

BIOFLOC TECHNOLOGY IN FISH AQUACULTURE

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Abstract: -

Bio-floc technology represents a significant advancement in aquaculture. It is a new method for improving water quality and using feed waste in aquaculture systems. This method converts ammonium and organic nitrogenous waste into bacterial biomass. It stimulates the growth of heterotrophic bacteria and promotes nitrogen uptake through the production of microbial proteins, aided by adding carbohydrates to the pond. Nitrogen from uneaten feed and the waste of cultured organisms becomes protein-rich feed for those same organisms. This process recycles nutrients and nitrogenous waste by maintaining a high carbon-to-nitrogen ratio. It provides essential and higher-quality nutrition for shrimp and fish, resulting in faster growth, lower feed conversion ratios and a reduced chance of disease. Water requirements in bio-floc technology are minimal, making it a better option compared to traditional systems, which constantly cycle water and nutrients and exhibit lower feed conversion ratios. However, there are several challenges to implementing bio-floc in Nepal. Frequent pond monitoring by technical staff is necessary. Choosing the right carbon source is crucial since fish performance and water quality in bio-floc ponds greatly rely on it. Additionally, certain vitamins needed for fish may not be produced by microbes, necessitating their identification and inclusion in feed. Despite the challenges, bio-floc technology can prove beneficial for farmers in Nepal.

Key words: Bio-floc; FCR; Microbial; Nitrogen; Pond; Aquaculture etc.

INTRODUCTION:

Bio-floc technology is seen as a breakthrough in aquaculture. It enhances water quality by adding carbon to the aquaculture system, either through an external carbon

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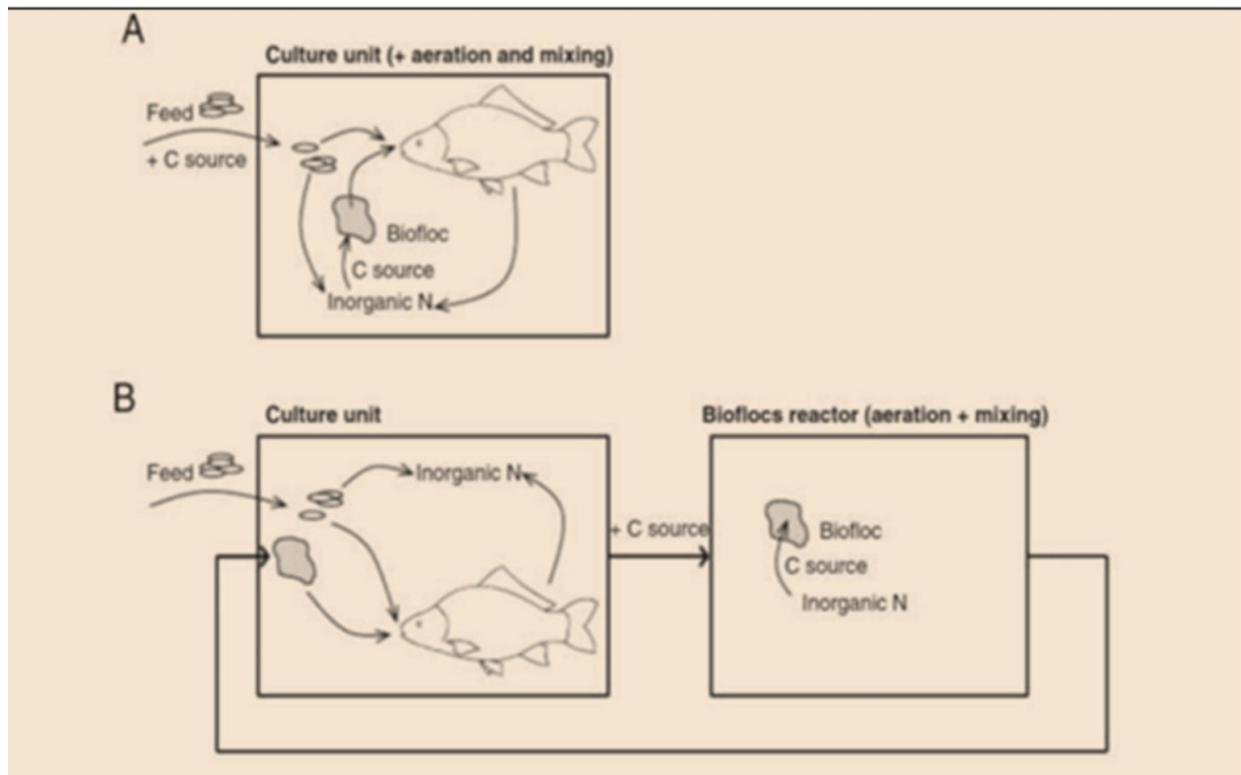
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source or increased carbon content in the feed. This technique is relatively new in commercial fish farming in Nepal. Bio-floc technology was first developed in the early 1970s at Ifremer-COP (French Research Institute for Exploitation of the Sea, Oceanic Center of Pacific) for various penaeid species, including *Penaeus monodon*, *Fenneropenaeus merguensis*, *Litopenaeus vannamei*, and *L. stylirostris* (Emerenciano, 2013). Indonesia leads the world in farms utilizing bio-floc or semi-bio-floc technology. Despite its benefits, only about 20% to 25% of shrimp and fish farms worldwide successfully implement bio-floc technology.

The primary goal of bio-floc technology is to recycle nutrients and nitrogenous waste by maintaining a high carbon-to-nitrogen ratio. Carbon sources like molasses, wheat bran, and cellulose encourage bacterial growth and uphold the C:N ratio in the culture system. Bio-floc technology not only maintains water quality but also provides essential and higher-quality nutrition to shrimp and fish, facilitating faster growth, lower feed conversion ratios and a decreased likelihood of disease. Various factors such as temperature, pH, dissolved

(Source: Avnimelech Y (1999) Carbon/nitrogen ratio as a control element in aquaculture systems. *Aquaculture* 176(3-4): 227-235. DOI: 10.1016/S0044-8486(99)00085-X).

CONCEPT OF BIOFLOC TECHNOLOGY:



Oxygen and organic loading rates impact floc formation in ponds. This method offers a practical and low-cost way to reduce inorganic nitrogen accumulation in ponds. It controls nitrogen levels by feeding bacteria carbohydrates, which in turn absorb nitrogen from the water to create microbial proteins. The relationship between carbohydrate addition, ammonium reduction and microbial protein production depends on several factors, including the microbial conversion coefficient, the C:N ratio in microbial biomass and the carbon content of the added material.

WORKING MECHANISM:

In bio-floc technology, heterotrophic bacteria consume organic matter. $C_6H_{12}O_6 + 6O_2 + 6CO_2 + \text{Energy}$ Since bacteria are protein-based, they require nitrogen. They utilize the chemical energy in organic materials and consume oxygen, although some bacteria can survive without it. Conditions for bacteria: Bacteria require ample food, so the pond must have enough organic residues and be properly aerated for optimal fish growth. The pond should be thoroughly mixed continuously, ideally 24 hours a day. Additionally, the bacterial population should range from 10^6 to 10^9 per cm^3 for effective operation. The pond effectively becomes a biotechnological industry tied to bio-floc technology.

NUTRITIONAL COMPOSITION IN BIO-FLOC:

Bio-floc offers substantial nutritional value. The dry weight protein ranges from 25% to 50%, fat content between 0.5% and 15%, and it serves as a good source of vitamins and minerals, particularly phosphorus. It has effects similar to probiotics, which are microorganisms introduced for health benefits; examples include *Lactobacillus* and *Lactococcus*. Dried bio-floc is used to replace fishmeal or soybean in feed. In studies using molasses as a carbon source, bio-floc cultured for *Litopenaeus vannamei* showed protein levels ranging from 28.7% to 43.1%, with lipid amounts between 2.11% and 3.625%. Another study using wheat flour to culture tilapia reported protein levels of 38% and lipids of 3.16% to 3.23%. Diverse species in bio-floc include rotifers, ciliates, protozoa, nematodes, copepods, bacteria, microalgae, and yeast, all contributing nutritionally and ecologically. For example, microalgae can have protein content ranging from 30% to 65% of dry weight. Chlorophytes and diatoms can have saturated fatty acids making up 15% to 40% of total fatty acids, while green microalgae typically show low concentrations of monounsaturated fatty acids but high amounts of polyunsaturated fatty acids. The proximate composition of certain plankton found in bio-floc shows that rotifers contain

54% to 60% crude protein, cladocerans have 50% to 68%, and copepods range from 70% to 71%.

FLOWCHART OF FEEDING A FISH IN BIO-FLOC TECHNOLOGY:

Here's a schematic calculation of the daily carbon required to eliminate nitrogen waste from uneaten feed and animal excretion in bio-floc: Daily feeding of 2% of fish weight 20 g feed added per kg fish per day Using feed with 25% protein 95 g protein added per kg fish per day + 16% of protein is nitrogen (Craig and Helfrich, 2002) 0.8 g nitrogen added per kg fish per day On average, 75% of the feed enters the water (ammonification of uneaten feed and excretion) 0.6 g nitrogen per kg fish per day ends up in the water Microorganisms require a C:N ratio of 10 Approximately 6 g carbon per kg fish per day is needed for bio-floc production. Adding a carbon-based substrate has been shown to reduce inorganic nitrogen in experimental shrimp tanks and commercial tilapia ponds. In tilapia ponds, the microbial proteins produced are absorbed by the fish, partially replacing feed protein and lowering feed costs (Avnimelech, 1999). Unlike carbon dioxide, nitrogenous compounds cannot escape into the air through diffusion or forced aeration in the pond. Therefore, intensifying aquaculture systems inherently leads to increased water

content of ammonium and other inorganic nitrogenous compounds.

FEED UTILIZATION:

Most available fish feeds have a feed conversion ratio (FCR) of 3, meaning it takes 3 kg of dry feed to produce 1 kg of fish. The FCR for wheat bran and rice-wheat bran is significantly higher than in bio-floc technology with periphytons. As a result, bio-floc requires less feed to produce the same amount of fish compared to traditional systems.

TOTAL FISH PRODUCTION:

In tilapia farming, the biomass can yield up to 200-300 tons/ha in well-managed bio-floc ponds. A treatment using crude fiber, wheat bran, rice-wheat bran, and bio-floc technology recorded the highest production of 3,803 kg/ha from tilapia fed crude fiber, while the lowest production of 2,883 kg/ha occurred in bio-floc using periphyton. Economically, bio-floc proved to be more profitable due to its reduced FCR (Nahar, 2015).

ECONOMIC ANALYSIS:

A basic economic analysis estimated the net profit from bio-floc culture over six months. The net profit was TK 48,519, 94,749.2, 99,453.3, and 71,230.7 per acre for crude fiber, wheat bran, bio-floc, and rice-wheat bran, respectively. The highest net profit of TK 99,453.3 per acre over six months came from bio-floc with periphyton, while the

lowest was TK 48,519.0 per acre from crude fiber with commercial tilapia feed.

ADVANTAGES OF BIO-FLOC TECHNOLOGY:

Bio-floc technology is an eco-friendly culture system. It reduces environmental impact. It improves land and water use efficiency. There is limited or no water exchange. It ensures higher productivity. It promotes improved biosecurity.. It reduces water pollution and the risk of pathogens spreading. It is cost-effective for feed production.

CHALLENGES IN BIO-FLOC TECHNOLOGY:

A key aspect of implementing bio-floc technology in aquaculture is monitoring the ponds. Bio-floc technology is not fully predictable and can be risky to apply at the farm level. Potential monitoring tools include measuring total suspended solids or bio-flocs and assessing the settleability of bio-floc.

Conclusion

In contrast, Bio-floc Technology (BFT) will help Aquaculture move towards an environmentally friendly approach and improve biosecurity. The consumption of microorganisms in BFT lowers the feed conversion ratio (FCR), which reduces costs for farmers. The microbial community can quickly break down nitrogen released from fish waste and uneaten food and turn it into

microbial protein, keeping the water clean. The physical, chemical, and biological interactions in bio-floc systems are complex. Further studies can explain specific phenomena and their potential applications in other biotechnological fields. BFT maintains water quality through continuous recycling and reduces FCR by recycling feces and waste in the pond. This method has proven to be more profitable than traditional fish farming, with higher production and lower feed input. It is particularly suitable for urban areas where land and water are limited but technology is advanced.

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