



Evaluation of water quality in biofloc and non biofloc systems of pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931)

¹ Kavitha K, ^{*2} Suneetha K, ³ Darwin CH, ⁴ Selvakumar P, ⁵ Muddula Krishna N, ⁶ Govinda Rao V

^{1, 2, 3} Department of Zoology & Aquaculture, Acharya Nagarjuna University, Nagarjuna Nagar, Andhra Pradesh, India

⁴ CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram, Kerala, India

⁵ ICAR-Central Institute of Fisheries Technology (CIFT), Visakhapatnam, Andhra Pradesh, India

⁶ Department of Aquaculture, Adikavi Nannaya University, Rajahmundry, East Godavari, Andhra Pradesh, India

Abstract

The present investigation was carried out to understand the water quality parameters *viz.*, Temperature, Dissolved Oxygen, Salinity, pH, Alkalinity, Hardness, Nitrite-nitrogen, Nitrate-nitrogen and Ammonia in two treatments A₁ (=Biofloc technology) and A₂ (=Non biofloc/control) with triplicates at Madanur village of Prakasam district, Andhra Pradesh, India. Temperature ranged from 27 °C to 29 °C in the ponds. Dissolved oxygen ranged from 5.89 to 8.6 mg/l. Minimum values of dissolved oxygen (5.6 to 7.8 mg/l) were recorded in A₂ treatments and maximum at A₁ (5.8 to 8.6 mg/l) treatments. Low salinity (5.0 ppt) was observed in A₂ tanks and high in A₁ (8.0 ppt). pH varied from 7.0 to 8.5. The alkalinity ranged from 70 to 230 mg/l minimum (70 mg/l) and maximum (230 mg/l) were observed in non biofloc treatments. The hardness values ranged from 1850 to 2460 mg/l. The nitrite-nitrogen was minimum (0.01 mg/l) in A₁ tanks and maximum (2.3 mg/l) in A₂ tanks. The nitrate-nitrogen was minimum (20-60mg/l) in non biofloc treatments and maximum (50-150 mg/l) in biofloc treatments. The ammonia values were (0.05 to 2.0 mg/l), maximum concentration (2.0 mg/l) was observed in A₂ treatments and minimum (0.12 mg/l) in A₁ tanks.

Keywords: *Litopenaeus vannamei*, biofloc technology, water quality parameters, eco-friendly

Introduction

Aquaculture is one of the fastest growing food-producing sector in the world ^[1, 2]. It has rising at an average annual rate of 6.6% since 1995 ^[3]. Globally, India occupies the second position after China, with sharing 10.0% of world's aquaculture production which is about 0.9% of the country GDP during 2015-16 ^[4, 5]. The vast resources in terms of water bodies and species of fish and shellfish in different agro-ecological regions of the country provide for a wide array of culture systems and practices ^[6]. The lucrative crustacean species, *Litopenaeus vannamei* is leading the overall aquaculture production in the country. It expanded rapidly across the country due to its growth rate, short culture period and high export value. However, various obstacles hampered the successful production of shrimp which includes deteriorated water quality. It directly leads to the spread of pathogens and causes disease outbreaks in the culture system. Therefore, maintaining the proper water quality plays a significant role in preventing the spreads of pathogens that can accelerate the growth of cultured shrimp ^[7]. Hence adopting new alternative approaches towards sustainable and an environment friendly technologies for enhancing the water quality towards the higher production in aquaculture systems remains necessary. Biofloc is one such technology that has recently gained attention as eco-friendly culture technique ^[8, 9, 10]. Biofloc technology (BFT) is a well established new technology which enhances the water quality in aquaculture by balancing the carbon and nitrogen ratio ^[11]. BFT will reduce the pollution of pond water, by lowering the

concentration of toxic ammonia, nitrite and hydrogen sulphate and improves the water quality. With these positive effects of BFT it has been widely practicing by shrimp farmers across the world ^[12] and now it's catching up among the Indian shrimp farmers. However, studies on perception of water quality parameters in BFT were scanty in India, and especially in Andhra Pradesh where the aqua production has grown tremendous pace and holds ranks first. Hence, the present study is aimed at assessing the effect of BFT application of water quality in shrimp culture pond.

Materials and Methods

The study was carried for a period of 120 days at Madanur village (15°33'31" N; 80°09'83" E), Prakasam district, Andhra Pradesh, India. The trial was composed of two treatments (A₁ and A₂) with three replicates each. A₁ belongs to biofloc technology, while the A₂ were non biofloc. Post larvae-9 of *L. vannamei*, obtained from a local hatchery were stocked with a density 120 Pl/m². Prior releasing the shrimp, the BFT ponds were levelled and fixed with high density polyethylene (HDPE) sheet. All the ponds were filled with water, then the water was disinfected with following standard methods ^[13]. After dechlorination, biofloc treatment was started for A₁ tanks as per the protocol described by Avnimelech ^[14]. In order to stimulate biofloc growth, BFT tanks were prepared nine days prior to the experiment. Continuous aeration was provided for all the tanks to supply sufficient oxygen. After attaining a floc volume of 0.5 to 1.0 ml/l, shrimp were introduced into the tanks. Sludge was

removed in order to control Nitrite and TSS in the BFT system. Water samples for the analysis were collected during June-September 2017, the surface water temperature of shrimp ponds was recorded in mornings before feeding with the help of mercury thermometer. Samples were collected in separate reagent bottles and analyzed at the laboratory for different parameters studied following the methods of APHA [15]. Imhoff cones were used to measure the floc volume. Microbiological test was done, to observe the vibrio count, spread plate technique was used. 1ml of cultured water was serially diluted and 10⁸, 10⁹ ml of serially diluted culture water was spread on Thiosulfate citrate bile salts sucrose (TCBS) agar and incubated overnight at 37°C to find out the presence of *Vibrio* [13].

Results and Discussion

Water quality data are summarized in Table 1. The lucrative shrimp, *L. vannamei* culture gaining more importance due to its unique taste, high nutritive value and persistent demand in domestic as well as in the export markets. Management of water quality parameters in shrimp culture ponds has been essential for optimum growth and viability of shrimp. Variation in the water quality parameters beyond a particular range will definitely have its impact on production and resulted in heavy economic losses. Temperature is one of the most important factors which influence the physiological responses in the organisms like respiration, metabolism, growth and reproduction [16]. The cultured shrimp grows best in a temperature range from 24 - 32 °C [17]. During the study, average temperatures were in the optimal condition in all the treatments which were ranged from 27°C to 29 °C. The level of dissolved oxygen in pond water depends on the production of phytoplankton and also weather conditions influence the dissolved oxygen concentration. The dissolved oxygen lethal for *L. vannamei* has reported 1.0 ppm in culture pond conditions [18]. The dissolved oxygen ranged from 5.8 to 8.6 mg/l in A₁ and 5.6 to 7.8 mg/l in A₂ tanks. To maintain DO levels all the tanks were supplied with aeration for sufficient supply of oxygen which is necessary for the formation of biofloc and also for shrimp. *L. vannamei* is a euryhaline species it can tolerate the wide range of salinity [19, 20]. In the present study, the salinity was observed ranged from 6.0 - 8.0 ppt, which shows higher in biofloc treatments than in non biofloc treatments 5.0 to 7.0 ppt. Probably salinity was higher due to the evaporation of water in the BFT treatments. However, salinity remained within acceptable limits for *L. vannamei* culture and thermal tolerance of shrimp species [21, 22, 23]. The pH in A₁ were in optimal condition for shrimp culture which were ranged from 8.0 - 8.5, whereas in A₂ treatments showed 7.0 to 8.5. The lower pH values were possibly a result of high respiration rates by the large number of microorganisms, which may have increased CO₂ concentrations. However, the permissible limit of pH in shrimp culture is 7.5 - 8.5 [24, 25]. Photosynthesis and

nitrification processes may occur in control system possibly resulted in pH fluctuation, as these processes are likely to alter CO₂ concentration and buffering capacity in water [26]. Alkalinity is the buffering capacity of the water. It can affect the primary productivity and also the water pH. In the present investigation, the alkalinity level showed higher values in control ranged from 70 to 230 mg/l than BFT treatments i.e., 90 to 190 mg/l. In BFT, the hardness of water fluctuated between 1850 to 2080 mg/l and in control, the levels of hardness were ranged from 1860 to 2640 mg/l during the culture period. Nitrite represents the intermediary form by the conversion of ammonia to nitrate. It is well known that ammonia and nitrite were highly toxic to the cultured shrimp. High nitrite concentrations commonly deactivate haemoglobin in the blood crustaceans [27]. However, blood of shrimp does not contain haemoglobin. Therefore, instead of haemoglobin, the oxygen binds to copper at the gills of the shrimp and delivered throughout the body and cause effect on the circulatory and immune system of aquatic organism [28]. In the present study, the nitrite-nitrogen levels were recorded from 0.01 to 1.0 mg/l in A₁ treatments. In treatments of A₂ it ranged from 0.5 to 2.3 mg/l which were out of favourable conditions. Nitrite concentration in BFT treatments seems to be relatively stable, the opposite was observed in non biofloc treatments which might be higher nitrification processes. For the culture of *L. vannamei*, the optimal levels of nitrite concentration is <1.0 mg/l [29]. Nitrate is an inorganic nitrogen compound formed at end of the nitrification process. The concentration of nitrate is usually higher when compared to ammonia and nitrite. High levels of nitrate will give effect to the osmoregulation and oxygen transport of the culture aquatic species [27]. The observed values of nitrate in A₁ were higher 50 to 150 mg/l compared to A₂ treatments 20 to 60 mg/l. In BFT, ammonia concentrations initially showed 0.05 mg/l and gradually decreased to nil, on the other hand, control showed relatively fluctuated values of 0.12 to 2.0 mg/l. In BFT system ammonia is up taken by heterotrophic bacteria, with the availability of NO₃ [29, 30]. Hassan *et al.* [31] have found higher dissolved oxygen, salinity, ammonia, nitrite-nitrogen, phosphates and are significantly higher in sampling stations inside culture ponds of mafia Island, Tanzania. Pankaj Kumar *et al.* [32] have observed the positive correlation between temperature and salinity, salinity and primary productivity, primary productivity and dissolved oxygen, dissolved oxygen and nitrate, nitrate and total available phosphorous at shrimp ponds. During the entire culture period H₂S was showed nil in both the treatments. Floc volume was gradually increased from 0.1mg/l to 15ml/l on 45th day. It may due to the maintenance of carbon and nitrogen ratio. These microbial flocs provide an excellent source of nutrients to shrimp that is available 24h per day to shrimp [14, 33]. The microbiological count was slowly reduced in the present study. According to Bianchi [34] the reduction of few *Vibrio* colonies found in biofloc water may be due to the antibiotic effect of biofloc.

Table 1: Water quality ranges in Biofloc treatment (A₁) and non biofloc treatment (A₂)

Treatment	Temperature (°C)	D O (mg/l)	Salinity (ppt)	pH	Alkalinity (mg/l)	Hardness (mg/l)	Ammonia (mg/l)	NO ₂ (mg/l)	NO ₃ (mg/l)
A ₁	27 – 29	5.8 – 8.6	6.0 – 8.0	8.0 - 8.5	90 – 190	1850 - 2080	0.05 – 0.1	0.01 - 1.0	50 - 150
A ₂	27 – 29	5.6 - 7.8	5.0 – 7.0	7.0 - 8.5	70 – 230	1860 - 2460	0.12 - 2.0	0.05 - 2.3	20 - 60

Conclusion

The results of this study showed that BFT aquaculture system can be an alternative method to enhance good water quality better than that of the shrimp reared in other conventional culture systems. The system is environmental-friendly one overcoming the problem in shrimp culture related to deterioration of environment quality. By enhancing the pond water quality, it resulted in good growth, high survival rate, and increased the yield. These better management practices in aquaculture systems are very essential to sustaining the good water quality management and protect the environmental deterioration.

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