). However the development of bioflocs under hypersaline conditions has not yet been fully understood.

2 Materials and Methods

In this study, the effects of carbon supplementation and salinity on Artemia growth, water quality, biofloc formation and its microbial biodiversity were studied in the zero-water exchanged Artemia culture system. Different carbon sources such as molasses, glucose, sucrose and corn flour were supplemented to the culture medium, the control group was fed only with microalgae Dunaliella viridis. In another experiment, molasses was chosen as carbon source. Bacteria Alkalibacterium sp. and archaea Halobacterium sp. isolated from the local saltponds, and enriched bacterial culture of brine water obtained from the local saltponds (salinity 80 g/L) were added to the culture medium, the control groups were fed with D. viridis or with D. viridis and molasses.

3 Results and Discussion

Carbohydrate supplementation significantly improved the total Artemia biomass ($P<0.05$) (Fig. 1). Total Artemia biomass in the treatment with molasses addition was significantly higher than those with glucose, sucrose and corn flour, and the Control treatment had the lowest value. Over a 14-day experimental period, DO in the culture column was kept at 6.5-7.5 mg L$^{-1}$ and pH ranged 7.8-8.1. Compared with the control, carbon supplementation significantly reduced the ammonium concentration, while molasses supplementation resulted in a lowest value ($P<0.05$) (Fig. 2).

After the first week of culture, Artemia in the Control treatment fed only with D. viridis died completely, thus no data recorded for this group. Compared to only molasses supplementation (M), addition of molasses and microorganisms such as Alkalibacterium sp. (A+M), Halobacterium sp. (H+M) and enriched bacteria culture (EBC+M) significantly increased the total Artemia biomass (Fig. 3) ($P<0.05$). There were trends of increasing total ammonium concentration at 2nd week and decreasing

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at 3rd week (Fig. 4). At first week carbon supplementation significantly reduced total ammonium concentration (P<0.05). No significant difference was observed among the treatment at second week (P>0.05). At third week, EBC+M and H+M treatments were significantly higher than other treatment (P<0.05).

In conclusion, carbon supplementation significantly improved the total Artemia biomass and reduced total ammonium nitrogen in the culture medium, indicating that carbon addition stimulated nitrogen assimilation by microorganisms and hence provided extra food for Artemia. Molasses seems to be the best carbon source, which may be linked to its various non-sugar components such as soluble gum, organic acids and amino acids, etc. Addition of halophilic bacteria, archaea and enriched bacterial culture also improved the total Artemia biomass, showing that the tested microorganisms are suitable food for Artemia. Higher total ammonium nitrogen observed in the treatments with microorganism addition maybe due to the higher metabolic activity for Artemia biomass obtained in these treatments, which could not be assimilated efficiently by microorganisms. Future study will focus on the microbial diversity of and nutritional quality of bioflocs on Artemia production.

Key words: Artemia, bioflocs, carbon, salinity, water quality, microbial diversity

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