Bio-floc Technology (BFT): An Intensive Eco Sustainable and Cost-Effective Tool for Aquaculture

Jaspreet Singh¹, Kamal Sarma¹, Tarkeshwar Kumar¹, S K Ahirwal¹, S Raut¹ and N R Keer²

¹ICAR-Research Complex for Eastern Region, Patna, Bihar-800 014 India; ²ICAR- Central Institute of Fisheries Education, Mumbai, Maharashtra-400061 India

ABSTRACT
The ever-increasing population and to fulfill their nutritional demand, along with sustainable utilization of natural resources is a big challenge for all food-producing sectors. Aquaculture is one of the most promising areas to mitigate global hunger, but it is also facing issues like water scarcity, landholding conflicts, high input cost, lower productivity & profitability etc. In this regard, biofloc technology is now considered one of the most suited technologies, where nutrients can recycle and reused sustainably to improve fish production with the minimal exchange of water. It can play a significant role in achieving the blue revolution in India.

Keywords: Aquaculture, Biofloc technology, Eco-sustainable, Nutritional.

Fisheries is one of the fastest-growing food-producing sectors in the world, which plays an essential role in the mitigation of poverty, malnutrition, and hunger as well as helps to make economic growth with the sustainable use of natural resources. Global fish production during 2018 was about 178.50 million tonnes (mt), and 87.15% of the total production was used for human consumption (FAO, 2020). World aquaculture achieved a mile-storm by contributing 46% of global fish production for the first time with an annual growth rate of 5.3% in 2018 (FAO, 2020). Henceforth, the aquaculture is drawing an important contribution in the world fisheries. However, demand for aquatic food is continuously rising and per capita, fish consumption, of fish has been increased from 9.0 kg in 1961 to 20.5 kg during 2018 (FAO, 2020). Due to overexploitation and recruitment failure, the scope for further increase in fish production from the marine environment is limited; henceforth it is clear that aquaculture will play a pre vital role in satisfying aquatic food demand.

Presently, the aquaculture industry faces severe problems such as competition for land and water, high operational cost, low productivity, poor seed quality, invasive exotic species, and their impact on native species, disease outbreaks, as well as domestic and industrial pollution. Indian Agriculture Census report revealed that average landholding size has reduced from 1.33 (2001) to 1.08 ha (2015), and the per capita water availability also declined by 70% from 1950 to 2011 and more than 86% are under the small and marginal category. This indicates that land and water will soon become a major limiting factor for further horizontal expansion of aquaculture areas. Moreover, with the present level of productivity will be impossible to provide nutritional security to the world's ever-growing population. Hence, the intensification of the production system is the need of the day. Moreover, intensification and expansion of the aquaculture system must be made in a sustainable way to achieve more production with lesser use of natural resources and without damaging the environment. The modern innovative technology also should support equitable cost/benefit ratio to accomplish the economic and social sustainability (Avnimelech, 2012). Biofloc technology (BFT) is one of the most recent technologies developed to improve environmental control over aquatic animal production and it can solve some of the major issues facing the conventional fish farming system. Apart from having various advantages like rational use of water and eco-friendly technology, it is also targeting very high production to meet nutritional security.

1. Overview of Biofloc Technology
1.1 Evolution of bio-floc concept
BFT was first developed in the 1970s, and its first commercial application was built-up in 1988 by a shrimp farm at the Belize Aquaculture Farm. Later, Prof. Yoram from Israel contributed immensely to the further modification and promotion of this encouraging technology. The technique developed in Israel subsequently spread to many other countries due to its several advantages.

1.2 Biofloc composition and nutritional value
Biofloc is an assemblage of beneficial microorganisms (60-70%) such as heterotrophic bacteria, fungi, algae, protozoans, copepods, nematodes, and rotifers etc. and inorganic matters (30-40%) like colloids,
detritus and dead cells. The biofloc aggregates have irregular shapes with full pores varying in size from the microscopic to 1000 μm with a wet-weight density of slightly >1 g/ml (Azim & Little 2008; Avnimelech, 2012). The Biofloc tank setup and floc matrix with floc grazers are illustrated in figure 1.

Fig : 1 a) Biofloc tank setup b) Biofloc matrix c) Floc grazers d) Biofloc concentration in Imhoff cone

The nutritional value of biofloc depends on the various factors such as the environmental condition, quality and quantity of applied carbon sources, microbial/ planktonic density, floc & fish stocking density in the water, food choice, and its ability to digest/ swallow by the culture organism. Nutritionally, biofloc contains 38% protein, 3% lipid, 6% fiber, 12% ash, and 19 kJ/g energy and also contains various bioactive compounds, including essential fatty acids (linoleic, linoleic, arachidonic, and eicosapentaenoic acids), carotenoids, free amino acids, vitamins and trace minerals (Ahmad et al., 2017). It is a complete source of essential nutrition for aquatic organisms that will enhance growth, survival, ingestion rate, nutrient absorption and defence mechanisms, and acts as a novel approach for health management in aquaculture.

1.3 Principle of biofloc technology

In general, only 25-30% fed protein in aquaculture pond is utilized by the culture animals, and the rest of the other nutrients accumulate as toxic nitrogenous (ammonia, nitrate, nitrite) waste, which increases the toxicity of water and harms to culture animal. Overcome this nitrogenous toxicity; regular water exchange is needed in typical aqua farming. BFT reforming this toxic nitrogenous waste (Nitrate, Nitrile, Ammonia, uneaten feed, faecal matter of fish etc.) into microbial protein biomass through beneficial heterotrophic bacteria with manipulation in C: N without any water exchange. BFT is working on bioremediation or wastewater recycling principles, and by this, all water parameters can be maintained in the optimum range. The best C:N ratio in an aquaculture system can be maintained (C:N ratio 10-15:1) by adding different locally available cheap carbon sources such as molasses, wheat flour, rice flour, Jaggery etc. (Emerenciano et al., 2013. The culture species can use this supplementary microbial protein as an additional food by which overall feed requirement can be reduced into aquaculture.

Hence, BFT is an advanced cost-effective, eco-friendly practical alternative to the other intensified culture practices, and in this technology, intensive farming can do with zero or limited water exchange. However, it can be the best tool for achieving high productivity to meet nutritional security.

Fig: 2 Biofloc technology and its working principle

2. Species suitable for biofloc culture systems

BFT is best suitable for species that have a healthy dietary system and the ability to tolerate poor water quality and can obtain nutrition from biofloc. Omnivore species are more suitable for the biofloc culture system. Species such as tilapia, pangasius, magur, singhi, common carp, catla, rohu, minor carps, shrimp etc. are found suitable for biofloc culture.

3. Application of biofloc technology in aquaculture

The BFT system has been used in the nursery and grow-out phase of various species such as shrimp & prawn (tiger shrimp, white leg shrimp, flower prawn, scampi etc.), fish (Tilapia, common carp, rohu, pangasius, magur, singhi etc.), ornamental fish (goldfish), etc. Several advantages such as higher survival rate 85-100% at higher stocking, high yield, higher disease resistance, higher profitability in small farms, and alternative to overcome over-wintering (weather) problems when farmers are operating indoor
facilities were observed nursery& grow-out phase in aquaculture (Emerenciano et al., 2013). A mixed feed of biofloc and artificial feed improves digestive activity, FCR, liver condition, and higher production. The bioactive compounds present in the biofloc enhancing the immune power, which provides more survivability and growth to reared animals.

The BFT can enhance the breeding performance as compared to the conventional aqua-farming system, (i.e. better brooder quality, more fecundity, high spawning activity etc. (Emerenciano et al., 2013). Better performance may be due to better water quality parameters and ad libitum availability of nutritious and mineral-rich biofloc food. These nutrients are required for early reproductive tissue formation in young breeders and results in better reproduction activity.

Now a day's sustainable approaches for getting protein sources are more important to the aquaculture industry. So, the BFT has been established as an alternative method to get quality protein or 'biofloc meal' through a bioreactor technology from its diverse micro-biota. In bioreactors, biofloc is converting all dissolved nutrients into single-cell protein and cleans-up the effluents of culture systems (Emerenciano et al., 2013). BFT is not only beneficial for producers but also for the consumer, which allows them to consume more animal protein, and thereby, it improves human beings with scarce economic resources.

4. Advantages of the Biofloc technology

- BFT is an eco-friendly and zero or minimal water exchange system, thus requires less natural resources like water and land, which can reduce initial input cost.
- It is suitable for intensive fish (Food & ornamental) and shellfish farming with all fresh/brackish/saline water ecosystems.
- It is highly productive and economically feasible
- Microbes present in the BFT system reduces toxic metabolites within the culture system and maintains the water quality.
- It minimize the pathogen spread and pollutant dissemination into the environment.
- It lowered the FCR rate due to the ad libitum availability of microbial-protein biomass.
- Biofloc improves the immunity of culture animal, thereby it minimize the chances of disease occurrence related issues.
- Biofloc improves the quality of broodstock and hence higher fertility and better quality fish seeds can be obtained.

5. Drawbacks of the biofloc system

- Higher skill and well-equipped laboratory facilities are required for water quality testing
- Consistently higher oxygen levels should be maintained throughout the culture practice and failure of which may lead to total breakdown of the culture system.
- Excess build-up of total suspended solids can lead to the proliferation of protozoan’s that may eat heterotrophic bacteria and disturb the production chain, affecting the quality and quantity of biofloc.
- After harvesting, discarding the highly productive effluent water may be an issue.
- An inadequate number of technical manpower and infrastructure facilities for running a biofloc system hampering technological up-scaling progress.

Conclusion

As the human population is continuously growing, the demand for food products is also rising. Hence, industries like aquaculture must be expanded to accomplish the growing demand for protein-rich food. In this regard, biofloc technology can play a major role to improved fish production with an eco-sustainable concept and ensuring the biosecurity and economic feasibility related issues of the intensive aquaculture. The BFT in India is still in still an infancy state. To make this technique more viable and visible, location and species-specific research programs may be designed with detail economic analysis. There is also a need to develop packages and practices of the technology and dissipating the information to farmers and entrepreneurs. Few demonstration models in the farmer’s field along with suitable extension support can play a significant role in the easy implementation of the technology.

References


Nile tilapia (*Oreochromis niloticus*).

