

Reduction of the Feeding Levels on *Litopenaeus Vannamei* Nursery Under Bioflock Conditions Using A Bioreactor System

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Abstrak

Agung Sudaryono and Rita Rostika. 2014. Reduction of the Feeding Levels on *Litopenaeus Vannamei* Nursery Under Bioflock Conditions Using A Bioreactor System. *Aquacultura Indonesiana*, 15 (1) : 41-45. The aim of this research was to evaluate whether the feeding levels in *Litopenaeus vannamei* nursery can be reduced without any adverse of the shrimp growth under bioflock conditions using a bioreactor system. There were 5 different reduced feeding levels as treatments in triplicates in this study ie. 10% reduction of the feeding level (A), 15% reduction of the feeding level (B), 20% reduction of the feeding level (C), 25% reduction of the feeding level (D), and no reduction of the feeding level (E; as control). Average daily gain (ADG), survival rate and water quality parameters were observed in the study. Results of the study showed that there were no significant differences ($P>0.05$) in ADG and survival rates among all treatments with ranges of 0.11-0.19 g/day and 74-79%, respectively. It means that under bioflock conditions using a bioreactor system the feeding levels in the *L. vannamei* nursery can be reduced up to 25% without any adverse in the growth performance. However, 20% feeding level reduction is recommended to give a better growth performance of *L. vannamei* in nursery system with biofloc.

Keywords: Average daily growth; Feeding level reduction; *Litopenaeus vannamei*; Nursery

Introduction

Increasing fish density and the number of feeds in aquaculture production can result in accumulation of organic matter in an aquatic environment. This accumulation can lead to reduce the water quality due to high anorganic nitrogen compound contents which are from metabolism waste, uneaten feeds, faeces dead algae and other organic matters (Azim and Little, 2008). Fish or shrimp will only assimilate 20-30% protein in the diets consumed, the rest will be excreted into the water in the form of anorganic nitrogen (Taw, 2010). Biofloc system is adopted to reduce accumulated toxic organic matters in the aquaculture media. The final result of biofloc technology application is to increase feed utilisation efficiency and improve the water quality (Avnimelech, 2007).

Anorganic nitrogen accumulation in aquaculture will be transformed to be heterotroph bacteria biomass and it depends on carbon: nitrogen (C/N) ratio. Manipulation C/N ratio can be adjusted by adding a carbon source into aquaculture media (Avnimelech, 1999; Azim *et al.*, 2007). According to Avimelech (1999), the optimal C/N ratio to boost the growth of heterotroph bacteria is 18:1 whereas Gunadi *et al.* (2009) reported the optimal C/N ratio on 20:1. Molase, rice pollard or casava flour are organic

carbon sources that can be added into the system. The use of biofloc technology in shrimp aquaculture (*Litopenaeus vannamei*) in Indonesia has proven to reduce 20% feed conversion ratio (FCR) and produce 50 tons shrimp/Ha harvested partially (Taw *et al.*, 2011). Bacteria biomass in heterotroph aquaculture system will form flocs that can be utilised as feed sources due to its high protein contents (Avnimelech, 2007; Crab *et al.*, 2007). Biofloc can also act as immunostimulant for fish or shrimp due to biofloc bacteria can produce catalase and superoxidase enzymes (Asaduzzaman *et al.*, 2008).

It has been reported by Kuhn *et al.* (2010) that biofloc can be used as natural foods for shrimp and can replace up to 67% commercial feeds need. As consequence, this will result in increasing feed utilisation efficiency. Tahe (2008) reported that vannamei shrimp with average initial weight of 0.18 ± 0.02 g cultured for 75 days at a density of 4 juveniles/L and on reducing feeding levels up to 25% have produced the highest daily growth rate (0.0526 ± 0.069 g/day). Maulani (2009) has also reported, *Litopenaeus vannamei* PL-13 cultured under biofloc media system with reducing the feeding allowance up to 25% had the highest daily growth rate (0.0149 ± 0.0003 g/day).

However, up to now, there is no publication on reducing the feeding levels up to

25% in *L. vannamei* nursery under biofloc conditions using a bioreactor system. The previous study indicated that vannamei shrimp treated with bioflocs using a bioreactor system has higher significant survival rate (0.97%) than does vannamei shrimp reared altogether with bioflocs (0.89%) (Rostika and Sudaryono, 2013). Thus, this study was conducted to evaluate whether the feeding levels in *Litopenaeus vannamei* nursery can be reduced without any adverse of the shrimp growth under bioflock conditions using a bioreactor system.

Materials and Methods

The study was conducted at Institute for Brackish and Sea Water Aquaculture Development, Cilebar District, Karawang Regency, West Java Province. The two sets of the study were prepared for 4 months from April to July 2013.

The animal tests of 400 PL-10 *Litopenaeus vannamei* per tank obtained from the commercial hatchery in Banten, commercial feed (crumble), mollase (as C source), commercial shrimp probiotic *Bacillus* sp. of Indonesian Aquaculture Society (MAI), and trash fish (as N source) were used as materials in the study.

The equipments consisting of fifteen 1 m³ rearing tanks, 2 biofloc bioreactor tanks, aerators, plastic pipes, aeration stones, heater, digital balance (0.01 and 0.1 g), water quality checker, spectrophotometer, Imhoff cone volume 1000 mL, camera, and bucket were used in the study.

Experimental Method and Protocol

A completely randomized design was used in the study consisting of 5 treatments of reducing different feeding levels with triplicates per treatment. The treatments were reducing feeding levels 10% (A), 15% (B), 20% (C), 25% (D) and no reduction of feeding level (normal feeding level as a control; E).

Biofloc preparation --- Two 600-L bioreactor tanks were washed by clean fresh water, sterilized by using 30 mg/L CaHClO₃ (antiseptic), washed again until clean from the antiseptic residu and then kept dry for 2 days. Sea water (30 ppt) were filled into the tanks equipped by aeration, then 1500 g of trash fish were added in the tanks and the water were aerated for 24 hours. A 600 g commercial probiotic propduct (*Bacillus* sp.) was diluted in 50 L sea water and mixed homogenly with 600 g

molases. The probiotic solution was activated for 6 hours and then poured into the bioreactor tanks. The biofloc production was controlled to monitor forming the density of floc particles for 1-2 days. If the biofloc density was less than 10% of the total water sample volume taken from the bioreactor, 411 g molases (as C source) and 10 g trash fish (as N source) were required to add into the bioreactor. On the other hand, if the biofloc density was more than 50% of the total water sample, some sea water were added in the bioreactor.

Feeding trials --- *Litopenaeus vannamei* (PL 10) were stocked at a density of 6 shrimp/L per rearing tank. A daily feeding level of 10% biomass weight with twice feeding frequency at 6:00 and 17:00 for 7 weeks was applied in the study. A bioflock of 1 mL/g shrimp biomass was given to the rearing tank. The growth of vannamei shrimp was observed every week by sampling 10% of total shrimp biomass.

The feeding trial was conducted at ambient temperature and subjected to natural photoperiod (approximately 12-h light/12-h dark during the experiment). Water quality parameters were assessed every 3 day for temperature, salinity, pH and DO and every 2 weeks for NH₃. Water temperature ranged between 26 and 29.0°C, salinity 5-10 ppt, pH 7-8, dissolved oxygen $\geq$ 5.0 mg/L, and total ammonia nitrogen < 0.01 mg/L.

Evaluation Parameters --- Average daily gain (ADG) and survival rate were determined to evaluate the effects of all treatments during the study. ADG was determined by using an equation as follows; $ADG = [final\ weight - initial\ weight] / rearing\ period\ (g/day)$. Survival rate (SR) was calculated by equation: $SR = [total\ life\ shrimp\ number\ at\ the\ end\ of\ the\ study / total\ initial\ life\ shrimp\ number] \times 100\%$.

Statistical analysis --- All data were statistically analyzed by the Statistical Analysis Program of SPSS Inc. One-way ANOVA and the Duncan's multiple comparison test at $P < 0.05$ were used to compare the observed values between treatments. All percentages data were transformed to arcsine values before analyzed (Zar, 1984).

Results and Discussion

Growth Performance

Average daily gain (ADG) data of *L. vannamei* shrimp as effects of different

feeding levels reduction for 7 weeks nursery rearing period under biofloc conditions using a bioreactor system were presented in Table 1 and Figure 1.

Statistically, there is no significant differences ($P>0.05$) of the shrimp growth for all 5 different feeding levels reduction. Increasing reduction of feeding levels from 0 to 25% did not resulted in different growth performances expressed in the form of ADG (average daily growth) with an average range of 0.11-0.19 g/day reared for a 7-weeks nursery period under biofloc conditions. It means that the shrimp can well grow regardless reducing the amount of feeds given when the shrimp were reared under a nursery system by using biofloc media. The shrimp had a similar growth response from week 1 to week 7 (See Figure 1). However, reduction of the feeding level at 20% relatively tends resulting in a better growth performance (ADG) than other treatments.

This results showed that the existence of biofloc in the media flew from a bioreactor

system can well replace the nutrition availability in quality and quantity of the commercial feeds as required by the shrimp when the feeding levels were reduced up to 25% for 49 days nursery period. This is a fact that shrimp has utilized biofloc biomass as an ingredient (nutrition sources) for compounded feeds. It has been reported by Moriarty (1997) that the particulate organic matter and other organisms in the microbial food web are as potential food sources for fish and shrimp. In biofloc technology, the availability of a large range of microorganisms such as phytoplankton, free and attached bacteria, macroaggregates of particulate organic matter and grazers (rotifers, ciliates and flagellates protozoa and copepods) are a key role in nutrition of cultured animals (Ray *et al.*, 2010). Biofloc biomass is a rich protein-lipid natural food (Avnimelech, 2007). This findings were in agreement with the facts reported by Moriarty (1997), Ray *et al.* (2010) and Avnimelech (2007).

Table 1. Average daily gain (ADG; g/day) of PL-10 *L. vannamei* shrimp at different feeding levels reduction for 7 weeks nursery rearing period under biofloc conditions.

Feeding level reduction	Average Daily Gain (g/day) on Week							
	1	2	3	4	5	6	7	Mean
Control	0.01	0.07	0.11	0.12	0.12	0.13	0.22	0.11
10% (A)	0.01	0.04	0.14	0.15	0.18	0.21	0.23	0.13
15% (B)	0.01	0.04	0.11	0.15	0.19	0.25	0.26	0.14
20% (C)	0.00	0.05	0.13	0.20	0.20	0.23	0.31	0.19
25% (D)	0.00	0.04	0.10	0.13	0.15	0.19	0.28	0.17

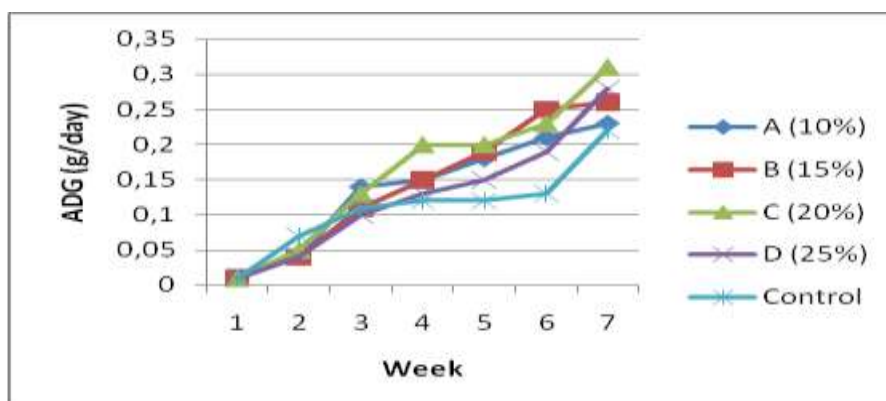


Figure 1. Trend of the growth performance (average daily gain, ADG; g/day) of PL-10 *L. vannamei* observed every week for 7 weeks nursery rearing period under biofloc conditions using a bioreactor system.

In application, this high mean ADG (0.19 g/day or 1.33 g/week) of the treatment C (20% feeding level reduction) (See Table 1 and Figure 1) was more benefits. This means that to achieve this ADG, 20% of conventional feeding ration can be reduced and as consequence this will lower costs in feed. Similar finding has been also reported by Panjaitan (2004) that growth enhancement of *Penaeus monodon* has been attributed to biofloc consumption in shrimp containing both bacterial and algae nutritional components. Burford *et al.* (2004) reported that biofloc consumed by *L. vannamei* could lower up to 29% of daily feed consumption. In tilapia, biofloc biomass could reduce the feed consumption up to 20% with no any adverse on the growth performance (Avnimelech *et al.*, 1994).

Mean ADG's (0.11-0.19 g/day) of this study under biofloc conditions for 7 weeks nursery period were similar to those (0.17-0.19 g/day) obtained from Samocha (2013^b) by using 4000 PL10-12 *L. vannamei* per m³. The findings were also in agreement with the ADG's 0.19 g/day and 0.26 g/day achieved by Samocha (2013^a) with 1.25 g and 1.9 g juveniles *L. vannamei* at stocking densities of 530/m³ and 500/m³, respectively. This could be concluded that biofloc biomass nutrition quality produced from a bioreactor system in the study might have similar performances to those produced by Samocha (2013^a; 2013^b).

The survival rates of shrimp *L. vannamei* in the study was not significant with a range of 74-79%. The survival rates of treatments A, B, C, D, and control were 77%, 78%, 79%, 74%, and 79%, respectively. The survival rates in the study were similar and in agreement with those of Samocha (2013^a; 2013^b) studies (75-80%) in both PL 10 and juveniles *L. vannamei* rearing under biofloc conditions.

It can be concluded in this study that under biofloc conditions using a bioreactor system, growth enhancement of *Litopenaeus vannamei* in nursery system can be achieved by reducing feeding levels up to 25% without any adverse in the growth performances. However, 20% feeding level reduction is recommended to give a better growth performance of *L. vannamei* in nursery system with biofloc.

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