A SEMINAR PAPER ON

PRODUCTION OF MONOSEX TILAPIA IN BIOFLOC BASED CULTURE SYSTEM

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Production of Monosex Tilapia in Biofloc based culture system[1]

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ABSTRACT

With the opening of numerous farms, tilapia has emerged as aquaculture's bright spot. It is also known as "aquatic chicken," and consumption has risen globally. As male tilapia grows twice than female and has ability against disease, so culture of tilapia grows very fast in recent years to fulfill people's protein need. But fish feed cost is 50% of the total cost of production and uneaten feed in normal pond deteriorate water quality results disease outbreak. So, monosex tilapia in biofloc technology (BFT) can be promising in achieving it's sustainability to aquaculture manufacturing without sacrificing the quality. The principle behind biofloc generation is the recycling of waste nutrients, particularly nitrogen, into microbial biomass which also lowering feed cost. One study reveal that, 3 supplemental feeds along with commercial tilapia feed (CF), wheat bran (WB), Biofloc technology (BFT) and rice bran + wheat bran (50:50) (RWB) have been particular for this experimentation. The stocking density changed into 125fingerlings/decimal with a median preliminary weight of 2.80±0.03 g of each. However, there was no significant ($P>0.05$) distinction in survival rate of fish the various treatments. The net profit was highest BFT receiving periphyton with lowering feed conversion ratio. In a different study, monosex Nile tilapia are kept in light-limited tanks using biofloc technology (BFT). (*Oreochromis niloticus*). In indoor tanks, two biofloc treatments and one control were run: BFT fed a healthy diet of 35% crude protein (CP), and 24% CP, and easy water control without biofloc with 35% CP. Fish survival reached 100 %. The comparison of the effects of biofloc technology (BFT) use on tilapia (*Oreochromis* sp.) production performance at various stocking densities. Further study evaluate monosex red tilapia production (masculinization) using immersion of tilapia larvae aged 10 days after hatching using the hormone 17α-metiltestosterone at a dose of 2 mg/l, stocking density of 250 individuals/m^3. Then the biofloc remedy with a density of 50 fish/m^3 and one 100 fish/m^3 without biofloc and with biofloc C/N ratio 15. The outcomes received that the pond with biofloc remedy has specific growth rate, feed efficiency, lower feed conversion ratio and survival rate better than control.

Key Words: Monosex, Bioflock, Growth Performance

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[1]A seminar paper presented at seminar course on March 30, 2023

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Chapter I

INTRODUCTION

Tilapia is a freshwater fish that has become increasingly popular in the aquaculture industry due to its ability to thrive in a variety of environmental conditions, high growth rate, and tasty meat. Tilapia is rich in protein, low in fat, and is a good source of omega-3 fatty acids, making it a great dietary supplement for people who are looking for an alternative to traditional sources of protein. Additionally, tilapia can be farmed in closed systems, making it an environmentally friendly option for fish farming. The benefit of tilapia cultivation is the capacity to reproduce and convey new generations speedy and proof against high-degree sickness and is extra bendy for cultivation in numerous systems. This fish additionally tolerate on shallow and turbid water (Silva *et al*., 2013). Intensive aquaculture is the preservation of fish with excessive density and excessive protein feed. Additionally, intensive aquaculture requires outstanding management, including water high-satisfactory control and various aquatic conditions that promote the best growth (Ekasari *et al*., 2013). The most practical way to increase fish production is to deepen the production of juvenile fish. However, the increase in density has the potential to lead to an excessive buildup of waste from uneaten feed, feces, and metabolic byproduct, which over time lowers the quality of the water (Fauzi *et al*., 2018). One answer that may be used to successful over the decline in water quality and aquaculture surroundings is made possible by utilizing biofloc technology. (De Schryver, 2008).

The principle behind biofloc generation is the recycling of waste nutrients, particularly nitrogen, into microbial biomass that may either be used in situ by cultured animals or captured and processed into feed ingredients (Avnimelech, 2009). By adjusting the C/N ratio in the water by changing the amount of carbohydrates in the feed or by adding an external carbon source to the water, heterotrophic bacteria are encouraged to thrive (Avnimelech *et al*., 1999), so that the bacteria can utilize the used ammonium to produce new biomass. Thus, water replenishment is no longer necessary if ammonium/ammonia is kept at a low, non-toxic concentration. By helping to supply high-quality fish juveniles, which are one of the most crucial inputs in production, biofloc technology improves production and productivity. Additionally, it helps to increase the quantity of fish produced. In regard to the former, biofloc technology could support the supply of high-quality seeds by strengthening the larvae's immunity and robustness and the reproductive efficiency of aquaculture animals (Ekasari *et al*., 2015).

BFT's use in increasing fish density led to better manufacturing but decreased fish development and survival. However, when fish used mixed sex, the uncontrolled reproduction process halted fish growth. Srisakultiew and Komonrat (2013) found out that in the tilapia culture, mixed sex can prevent growth because the energy needed for growth is also used for gonadal development. By using male monosex seed, the problem of shifting growth energy in combination cultivation may be overcome. Because male tilapia grow nearly twice as quickly as female tilapia, male monosex seeds were chosen (Firdous *et al*., 2011; Silva *et al*., 2013).

The use of a combination of sex reversal technology for producing monosex seeds and biofloc technology in-depth tilapia life is predicted to be a method to increase tilapia productivity and control aquaculture waste in order to create sustainable and environmentally friendly aquaculture. Today, tilapia has become the shining star of aquaculture with many farms beginning, which is also popular as 'aquatic chicken' and the rate of consumption has increased across the globe (Fitzsimmons, K., 2005). Annual global production of cultured tilapia has increased continuously in recent years. Since Fish feed accounts for over 50% of the total cost of fish production (Craig, S. and L.A. Helfrich, 2002), aquaculture sustainability depends on feed source and management. Consequently, developing nutrition strategies such as bioflocs and periphyton based culture are initiated to maximize the contribution of natural food which would help to expand aquaculture production.

OBJECTIVES

The study has started to achieve the following objectives;

- To explore the possible contribution of biofloc technology application to monosex tilapia production.
- To assess the importance of monosex tilapia in biofloc culture result lowering feed cost.
- To analyze the application of biofloc technology using male monosex red tilapia fish to growth, survival rate, feed conversion ratio and feed efficiency profile.

Chapter II
MATERIALS AND METHODS

This seminar paper is solely an overview paper. All of the information has been collected from the secondary sources. The study was carried out based on the information through review of related thesis, journals, reports and books. The necessary data were collected from source like internet, National Fish week compendiums, different annual statistical yearbooks of Bangladesh, newspapers, watching with different on-going researches in YouTube. I got suggestion and valuable information from my major professor and my course instructors. I myself compiled the collected information and prepared this seminar paper.

Chapter III
REVIEW OF FINDINGS

3.1. Basic view of Monosex Tilapia

3.1.1. Monosex Tilapia Production

Monosex culture is certainly considered one among the simple techniques of controlling Tilapia populations that have been achieved in a few international locations for aquaculture purposes. This method consists of hybridization, hormone augmentation (intercourse reversal). Males are favored due to the fact they develop almost two times as rapid as females, which can be resulting from a sex specific physiological potential for growth, female mouthbrooding or the greater competitive feeding conduct of males. Expected survival for all-male culture is 90% or more. Monosex fish has the capability to tolerate severe environmental situations which includes temperature, salinity, low dissolve oxygen, more uniformity of length is performed at harvest due to the fact not one of the fish is losing power in gonadal development (Wang, 2000).

3.1.2. Monosex seed Production by Hybridization

It is reported that a good number of the crosses carried out to produce monosex fish were made from a combination of the pure breed of the mouth brooding tilapia; this crosses results in producing fish whose sex orientation skewed towards all male. Table 1 shows some of the crosses that lead to all-male progeny and their best results reported. Among the major constraints in producing hybrids are: maintaining the purity of brood stocks, limited fecundity of parent fish which restricts fry production and difficulty in producing sufficient number of hybrid fry due to spawning incompatibilities between the parent species. In as much as not all crosses produce 100% males, the hybrids may still be subjected to manual separation of sexes or hormone augmentation.

Table 1. Hybridization of some tilapia species and proportion of male progeny produced

Crosses (♂ x ♀)	Males (%)	References
O. aureus x O. niloticus (Ugadan strain)	96-100	Pruginin, 1975
O.hornorum x O. spilurus	100	Hulata *et al.,* 1983
O. aureus x O. vulcani	98-100	Pruginin, 1975
O. macrochir x O. niloticus	100	Wohlfarth *et al.,* 1990
O.urolepsis hormorum x O. nigra	98-100	Wohlfarth *et al.,* 1990
O.urolepsis hormorum x O. vulcani	98-100	Majumdar *et al., 1983*
O. macrochir x O. mossambucus	100	Majumdar *et al.,* 1983
O.hornorum x O. niloticus	100	Wohlfarth *et al.,* 1990

O.urolepsis hormorum x O. niloticus	100	Wohlfarth *et al.,* 1990
O. aureus x O. niloticus (Stirling strain)	100	Marengoni *et al.,* 1998
O. aureus x O. mossambicus	100	Beadmore *et al.,* 2001
O.hornorum x O. mossambicus	100	Hickling, 1960

3.1.3. Monosex seed Production by Hormone Treatment

The principle of hormone augmentation method lies on the fact that at the stage when the tilapia larvae are said to be sexually undifferentiated (right after hatching up to about 2 weeks or up to the swim-up stage) the extent of the androgen (male hormone) and the estrogen (female hormone) present in a fish is equal thus, augmenting one of the hormones that is originally present in the fish will direct the fish to either male or female depending upon the hormone introduced.

Fig.1. 17α-methyltestosterone male hormone

Accordingly, if the tilapia larvae are fed with feeds that are incorporated with male hormone (e.g. 17α-methyltestosterone), the fish will develop into phenotypic male (physically appears and functions as male but possesses the female genotype (XX); in the same way, if a female hormone is mixed with the feed that is taken by the fish, then the fish will be directed to phenotypic female (physically appears and functions as female but possesses the male genotype (XY). Feeding the larvae with hormone treated diet, e.g., 17α-methyltestosterone or estrogen between the second and sixth week after hatching has been observed to have produced high percentage of males and females, respectively.

Table.2. List of successful use of of hormones in producing monosex tilapia in different time period

Species	Hormone	Duration	Male (%)	References
Oreochromis niloticus	Fadrozole	30 days	92.5-96	Wohlfarth *et al.,* 1990
O. niloticus	17 α-ethynyltestosterone	25-28 days	91-99.4	Pruginin, 1967
O. niloticus	17 α methyldihydrotestosterone	21 days	99	Guerrero (1975)
O. niloticus	17 α methyldihydrotestosterone	4 h	100	Majumdar *et al.,* 1983
O. mossambicus	17 α methyldihydrotestosterone	18 days	100	Guerrero (1975)
O. mossambicus	17 α methyldihydrotestosterone	42 days	100	Hickling, 1960)
O. aureus	17 α methyldihydrotestosterone	25-28 days	83-97	Majumdar *et al.,* 1983

3.2. Basic view of Biofloc

3.2.1. Essential thing of Biofloc preparation

Biofloc is the macro-aggregation of bacteria, algae, detritus and different decomposed additives (Avnimelech *et al.,* 1999). It is the aggregate of bacteria, diatoms, zooplankton, protozoa, macro-algae, feces, uneaten feed ,and exoskeleton from lifeless organisms (Decamp et al., 2008). It is a collection of biotic and abiotic particulate additives suspended withinside the water which incorporates bacteria, planktons, and different natural materials (Hargreaves *et al*., 2006)

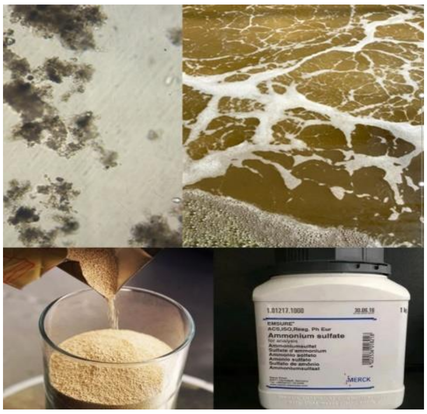

Fig 2. Components needed for biofloc preparation (Beneficial microorganism, carbon & nitrogen source). (Source: Daniel N and P. Nageswari 2017)

3.2.2 Nutritional quality of biofloc

The biofloc samples have been analyzed for Kjeldahl nitrogen (Kj-N), total ammonia nitrogen (TAN), total suspended solids (TSS) and volatile suspended solids (VSS). The distinction among Kjeldahl-N and TAN become used to calculate the protein content material of the bioflocs via way of means of multiplying the natural nitrogen content material via way of means of 6.25 .

The ash content material become decided the use of TSS and VSS values. Protein, lipid and ash content material had been expressed as percent of the dry weight (% DW) of the bioflocs. The overall carbohydrate become calculated in keeping with the subsequent formula: carbohydrate (% DW) = 100 – {crude protein (% DW) + lipid (% DW) + ash (% DW)} (Mansour *et al.,* 2017). The gross strength content material of the diets become calculated the use of kilo joule (kJ/g DW) values of 23.0, 38.1 and 17.2 for protein, lipid and carbohydrate respectively in (Table. 3).

Table. 3. Proximate composition of biofloc

Component	Crude amount
Protein	23.0 (kJ/g DW)
Lipid	38.1 (kJ/g DW)
Carbohydrate	17.2 (kJ/g DW)

3.2.3. Biofloc preparation

If nitrogen and carbon are nicely balanced in the solution, ammonium similarly to natural nitrogenous waste can be transformed into bacterial biomass (Schneider *et al.,* 2005). By including carbohydrates to the pond, heterotrophic bacterial boom is inspired and nitrogen uptake via the manufacturing of microbial proteins takes place (Avnimelech *et al.,* 1999) (Fig.3). The microbial biomass yield consistent with unit substrate of heterotrophic micro organism is ready 0.5 g biomass C/g substrate C used (Eding *et al.,* 2006) .Suspended boom in ponds includes phytoplankton, micro organism, aggregates of residing and useless particulate natural matter, and grazers of the micro organism (Hargreaves *et al.,* 2006).

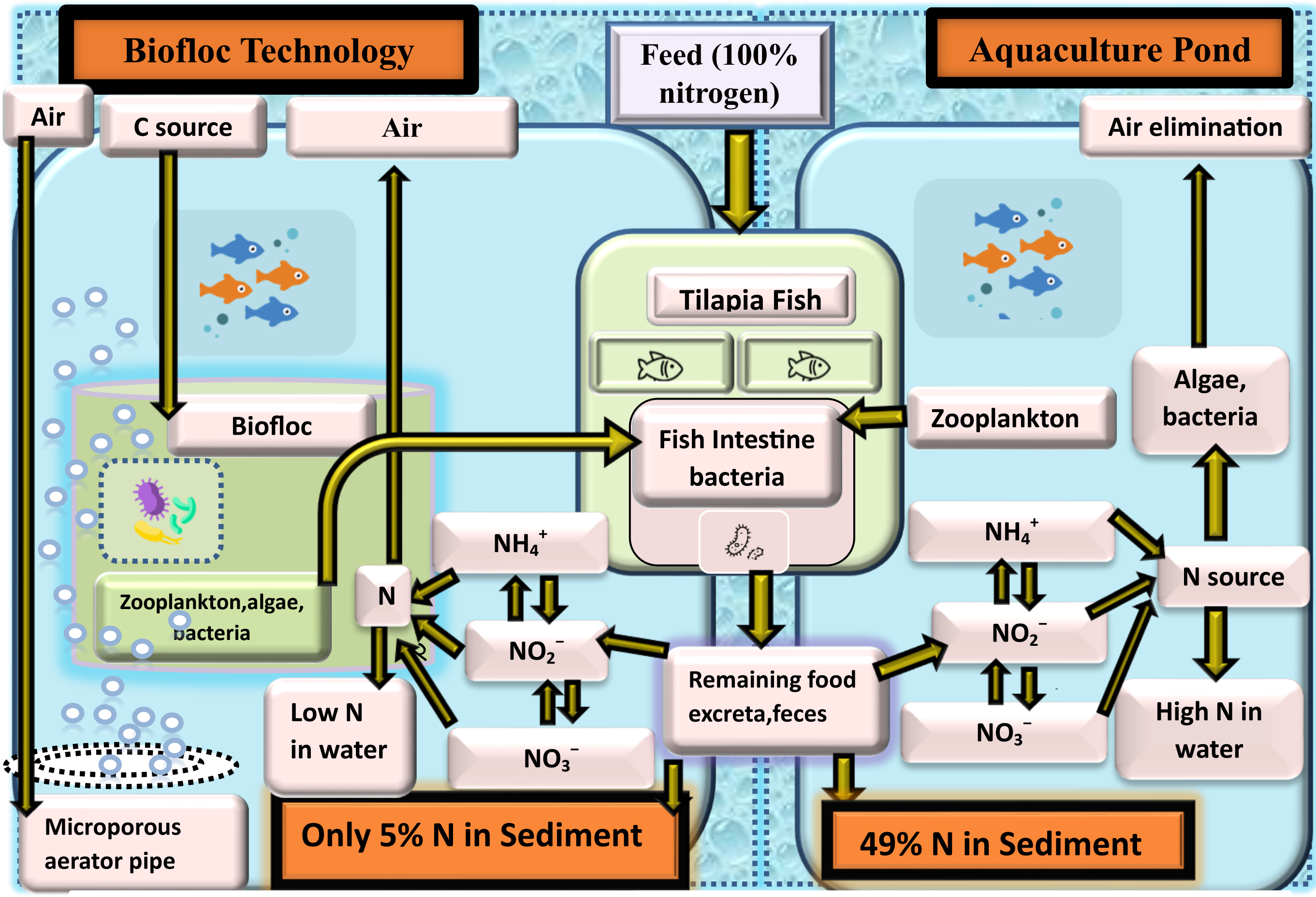

Fig 3. Role of microbial communities in biofloc technology (BFT) to improved water quality and fish yield in freshwater indoor and outdoor pond aquaculture

3.2.4. Benefits of Biofloc Technology (BFT) system

Its cultural system is environmentally friendly. It lessens environmental impact and increases the effectiveness of using land and water. It exchanges water very little or not at all. It improves feed conversion, survival rates, and growth performance in culture systems. increased biosecurity. It reduces pathogen introduction and dissemination danger as well as water contamination & efficient generation of feed. It reduced the expense of conventional feed and the utilization of protein-rich feed. By using less expensive food fish and trash fish in the preparation of fish feed, it lessens the demand on capture fisheries.

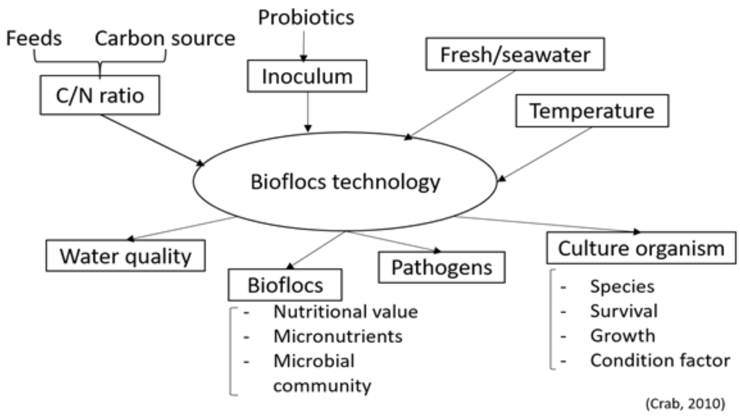

Fig 4. Overview of possible parameters of bioflocs technology and their probable effects. (Crab, 2010)

Table. 4. Some research on monosex tilapia fish was done with relation to (BFT)-based culture systems

SL. No.	Species studied	Results acquired in the study with (BFT)	Reference
1	*Oreochromis niloticus*	Fish survival was 100% and results in biofloc utilization as food	(Azim and Little, *et al.,* 2008)
2	*Oreochromis sps.*	Improvement in the water quality, fish survival and minimization in the external feed requirement	(Sharma *et al.,* 2015)

3.3. Applications and results

3.3.1. Physico-chemical parameter of water in (BFT) for fish population

Most of the uneaten feeds that are present in the water are thought to harm the pond's water quality and endanger the animals' susceptibility to disease. (Francis-Floyd *et al.,* 2009). It was shown in earlier research that implementing biofloc technology would resolve the issues relating to ammonia toxicity. As heterotrophic bacteria consume more nitrogen, the nitrification process advances, ensuring a decrease in the concentration of ammonium in culture systems. (Hargreaves, 2006). The study also showed that, when compared to nitrifying bacteria, the production rate for heterotrophic bacteria for the consumption of ammonium is ten times higher. (Hargreaves, 2006).

Nahar and Bakar *et al.* (2015) conducted a study in which the values of water quality measures, such as water temperature, dissolved oxygen, pH, and clarity, are displayed in different treatments. (Table. 5). In the CF, WB, BFT, and RWB treatments, the mean water temperatures were 23.33±1.04, 23.21±1.06, 23.10±1.03, and 23.15±1.03°C, respectively. (Table 5). The cold weather and brilliant sunshine may have contributed to the study's greatest (29.91°C) and lowest (17.86°C) water temperatures. Temperature has a direct impact on the amount of dissolved oxygen in the water. It also has an impact on the metabolism of cultured species, which impacts various elements of fish growth. The ideal water temperature for stable flocs in BFT setups may be between 20 and 25 °C, according to obtain stable flocs proposed by Craig and Helfrich. Tilapia (*O. niloticus*) could not grow and could not endure temperatures below 10°C for more than a few days. The daytime temperature in the ponds during the current investigation didn't drop below 17.86°C, and fish are likely to have continued to eat. In CF, WB, BFT, and RWB, respectively, dissolved oxygen (DO) ranged from 4.25 to 6.10 mg/l with mean values of 5.18 0.17, 5.05 0.16, 4.83 0.17, and 4.92 0.19 mg/l.

Table.5. Water quality parameter mean values (±SE) recorded over the course of the study

Water quality parameters	CF	WB	BFT	RWB
Temperature (°C)	23.33±1.04	23.21±1.06	23.10±1.03	23.15±1.03
Dissolved oxygen (mg/l)	5.18±0.17	5.05±0.16	4.83±0.17	4.92±0.19
pH	7.00±0.03	7.06±0.04	7.10±0.05	7.08±0.05
Transparency (cm)	34.24±0.25	29.86±0.01	26.06±0.39	31.06±0.30

Values are mean ± standard error, CF: commercial feed, WB: wheat bran, BFT: biofloc technology, RWB: rice and wheat bran

3.3.2. Growth efficiency in Biofloc based Monosex tilapia

According to Nahar and Bakar *et al.* (2015) ,The beginning weights of the fish were not significantly different (P>0.05), however by the conclusion of the rearing period, the mean weight gain of monosex GIFT tilapia was highest in the group receiving commercial tilapia diet and lowest in the group receiving periphyton. (Table 6). In WB, BFT, and RWB, respectively, the mean weight growth of tilapia did not differ significantly (P>0.05). The fastest growth of *O. niloticus* was seen when commercial diet supplements were used. Tilapia that were fed WB and BFT as a single ingredient gained 124.0 and 118.54 g of weight, respectively. Fish fed RWB, however, saw intermediate weight gains between WB and BFT. Similar outcomes were also reported by (Hossain *et al.,*2005) whose over-wintered mono-sex tilapia culture gained 140.602.84 g of weight while being fed a designed diet for six months.

Table. 6. Mono-sex tilapia (*O. niloticus*) growth rates over the research period

Parameters	CF	WB	BFT	RWB
Mean initial weight (g)	2.80 ± 0.03	2.80 ± 0.03	2.80 ± 0.03	2.80 ± 0.03
Mean final weight (g)	150.61 ±7.47	126.80 ±2.84	92.34 ±3.71	122.35 ±1.84
Mean weight gain (g)	147.81 ±7.47	124.00 ±2.84	118.54 ±3.71	119.54 ±1.84
SGR (% day)	3.32 ± 0.05	3.18 ± 0.02	3.14 ± 0.03	3.15 ± 0.02
FCR	1.84 ±0.04	2.07 ±0.04	0.00	2.09 ± 0.04
Survival (%)	83.33 ± 6.51	81.33 ±3.21	78.67 ±3.06	81.00 ±3.00
Production (Kg/decimal)	15.39 ± 0.42	12.60 ± 0.	9.67 ± 0.35	12.10 ± 0.22
Production (Kg/ha)	3802.88 ±139	3112.2 ±101	2388.5 ±117	2989.5 ±72

Values are mean ± standard error, CF: commercial feed, WB: wheat bran, BFT: biofloc technology, RWB: rice and wheat bran

Azim and Little *et al.* (2008) conducted a study to assess the growth efficiency parameters of tilapia. (Table.7). The survival rate of tilapia in both treatment and control tanks was 100%. The average weight of each fish at harvest was 9–10% greater in the BFT treatments than in the control. Individual weight gain and net fish output were 44–64% higher in the BFT treatments than in the control demonstrating that fish consume biofloc as food.

The majority of tilapias are known to consume food particles created in-situ, including suspended microorganisms. (Beveridge *et al.,* 1989; Beveridge and Baird, 2000). The biofloc uptake by Mozambique tilapia has also been verified by Avnimelech *et al.* (2007) using a technique called stable nitrogen isotope labeling. However, there was no discernible difference in fish growth or productivity in tanks that received 35% and 24% of their CP from the BFT. In comparison to the BFT treatments, the FCR value was noticeably greater in the control group. Despite the fact that there was ample proof that the biofloc had a major impact on fish growth and productivity. Little *et al*. (2008) examined the 10-28 kg fish m^{-3} final biomass levels attained year-round in indoor and outdoor BFT systems.

Table.7. Monosex growth performance Nile tilapia in tanks with activated suspension and tanks with clean water are fed varying amounts of protein feed

Parameters	35% CP without biofloc	35% CP with biofloc	24% CP with biofloc
Initial individual weight (g)	99.61±13.74	100.69±13.61	98.45±12.71
Final individual weight (g)	127.51±28.17	140.72±27.26	138.58±24.99
Survival (%)	100	100	100
Individual weight gain (g)	27.9±0.69	40.04±3.04	40.08±4.34
Net yield (kg m^{-3})	3.35±0.08	4.80±0.60	4.90±0.59
FCR	4.97±0.12	3.51±0.44	3.44±0.45

FCR: Feed conversion Ratio

Amany *et al.* (2019) conducted a study to compare the growth performance of fish under BFT treatments and BFT with 10% WE. When compared to fish in the control group, fish in BFT treatments and BFT with 10% WE showed considerably better growth performance (P >0.05). (final body weight, weight gain, average daily gain and specific growth rate). In comparison to the control group, the ultimate weight increased by 28.70 and 22.20%, respectively, using BFT or BFT with 10% WE. The survival rate was high (98–99%) across all experiments, and rearing fish using BFT technology with no WE or minimal WE (10%) had no detrimental effects on the survival rate. (Table.8). Additionally, the current findings supported that When compared to the control, intensive tilapia production in BFT systems considerably increases feed and nutrient use significantly(P > 0.05).

Table.8. Growth performance and the effects of BFT and BFT with 10% WE

Item	Control	BFT	BFT + 10% WE
Initial weight (g/fish)	3.38±0.02	3.44±0.02	3.37±0.03
Feed intake (g/fish)	20.16^{b}±0.15	22.67^{a}±0.23	22.19^{a}±0.24
Weight gain (g/fish)	8.78^{b}±0.26	12.22^{a}±0.38	11.49^{a}±0.27

Final weight (g/fish)	12.16^{b}±0.25	15.65^{a}±0.36	14.86^{a}±0.28
ADG (g/fish/day)	0.07^{b}±0.0	0.10^{a}±0.0	0.10^{a}±0.0
SGR (%/day)	1.07^{b}±0.02	1.26^{a}±0.02	1.24^{a}±0.01
Survival rate (%)	98±0.82	99±0.67	98±1.11

*Means with various letters in the same raw differ significantly from one another. (P>0.05). WE: Water exchange; ADG: Average daily gain; SGR: Specific growth rate; BFT: Biofloc technology

The addition of a carbon source caused a progressive rise in floc volume over time. The BFT tanks in this investigation had appropriate BFTs that were created and kept there, and the total suspended solid levels were kept below reasonable bounds.

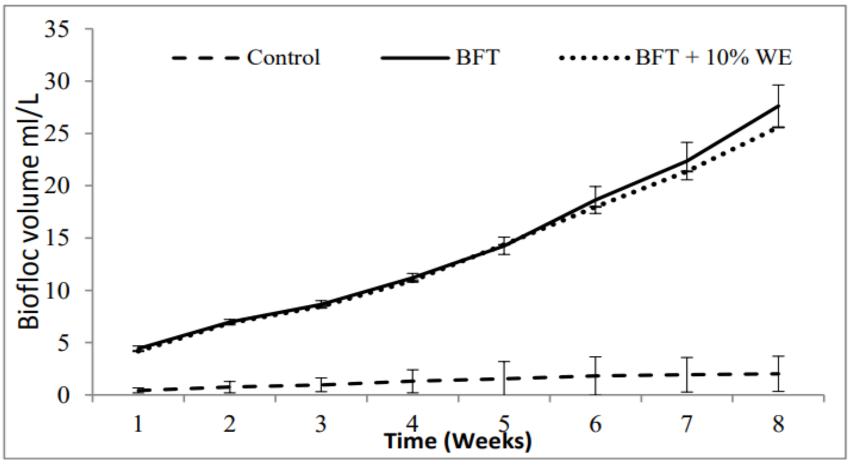

Fig. 5. Effect of BFT and BFT with 10% WE on BFT volume of monosex Nile tilapia, *O. niloticus*, fingerlings rearing tanks. BFT: Biofloc technology; WE: Water exchange.

According to Rinaldi *et al.*,(2021), generation of monosex red tilapia (masculinization) with stocking density of 250 individuals/m^3 and hormone immersion in tilapia larvae 10 days after hatching. This study's treatments include K1: a density of 50 fish/ m^3 without biofloc, K2: a density of 100 fish/ m^3 without biofloc, P1: a density of 50 fish/ m^3 with a BFT C/N ratio of 15, and P2: a density of 100 fish/ m^3 with a BFT C/N ratio 15. Molasses with a 15:1 C/N ratio was introduced each week to the BFT treatments as an external organic C source.

Red tilapia generally, both in P1 and P2, have a greater specific growth rate than the control. (Fig. 6). The P2 treatment's specific growth rate value (2.16%) is higher than the P1 treatment's. (1.33%), where 1.26% and 1.01% for the control in P1 and P2, respectively. However, at a stocking density of 50 fish/ m^3 (P1), the specific growth rate of the biofloc treatment was not significantly different from the control (K1) (p> 0.05), however a stocking density of 100 fish/ m^3 (P2) was significantly different from the control (K2) (p <0.05).

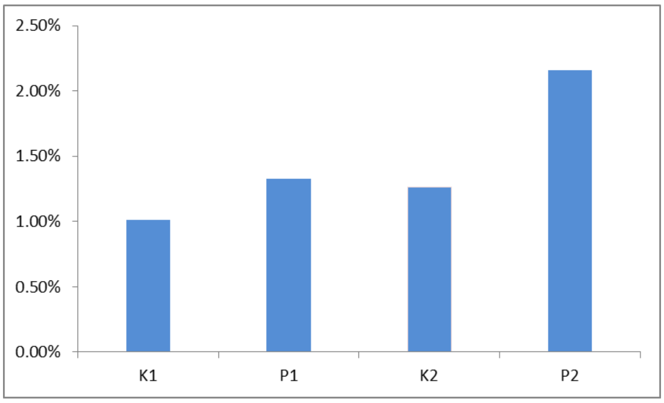

Fig. 6. Specific growth rate(%) of red monosex tilapia

The survival rate in the biofloc treatment is higher than the control at stocking densities of 50 and 100 fish / m^3. Biofloc treatment had the highest survival rate at 99%. (Fig. 7). However, at a stocking density of 50 fish / m^3 (P1), the viability of the biofloc treatment was not significantly different from the control (K1) (p> 0.05), however a stocking density of 100 fish / m^3 (P2) was significantly different from the control (K2) (p <0.05).

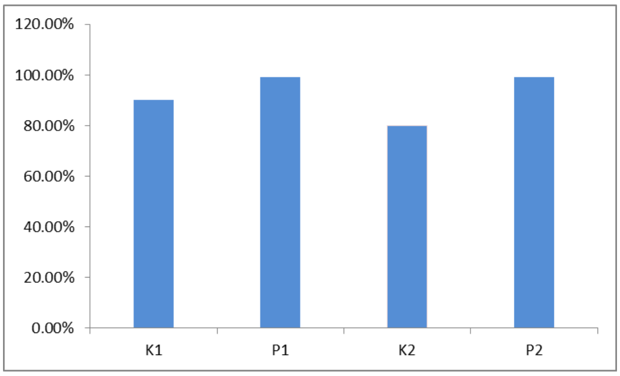

Fig. 7. Survival rate(%) of red monosex tilapia

Based on the findings, it was determined that the biofloc treatment's FCR value at both stocking densities was lower than that of each control. The biofloc treatment with a stocking density of 100 fish / m^3 had the lowest FCR value, which was 1.48. (Fig. 8). The FCR of the biofloc treatment, however, was not significantly different from the control (K1) at a stocking density of 50 fish / m^3 (P1), However, the stocking density of 100 fish / m^3 (P2) was significantly different from the control (K2) (p <0.05).

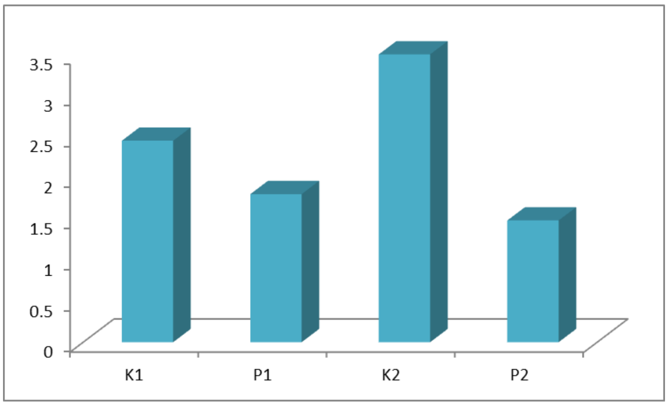

Fig. 8. Feed Convertion ratio (FCR) of red monosex tilapia

Compared to the control, feed efficiency with the biofloc treatment was higher for both stocking densities. The highest feeding efficiency value, 67%, is often achieved with a biofloc treatment on a stocking density of 100 fish / m^3. (Fig. 9). While feed efficiency with the biofloc treatment at the 50 fish / m^3 (P1) stocking density was not significantly different from control (K1) ($p > 0.05$), it was significantly different at the 100 fish / m^3 (P2) stocking density from control (K2) ($p < 0.05$).

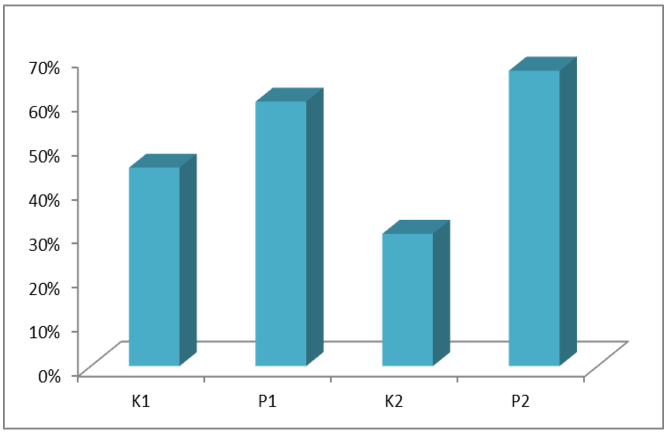

Fig. 9. Feed efficiency(%) of red monosex tilapia

3.4. Economic Analysis of Monosex Tilapia Fish Production in Biofloc

To calculate the net profit from this cultural enterprise, a straightforward economic analysis was done. (Table 9). In CF, WB, BFT, and RWB, respectively, the net profit from the six-month culture period was calculated to be Tk. 48,519.0, 94,749.2, 99,453.3, and 71,230.7/acre. The BFT receiving periphyton achieved the maximum net profit of Tk. 99,453.3/acre/6 months, while the CF getting commercial tilapia feed experienced the lowest net profit of Tk. 48,519.0/acre/6 months (Fig. 10 and Table 9). (Nahar *et.al.,* 2015).

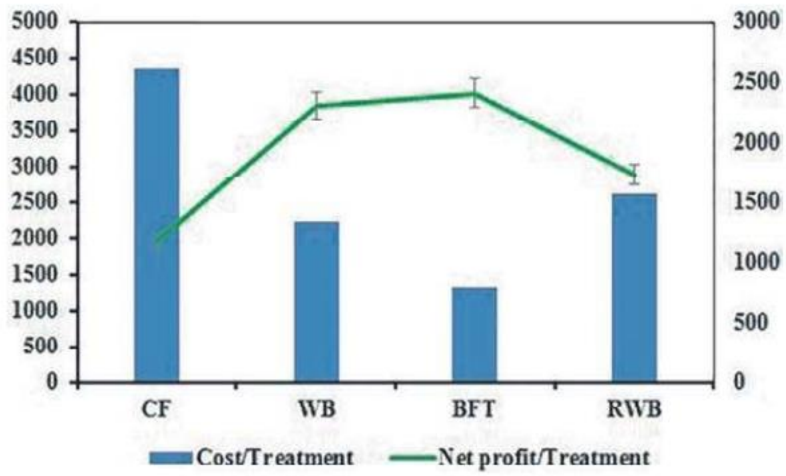

Fig.10. The cost-benefit analysis of mono-sex tilapia farming in Bangladesh from March 2014 to August 2014, a period of six months. (Nahar *et.al.,* 2015)

Table.9. Analysis of the economics of a 6-month experiment with mono-sex tilapia culture overwintering in ponds

Investment (Tk.)	**CF**	**WB**	**BFT**	**RWB**
Pond preparation	67.500	67.500	67.500	67.500
Cost of fingerlings	750.00	750.00	750.00	750.00
Feed cost	3240.0	1261.0	00	1625.0
Operational cost	304.30	155.88	500.00	183.18
Total cost	4361.8	1317.5	1317.5	2625.70
Production (Kg/ treatment)	92.340	75.600	62.200	72.600
Gross income from sale	5540.40	4536.00	3732.0	4356.0
Net profit/treatment/6months	1178.60	2301.60	2414.5	1730.30
Net profit/ha/6months	48,519.0	94,749.2	99,453.3	71,230.7

Chapter IV

CONCLUSIONS

Enhancing monosex tilapia production with biofloc technology has advantages that will help us accomplish our sustainable development objectives. With the help of this technology, exploration of production capacity might increase while causing less damage to the environment. The system needs to be optimized in terms of operating characteristics, such as in terms of nutrient recycling, production, and immunological impacts.

After reviewing numerous papers, it was discovered that while getting commercial tilapia feed resulted in the highest overall production, BFT received the highest net profit because of the periphyton it received. There were some profits identified in Wheat Bran and Rice & Wheat Bran as well, but they were lower than those in BFT, thus farmers may not have benefited more economically from WB and RWB. Consequently, the findings indicated that it is feasible to successfully monosex culture. For the culture of mono-sex tilapia in the Bangladeshi farming system, GIFT tilapia with BFT and mono-sex tilapia culture with periphyton are more cost-effective and advantageous than wheat bran and even commercial tilapia feed.

Using male monosex juveniles to treat the biofloc systems in red tilapia can increase the fish's specific growth rate, feed efficiency, survival rate, and lower FCR value.

So concluded form the review that biofloc technology has a lot to offer in terms of enhancing biosecurity, reducing pathogenic contact, reducing feed use, increasing growth and survival, and ultimately increasing system output. Farmers must receive hands-on instruction regarding the biofloc technology's success stories and financial advantages.

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