Review Article

An Insight on the Prospects of Biofloc Technology (BFT) in the North-Eastern States of India

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Submission Date: 20-12-2021; Revision Date: 30-12-2021; Accepted Date: 13-01-2021.

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ABSTRACT

Aquaculture farming is presently facing challenges in terms of effluent discharge it releases into the natural environment. Farmers opt for intensive culture methods for high production which results in deteriorated water quality of the surrounding habitat and introduces pathogen, leading to disease outbreak. The north-eastern region of India is one of the hotspots of freshwater fish biodiversity in the world with apprx. 300 fish species belongings to 10 different orders, 37 families and 114 genuses. The region covers largest part of the Eastern Himalayan ranges. Topographically hilly regions are resource poor for aquaculture in terms of land and water and most of the land areas are also flood prone. Thus it caused the need of a sustainable aquaculture technology. This article focuses on an advanced technology, called Biofloc technology based on zero water exchange and wastes recycling produced inside the cultured system by utilizing the mixture of bacteria, algae, detritus forming the microbial floc. The water quality remains maintained due to the conversion of the toxic nitrogenous wastes of the cultured species into proteinaceous diet which can be eventually consumed by the cultured species itself, thus replacing the high cost fish feed available in the market. This novel technology proves to be a cost effective as it utilizes fewer resources in terms of water, space, energy and eventually capital with a low operating and management cost. The north-eastern states of India can adapt this technology for a high yield in fish production and to boost up the rural economy, employment generation and also to conserve the valuable species of the region.

Key words: Biofloc technology, Sustainable aquaculture, Zero water exchange, Nutrient cycling, Nutritious microbial cells, Northeast India.

INTRODUCTION

Aquaculture at present is considered as one of the fastest growing industries in the world.[1] Growing concerns about health benefits of fish protein as the conventional nutritious source have gradually increased its intake preference over red meat which in turn raised the demand of fish production in recent years over the world. The global population is estimated to increase from 7.6 to 9.8 billion by 2050 which will eventually lead to the increase in food demand.[2] Owing to the great demand of fish protein, the aquaculture industry is being growing at a faster rate of ~9% per year since 1970.[3] But due to the shortage of land and water system farmers are bound to practise intensive culture practices to attain high productivity.[4] High stocking densities are maintained by the use of higher amount of artificial fish feeds.[5] Although this practice helps in attaining higher productivity, new challenges are also being faced continuously. The cultured species consumes limited amount of feed and the uneaten left over residue gets accumulated in the system, increasing the nitrogen content resulting in deteriorated water quality. This creates a stressful environment which results in disease outbreak leading to a substantial economic loss.[6] This cultured water when released to the surrounding habitat has the potential to pollute the natural water bodies and introduce pathogens.[7,8] Hence there comes the need of a sustainable approach that can raise the productivity

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by impacting less on natural environment. The present article stresses on a technology which is sustainable, cost effective and has less residual effect. Biofloc technology is the novel technology that operates on zero water exchange within a confined and limited space, reducing the use of high cost artificial fish feeds. High growth of fish with a boost in immunity conferring disease resistance was seen to be cultured under this technology.[9,10]

Biofloc is an advanced technology based on zero water exchange and recycling of the wastes produced inside the cultured system. This technology proved to be successful way back in 1988 when Sopomer farm in Tahit, French Polynesia made a world record in production of 20–25 ton/ha/year using 1000 m^2 concrete tanks.[11,12] Biofloc technology uses the mixture of bacteria, algae, detritus forming the microbial floc that maintains the water quality by converting the toxic nitrogenous wastes of the cultured species into proteinaceous diet which can be eventually consumed by the cultured species itself, thus replacing the high cost fish feed available in the market.[13] This technology was first developed during the eighties, then known as activated suspension technique. A high level of microbial floc is maintained in suspension providing continuous aeration and carbon sources.[14] The waste products in the culture system are organic matter mostly generated from accumulation of unconsumed feed, fertilizers and faecal matters. Continuous aeration decomposes the organic matter and helps in the development of heterotrophic micro-organisms. These micro-organisms produces new microbial cells by utilizing the nitrogen by products present in the waste and the available carbon present in cultured medium. The development of microbial floc of cells not only acts as a source of protein rich food for the cultured species, it also reduces the accumulation of toxic nitrogen waste in the culture medium.[15,16] Thus, the need of frequent exchange of water to remove the toxic accumulation of nitrogen become significantly reduced which also decreases the quantity of water used.[17] Frequent change of water may introduce pathogen, increasing the risk of disease manifestation which also causes a hindrance in productivity. The toxic ammonia nitrogen (TAN) is maintained at safe level due to conversion, providing a stress free environment to the cultured species. Zero or minimal exchange of water also helps in maintaining the temperature in aquatic system with less heat fluctuations.[18] This facilitates building of organic matter that acts as substrate for development of microbial floc. Thus Biofloc technology - a sustainable and eco friendly approach in aquaculture can be adapted to overcome the major challenges faced by this sector.

The north-eastern states of India are considered to be the hotspot of fish biodiversity.[19] Farmers of the region generally cultivate fishes in local ponds and natural resources which are prone to a heavy loss due to escapes during the flood seasons. The hilly areas of the northeast region are resource poor in terms of land and water for fish culture, so they practices intensive culture methods to increase the productivity. But these practices negatively impact the surrounding environment by releasing toxic by products. It also causes stress on fishes which results in inferior product quality. Biofloc technology can be a promising technology which can be adopted by fish farmers that will provide a massive yield from a relatively small area than conventional aquaculture practices without releasing any toxic effluents into the environment. The vast available natural resources and traditional farms can be easily modified to suite this sustainable technology. Many indigenous small fishes that are highly nutritious can be cultivated in high proportion and can be exported to the other parts of the country. This study highlights the possible benefits of implementation of Biofloc technology in the north-eastern states of India, its future prospects and strategies for improvement and development of aquaculture in the region by assembling and compiling the available knowledge that can be useful to overcome the challenges in production and increasing its share in contribution to the country's economy. The north-eastern region of India, with vast variety of fish resources has tremendous potential to contribute to the India's share by adopting sustainable scientific technology in global aquaculture.

APPROACH

This study provides an insight on the sustainable approach of Biofloc technology with baseline information, focusing on the introduction of a novel technology to the north-eastern states of India which has been facing several constrains in aquaculture production since decades. The north-eastern region of India harbours about 300 fish species belongings to 10 different orders, 37 families and 114 genuses and apprx. 60% of these have the ornamental value. Many of these fish species have high nutrients, carcass and economic value and can be cultured as potential candidates in this technology once the proper operation procedure could be introduced to the fish farmers of the region. This could result in the boost in economy and employment generation of the region as well as the farmers involved in aquaculture.

LITERATURE SEARCH

Literature search for the study was done using database – Science Direct, PubMed and Google Scholar. Combination of keywords used for the collection of literature includes "Biofloc, nutrient cycling, zero water exchange and sustainable aquaculture, blue revolution, nutrient microbial cells and aquaculture constrains in northeast India" with restriction made in the publication date. The number of studies presented by the databases- Science Direct (150), Google Scholar (235), PubMed (44).

ELIGIBILITY CRITERIA

The selection process of the studies for the current investigation is presented in (Figure 1). This article focuses on the basic principle and operating procedures of the Biofloc technology for the application and adoption of this technology in the north-eastern states of India. Data published between 2003 to till date in English language were included in this study. There was no restriction in countries where the studies were conducted but Indian studies with special reference to the relevance to the region were prioritized to outline the constraints faced in aquaculture. However, studies without availability of full text and that are only presented as abstracts and not in English language were excluded.

PRINCIPLE OF BIOFLOC TECHNOLOGY

Biofloc technology is based on the practice of waste nutrient recycling, particularly the nitrogenous wastes of cultured species into microbial biomass that can be reused as food source for the cultured animals itself. Although toxic nitrogenous compounds may be of significant concern in aquaculture, but it is equally essential in building body proteins, tissues, fluids and molecules and is also necessary in various physiological processes.[20] Nitrogen is also the constituent nitrogenous bases of nucleic acids, pigments, adenosine phosphates etc.[21] Thus it can be efficiently used up from the wastes by recycling, done by bacteria as a part of complex food web in Biofloc technology. Heterotrophic bacteria use organic compounds (feed, fertilizers and faecal matters) as carbon and nitrogen source for their growth and production of new microbial cells. These cells requires more nitrogen for their metabolic activity which is made available by converting the toxic ammonia (nitrogenous wastes) into nitrite followed by the oxidation of nitrite to nitrate rapidly by the process of nitrification, reducing the accumulation of toxic ammonia in the culture system.[22] Maintenance of optimum growth of these useful micro-organism requires high carbon to nitrogen ratio (C:N). When bacteria are provided with high carbon and low nitrogen concentration based feed they are bound to uptake the required nitrogen available from water to form new microbial cells, thus reducing the accumulation of toxic substances from water and converting them into new nutritious protein cells.[16] Manipulation of C:N ratio helps in growth of bacteria rather than algae. Bacteria engulf up the nitrogenous wastes ten to hundred times more efficiently than algae does, and turn them into high protein feed.[23] Thus bacteria rather than algae dominate the Biofloc for recirculation of nutrient and purification of water. However, high algal growth may result in algal bloom that can adversely affect the water quality and survival of cultured species.

Carbon sources generally applied in BFT are often the by-products that were derived from food industries, preferentially locally available. Cheap sources of carbohydrates such as molasses, glycerol, complex starch such as cellulose and plant meals (i.e. wheat, corn, rice etc.) can be pelletized to use. According to the price and purpose, different carbon sources can be chosen which leads to the development and assimilation of different micro-organism of different nutritional value. Monosaccharide such as glucose and sucrose, polysaccharide such as starch, cellulose, some grains containing carbon, protein and lipids can also use as carbon source.[23]

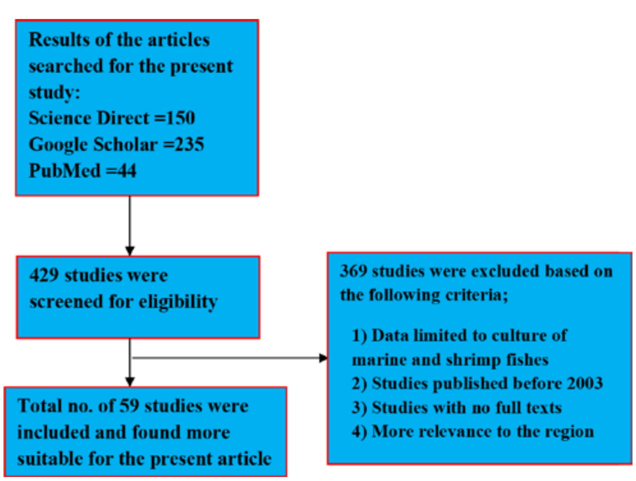

Figure 1: Flowchart showing the screening, selection and exclusion of research data employed in the present study.

GENERATION OF BIOFLOC AND ITS COMPOSITION IN CULTURE SYSTEM

There are different approaches for preparing Biofloc in the culture system. It depends upon the design and compatibility of the system, species to be cultured and intensity of farming. The tank to be used for Biofloc must be first washed to prevent any contamination from harmful bacteria or disease followed by filling the same with approx 35-50% of freshwater. Continuous aeration must be provided for availability of oxygen to prepare the water for Biofloc development. Addition of salt (1kg/10000 L of water) helps the water to maintain the total dissolved solid (TDS) and also helps fishes in strain. pH of the system is maintained by addition of calcium carbonate. Nitrogen level in the system is initially built up using nitrogenous feed or any organic substance. Autotrophic algae can be grown by using biofertilizers containing nitrogen and phosphorus. Subsequently, CHO source is added to maintain a high C:N ratio which will stimulate development and conversion of autotrophic micro-organism into heterotrophic floc. As a result, transition of water colour from green to brown could be observed. This natural process of floc development requires 7 to 10 days. At first, ammonia level rises to a peak which then falls due to conversion into nitrite by the developed flocs. By introducing more carbon sources into the water, the total ammonia nitrogen can be stabilized and controlled (Figure 2).[23]

Biofloc can also be generated in a very short period of time by inoculation of previous successful Biofloc culture water. Fermented product of molasses, rice bran, wheat flour etc. can also be used for quick Biofloc generation. Sometimes cultured Biofloc masses are dried into powdered form which can be later fermented with carbon sources for production of new flocs within a short period of time.[23] Sometimes commercial bacteria consortia popularly known as probiotics are also used in the process.[24]

Microbial communities formed in a typical biofloc consist of phytoplankton, bacteria and aggregates of living and dead particulate organic matter.[22] They are divided into photoautotrophic, chemo-autotrophic and heterotrophic system. The photoautrotopic system consists mostly of algae such as *Chlorophyta, Chrysophyta*, and *Cyanophyta* and diatoms that breaks down the nitrites and nitrates in the nitrogen cycle. They assimilate ammonia and nitrates to produce biomass, consumes CO_2 and produces oxygen. This system is less favoured in high C:N ratio.. Chemoautotrophic system consist of aerobic bacteria such as *Nitrosomonas* and *Nitrobacter* that acts on ammonia converting it into nitrates and is supported by intermediate C:N ratio and the heterotrophic system consists of species like *Aeronomas* and *Pseudomonas* which not only reduces the toxic ammonia but also converts these into single cell microbial protein to be fed by the cultured species.[12] All three conversion system interplays for the management of toxic wastes produced in the system. These microorganisms play 3 major roles in the culture system; These micro-organisms play 3 major roles in the culture system;

1. Water quality management by uptake of nitrogenous wastes and unused feed and converting those into microbial protein.
2. Decreasing the use of additional fish feed, reducing the feed costs and increasing the feasibility of the culture by reducing the feed conversion ratio (FCR).
3. They act antagonistically and compete with the pathogens, preventing diseases and also act as immune stimulant to the cultured species.[25]

APPLICABILITY AND CHALLENGES OF BIOFLOC TECHNOLOGY (BFT) IN NORTHEAST INDIA

The north-eastern region of India covering eight states viz., Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Tripura, considered as one of the richest regions of natural resources in the world.[26] The region extends between 21° 57' N - 29° 30' N, longitude and 89°46' E - 97° 30' E, covering an area of 262,179 km^2, with a population of 4, 54, 86, 784,[27] accounting for 3.7% of total population of India.[28] 95% of population of the region are fish eaters.[27] Among the states, Assam, Manipur and Tripura have a rich tradition of consuming fish. An average of 88% of the region belongs to the fish eating population.[28] Literature shows, the total fish production of the north-eastern region accounts 233,709 tonnes with a deficiency of 196,163 tonnes of required production and more than 38000 tonnes of fish being imported to meet the demand. Endowed with natural water resources and enormous potential in aquaculture, the region still has to depend on states like Andhra Pradesh, Orissa, West Bengal and neighbouring countries of Bangladesh and Myanmar to fulfil the increasing demand. Natural water resources of the

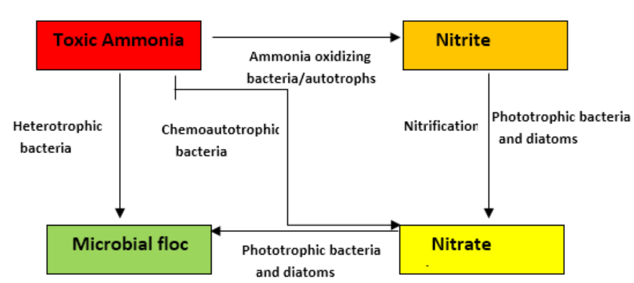

Figure 2: Recycling process of toxic nitrogenous waste in Biofloc culture system.

region are used for traditional cultivation of small and sizeable number of fishes, generally for family consumption which is not sufficient to compete with the major fish producing states. Besides, most of the areas of the region are flood prone for which the farmers have to face problems during the flood seasons due to escapes of the cultivated fish in high number. The hilly areas of north-eastern region faces constrains in the availability of land and water for aquaculture. Among the available resources are hill stream, local ponds and mini barrages that hinder the expansion. This huge gap between demand and supply urges the need of increase in fish production in the region. The need for land area, expensive fish feeds, disease outbreaks, overfishing, pollution, water quality management in intensive aquaculture system, predation and escapes of cultured species are some of the causes of shortfall of culturing fishes in natural resources. Additionally, intensive aquaculture practices results in a stressful environment due to the release of nitrogen based wastes, unused feed, accumulation of antibiotics and pesticides over time in the cultured pond which are released as toxic substances causing harm to the surrounding natural environment (Table 1 and 2).

The hilly areas of the north-eastern states also faces challenges in cultivating fishes that cannot sustain low temperature which makes them selective in propagating the culture. Prevailing climatic variability in the region also limits the productivity.[28] Water availability for aquaculture in these areas is also a major concern. Most of the fish species are obtained from the hill streams. Farmers rely on natural fish resources which cannot fulfil the need of fish demand in the region. Thus only a limited group of fish species are cultured in these areas. In Biofloc technology, all these problems can be monitored in a controlled system. Indigenous fish species of northeast region with high medicinal value can be cultured using this technology and exported to the other parts of the country. Exotic and profitable species can also be cultured by providing the required parameters in Biofloc technology. And small indigenous fishes of high nutrient content, used in traditional dishes of the region can also conquer the market of the other states of India if the production can be boosted by adoption of this scientific technology.

Farmers of north-eastern states of India associated with aquaculture are resource poor and are unaware of advanced technologies that can boost up the production. Sustainable and eco-friendly approach of Biofloc can immensely help these farmers to operate aquaculture with less land and labour and can increase the production of fish of bigger sizes than the traditional catches. The micro-organisms developed in the system itself act as nutritious protein feeds for the cultured species, lowering the feed requirement and cost. Moreover this technology is done in a controlled environment without any effect of natural calamities or predation. Government of India has assisted the use of this technology for increase in the production of aquaculture by providing trainings and technical hand holdings to the fish farmers. Private fish farms have also taken initiative to train the farmers at reasonable prices to boost their production in low economic and low labour cost. This would be a boon towards making the youth self-reliant. However in this process, selection of species is crucial one, as species that can tolerate poor water quality, intermediate dissolve oxygen, elevated stocking density and can directly feed on flocs to derive nutritional advantage will be the most suitable one.[29,5]

Biofloc technology is one of the effluent alternative aquaculture systems with many advantages that can uplift aquaculture by its sustainable approach. With the emergence of increasing disease outbreak, zero water exchange in the technology minimizes this risk, certifying biosecurity in culture system.[30] The microbial flocs developed under continuous aeration, itself serve as a source of nutritious feed that result in low FCR, thus reducing the feed cost to the farmers.[31,32] Unlike the artificial fish feed, these natural flocs are available throughout, facilitating the cultured animals to fed upon whenever in need. This ensures improvement in the body weight of the species. Beneficial micro-organisms in biofloc compete with the pathogenic bacteria and prevent them from colonizing in the culture system. It supplies quality nutrients that increase the growth of the cultured species with improved immune system.[33,34] Literature shows consumption of proteinaceous flocs by culture fishes and shrimps reflect numerous benefits such as improvement in growth, enhancement in immunity and antioxidant property.[35] This

technology does not only solved the problems of shortage of land for aquaculture expansion, but a high stock can be cultured at a single time without any toxic accumulation that could lead to a profitable income within a less period of time.

CONCLUSION AND FUTURE PERSPECTIVE

Biofloc technology is now known as “new blue revolutioner” in the field of aquaculture due to its sustainable and eco friendly approach towards the environment. North-eastern region of India is a hotspot of fish resources including small indigenous fishes, ornamental and commercial fish with high nutrition

Table 1: Biofloc Technology (BFT) and its efficacy in various fish and fisheries culture system of different region.

Culture species	Family	Efficacy of Biofloc	Study site	Reference
Labeo rohita, Cirrihinus mrigala, Catla catla (polyculture)	Cyprinidae	Nutritional quality of harvested biofloc was found suitable for IMC to be used as a supplemental feed. Besides BFT required 38% less water exchange to maintain the nitrogen level.	Kharagpur ,West Bengal, India	[36]
Cyprinus carpio	Cyprinidae	Application of biofloc based feed in the culture system resulted in absolute weight gain of the cultured species.	West Bengal University of Animal and Fishery Sciences, Chakgaria, Kolkata,India	[37]
Labeo rohita	Cyprinidae	Demonstrated excellent growth rate 87.5 % more yield than the corresponding control treatment with zero mortality in a culture span of 90 days	Kharagpur, West Bengal, India	[38]
Oreochromis niloticus (Genetically improved farmed tilapia)	Cichlidae	Enhanced growth performance with increase non specific immune response parameters in the cultivated species.	Rajiv Gandhi Centre for Aquaculture, Andhra Pradesh, India	[39]
Carassius auratus	Cyprinidae	Survival rate of goldfish (larvae) and the mean weight gain of goldfish in biofloc treatment showed higher values than that of control set.	Fisheries College and Research Institute, Thoothukudi, India	[40]
Labeo rohita	Cyprinidae	Cultured species shows enhanced growth and non-specific immune responses under zero-water exchange system and hence ensures sustainability	Array Farm, Goregaon, and Mumbai, India	[41]
Penaeus monodon	Penaeidae	Dietary supplementation of biofloc feed enhanced the growth and digestive enzyme activities in tiger shrimp juvenile.	Kakdwip Research Centre and Central Institute of Brackishwater Aquaculture, Kakdwip, West Bengal, India	[42]
Litopenaeus vannamei	Penaeidae	Use of wheat flour for biofloc production effectively increases the production and contributes towards good water quality resulting in increased growth and higher production of the species.	Central Institute of Fisheries Education (CIFE), Versova, Mumbai, India	[43]
Labeo rohita	Cyprinidae	High survivability and growth of the cultured species due to the significant contribution of the biofloc system.	Lembucherra, Tripura, India	[44]
Penaeus vannamei	Penaeidae	A significant improvement in the feed conversion efficiency (FCR) and growth parameters was noticed.	Ghent University, Belgium.	[45]
Pseudotropheus saulosi	Cichlidae	Beneficial bacteria in biofloc create a natural probiotics effect that helps to improve immune response of the cultured species to fight with pathogens.	Tuticorin, Tamil Nadu, India.	[46]
Cyprinus carpio	Cyprinidae	Developed biofloc improved the water quality, feeding performance, growth and biochemical composition of carp species.	Azadegan fish farming complex, South eastern Iran.	[47]
Oreochromis niloticus	Cichlidae	The nutritional quality of biofloc was appropriate for fish production and survival was 45% and 100% respectively, as compared to control.	Tropical Aquarium Laboratory of the Institute of Aquaculture, University of Stirling, United Kingdom.	[48]
Oreochromis niloticus	Cichlidae	Biofloc improves the quality, growth and performance of the larvae of the species cultured.	Bogor Agricultural University, Indonesia.	[49]
Penaeus monodon	Penaeidae	Biofloc increases growth yields and survival level of the cultured species at low water replacement rates.	Annamalai University, Parangipettai, Tamil Nadu, India.	[50]
Cyprinus carpio	Cyprinidae	Growth of the common carp fingerlings improved significantly in all the biofloc treatments compared to the control.	Directorate of Coldwater Fisheries research, Bhimtal, Uttarakhand, India.	[51]
Cyprinus carpio	Cyprinidae	Waste nitrogen is being recycled between dissolved ammonia and bacterial biomass reducing the environmental risk of polluted water discharge from culture systems.	Jammu, India.	[52]

Table 2: Types of Biofloc generation with different carbon (substrate) sources and its role in culture sustem.

Carbon source (substrate)	Types of Biofloc developed	Culture species	Role of the developed Biofloc in culture system	Reference
Molasses, glycerol and plant meals (i.e. wheat, corn, rice, and tapioca)	Rotifers, protozoans (ciliates and flagellates), crustaceans and nematodes.	*Penaeus monodon, Fenneropenaeus merguiensis, Litopenaeus vannamei*	Biofloc maintained the water quality and provides nutrition to the cultured animals and helped in nutrient cycling.	[53]
Molasses and rice powder	Tintinids, Ciliates, *Bacillus* sp. Copepods, *Spirulina* and Nematodes.	*Oreochromis niloticus*	Biofloc developed inhibited the development of potential pathogen bacteria in aquaculture.	[54]
Sugarcane, molasses, tapioca flour and wheat flour	Vibrionaceae, Enterobacteriaceae Alteromonadaceae and Micrococcaceae.	*Litopenaeus vannamei*	Developed microbes improve water quality than control.	[43]
Waste flours viz. wheat flour, rice flour and tapioca flour	Diatom, Protozoa, Rotifer and other micro-organisms.	*Labeo rohita, Cirrihinus mrigala, Catla catla*	Enhanced generation of biofloc that can efficiently utilized nitrogen resulting in substantial removal of TAN and NO_2-N.	[55]
Tapioca starch	Diatoms, *Microspora*, *Oocystis*, *Ulothrix* and *Scenedesmus, Microcystis Aphanizomenon*, *Gomphosphaeria*, *Euglena*, Crustacean Nauplii, *Asplanchna*, *Brachionus*.	*Macrobrachium rosenbergii*	Phytoplankton and algal periphyton forms the base of the aquatic food web and heterotrophic organisms act as consumer or decomposer to the pond ecosystem.	[56]
Glycerol	Heterotrophic and autotrophic bacteria, microalgae, zooplankton and others.	*Clarias gariepinus*	Improved the resistance of *Clarias gariepinus* to the bacterial pathogen *Aeromonas hydrophila*.	[57]
Groundnut oil-cake, rice bran and wheat floor	Protozoa grazers, rotifers, bacteria and diatoms.	*Labeo rohita*	The micro-organism community present in biofloc was provided a continuous natural food source and found to be quite suitable for development of the cultured species.	[58]
Corn starch	Heterotrophic bacteria algae, protozoan, ciliates, rotifers, zooplankton.	*Cyprinus carpio specularis, Hypophthalmichthys molitrix*	Biofloc developed had the highest ammonia removal capacity.	[59]

contents. Communities of north-eastern India have considered fish as one of the important commodities in ritual, custom and medicine. Therefore, a large section of people are actively involved in fish culture. Locally available fish species of the region and their fermented products also have a good price in the local market. Popularity of native and indigenous fish species of the region can be gained in global market by adopting this magic technology which can immensely uplift the livelihood and income of the rural fish farmers including skilled youths, aqua-entrepreneurs and aquaculture lovers. The problems of escapes during flood seasons, predation of cultivated species, shortage of land for culture, high cost of artificial fish feed etc. can also be overcome through this technology. However, selection of candidate species is necessary for a successful result in Biofloc technology. Also, technical knowledge needs to be transferred practically and emphasis should be given on economic benefits of the technique. Although this technology has tremendously been applied in aquaculture outside India, only a little research is carried out in northeast India. And more investigation must be carried out to identify potential, prospective and efficient candidates in this system. The technology will only be effective through proper understanding of the operation principle so that required manipulation of the important parameters could be carried out to fulfil the needs of the cultured species for a better yield in near future.

ACKNOWLEDGEMENT

Authors are thankful to the Dibrugarh University for providing necessary support and facility.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

BFT: Biofloc Technology; **TAN:** Toxic ammonia nitrogen; **C:N:** Carbon to Nitrogen ratio; **TDS:** Total dissolved solid; **CHO:** Carbon, Hydrogen and Oxygen; **FCR:** Feed Conversion Ratio.

SUMMARY

Biofloc technology is based on the practice of waste nutrient recycling that utilizes less space and resources for the culture of fish species of high economic value. Several constrains in fish farming activities like unavailability of land, shortage of food, water exchange, occurrence of flood, fish escapes in hilly areas etc can be overcome by adopting this technology. It is one of the effluent alternative aquaculture systems with many advantages that can uplift aquaculture by its sustainable approach. The microbial flocs developed inside the system serve as a source of nutritious feed.

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Cite this article: Singh MK, Boruah D, An Insight on the Prospects of Biofloc Technology (BFT) in the North-eastern States of India. Asian J Biol Life Sci. 2022;11(1):20-8.