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Biofloc Technology: A Sustainable Smart Technology

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Abstract

The demand for food is increasing with the continuous rise in global population. Aquaculture is one of the major contributors of cheap animal protein that can overcome malnutrition and meeting of high protein demand. Modern farming practices have become increasingly intensive to produce the required worldwide proteins yet they cause additional environmental damage and adverse effects in groundwater quality and health risks through epidemics. Long-term sustainability requires the implementation of sustainable eco-friendly technologies that were designed to specifically handle these challenges. Biofloc Technology (BFT) represents an innovative solution to turn aquaculture into a sustainable project through its transformation of toxic wastes using carbon sources.

Keywords: Biofloc technology, C:N ratio, Essentiality, Floc preparation

Introduction

As the need for aquatic food rises, it is projected that aquaculture production will increase from 40 million tons to 80 million tons between 2008 and 2050. The demand is rising in tandem with the increase in nearly seven billion people globally (Halim *et al.*, 2019). As a result, there is an increasing demand for aquaculture produce. To meet the need, traditional methods are used, but they have a number of drawbacks. For instance, constructing sizable aquaculture farms contaminates the water used for aquaculture breeding and pollutes the coastal ecosystem (Yu *et al.*, 2023). Besides this, with rising intensification in aquaculture, there is a surge of high amounts of wastes and nutrients in the water which affects farming due to over-enrichment of nutrients resulting in deterioration of water quality and disease outbreaks (Inkam *et al.*, 2018). Adoption of an environmental friendly aquaculture system is the need of the hour where microbial protein can be generated with the addition of carbon sources through feed and beneficial microbiota that can facilitate the absorption of ammonia and foster aquaculture production in a sustainable manner (Crab *et al.*, 2012). Biofloc technology having diverse assets, provide welfare in the improvement of aquaculture production and brings about sustainable aquaculture development goals (Halim *et al.*, 2019).

What is Biofloc Technology?

An innovative aquaculture production technique known as “Biofloc technology” uses the buildup of bacteria, algae and protozoa in addition to suspended organic matter to improve water quality, convert hazardous waste into beneficial products and prevent disease outbreaks (Yu *et al.*, 2023). In order to increase fish production, profitability and environmental protection, this technology promotes the mass cultivation of microorganisms that help maintain water quality, improve culture viability by lowering the feed conversion ratio, sequester greenhouse gases and ensure biosecurity (Figure 1). Compared to the majority of conventional fish farming methods, biofloc farming requires less initial investment because it only needs sunlight, a carbon source and aeration which can also be solar-based (Crab *et al.*, 2012). Biofloc technology (BFT) is an environmentally friendly and sustainable aquaculture method that has been used both commercially and in scientific settings to cultivate species like tilapia, shrimp, pangasius and common carp in India. Because biofloc may function as a natural food source, it is economical and requires less high-protein feed, which lowers feeding expenditures and results in half of operating costs (Inkam *et al.*, 2018). Biofloc technology features a system that relies on little or no water exchange and can convert nitrogen into microbial biomass, which can be used as feed for cultured

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species. Phytoplankton, bacteria and aggregates of both living and decaying organic matter, along with organisms that graze on bacteria, accumulate in the system where a dense microbial floc develops (Zafar and Rana, 2022).

Figure 1: Biofloc Fish Farming Units at College of Fisheries, AAU, Raha

BFT as Waste and Water Management Tool

BFT is a sustainable, environmental friendly method that relies on the development of *in-situ* culture microorganisms and has the benefit of minimum to no water exchange. Additionally, BFT converts the surplus nitrogen to create feed ingredients for farmed fish and continually recycles the nutrients (Zafar and Rana, 2022). In an era of land and water scarcity, biofloc technology consumes less water and farming space, produces less pollution and releases fewer pollutants into the environment. Furthermore, prior study indicates that the application of BFT to mitigate ammonia toxicity facilitates the nitrification process, which diminishes nitrogen levels through the proliferation of heterotrophic bacteria, hence reducing ammonia concentrations in the culture system (Halim *et al.*, 2019).

Maintenance of C:N Ratio

Utilization of microbial protein through maintenance of carbon and nitrogen is one of the best strategies for removing increasing amounts of inorganic nitrogen loadings and ammonia through aquafeed in biofloc technology. This is also regarded as a fundamental requirement for regulating organic carbon and microbial community production (Zafar and Rana, 2022). By conserving the C:N ratio, inorganic carbon diminished into organic carbon. In BFT, carbohydrates are used in respiration, so the C:N ratio must be maintained beyond bacterial accumulation in aerobic conditions. Along with this, if the ratio is properly maintained and is high, then the microbial community would consume the toxic inorganic components, so the accumulation of NH_4^+ and NO_2^- would be stopped (Halim *et al.*, 2019).

Biofloc Preparation

Bacteria, algae, detritus, diatoms, zooplankton, protozoa, macroalgae and other decomposing materials typically make up biofloc. The fusion of biotic and abiotic particulate matter mixed in water is called biofloc. The biofloc is made from carbon sources such as molasses, jaggery, wheat flour or damp soil from the pond bottom which is a source of organic carbon. When carbohydrates are added to water, heterotrophic bacteria begin to multiply, aid in nitrogen uptake and make microbial protein. When heterotrophic organisms use substrate carbon they produce approx. 0.5 g of biomass carbon per gram of substrate carbon (Halim *et al.*, 2019).

BFT Essentiality

Due to high demand and lack of proper management in the aquaculture field, it raises concerns on the topic of environmental sustainability, outbreaks of disease and also the health of aquatic organisms. So to overcome these problems, there is a requirement to initiate an environment friendly aquaculture set-up and for this, the Biofloc System is a key that can resolve various complications, which include:

1. Microorganisms present in biofloc engage with the infectious bacteria to purify water and also serve as a nutrient for the cultured organisms.

2. As biofloc doesn't require water exchange, it helps in controlling outbreaks of pathogens and promotes a sustainable system, also reducing the use of natural resources (Yu *et al.*, 2023).

Limitations

As we all know, everything has disadvantages; BFT is not exceptional in this case. Among these, one of the disadvantages is continuing the C:N ratio throughout the farming. Besides this, biofloc technology needs continuous aeration, thus requiring a continuous electricity supply (Zafar and Rana, 2022).

Conclusion

Biofloc technology effectively controls, converts and utilizes toxic waste (ammonia) into useful products, like protein, so that cultured aquatic organisms can use it in their growth and other metabolic activities. This technology can bring sustainable goals to the aquaculture field as it uses a zero-water exchange method. BFT is based on how this technology can remove nitrogen from water and make it suitable for cultured species to use. Biofloc technology can bring solutions to aquaculture problems and help generate more revenue from minimal expenditure. But for BFT operation, it depends on awareness, practical knowledge and scientific application, like managing the C:N ratio, floc maintenance, *etc*. This smart technology is still not popular and has disadvantages like aeration problems and floc formation time, so a lot more research is needed.

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