Chelonian Conservation And Biology

Vol. 18 No. 2 (2023) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI: doi.org/10.18011/2023.11(2).1026.1036

SUSTAINABLE SHRIMP (*LITOPENAEUS VANNAMEI*) FARMING THROUGH EFFICACIOUS BIOFLOC MANAGEMENT ENHANCES WATER QUALITY, GROWTH, AND SURVIVAL RATES.

Vivekananda Babu1[1], Ayyaru Gopalakrishnan[*]

[1,2]Centre of Advanced study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608502, Tamilnadu, India

*Corresponding author: Ayyaru Gopalakrishnan , aquagopal@gmail.com

https://orcid.org/0000-0001-5553-987X

ABSTRACT

Profitability in aquaculture is directly proportional to the quantum of biomass produced per harvest. With the utilization of scientifically improvised methods like biofloc management there is high probability to grow more biomass from limited space and attain better financial success in eco-friendly methods. Moreover, because of the great protein value of shrimps, huge economic potential, vulnerability to disease and changes in weather, adoption of biofloc technology has become popular. Current studies focus on biofloc innovations to address challenges of poor survival, growth, and water quality management in *Litopenaeus vannamei* culture which are necessary to minimise disease prevalence and loss in shrimp farming.

Keywords: *Litopenaeus vannamei*, Biofloc innovation, Survival, Water quality management

Introduction:

Shrimp culture and adoption of modern technological innovations in production are the current needs in Indian aquaculture to increase production and export potential of the country. This is likewise helped by the technical improvement of methods to extend utility of new concepts in hydroponics, Biofloc management, to develop productivity in aquaculture industry. Despite the prevalence of various viral and bacterial diseases, the improvements in biofloc management have proved as reliable alternative to the conventional shrimp production and brought about the increment in the total production of shrimp [1,2]. This method helps in improvising the water quality by nitrogen take-up by the action of microbes resulting in better immunity and survivability. Principally various species of fish and shrimp are cultured by aquaculture farmers through Biofloc technology [3,4].

Shrimp production through biofloc technology has acquired significance because of its high protein value. In any case, this improvisation involves production challenges because of the occurrence of different diseases, particularly Acute Hepatopancreatic Necrosis Disease (AHND) prompting higher mortality among the shrimps [5]. This infections result is the consequences of poor growth and mortality. To prevent production challenges and diseases, shrimp culture by utilizing biofloc technology has ended up being an efficient way of culturing shrimps. The success of the biofloc setups depends on the principle of reusing supplements, managing the ratio of Carbon and Nitrogen (C/N) of the culture water by changing the quantities of carbon or starch supplementation. The use of the Biofloc technology has brought about a huge expansion in the development and endurance pace of shrimp [6]. It has also been observed that the intrinsic invulnerability of the shrimp has been decidedly emanated by the Biofloc method, consequently improving the immunity of the shrimp to prevent contamination against pathogenic microbes [7].

Materials and Methods:

Study area: The experimentation was carried out at a corporate aquaculture farm facility in Cuddalore district, Tamilnadu. Post Larvae (PL) were acquired from CAA certified Shrimp Hatchery in Pondicherry.

Experimental design:

This experimental work was done in specific steps like, preparation of tanks, arrangements required for the tanks, setting up the flocs in the tank. Monitoring the water quality, feed management, growth, and survival rate.

Devising experiment tanks and biofloc development:

Litopenaeus vannamei Post Larvae (PL) were tested negative for Vibriosis, WSSV by PCR examination. PL were transported in oxygenated twofold polythene sacks with squashed ice packs to maintain optimal temperature and to decrease pressure to the PL. Each tank was cleaned and sanitized by chlorination and dried for 2 days. There was a reservoir tank in the size of 300 $m^{2.}$ This Reservoir tank was filled with 8 ppt water and was cleaned using bleaching powder at 5 ppm and left for 3 days for dechlorination. The PL were treated with potassium permanganate and then the tank water was added gradually into the PL seed packs to acclimatise the salinity and pH and PL were stocked gradually into the tanks.

Prior to stocking the PL, the Biofloc tanks (i.e., T1, N1) were made ready. On the first-day ammonium chloride was added to initiate a nitrogen source in the test tanks. On day 3 and day 5 carbon sources were given and on day 7 twice the quantity of carbon source was added. On day 9 PL-10 were brought into the tanks. Because of the increase in carbon and nitrogen sources, the colour of the water changed to light brown demonstrating the development of floc. Thus, was formation of the microbial floc was initiated. Imhoff cones were utilized to quantify the amount of Biofloc. The cones have imprinted outward graduations helps to quantify the volume of solids that settle from 1 litre of culture water from tanks. The time taken for settlement of floc was normally 10 to 25 min. The higher volume of the floc i.e., 10 to15ml/lit will deliver high benefits in Biofloc tanks for growth of *Litopenaeus vannamei*. At first, 0.15ml of floc was noticed, and it progressively expanded.

In this experimental setup three sets comprising 9 tanks were utilised for the segmented culture analysis. T1, T2, T3, N1, N2, N3 and C1, C2, C3. Among those 9 tanks C1, C2, C3 were taken as control without utilization of biofloc technology, grown in conventional way and T1, T2, T3 and N1, N2, N3 were taken as a treatment tanks (test tanks) which has biofloc. All tanks were provided with air circulation to maintain optimal dissolved oxygen which is important for the development of biofloc for shrimp. The sizes of the tanks T1, N1 and C1 are 60 m^2, T2, N2 and C2 are 120 m^2, T3, N3 and C3 are 250 $m^{2.}$ From the beginning, the PL were stocked in T1, N1 and C1 tanks with a stocking density of 150 PL/ m^2. After 40 days of culture, they were moved to T2, N2 C2 along with the culture floc water and after 80 days they were moved to T3, N3, C3 respectively up to harvest i.e., 120 days.

Water quality parameters

Throughout the study period, testing of water quality parameters like Temperature, Dissolved Oxygen (DO), pH, Ammonia, Nitrite, Nitrate and Total alkalinity were monitored consistently. Samples were analysed between 6:00 to 8:30 during the morning hours and between 5:00 to 6:30 during the night hours. The pH of the water was estimated by using Elico pH meter. Water temperature was estimated utilizing a mercury thermometer. Turbidity of the water was evaluated with the assistance of a Secchi disk. Salinity was measured with portable refractometer.

Microbiological Test

Microbiology tests were done three times in a week in spread plate method. 1ml of distilled water was serially diluted up to 10^8 and 10^9 ml and inoculum was spread on Thiosulfate citrate bile salts sucrose (TCBS) agar and incubated at 37°C to test contamination and spread of vibrio.

Feed management

Initially PL feed was given, and later Blanca feed (CP Aquaculture, India private limited) was given four times every day at 7 am, 11 am, 2 pm, 6 pm. The feed amount was adjusted relying upon the floc volume. No water exchange was done during the study period except during the stocking into T2, N2 and T3, N3 subsequently. Measures were taken consistently to control the Nitrite and TSS spikes in the biofloc setup.

RESULTS

In this study water quality parameters in the control tanks and biofloc test tanks were monitored and compared regularly for 120 days and values were as following

Table 1: The values of water quality in the biofloc test tanks

Parameters	Range
Salinity (ppt)	5.9-7.2
Temperature (ºC)	28.2 – 29.2
pH	7.5 - 8.5

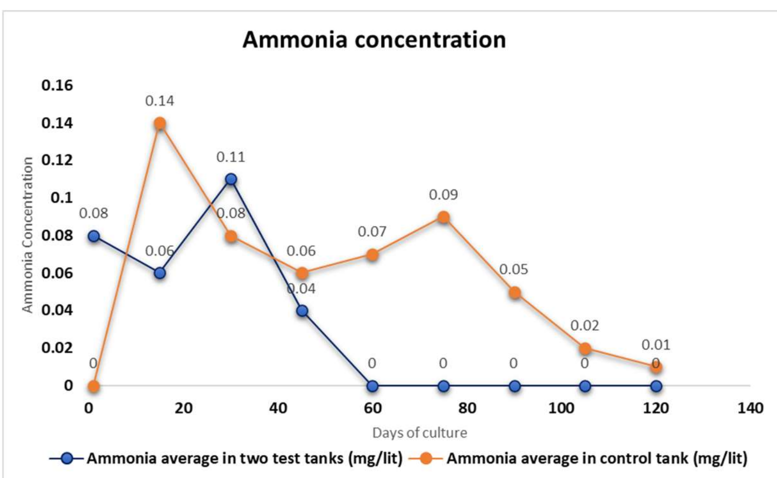
DO (mg/lit)	6.3 - 7.6
Transparency (cm)	30 – 12

Results of water quality parameters like alkalinity, nitrite and nitrate compared to that of control are in (Table 2).

Table 2: Comparison of water quality parameters in Test tanks Control tanks

Days	Ammonia average in two test tanks (mg/lit)	Ammonia average in control tank (mg/lit)	Nitrite average in two test tanks (mg/lit)	Nitrite average in control tank (mg/lit)	Nitrate average in two test tanks (mg/lit)	Nitrate average in control tank (mg/lit)
1	0.08	0	0.05	0	0	0
15	0.06	0.14	0.6	1.2	50	20
30	0.11	0.08	1.2	1.5	70	40
45	0.04	0.06	1	1.8	100	50
60	0	0.07	0.7	2.1	115	60
75	0	0.09	0.5	2.2	120	50
90	0	0.05	0.4	2	130	40
105	0	0.02	0.2	2.1	115	40
120	0	0.01	0.2	2.3	110	30

Figure 1: Ammonia concentration in two test tanks and in control tanks



Fluctuations in Ammonia levels persistently observed in the control tanks (**Figure 1)** caused stress and **mortality of shrimp especially** between **60th and 80th Doc.**

Figure 2: The concentration of Nitrite in two test tanks and in control tanks

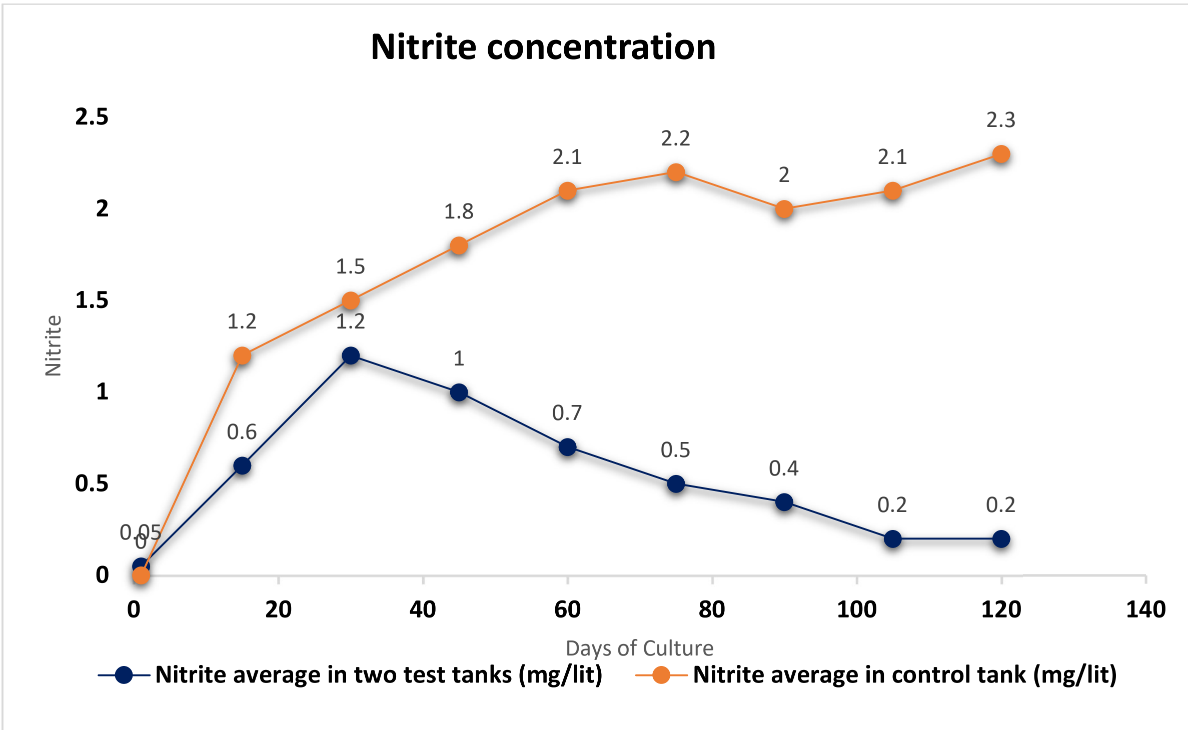
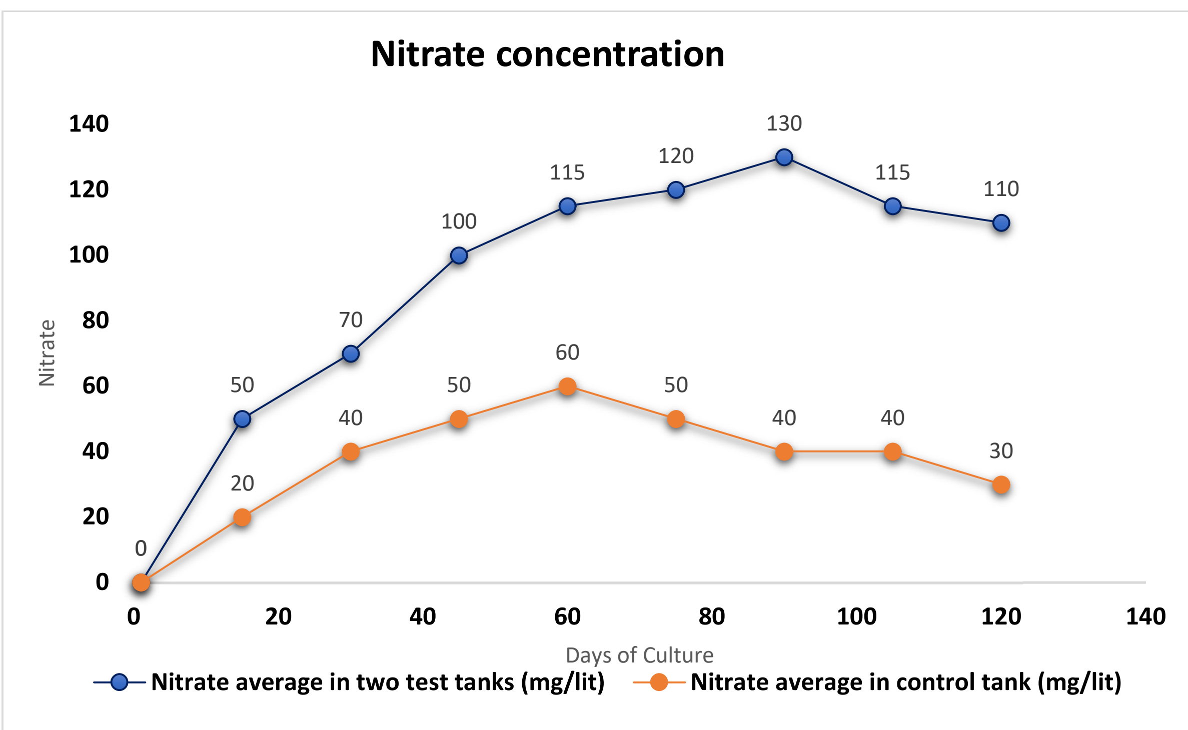
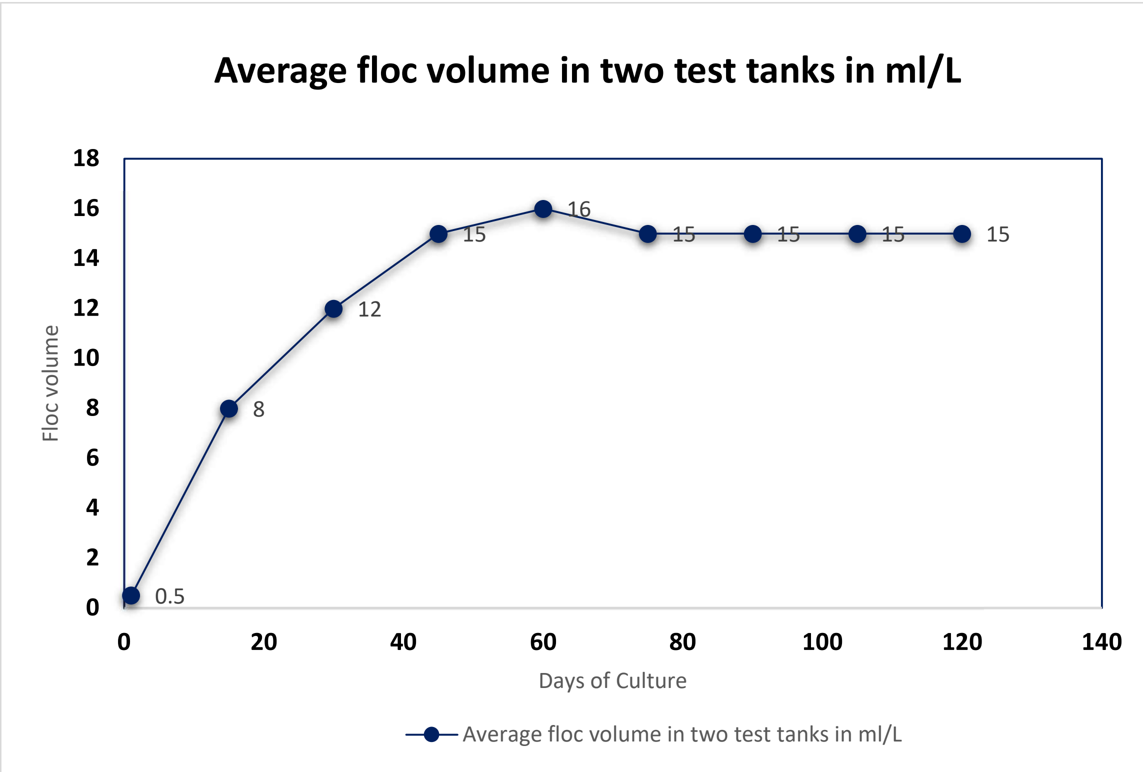


Figure 3: The concentration of Nitrate in two test tanks and in control tanks



Nitrite and Nitrate values **peaked towards the end of the culture in control tanks** as evident from **Figure 2 and Figure 3** causing decline in survival rate in control tanks. Ammonia, Nitrite and Nitrate concentrations **were in optimal range** in Biofloc test tanks resulting in high survival and lesser mortality compared to the control group.

Figure 4: The concentration of floc in ml/L in two test tanks



Unlike conventional culture method in control tanks, gradual increase in the floc volume was observed in Biofloc test tanks (Figure 4). This floc serves as natural feed thereby decreasing the overall feed consumption, FCR and feed wastage.

Figure 5: The value of Total Alkalinity in two test tanks and control tanks

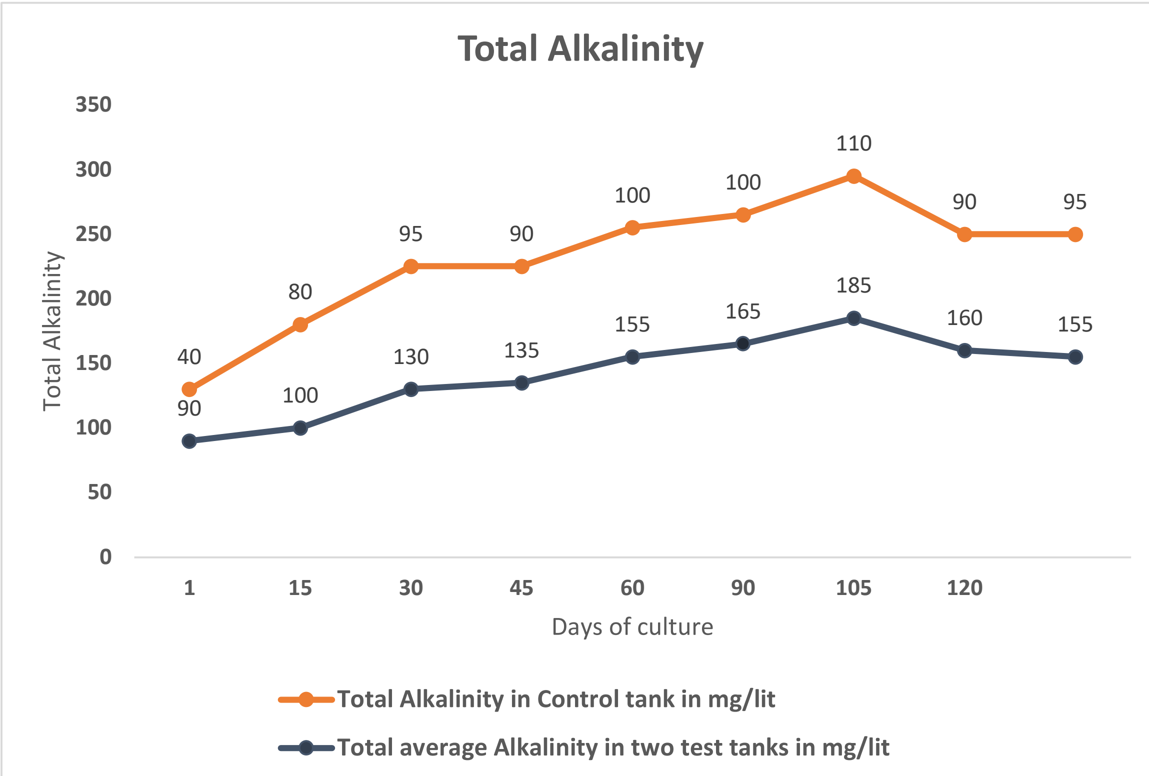


Figure 5 reveals that frequent Alkalinity fluctuations were observed in control tanks resulting in stress and decreased growth rate. Total alkalinity was observed to be in optimal range throughout the test period in the Biofloc test tanks decreasing the susceptibility to disease outbreaks and mortality.

The growth of *Litopenaeus vannamei* in control and test tanks were observed and recorded. On Day 1, the growth was similar in the two test tanks and in the control tank. Later, it was observed that the growth of shrimp was quicker in test tanks than that of the control tank. On the last day of study, it was observed that there were notable differences between the development in the both the test tanks when compared with the control tank. The results have shown that the normal overall growth performance of shrimp in the test tanks is 19.63% more than that of the control tank.

Figure 6: The Average Body Weight (ABW) of shrimp in two test tanks and control tanks

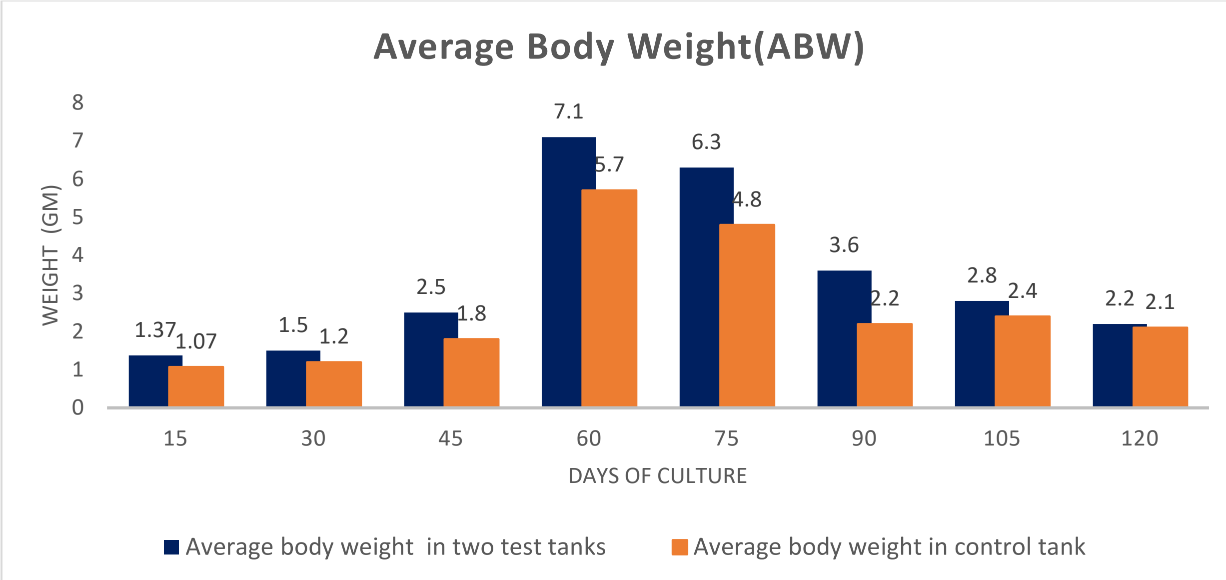


Figure 7: The difference between average growth two test tanks and control tanks

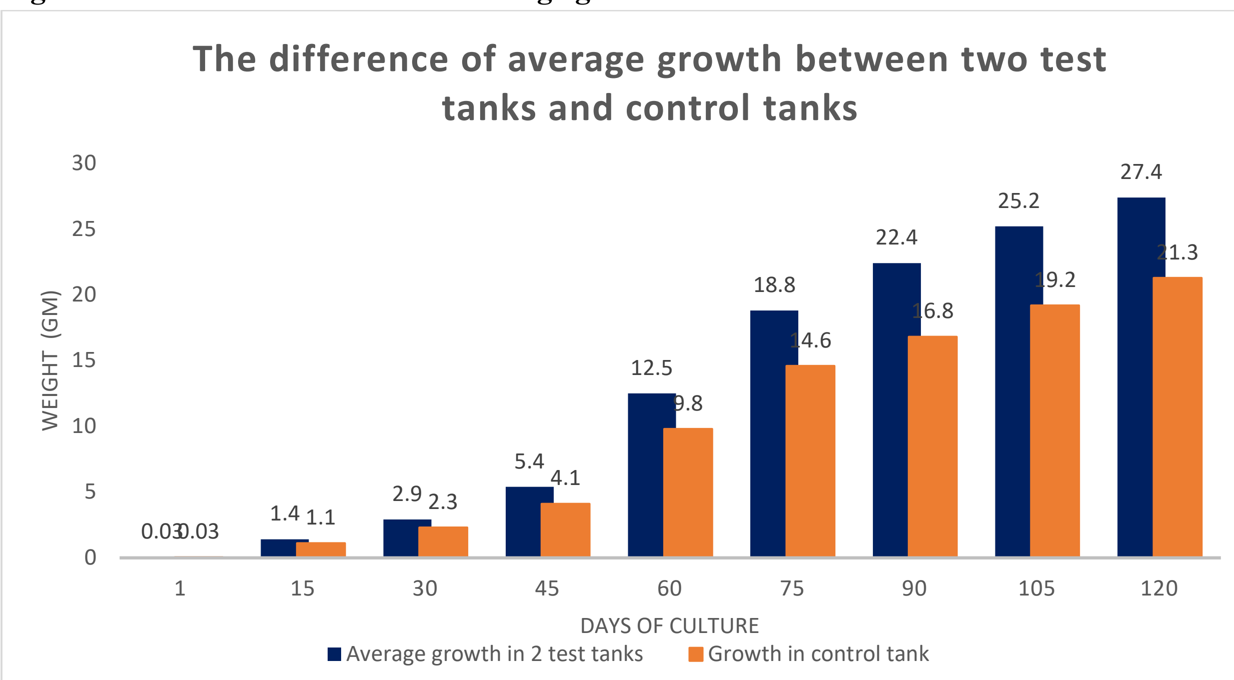


Figure 8: The survival rate of shrimp in control tanks and two test tanks

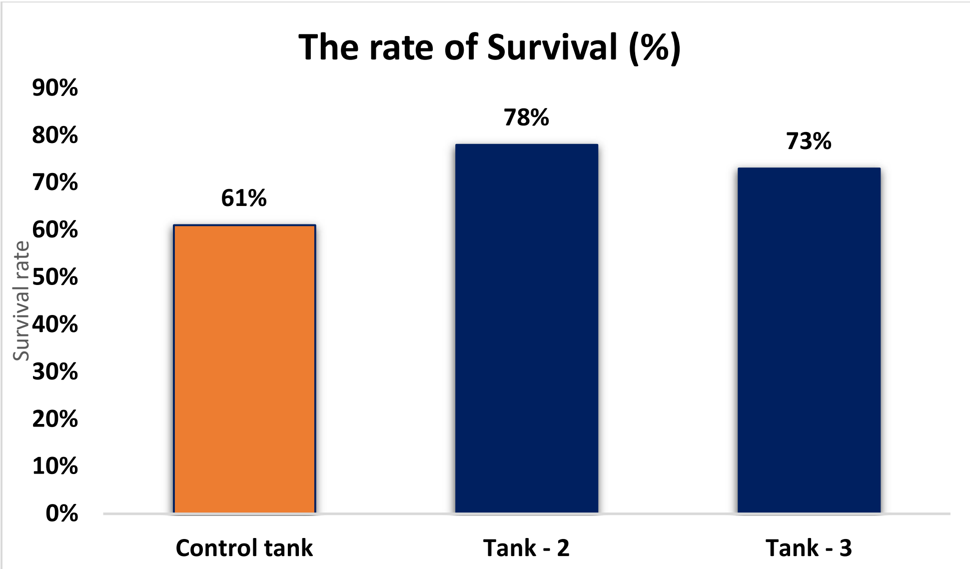


Figure 6 shows the results of growth in two test and control tanks while Figure 7 address the growth variation in two test tanks and control tanks. Figure 8 reveals the survival rate of test and control tanks. It was observed that the survival rates of biofloc tanks 78% in Test Tank 2 and 73% in Test Tank 1 were high compared to 61% in control tank. H_2S was not traced during the trial period.

DISCUSSION

Innovations in biofloc technology can be adopted to grow shrimp with better growth rate and immunity preventing risks of high mortality in shrimp farming. Water quality parameters like alkalinity, nitrite, nitrate was observed to be in optimal range enhancing better growth in two test tanks compared to that of control [8]. Increase in Nitrite value has been accounted for causing poor growth and sudden mortalities in shrimp culture [11]. Such Nitrite spikes were higher in the control tank than the two test tanks during the culture period. The fundamental finding of this study was that the growth by increase in average body weight gain (ABW) and development of *Litopenaeus vannamei* is higher in the two biofloc test tanks when compared with the shrimp in conventionally grown control tank.

Results and Conclusion

The biofloc test tanks shown rapid growth compared to the control. Except for the spike in number of green vibrio colonies twice in the control pond, microbiology results of vibrio colonies were in optimal ranges during the culture period. No clinical symptoms of bacterial diseases were observed in treatment tanks during the trial period. Survival was 17% higher in the test tank 2 and 12 % higher in the test tank 1 compared to the control tank. Noteworthy improvement in growth, water quality parameters, survival rate, carrying capacity associated with the test tanks were much higher than the control tanks. Unlike the conventional culture practice, in biofloc method water exchange is minimal and hence more sustainable. Shrimp grown this way has higher resistance against disease proving that adopting the Biofloc Technology results in better immunity and profits in Indian shrimp farming.

References:

1) Bossier, P., and Ekasari, J. (2017). Biofloc technology application in aquaculture to support sustainable development goals. Microb. Biotechnology. 10, 1012–1016. doi: 10.1111/1751-7915.12836
2) Burford MA, Thompson PJ, McIntosh RP, Bauman RH, Pearson DC. Nutrient and microbial dynamics in high-intensity, zero-exchange shrimp ponds in Belize. Aquaculture. 2003 Apr 2;219(1-4):393-411.
3) Devi AC, Kurup BM. Biofloc technology: an overview and its application in the animal food industry. International Journal of Fisheries and Aquaculture Sciences. 2015;5(1):1-20.
4) El-Sayed AF. Use of biofloc technology in shrimp aquaculture: a comprehensive review, with emphasis on the last decade. Reviews in Aquaculture. 2021 Jan;13(1):676-705.
5) Emerenciano M, Cuzon G, Goguenheim J, Gaxiola G, Aquacop. Floc contribution on spawning performance of blue shrimp Litopenaeus stylirostris. Aquaculture Research. 2012a; 44:75–85.
6) Fatimah, N., Pande, G. S. J., Natrah, F. M. I., Meritha, W. W., Widanarni, L., Sucipto, A., et al. (2019). The role of microbial quorum sensing on the characteristics and functionality of biofloc in aquaculture systems. Aquaculture 504, 420–426. Doi: 10.1016/j.aquaculture.2019.02.022
7) Furtado, P.S., Campos, B.R., Serra, F.P. et al. Effects of nitrate toxicity in the Pacific white shrimp, Litopenaeus vannamei, reared with biofloc technology (BFT). Aquacult Int 23, 315–327 (2015). https://doi.org/10.1007/s10499-014-9817-z
8) Gross, A., Abutbul, S., & Zilberg, D. (2004). Acute and Chronic Effects of Nitrite on White Shrimp, Litopenaeus vannamei, Cultured in Low-Salinity Brackish Water. Journal of the World Aquaculture Society, 35(3), 315–321. https://doi.org/10.1111/j.1749-7345.2004.tb00095.x
9) Kalaimani, N., Ravisankar, T., Chakravarthy, N., Raja, S., Santiago, T. C., Ponniah, A. G., Economic losses due to disease incidences in shrimp farms of India. Fish. Techno., 50(2013): 80-86
10) Kuhn DD, Boardman GD, Lawrence AL, Marsh L, Flick Jr GJ. Microbial floc meal as a replacement ingredient for fish meal and soybean protein in shrimp feed. Aquaculture. 2009 Nov 1;296(1-2):51-7.
11) Kuhn DD, Lawrence AL, Boardman GD, Patnaik S, Marsh L, Flick Jr GJ. Evaluation of two types of biofloc derived from biological treatment of fish effluent as feed ingredients for Pacific white shrimp, Litopenaeus vannamei. Aquaculture. 2010 May 24;303(1-4):28-33.
12) Kumar, V. S., Pandey, P. K., Anand, T., Bhuvaneswari, G. R., Dhinakaran, A., and Kumar, S. (2018). Biofloc improves water, effluent quality, and growth parameters of Penaeus vannamei in an intensive culture system. J. Environ. Manag. 215, 206–215. doi: 10.1016/j.jenvman.2018.03.015

13) Lightner, D. V., The penaeid shrimp viruses TSV, IHHNV, WSSV and YHV: status in the Americas, available strategies, gnostic methods, and management str Albaquult., 9(1999): 27-52.
14) Maurício Gustavo Coelho Emerenciano, Luis Rafael Martínez- Córdova, Marcel Martínez-Porchas and Anselmo Miranda-Baeza (January 18th, 2017). Biofloc Technology (BFT): A Tool for Water Quality Management in Aquaculture, Water Quality, Hlanganani Tutu, IntechOpen, DOI: 10.5772/66416.
15) Sajali, U. S. B. A., Atkinson, N. L., Desbois, A. P., Little, D. C., Murray, F. J., and Shinn, A. P. (2019). Prophylactic properties of bio floc- or Nile tilapia conditioned water against Vibrio parahaemolyticus infection of whiteleg shrimp (Penaeus vannamei). Aquaculture 498, 496–502. doi: 10.1016/j.aquaculture. 2018.09.002
16) Wasielesky Jr W, Atwood H, Stokes A, Browdy CL. Effect of natural production in a zero-exchange suspended microbial floc based super-intensive culture system for white shrimp Litopenaeus vannamei. Aquaculture. 2006 Aug 31;258(1-4):396-403.
17) Zhao, M., Yao, D., Li, S., Zhang, Y., & Aweya, J. J. (2020). Effects of ammonia on shrimp physiology and immunity: a review. Reviews in Aquaculture, 12(4), 2194–2211. https://doi.org/10.1111/raq.12429