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Miracle of using biofloc technology for fish culture in Bangladesh

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Abstract
Bio-floc technology ensures increased aquaculture intensification and the most efficient use of land, water, and feed resources, all while minimizing environmental impact. Bangladeshi farmers hope that Biofloc technology will provide them with a new horizon in the face of massive climate change. With the introduction of bioflock technology, the cost of fish production for farmers is falling. With the filling of rivers, canals, and beels, the number of houses and factories in Bangladesh is expanding. With all of this in mind, biofloc technology is timeless and sustainable for high-density fish farming in a small area, ensuring safe net food and increased production. As the fishing industry has evolved, more innovative and efficient methods of raising and harvesting fish have been adopted to meet the demands. The Biofloc technology, for example, was developed to cope with wastewater management, sustain biochemical cycles, and preserve aquatic life's nutritional levels. Within a short period of time, this approach has experienced tremendous growth. It is now widely utilized to assure the continued growth of aquatic life and the fishing sector. Its main goal is to convert the hazardous waste material produced in aquatic environments into protein-rich food for the creatures that live there.

Keywords: Bio-floc, aquaculture, water quality, floc composition

Introduction
Aquaculture is one of the main sectors in Bangladesh's economy, contributing significantly to food nutrition, income, employment, and foreign exchange profits. It is outpacing all other animal food-producing industries in terms of growth. Bangladesh's aquaculture has witnessed a revolution in the last two decades, propelling the country to fifth place internationally (FAO, 2018) [20] in terms of total aquaculture production. In Bangladesh, aquaculture presently provides over half of the fish consumed directly and is expected to continue to rise (DoF, 2017) [17]. Bangladesh's aquaculture industry is becoming an increasingly important source of protein for human consumption. Bangladesh's growing population needs more intensive aquaculture output without sacrificing quality. However, aquaculture waste management has become a growing concern for environmental protection. The latest "blue revolution" in aquaculture, Biofloc technology, could help achieve this sustainability. Applications have been seen in South Korea, Indonesia, Malaysia, Thailand, China, Australia, Hawaii, Brazil, Ecuador, Peru, the United States, Mexico, Guatemala, and Belize (Emerenciano com pers. 2011) [18]. The development of appropriate technologies for this fish's rearing is critical for increasing output as well as conservation and rehabilitation. A high-density stocking density in a small space is required to boost this fish's output. For optimum growth and survival, as well as maximum production and profit from this fish, it would be necessary to stock at a reasonable stocking density (Chakraborty *et al*. 2007, Rahman *et al*. 2005) [10, 33]. Biofloc fish farming is critical for developing nations like Bangladesh to solve difficulties like nutrient scarcity, nutrient demand-supply gaps, and water-land competition. Because fish culture is highly esteemed and valued in Bangladesh, the Biofloc technology is an effective tool for increasing fish output and supply while maintaining a balance between demand and the availability of natural food resources. Traditional fish farmers are using the Biofloc technology to improve productivity since it allows them to produce tons of fish with minimal water discharge and environmental impact.

Biofloc fish farming, which is available in Bangladesh, requires a variety of instruments and equipment.

History of biofloc technology

The Ifremer Institute in France was the first to design a biofloc system with various shrimp species in the 1970s. Another beginning of biofloc technology on an experimental basis happened in the 1980s and 1990s (Aquacop, 1985; Wyban and Sweeney, 1990; Hopkins *et al.* 1993; Sandifer; Hopkins, 1996 Burford *et al.* 2004) [1, 41, 21, 35, 9]. In parallel to this, the Ifremer institute in France conducted a scientific program to gain a deeper knowledge of the biofloc technology system (Ectron). Many nations in Latin and Central America have adopted biofloc technology in recent years, including the United States, South Korea, Brazil, China, Italy, Australia, India, and Indonesia (Taw, 2010) [38]. Many research institutes in many nations have recently used biofloc technology to investigate bacterial identification, energy kinetics, economics, and lower water management costs. More applications of this cutting-edge waste management system are being investigated.

Mode of action in biofloc

When there is no water exchange, a Biofloc system is called a waste treatment system. Starting the system with a carbon supply replenishment is the backbone for starting the system with a carbon: nitrogen ratio (C: N ratio) of ten ensures heterotrophic bacteria activation (Avnimelech, 1999; De Schryver *et al.*, 2008) [5, 16]. The last has the ability to assimilate nitrogen wastes and recycle them into microbial protein, whereas the last is made up of bacteria floccules that attract other organisms such as micro/macroinvertebrates, filamentous organisms, and fungi, ciliates, flagellates, rotifers, nematodes, metazoans, and detritus. Bacterial flocs could be used as a supplement for tilapia, carp, and shrimp (Fig.1). As a result, water quality and fish culture performance could be improved (Crab, 2010) [11].

Fig 1: Mode of action and advantages of biofloc system (Zidan *et al.*, 2015) [42]

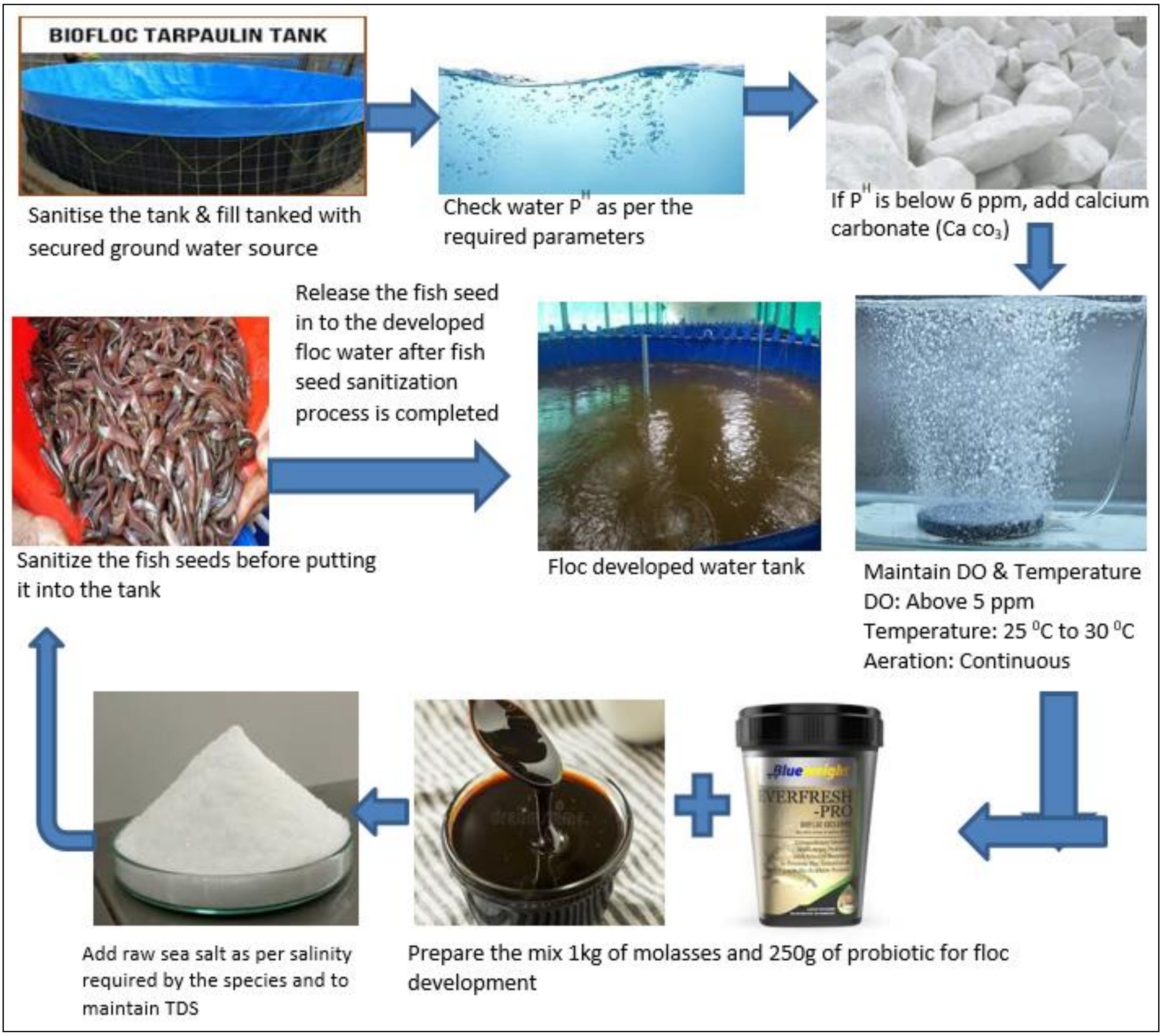
Biofloc Development

Biological polymeric ingredients are required to generate the bio floc in order to keep the components together and create a matrix that envelopes the cells. The microorganisms are protected from predators by this matrix, which also serves as a substrate and offers direct access to nutrients (De Schryver *et al*. 2008) [16]. The microbiota prevalent in the body influences the biodiversity of the species that occupy the flocs; some of them may act as biological control agents against infections through competitive exclusion or probiotic capabilities (Ray *et al*. 2010) [34]. However, in order to grow heterotrophic bacteria in the biofloc, the carbon/nitrogen (C:N) ratio in the body of water must be adjusted, and it takes around 20 units of carbon to ingest one nitrogen unit, this is obtained by adding a food of low protein and one carbohydrate such as molasses insufficient amount (Avnimelech 1999; Emerenciano *com pers.*, 2011) [5, 18]. When this rate is high enough, microorganisms inside the microsystem begin to utilize hazardous substances as energy sources, such as organic carbon, ammonia nitrogen, nitrates, nitrites, and phosphates, which are oxidized by algae, fungi, and other bacteria. Non-consumed nitrogen by the organisms in the culture can be used to produce microbe protein instead of toxic compounds, which helps control toxic inorganic nitrogen. Residual food and the rest of the phytoplankton production will also be broken down into simpler compounds, which help control toxic inorganic nitrogen. The growth of bacterial colonies and microorganisms causes an increase in biofloc biomass, which must have a density of 10 to 15 mL in order for the system to function effectively. Excess protein can be used as a protein source for organisms, either directly or in the form of flour or feed (Avnimelech 1999; De Schryver *et al*. 2008; Emerenciano com pers. 2011) [5, 16, 18].

Potentiality of Biofloc Technology

This technology is critical for zero water exchange, which means that no water exchange is required within the culture water. As a result, less water is required, which is not only cost-effective for farmers but also reduces pathogenic animal entry through water, ensuring greater biosecurity within the fish culture. This method allows the animals to be reared at a lower stocking density while still receiving adequate nutrition (Crab *et al*., 2010; Crab *et al*., 2012) [11, 12]. Because biofloc will provide feed for the cultivable animals, the feed demand is significantly reduced, resulting in a lower FCR (Krummenauer, 2011; Perez-Fuentes *et al*., 2013) [25, 32]. As a result of the technology's application, farmers' feed costs will be reduced. Biofloc promotes fish survival because helpful microorganisms predominate in the biofloc and act as antagonists to pathogenic bacteria, preventing disease outbreaks and increasing the percentage of fish that survive the harvest. This way, the (good) bacteria present in the biofloc prevent the colonization of any dangerous bacteria, ensuring that the fish on the farms have the best chance of survival (Megahed, 2010; Perez-Fuentes *et al*., 2013) [30, 32]. The polyhydroxyl butyrate (PHB) produced by Biofloc bacteria is advantageous in the digestion and metabolism of fatty acids as well as fish growth (De. Schryver *et al*., 2008) [16]. Biofloc waters are high in heterotrophic bacteria that use hazardous nitrogenous materials as a growth substrate, which helps to preserve the water quality by lowering organic loads and the system's biochemical oxygen requirement (Barak *et al.*, 2003) [7]. A biofloc is a diverse collection of bacteria, algae, protozoa, and other zooplankton creatures that may number in the thousands. We still don't know enough about the bioflocs' composition, our ability to influence them, or the various consequences it could have on fish production and other ecosystems.

Water preparation for floc development



Biochemical composition of biofloc

Precipitated biofloc is a nutrient-dense substance that comprises protein, fat, ash, fiber, and carbohydrates, as well as minerals and vitamins. According to Kuhn and Lawrence (2012) [28], environmental conditions, diverse carbon sources, TSS levels, salinity, stocking density, light intensity, microbes, and biofloc age are the limiting elements that determine the nutritional composition of biofloc. Biofloc crude protein, ash, and carbohydrate values ranged from 18.4 to 58 percent, 0.1 to 5.4 percent, 11.8 to 42 percent, and 19-36.4 percent in prior research Dantas *et al*., 2016 [15]; Kuhn *et al.*, 2016 [27]; Maica *et al*., 2012 [29]; Emerenciano *et al.*, 2012 [18]; Kuhn *et al*., 2010 [26] and Azim and Little, 2008 [6]. (Table 1).

Table 1: Proximate analysis of biofloc particles in different studies-

Protein%	Lipid%	Ash%	Carbohydrate%	Reference
37.93-38.41	3.16-3.23	11.83-13.38	-	Azim and Little, (2008) [6]
24.7	0.4	36.6	-	Dantas *et al.* (2016) [15]
28-58	2.3-5.4	17-27	14-50	Crab *et al.* (2010) [14]
38.8 – 40.5	<0.1	11.8 – 24.7	25.3 – 31.2	Kuhn *et al.* (2010) [26]
38	0.42	31.6	19	Kuhn *et al.* (2016) [27]
23.1 – 30.73	0.86 – 2.18	21.81-39.83	-	Khanjani *et al.* (2016) [24]
28.76 – 43.15	2.11 – 3.62	22.1 – 42.1	-	Maica *et al.* (2012) [29]
18.4 – 26.3	0.3 – 0.7	34.5 – 41.5	20.2 – 35.7	Emerenciano *et al.* (2012) [18]
30.4	0.47	39.2	29.4	Emerenciano *et al.* (2011) [19]

Water quality parameter

Any aquaculture system relies heavily on the quality of its water. It is very important for fish health, and any decrease in water quality induces stress and sickness in fish (Arulampalam *et al*., 1998) [2]. Each water quality measure interacts with and influences the others in a variety of ways (Joseph *et al*., 1993) [23]. Because the fish's entire life process is entirely dependent on the quality of its surroundings (Bolorunduro and Abdullah, 1996) [8] a proper water condition is essential for their survival and growth. Fish in biofloc's aquaculture systems Joseph (2009) [22] states that water quality control is an important component of a successful fish rearing approach. As a result, water quality determines whether an aquaculture operation succeeds or fails. Water quality in any environment reveals a lot about the resources available for supporting life in that ecosystem. A wide variety of physical and chemical characteristics influence the quality of water supplies. To determine the quantity and source of any pollutant load, these factors must be assessed and monitored (Thirupathaiah *et al*., 2012) [39].

Water Quality Management

The C/N ratio has long been used as a measure of how quickly organic matter decomposes. When the organic matter has a low nitrogen concentration (i.e. a high C/N ratio), some of the nitrogen required for microbial development is acquired from the water column and adsorbed as microbial protein. In the BFT culture tank, the microbial community of heterotrophic bacteria consumes a greater level of dissolved oxygen, accounting for up to 77% of total oxygen consumption (Olah *et al.*, 1987; Visscher and Duerr, 1991; Avnimelech *et al*., 1992; Sun *et al*., 2001) [31, 40, 4, 37]. To eliminate inorganic nitrogen, Avnimelech (1999) [5] indicated that the C/N ratio in the pond should be 10.75. Even at high stocking densities of 20 kg/m3 at harvest, Crab *et al*., (2009) [13] found that carbon-rich and low protein feed (in experiment meal) could maintain a 1:20 C/N ratio and restrict the appearance of inorganic nitrogen species. If the system's carbon and nitrogen levels are well balanced (Schneider *et al*., 2005) [36]. Fish uptake of bio-flocs is most likely influenced by fish species and eating characteristics, as well as fish size, floc size, and density (Avnimelech, 2009) [3]. The total alkalinity level fluctuated a lot in the biofloc fish culture tank, whereas it was consistent in the control tanks.

Advantages of biofloc technology

- There is no possibility of fish being stolen
- There is no chance of flooding
- Unadulterated fish is available
- Farmers spend less on fish production
- Biofloc requires very little manpower for fish farming
- Biofloc only works if there is a small area for fish farming
- There is no need to apply any chemical fertilizer
- It goes without saying that there is no need to change the water
- Fish production is increased through biofloc technology

Limitations of biofloc system

- Power consumption is high
- Uninterrupted power supply is required
- The alternative is to have more than one generator
- In our country, the commercial rate of electricity is higher than that of agriculture, so the cost is comparatively higher
- Skilled trained manpower is required

Challenges in biofloc technology for farmers

- The amount of ammonia and nitrite increases during fish farming
- The number of floc increases and as a result, the fish gills become clogged and ultimately, the fish dies
- Carbon sources are not found in good quality
- Parasite infestation occurs due to poor quality of carbon source
- The quality of probiotics is not good and the floc formation is hampered
- It is difficult to get good quality probiotics in our country

Recommendation

- The fish must be acclimatized before being released into the biofloc tank
- After the floc grows in the biofloc tank, the fish should be released
- Examples of catfish are shing (*Heteropneustes fossilis*), gulsha (*Mystus cavasius*), and pabda (*Ompok pabda*), etc. should weigh less than 4 to 5 grams.
- It is better not to use powdered food in the biofloc tank for small size fish fry
- It is important to ensure a high aeration system for fish farming in biofloc tanks
- Biofloc should be farmed by skilled manpower
- Good quality carbon sources must be ensured
- Partial water can be changed if the amount of floc is more
- When the amount of floc decreases, carbon must be added

Conclusion

Biofloc technology is a green and long-term solution. This approach is water efficient and ensures biosafety because water does not need to be changed. Because the trash is managed in the tank, this method is environmentally benign. Furthermore, because waste is a protein source, the desired yield of catfish can be achieved with only a modest amount of food. It also yields a lot more than traditional farming methods. This kind of fish farming is regarded as ideal due to land and water shortages in populous nations such as Bangladesh. The Biofloc device will boost catfish growth. Biofloc density will have a significant influence on catfish growth. As a result, biofloc technology is projected to transform fish farming in the future as a sustainable, profitable, and environmentally beneficial technology. This system has a bright future since it can help achieve the high levels of output required to meet the demands of an ever-increasing human population.

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