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A study of freshwater fish farming of biofloc ponds in district Kaushambi Uttar Pradesh

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Abstract

The present study in biofloc pond is an initiative in district Kaushambi Uttar Pradesh. The fish farmers have made biofloc ponds with some modifications in their fish culture ponds. The study was conducted during June to November month in 2022 in three village biofloc ponds of District Kaushambi. The fish farmers of Kaushambi belongs to rural area and lack awareness and training in relation to biofloc fish farming. The fish production in Chalauli and Malahipur biofloc Pond were 80 quintal and 42 quintals respectively against the seed stocking of 9000. In Myohar biofloc pond it was 30 quintals against the seed stocking of 8000. The fishes which are cultured in Biofloc are *pangasianodon hypothalamus, clarias batracus, heteropneustis fossils* and *cirrhinus mrigala. Pangasiandon* was found to be the most cultured species. Most of the farmers were found young, educated, least experienced and small-scale investors. Prevention of diseases and therapeutic measures were found satisfactory. The farmers were also not aware about carbon: nitrogen ratio but they try to maintain it.

Keywords: Biofloc ponds; Therapeutic measures; Seed stocking; Fish production; Carbon nitrogen ratio

1. Introduction

The global population is expected to reach 9.6 billion by year 2050. The demand for animal protein is increasing year by year. Now it is a challenge to provide quality protein by safeguarding its natural resources for future generations. Aquaculture plays a key role by providing animal protein as well as generating employment, economic growth, and good health. The biofloc technology (BFT) have gained attention during last few years (Avenimelech,2009, Ahmed et al.,2017). BFT is considered as new "blue revolution" since nutrients can be recycled and reused in the culture medium by the minimum or zero water exchange. BFT is an environment friendly aquaculture technique based on in-situ microorganism production. Biofloc is the suspended growth in ponds/tanks which is the aggregates of living and dead particulate organic matter, phytoplankton, bacteria and grazers of bacteria. Now-a-days biofloc technology is widely used for culturing numerous shrimp and fish species by microbial immobilization of ammonium with limited water exchange facilities (Ekasari et al., 2015). Biofloc technology uses a zero- water exchange system to improve water quality by adjusting C/N ratio to transform harmful nitrogenous wastes into beneficial microbial community. BFT is an eco-friendly and a low cast alternative for intensive fish production which not only increases production but also enhances the net profit. The principle of BFT is based on nutrient recycling through elevating the carbon-to-nitrogen (C/N) which stimulates the growth of microbial community such as heterotrophic bacteria and algae within the system (Avnimelech2006, Ahmed et al.,2017). A C/N ratio of 10:1 was found to be optimum for higher growth and better survival of spawn-to-fry and fry-to-fingerlings rearing of *Hypseolbarbus punchellus* in the biofloc system. (ICAR-CIFA annual report 2022). Uttar Pradesh the fourth largest state of India produced almost 810 thousand metric tons of fish in fiscal year 2022. The state government provide various grants and subsidies to encourage fish farmers to adopt biofloc technology. The state government announced a scheme a subsidy of 60% on the cast of setting up a biofloc fish farm to farmers. In conventional aquaculture large amount of water are required to remove waste and maintain water

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quality. Biofloc systems reduce the need for water exchange by up to 90% reducing water uses and environmental impact. Another significant benefit of biofloc fish farming is the production of high-quality protein. Biofloc system also creates a healthier environment for the fish reducing the risk of disease and mortality. Biofloc fish farming offers economic benefits as the system requires less labor as compared to traditional aquaculture. The reduced need for water exchange and external feed reduces operational casts and the higher yield and faster growth rates results in increased profit. In aquatic biofloc system there are three likely energy sources. The first is sunlight for photoautotrophic microorganism such as algae and vascular plants. The second source of energy is the form of inorganic compounds that are used by the microorganisms that oxidize reduced forms of simple compounds especially nitrogen to obtain energy. In fish farming by metabolizing organic nitrogen and ammonia, nitrogen is oxidized to nitrite and nitrate. The third source of energy is organic compounds that are transformed by microorganisms. The transformed energy is used to synthesize protein from the nitrogen sources. Biofloc aquaculture requires additional carbon source into the system because carbohydrates in the system may be insufficient. Some of the sources of carbon that can be used in aquaculture crops are glycerol, sodium acetate, sugar, tapioca flour, wheat flour and molasses. For a biofloc system to operate efficiently, it is best to maintain C/N ratio between 10:1 and 20:1. Bacteria required for biofloc processes are *Nitrosomonas, Nitrobacter, Bacillus subtilis, Bacillus licheniformis, Rhodococus, Rhodobacter, Bacillus species* and *Pseudomonas etc.* Biofloc technology provides more efficient and sustainable aquaculture by reducing environmental impacts.

2. Materials and Methods

A study was conducted during June-November 2022 in three biofloc ponds of district Kaushambi. Village-Chalauli and village-Malhipur biofloc ponds is situated in Chail tehsil. Village-Myohar biofloc pond is situated in Manjhanpur tehsil. These three sites were selected for the study (Fig.1,2,3). A total of 36 respondents were selected from three villages. A total of 12 farmers from each site who were performing biofloc fish culture in ponds were selected. These farmers were harvested one crop earlier. The farmers were selected by simple random sampling method and were contacted. All the farmers were interviewed to gather data. All the information were accumulated, percentage calculated and presented in tabular form to understand the biofloc fish farming in district Kaushambi. Information was collected from the respondents on farmers category, culture practices, water quality monitoring practices, heterotrophic bacteria management, feed management, preventive health management, diseases and mortality, therapeutic measures, production economics satisfaction and future prospects. (Table-1)

Table 1 Biofloc fish pond size

S.N.	Name of villages	Size (square meter)
1.	Chalauli	24 meter × 40 meter = 960 sq. meter
2.	Malhipur	25 meter × 40 meter =1000 sq. meter
3.	Myohar	80 meter × 13 meter = 1040 sq. meter

Figure1 Chalauli biofloc pond

Figure 2 Malhipur biofloc pond

Figure 3 Myohar biofloc pond

3. Results and Discussion

3.1. Farmers Category

Table 2 Farmers Category

Demographics	Category	No. of respondents (Percentage)
Age	Below 40	23 (63.8)
	40-60	10 (27.7)
	More than 60	3 (8.3)
Education	Illiterate	4 (11.1)
	Literate	22 (61.1)
	Professional	10 (27.7)
Experience	<1year	18 (50)
	None	18 (50)
Training source	Government	18 (50)
	Private	8 (23)
	Friends	10 (27)

Out of the total surveyed respondent maximum were found to be young with good educational background. Among the respondents only 27.7% was professional and 11.1% was illiterate. Biofloc culture is a new business to the farmers of Kaushambi and they had an experience of less than one year. It was found that 50% of the farmers were trained by department of fisheries of Kaushambi and the other from internet/whats app and friends. (Table-2)

3.2. Culture Practices and Biochemical Parameters

The farmers of Kaushambi were found culturing mainly Pangasius species. The seeds are easily available to them. All the farmers of three villages were culturing mainly pangasius species in their biofloc ponds. The stocking size of this species was 0.5-1 gram per fish. The low stocking density was found for Pangas. In West Bengal the Tilapia and Koi farmers were found to maintain higher stocking densities. Higher stocking density is usually impacting water quality and impart main stress to the aquatic life (D Oliviera et al.,2012). The seasonal culture (excluding December-February) was found more suitable it was due to disease predominance and difficulties in maintaining heterographic bacteria at low temperature.

Water quality monitoring in ponds is the daily observation and analysis of water parameters to ensure provisional water quality. The farmers were found to be aware about the ideal water quality. The farmers knew that deviation from the optimum range might adversely affect the crop. Monitoring of major water quality parameters are pH, D/O, NO2 TAN, TDS and floc volume measurement by Imhoff cone. The monitoring of pH level in a safe range is very important in a fish pond because its fluctuations can directly impact metabolism which finally leading to the death of fish. The pH of ponds was found between 7.5 to 8.5. Nees (1946) and Banerjia (1967) had observed the variation in water pH from 7.1 to 8.0 as optimum for fish production.

The temperature has an important role in deciding the biotic features of the water body. The temperature varied from 5.6 degree Celsius to 45.8 degree Celsius during the study. The rainfall ranges from 12.5 mm to 75.6 mm in 2021-22. The humidity ranges from 30% to 94%. The minimum humidity was noticed in April and maximum in October month (Indian meteorological department report 2021-22, Government of India and U.P.). The dissolve oxygen (D/O) is the most important and critical parameter requiring continuous monitoring in aquaculture production system. D/O is considered as the key test to understand water pollution and degree of eutrophication (APHA1985). The metabolism and growth of fish depends on D/O. D/O was higher during summer month and lower during winter month. Total dissolved solids (TDS) consist of nutrients and minerals like magnesium, calcium, nitrogen, sulphate and phosphate was recorded highest in winter and lowest in summer. According to WHO, TDS level less than 300 mg/liter is considered as excellent, between 300 and 600 mg/liter is good, 600-900 is fair, 900-1200 is poor and TDS level more than 1200 mg/liter is unacceptable. The total alkalinity was found minimum during winter and maximum during summer season. The total alkalinity was maintained by Liming and fertilizers by fish farmers. The alkalinity less than 100 mg/ L is not suitable for fish culture (Scroeder 1980, banarjia 1967). The quality of the pond depends on the physical, chemical and biological characteristics of water. (Latha N, R Mohan 2010 and S.E. Sinde 2011). In aquaculture system water exchange is important to maintain water quality for deterioration. Hence minimum or zero- water exchange culture techniques increase nitrogen levels in water (Randal and Tsui 2002). The farmers of Chalauli biofloc pond have changed water three times while the farmers of Malhipur biofloc pond perform partial water exchange during emergency. In Myohar biofloc pond they have changed 30% of pond water 3 times in six months. Sometimes the farmers of rural areas faced culture failure during long power cut off. The high value of transparency, temperature and pH were the most valuable parameter that has affected phytoplankton and zooplankton's quantitatively and qualitatively (Mishra Y. 2021-22) The quality of an ecosystem depends on the physicochemical characteristics and biological diversity of the system. (Tiwari and Chauhan 2006).

3.3. Heterotrophic Bacteria and Feed Management

In biofloc culture the farmers were prepared heterographic bacterial floc. Majority of the farmers were found to prepare bacterial inoculum outside the pond. The farmers prepare inoculum by mixing carbon source and probiotic in a small bucket with continuous aeration which was called FCO (Fermented carbon organic). Some farmers prepared it directly into the culture pond with continuous aeration prior to the fish stocking. It is very critical to maintain optimum floc levels because high fluctuations of pH and alkalinity, high concentrations of inorganic nitrogen might have chronic effects on fish health (Azim and Little, 2008). The commonly used flock volume by farmers for culturing Singhi, Magur and Bata it was 15-20 ml. In Kaushambi the floc volume used for pangas was 20-25 ml. This was due to different feeding habits of different fish species. Biofloc formation in the biofloc water pond is correlated to the dissolved ammoniacal nitrogen from feed and fish excretions by heterotrophic bacteria (Wang et al.,2016). It was found that some farmers have clear knowledge of C:N ratio. Majority of farmers were found to have knowledge of C:N ratio which was directly proportional to the flock volume. The availability of inexpensive and easily available carbon source is important to run the system besides controlled management (Zaki et al., 2020). The farmers of Kaushambi have used molasses plus Rice

bran polish and mustard cake as probiotic. They used it in the ratio of 250 grams molasses plus 10kg rice polish and 10 kg of mustard cake. They mix it with 50 liters of water and kept it for three days in summer and 5 to 6 days in winter for fermentation and then used in the biofloc pond water. Most of the farmers were also used commercial probiotics in the biofloc ponds. The study found that the farmers had not estimated the bacterial load in the pond. Most of the farmers have observed the watercolor and flock volume to confirm the existence of heterotrophic bacteria in the biofloc pond. It was found that all the farmers had used supplementary feed along with flock for Singhi, Magur and Pangas.

3.4. Health, Diseases, Mortality and Therapeutic Measures

Fish health management has become continuous operation for preventing sudden outbreak of epizootics that occur due to environmental deterioration, improper feeding and overcrowding. The normal functioning of all bodily organs denotes healthy conditions while any degradation from the normal functioning is termed as diseased condition. The farming system in biofloc Pond decide the health status of fishes. Many demerits were found in respect of disease concerned. Non removal of uneaten feed led to subsequent water quality deterioration which was very common. Farmers used to check water quality parameters they also need to check fish growth weekly. Incorporation of calcium, vitamin mineral mixture or any digestive enzyme along with food to enhance the fish health status was practiced rarely. In aquaculture, diseases and mortality of fishes are very common. In biofloc pond culture system of Kaushambi were found to be presence of ulcer, hemorrhages, fish rot and tail rot in all the three sites. In some fishes' dropsy was confirmed. It was found in the study that many of the disorders and diseases that are known to occur in fish are the result of stress, poor water quality, overcrowding and failures to quarantine any new or sick fish to avoid spread of disease. Scale loss in fishes was due to poor water quality and fin erosion either due to infection or attack by co-species during shortages of food. The major disease in Pangas, Singhi, Magur, was found mat like fungal growth in Chalauli fish pond. The fishes were found slow growth and nonuniform size reported in all three sites. The late fingerling stage of Singhi and Magur was reported to be most affected group. The fingerling was found the most affected group whereas fry size was reported as the least affected group. During the whole culture period maximum disease outbreak occurred during 4^{th} month in Pangas but it was found in all the month in Singhi and Magur. The autumn season was found to be the highest disease prevalence, followed by rainy and summer season for all fishes. It was also found that fluctuation of temperature and stress were the major factors for disease occurrence. Mass mortalities of cultured fishes were also reported. In Pangas both sudden and slow mortality was reported.

In biofloc culture system there is a presence of dense microbial community which promote a competitive environment that inhibits the growth of harmful pathogens. The biofloc trap and immobilize pathogens limits their spread and reduce the need for chemical treatments. So biofloc is a naturally disease control system which minimize the use of antibiotics and chemicals which contribute to safe and healthy fish production. The farmers had used water/aqua sanitizer for precautionary measures when the pond is ready which removes harmful bacteria and infections so that new fishes in the Next batch do not get infected. It also maintains pH, D/O, alkalinity and hardness of water. A dose of potassium per magnate (KMNO4) is introduced when water of the pond looks dirty to Disinfect the pond water. The farmers were changed about 30% of the pond water monthly.

3.5. Production

Fisheries experts explains that if someone cultivates fish in a biofloc pond of 10 thousand liters then he will get the production of up to 500 kilogram of fish in five months. To get this production of fish, one hectare area pond is needed. The biofloc provides additional nutrition to the fish, improving their growth rate and overall productivity. Biofloc fish culture has gained importance among unemployed youth because they knew that highly profitable intensive culture system can be manipulated easily. During the study it was found that most of the fish seeds did not survive and majority due to adverse water quality and diseases. The fish production of Chalauli biofloc Pond was found to be 80 quintals against the seed stocking of 9000. In Malhipur biofloc Pond it was estimated to be 42 quintals against the seed stocking of 9000. In Myohar the production was very low and it was 30 quintals against the fish stocking of 8000.An overall profit of farmers were estimated to be about 15-20 percent of total cost. The farmers of Kaushambi were faced many problems in relation to bioflc fish forming. Majority of the farmers were small scale investors. Despite high production the profit was not satisfactory because of low market price, low acceptability by consumers, and excessive mortality. The study has also shown the production was not so high due to lack of proper management of the bifloc pond. Most of the farmers were found satisfied with the biofloc techniques of fish farming and they decided to go forward on large scale biofloc farming.

4. Conclusion

The biofloc system offers several benefits including reduced water usage and environmental impacts, production of high-quality protein and economic efficiency. Biofloc fish farming is a very profitable business and in India, we need that

new generation must focus on this sector and help our country to get rid of poverty and become economically powerful. From the above study it is concluded that the farmers of Kaushambi belongs to rural area and poor families hence they are not efficient to manage biofloc properly. They are not trained farmers and depend on you tube, video and social media to solve their problems. The government should need to conduct awareness program, training for knowledge and capacity building. It was found during the study that the farmers have not much knowledge about selection of spices, ideal water quality, probiotics, feeding norms, and proper carbon to nitrogen ratio in the biofloc ponds.

Compliance with ethical standards

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Statement of ethical approval

The present research work does not contain any studies performed on animals/humans' subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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