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Integration of Sustainable Aquaculture Techniques: Biofloc and Integrated Multi-Trophic Aquaculture (IMTA)

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Abstract

A new sustainable technique called Biofloc has lot of potential for the production of fish. With an expanding worldwide population comes a greater need for aquatic food, thus aquaculture is escalating much more quickly to meet this demand. Biofloc is a zero-water exchange, eco-friendly system that enhances water quality and the bio-flocculants act as feed. But the major problem with biofloc is the increasing total suspended solid and organic load with increasing duration which not only deteriorates water quality but also causes mortality. Therefore, there's an urgent need for sustainable utilization of these accumulated substances. A solution to this is the integration of biofloc and IMTA. In this integration, the accumulated TSS and organic waste can be used as feed by another organism. This integration can also improve sustainability by reducing the effluents released into the environment and bringing economic diversity by producing other value-added species and thereby increasing yield.

Keywords: Aquaculture, Biofloc, IMTA, Total Suspended Solids

Introduction

Global demand for food is increasing due to increasing global population. Aquaculture is a food manufacturing sector that offers opportunities to alleviate hunger, poverty, and malnutrition. There is a necessity to increase aquaculture production to satisfy the increasing per capita demand and population. The limited availability of natural resources hinders the development of a sustainable aquaculture industry. The biggest challenge is to protect these natural resources for future generations. With these limitations in mind there is an urgent need to develop a system that utilizes fewer resources including water, space, energy, and capital, and at the same time must have less impact on the environment. One of the most exciting and promising technology is Biofloc technology (BFT) which helps in solving these challenges. It's an eco-friendly, zero water exchange technology and also helps in improving water quality. The bio-flocculants can be used as feed by the cultivable organisms thereby reducing the cost of feed. But as the culture period increases the total suspended solids (TSS) and organic matter gets accumulated in the culture tanks which is a threat to the culture organisms. These might also pose danger to the aquatic ecosystems and surrounding environment. Therefore, there is an urgent need for sustainable utilization of the accumulated substances and organic wastes. A solution to this is the integration of biofloc and IMTA systems. In this integration, the accumulated TSS and organic waste can be used as feed by another organism. This integration can also improve aquaculture sustainability by reducing the effluents released into the environment and bringing economic diversity by producing other value-added species and thereby increasing yield.

Biofloc: A New Sustainable Aquaculture Technology

Biofloc is a new sustainable technology that has great potential for fish production. The fundamental idea behind biofloc technology is the recycling of waste nutrients, particularly nitrogen, into microbial biomass that may either be consumed directly by the cultured animals or harvested and converted into feed components (Avnimelech, 2009). National Agricultural Library Glossary (United States Department of Agriculture) defined biofloc as the use of aggregates of bacteria, algae or protozoa which are held together in a matrix along with particulate organic matter for the purpose of improving water quality, waste treatment, and disease prevention in intensive aquaculture systems.

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The physiochemical forces of attraction and a polymer matrix made of substances like polysaccharides, proteins, and humic complexes keep these flocs together.

Biofloc is a microbial pool and has many beneficial bacteria that helps to eliminate nitrogen waste by their conversion into less toxic forms *i.e.*, nitrite and nitrate and also these bacteria act as feed and helps in maintaining water quality, improves immune response of the culture organisms. The nitrogen conversion happens in three pathways by the help of photoautotrophic, chemoautotrophic and heterotrophic bacteria. Carbon-nitrogen ratio (C/N) is crucial in the biofloc system for the conversion of hazardous inorganic nitrogen compounds into beneficial microbial biomass which serves as a direct source of food for the cultured aquatic species. Algae (photoautotrophic) and heterotrophic dominated biofloc system was observed at C/N 9 and C/N 18 respectively (Xu *et al*., 2016). Other characteristics of their bacteria are shown in table 1.

Table 1: Characteristics of bacteria found in biofloc and their function

Heterotrophic Bacteria	Photoautotrophic Bacteria	Chemoautotrophic Bacteria
Require greater amount of dissolved oxygen and dominates at higher oxygen rates.	Require low oxygen and prevail at lower oxygen rates.	Require moderate amount of oxygen.
Bacterial activity is higher at limited light conditions.	Bacterial activity is higher at day time when the photosynthesis is at peak.	Bacterial activity is not dependent on light and photosynthesis.
Predominated by heterotrophic bacteria.	Predominated by algae.	Predominated by nitrifying bacteria (*Nitrobacter, Nitrosomonas, Nitrosococcus etc.*).
High C/N ratio favours this bacterium.	Low C/N ratio favours these bacteria.	Moderate C/N ratio favours these bacteria.
Helps in converting ammonia-nitrogen to consumable bacterial biomass.	Helps in decreasing ammonia-nitrogen through its uptake by phytoplankton.	Helps in converting ammonia-nitrogen to nitrite and then to less toxic nitrate.

But the problem with the biofloc system is the increase in organic load with increasing duration which settles at bottom and also clogs the gills of the culture organisms. This might pose a danger to the aquatic ecosystems and environment when these effluents are released. Therefore, there is an urgent need for sustainable utilization of the accumulated substances. A solution to this is the integration of biofloc and IMTA systems.

IMTA System

IMTA is integration of two or more aquatic species of different trophic levels and farming them together in the same environmental system, where the wastes of one species are recycled or used to become inputs for another (Chopin *et al*., 2001). The integration can be done between different species like shrimp, tilapia, mullet, sea weeds, bivalves, plants *etc*.

Integration of Biofloc and IMTA

Integrating biofloc and IMTA may solve the major organic load problem of biofloc system. In this integration, the biofloc with organic load from culture system is transferred or pumped to another system where this waste can be efficiently used by the other culture organisms. Many species like tilapia, mullets, bivalves can accept the solids from biofloc as feed so there by reducing the cost of feed and improving the FCR. Halophytes like Sarcocornia, Salicornia and sea weeds like *Ulva* can also be used for this integration purpose. These plants have the ability to absorb nitrogen in different forms (ammonia, nitrite and nitrate) from the water along with N & P which indirectly helps in maintaining water quality. Many plants and sea weeds like *Ulva* have some bioactive compounds like carotenoids and a polysaccharide, the latter one acting as a prebiotic for aquatic animals (Peso-Echarri *et al*., 2012). Also, the plants help in the absorption of inorganic nutrients present in water. The integrated plants also showed better nitrogen, chlorophyll-a, and carotenoids contents when compared to control plants. This integration not only helps in reducing organic load but also helps in improving water quality, reducing effluent and also induces economic diversity. Integration of biofloc and IMTA is shown in Figure 1.

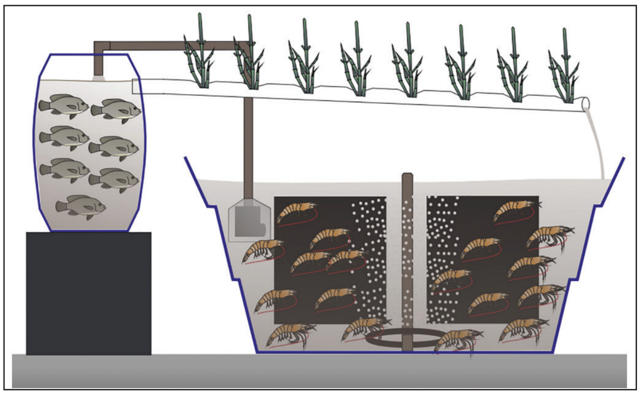

Figure 1: Flow diagram of the integrated experimental unit of shrimp (*Litopeneaus vannamei*) in biofloc system with Tilapia (*Oreochromis niloticus*) and Sarcocornia (*Sarcocornia ambigua*) [Source: Poli *et al*., 2019]

Conclusion

The integration of biofloc and IMTA can become a sustainable aquaculture technology. As this system is excellent for recycling wastes, the organic load from effluents does not harm the ecological balance of environment. Integration also helps in improving water quality, improves FCR thereby increasing the economic profitability and also the integration with some plants like *Ulva* improves the health performance of culture organisms as they contain bioactive compounds. Moreover, this integration also helps in bringing economic diversity by producing other value-added species and thereby increasing yield.

References

Avnimelech, Y., 2009. *Biofloc Technology - A Practical Guide Book*. World Aquaculture Society, USA. p. 182.

Chopin, T., Buschmann, A.H., Halling, C., Troell, M., Kautsky, N., Neori, A., Kraemer, G.P., Zertuche-Gonzalez, J.A., Yarish, C., Neefus, C., 2001. Integrating seaweeds into marine aquaculture systems: a key toward sustainability. *Journal of Phycology* 37(6), 975-986.

Peso-Echarri, P., Frontela-Saseta, C., Gonzalez-Bermudez, C.A., Ros-Berruezo, G.F., Martinez-Gracia, C., 2012. Polysaccharides from seaweed as ingredients in marine aquaculture feeding: alginate, carrageenan and ulvan. *Rev. Biol. Mar. Oceanogr* 47, 373-381.

Poli, M.A., Legarda, E.C., de Lorenzo, M.A., Pinheiro, I., Martins, M.A., Seiffert, W.Q., do Nascimento Vieira, F., 2019. Integrated multitrophic aquaculture applied to shrimp rearing in a biofloc system. *Aquaculture* 511, 734274.

Xu, W.J., Morris, T.C., Samocha, T.M., 2016. Effects of C/N ratio on biofloc development, water quality, and performance of *Litopenaeus vannamei* juveniles in a biofloc-based, high-density, zero-exchange, outdoor tank system. *Aquaculture* 453, 169-175.