Effectivity of Innovative Biofloc Technology : Mono-sex Tilapia Production in TVET Facilities


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Declaration

We declare that the work is carried out by the research team .Whole or any part of the work has not been submitted before as a research proposal. The content of the paper is the result of work which has been carried out since the approval of this research program. All the ethics procedures and guidelines have been followed properly while preparing the research.

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Abstract

The experiment was conducted to assess the effectiveness of biofloc technology for farming of mono-sex genetically improved farmed tilapia (*Oreochromis niloticus*) for 180 days in two-cemented tanks having water holding capacity in each tank approximately 10 tones inside the Lakshmipur government technical school and college campus. It was the preliminary and first time experimental research in the tvet institute by using local facilities of the institute. The fishes were stocked at the rate of 50 and 100 individual's m^{-3} with a mean initial weight of 2.5gm of each fish in the T_1 and T_2 treatment respectively. The fishes were given oil coated nourish nursery-2 (1.0 mm size) and pre-starter (1.5 mm size) feed twice daily at the rate of 10% body weight and the feeding rate was reduced gradually to 2% up to the end of the experiment. After 180 days of rearing, biomass increase of the fishes 0.88gm day^{-1} and 0.64gm day^{-1} in T_1 and T_2 treatment respectively. However, food conversion ratio (FCR) was 1.17±0.11 and 1.25±0.09 in T_1 and T_2 treatment respectively. The study showed that per day biomass, increase of fishes in T_1 was statistically higher ($P < 0.05$) and FCR values were more or less similar ($P > 0.05$) among the treatments. The experiment indicated that higher density of mono-sex GIFT tilapia in T_2 treatments performs the better in terms of biomass production of fishes with minimum FCR in biofloc system .The benefit cost ratio (BCR) of T_1 and T_2 treatment, were 1.72 and 1.73 respectively .The results of the present study suggested that the specific growth rate (SGR % per day) of fish in low density, T_1 treatment (50 individual's m^{-3})was higher than high density,T_2 treatment (100 individuals m^{-3}).But total biomass and net profit was observed in higher than low density .

Keywords: Effectiveness, innovative, mono-sex tilapia, stocking density, growth, biofloc.

Executive Summery

Aquaculture sector needs more studies to explore information for sustainable development and implication in commercial venture. To sustain the tilapia production in biofloc system, we need appropriate technology and its proper utilization. Biofloc is a protein rich macro aggregate. Shortly culture of beneficial bacteria is called biofloc technology. Biofloc technology is gaining considerable attention and rapidly growing aquaculture technology for freshwater, brackish water and marine water aquaculture. There was no practice of production orientated activities at technical & vocational education & training institutes. It was the first time and preliminary research work at technical school and college in Bangladesh. These culture systems create opportunity for our enrolled students to acquire practical skills and knowledge, enhance self-confidence and promote entrepreneurship. Therefore, the study was conducted to determine the growth performance, suitable stocking density and measure the profitability of mono-sex tilapia culture in biofloc system by using existing facilities of tvet institute. The experiment was conducted to assess the effectiveness of biofloc technology for farming of mono-sex genetically improved farmed tilapia (*Oreochromis niloticus*) for 180 days in two-cemented tanks having water holding capacity in each tank approximately 10 tones inside the Lakshmipur government technical school and college campus. The fishes were stocked at the rate of 50 and 100 individual's m^{-3} with a mean initial weight of 2.5gm of each fish in the T_1 and T_2 treatment respectively. For budget constraint there was no replication. It was the first time preliminary research work in tsc , so we have to face some challenge and limitations. The fishes were given oil coated nourish nursery-2 (1.0 mm size) and pre-starter (1.5 mm size) feed twice daily at the rate of 10% body weight and the feeding rate was reduced gradually to 2% up to the end of the experiment. After 180 days of rearing, biomass increase of the fishes 0.88gm day^{-1} and 0.64gm day^{-1} in T_1 and T_2 treatment respectively. However, food conversion ratio (FCR) were 1.17±0.11 and 1.25±0.09 in T_1 and T_2 treatment respectively. The mean least FCR value 1.17 was found in T_1 treatment where the fish density was 50 individual's m^{-3}. The highest mean FCR value 1.25 was found in T_2 treatments where the fish density was 100 individuals m^{-3}. These findings were in agreement with Hossain *et al.* (2005) who found FCR of 1.58 ± 0.04 and 1.64 ±0.02 for male mono-sex and mixed sex *O. niloticus*, respectively. The study showed that per day biomass, increase of fishes in T_1 was statistically higher ($P < 0.05$) and FCR values were more or less similar ($P > 0.05$) among the treatments. The experiment indicated that higher density of mono-sex GIFT tilapia in T_2 treatments performs the better in terms of biomass production of fishes with minimum FCR in biofloc system .The benefit cost ratio (BCR) of T_1 and T_2 treatment, were 1.72 and 1.73 respectively .The results of the present study suggested that the specific growth rate (SGR % per day) of fish in low density, T_1 treatment was higher than high density,T_2 treatment. But total biomass and net profit was observed in higher than low density. Our enrolled TVET students, young generations,

teachers and community people who are energetic are the respondent of the study. They can easily demonstrate production related activities by using existing lab facilities and logistic support which can help self-employment.

List of abbreviations

TVET	Technical & Vocational Education & Training
SGR	Specific Growth Rate
FCR	Food Conversion Ratio
BCR	Benefit Cost Ratio
ANOVA	Analysis of Variance
DMRT	Duncan’s Multiple Range Test
SPSS	Statistical Package for Social Science
DO	Dissolved Oxygen
TAN	Total Ammonia Nitrogen
TSS	Total Suspended Solids
FV	Floc Volume
GIFT	Genetically Improved Farm Tilapia
BFT	Biofloc Technology
SAU	Sylhet Agricultural University
FCO	Fermented Carbon Organic
C/N	Carbon/Nitrogen

Chapter 1

Introduction of the study

The rapid growth of aquaculture and projection of continued expansion necessary to meet future protein demands depends upon increasing productivity without overburdening land and water resources. To do this, the industry will need to apply sustainable technologies which minimize environmental effects and develop cost effective production systems. Biofloc technologies can provide a major contribution towards meeting these goals while producing high quality, safe, attractive and socially acceptable products. Biofloc is a protein rich macro aggregate of organic and micro-organism including diatoms, bacteria, protozoa, algae, fecal pellets, remaining lead organism and other invertebrates. The main aspect of biofloc is to produce protein feed from the fishes' waste. Biofloc technologies facilitate intensive culture while reducing investment and maintenance costs and incorporating the potential to recycle feed. Using artificial aeration to meet oxygen demand and suspend organic particles, development of a heterotrophic microbial community was encouraged in the pond. This diverse microbial community functions to mineralize wastes improve protein utilization and reduce opportunities for dominance of pathogenic strains. This technology can increase higher production than that of the existing culture practice. In the country like Bangladesh, where land and water are very scarce, biofloc technology can open a new window in aquaculture.

Fisheries and aquaculture provides food, nutrition, income and subsistence for hundreds millions people around the world and recognized imperative safe protein sources also known as brain food; and contains all essential amino acids and easy to digest. Biofloc technology is an environment friendly modern zero to minimal water exchange aquaculture system and stimulate to proliferate heterotrophic organisms and require organic carbon source supplementation to maintain carbon nitrogen ratio which remove hazardous nitrogenous compound, provides on station live feed; improve productivity and enhance performance in terms of growth, survival, feed utilization ratio, food conversion ratio and resistance to pathogens as well as ensure beneficial nutritional compounds (Avnimelech, 1999; Azim and Little, 2008; Pérez-Fuentes *et al.*, 2016; Liu *et al.*, 2018).The biofloc system used Imhoff cone to measured floc volume and expressed as mlL^{-1} for biofloc farm management (Avnimelech 2009; Taw 2010; Hargreaves 2013; Poh *et al*. 2014; Samocha *et al*. 2019). The aforementioned scientific studies discussed in detail the successful application of biofloc technology in aquaculture sectors for tilapia fish fry, fingerling production; and grow-out production as well as brood stock rearing while biofloc culture system improves productivity, animal performance, healthcare and bio-security.

Furthermore, tilapia aquaculture sector needs more studies to explore information for sustainable development and implication in commercial venture. To sustain the tilapia production in biofloc system, we need appropriate technology and its proper utilization. There is no work at TVET institutes in their existing biofloc culture system facilities in Bangladesh to acquire practical knowledge for their production oriented practical classes for the students. Our enrolled TVET students, young generations, who are energetic are the respondent of the study. They can engage production related activities by using existing lab facilities and logistic support, which can help self-employment. Therefore, the study was conducted to determine the effect of different densities on biomass of fishes and growth of tilapia, water quality condition and microorganisms in solids removal biofloc system of growing phase of mono-sex tilapia in the existing TVET facilities for the students in Bangladesh in the following objectives.

1.1 Objectives of the study

i. To determine the growth performance of mono-sex tilapia in biofloc system.

ii. To assess the suitable stocking density in biofloc system.

iii. To measure the profitability of tilapia culture in biofloc system.

1.2 Statement of the problem

Bangladesh is an agro-based country in the world. To sustain our agricultural productivity we need appropriate technology and its proper utilization. To meet up our protein demand and create new dimension in employability of TVET graduate, Directorate of Technical Education included fish culture and breeding trade in SSC & HSC (voc) courses in o6 technical school and college. Here students exercise many production oriented practical classes. There is no scope in our TVET institute to acquire practical knowledge, enhance self-confidence & gainful activities in real life for enrolling student. At present most of practical classes are perform traditionally there is scope in institute work hands on individually. Therefore our tvet students are not focus on the skills in real field.

It is a preliminary experimental study to check it is possible to start up a new practice in tvet institute for production based practical oriented activities by using local facility. This technology is low investment and quick return procedure.

Biofloc technology is using in our country some progressive entrepreneur as their own will. But there is no definite research is this technology in Bangladesh about stocking density, biomass and FCR value of feed using in experiment.

For better economic return in fish production in biofloc technology a certain period stocking density of fish and FCR value of feed is prime factor. To observe growth performance and FCR value of fish feed of tilapia fingerlings we take this experiment in primarily.

1.3 Importance and Rational of the study

1. Maximum fish production and reducing production cost.

2. Reducing pressure in existing water aeries for other fish species culture.

3. High stocking density with minimum FCR.

5. Putting minimum residual waste to the natural environment.

6. Utilization of harmful water microorganisms into rich foods for fish.

7. It reduces the food consumption of fish to one fourth of the food needed.

1.4 Audiences/Respondent of the study

Our enrolling students,young generations, teachers, community peoples are the audiences/respondent of the study.

1.5 Scope and Limitation

Scope

1. TVET student learning, how biofloc technology works in fish culture system
2. The output/findings from this small experience will bear sum implications for further large scale expansion of the technology
3. It will give birth/ridge of sum entrepreneurship in the advanced aeries.

Limitation

1. Initial high investment cost
2. Seasonal oscillation (tem. rain fall etc.)
3. Presence of iron in water may harmful the productivity
4. Lack of technical manpower/technician and logistic support to introduce this technology.

1.6 Outline of the Report

The outline of the research report is organized as follows:

Chapter 1: Introduction. This chapter discusses the basic introduction of the study. Also, the purpose of the study providing insight and understanding of the mono-sex tilapia culture in biofloc system in Bangladesh from the perspective of the world trend. It begins with a detailed discussion about different species in different biofloc culture system. In the meantime, it also comprises the rationality of the study behind this work.

Chapter 2: Literature review. This chapter discusses the purpose of providing insight and understanding on the mono-sex tilapia culture in biofloc system in Bangladesh from the perspective of world trend. It begins with a detailed discussion about different literature reviews and techniques that are currently integrated into different sectors.

Chapter 3: Methodology of the study. This chapter presents which type material used in it and methodology in details. How to mono-sex tilapia culture in biofloc system, sampling ,feeding procedure and growth rate measurement.

Chapter 4: Results and Discussion. This chapter comprises the results obtained from the various instrumental analyses. Though this approach can fulfill a part of demands.

Chapter 5: Major Findings, Challenge and limitation. This chapter describes the major achievements and also provides objectives of the study that have been asked throughout the process.

Chapter 6: Conclusion and Recommendations. This chapter concludes the whole process study and shows the recommendations for practice and future scopes.

Chapter 2
Literature Review

Biofloc technology is gaining considerable attention and rapidly growing aquaculture technology for freshwater, brackish water and marine water aquaculture industries owing to its tremendous ability to maintain water quality improve growth and survival and provide food and robustness to culture animal. In early 70's the biofloc technology (BFT) was developed for the maturation of penaied shrimp such as black tiger prawn *Penaeus monodon*, , white leg shrimp *Litopenaeus vannamei* and western blue shrimp *L. stylirostris* reported (Aqua cop, 1975; Sohier, 1986).Presently the biofloc technology are well developed and many historical aquaculture system have already achieved *i.e.* potential application of biofloc technology for tilapia and shrimp , the application of biofloc systems are found in freshwater, brackish water and marine water for hatchery phase, nursery operation, grow-out production and bloodstock rearing.

2.1 Biofloc system in aquaculture

There are many studies have already initiated and it is perceived that the freshwater biofloc system having huge prospects in aquaculture industries. Now a days, tilapia aquaculture is being considered paramount important for cheap animal production system; also well known as aquatic chicken and supporting mass population in globally for protein source. Presently three species of tilapia viz. *Oreochromis niloticus*, *O. mossambicus* and *O. andersonii* were tested in biofloc system and found most promising candidate in biofloc system while higher performance was achieved for *O. niloticus*(Day *et al.*, 2016) and it also raised with hybrid African cat fish *Clarias gariepinus x Clarias macrocephalus*(Wankanapol and Chaibu, 2017). The tilapia species can be culture in different CN ratio of 10-20 (Nootong *et al.*, 2011; Long *et al.*, 2015; Pérez-Fuentes *et al.*, 2016; Wankanapol and Chaibu, 2017) with various carbon sources and they ensured higher growth, survival and diseases resistance to pathogen. The poly-culture of *C. carpio*, *H. molitrix* and *A. nobilis* are gained attention owing to their promising performance (Zhao *et al.*, 2014) in freshwater biofloc system and in future it can be applied to test poly culture with others species.*Clarias gariepinus* is also be good candidate for freshwater biofloc system for monoculture (Bakar *et al.*, 2015; Dauda *et al.*, 2018; Fauji *et al.*, 2018) and poly culture with tilapia (Wankanapol and Chaibu, 2017). According to Fauji *et al.* (2018) stocking density 6-8 individuals L^{-1} provides good growth and survival; Dauda *et al.* (2017 & 2018) assessed rice bran carbon source is not suitable and instead that glycerol provide better performance while C-N ratio of 15 was showing sustainability in terms productivity and diseases resistance to pathogen. *Carassius auratus* Gibelio was also performed well in biofloc system. In addition,Zhang *et al.* (2018) found high level of TSS (1000 ml L^{-1}) provide the higher weight gain, specific growth and survival; lower protein feed also improve growth and FCR (Li *et al.*, 2018).

Labeo victorianus also cultured in freshwater biofloc system and Magondu *et al.* (2013) confirmed higher growth, survival and production with supplement of corn starch at the ratio of 20. *Labeo rohita* is one of the most aquaculture species in many Asian countries and supporting improvise farmers for income generation and nutrition; Sharma *et al.* (2015) and Ahmad *et al.* (2016) culture it in biofloc system and having prospects in biofloc based aquaculture. From their research it can be assumed that others species of Indian major carps can be tested for future development of biofloc based Indian major carp culture.Biofloc provide higher growth for *Procambarus clarkia* while survival was not improve and remained scope of future research (Li e*t al.*, 2019).Biofloc system did not improve *Mugil cephalus* and *Tinca tinca* performance (Vinatea *et al.*, 2018). Two hybrid species of fishes i.e. *Moronechrysops* × *M. saxatilis*and ,*Clarias gariepinus x Clarias macrocephalus* draw some potentiality in bifloc based aquaculture farming sector (Wankanapol and Chaibu, 2017; Green *et al.*, 2018). *M. rosenbergii* is the sole freshwater prawn farming species and proven very good candidate for freshwater biofloc based aquaculture farming. In addition, Pond based biofloc system greatly improved prawn growth, survival and proximate with addition of molasses at the rate of CN ratio 20 (Pérez-Fuentes *et al.*, 2013). From above reviewed, it is obvious that in freshwater biofloc arena still having scope to explore more knowledge and information and required more studies.

2.2 Physico-chemical features of water in biofloc technology

The review based mean value of water quality conditions of four key species *i.e.* white leg shrimp, tilapia, African catfish and freshwater giant prawn cultured in biofloc system and their effects discussed below-

2.2.1 Temperature

The water temperature is an important factor affecting water quality conditions for aquaculture and responsible for growth, survival of culture animals including aquatic microorganisms proliferations and which is not exception for biofloc based aquaculture system. The mean temperature ranged from 23.8 to 29.7 ºC for white leg shrimp, from 21.95 to 30.34 ºC for *M. rosenbergii*, from 22.5 to 29 ºC for tilapia and from 25 to 29.62 ºC for African catfish were reported for biofloc system. Recently, several studies assessed the role of temperature in biofloc system. In addition, stable floc found between 20 ºC to 25 ºC while increased of temperature biofloc lose floatability and deposited as sludge in the bottom (Sharma *et al.*, 2017). According to Wilén *et al.* (2000) high deflocculating of flocks in activated sludge system showed at 4°C than (18-20°C) owing to decreased of microbial activity in cool water. Krishna and Van Loosdrecht (1999) stated that higher level of temperature between 30 and 35°C produced huge flocks (SVI≥ 500 mL g^{-1}) in activated sludge system. Yao *et al.* (2013) found the total ammonia-nitrogen (10 mg L^{-1}) removal occurred within 6 h for 15, 20 and 30°C while the 25ºC group required only 3 h for sequencing batch reactors using biofloc technology to treat aquaculture sludge. Hostins *et al.* (2015) tested different temperature of 21, 24, 27, 30 and

33ºC for *Farfantepenaeus brasiliensis* super-intensive nursery phase in biofloc system and found that increasing of temperature increased the growth of 0.10, 0.18, 0.27, 0.34 and 0.49 g for 21, 24, 27, 30 and 33ºC temperatures respectively while lower survival of 65% and 26% for 30 and 33ºC based biofloc system. During 15 days compensatory growth study in 30ºC showed lower growth for 21ºC reared pink shrimp. Therefore, they suggested approximately 27ºC for super intensive nursery phase and nursery rearing could be carried out in lower temperature to ensure the higher survival and compensatory growth achieved when the temperature. de Souza *et al.* (2016) assessed the antioxidant enzyme activities and immunological system analysis of *Litopenaeus vannamei* in different temperatures of 15, 21, 27 and 33°C based biofloc system and found that 15 and 33°C reared shrimp showed higher antioxidant enzyme activity while immunological parameters found no differences among temperatures.

2.2.2 pH and alkalinity

pH and alkalinity are most important factor affecting water quality parameters in biofloc system. In biofloc system, as attribute we stimulate to grow floc by maintaining of CN ratios with addition of carbon sources, which aggregates heterotrophic, chemosynthetic and autotrophic bacteria, and consuming alkaline substances and leading to reduction of alkalinity and pH. Ebeling *et al.*, (2006) reported that each gram ammonium-N converted into 8.07g of microbial biomass with 9.65g of carbon dioxide as the by-product by heterotrophic bacteria required 15.17g of carbohydrate, 4.71g of dissolved oxygen and 3.57g of alkalinity. Furtado *et al.* (2011) observed that pH and alkalinity decreased during the study period without correction of pH and alkalinity in biofloc system. They also found lime and sodium bicarbonate addition in biofloc systems provides good water quality conditions include stable pH and alkalinity as well as higher growth, survival, productivity and minimum FCR were obtained for *L. vannamei*. The addition of sodium bicarbonate, calcium hydroxide and calcium carbonate were found effective correction of pH and alkalinity in biofloc system while sodium bicarbonate treatment showed higher growth of tilapia. According to Zhang *et al.* (2017) without addition of sodium bicarbonate to maintain the pH and alkalinity in biofloc system found significant decreased of pH and alkalinity which also led to lower growth, survival and higher FCR than the addition of sodium bicarbonate treatments for *L. vannamei*. Therefore, pH and alkalinity maintain in bioflocs system are utmost required. Based on present reviews, the mean pH values found from 6.86 to 8.26, 7.95 to 8.92, 8.28 to 8.08 and 5.0 to 8.0 for white leg shrimp, giant freshwater prawn, tilapia and African catfish respectively in biofloc system

2.2.3 Dissolve oxygen

Biofloc system requires sufficient aeration and mixing to support more energy used by floc microorganisms. The mean dissolved oxygen ranged of 4.9 to 7.6, 5.21 to 8.05, 3.19 to 7.39 and 3.64 to 8.0 mgL^{-1} for white leg shrimp, giant freshwater prawn, tilapia and African catfish respectively. Biofloc system reduced oxygen than control and reduction of oxygen level with increasing of CN ratios are well documented (Emerenciano *et al.*, 2012; Pérez-Fuentes *et al.*, 2013; Rajkumar *et al.*, 2016; Dauda *et al.*, 2017, 2018; Liu *et al.*, 2018; Panigrahi *et al.*, 2018; Panigrahi *et al.*, 2019).

2.2.4 Nitrogenous compound

The three nitrogenous compounds are of ammonia-N, nitrite-N and nitrate-N are existed in aquatic system. The ammonia-N constitute of ionized ammonia–nitrogen (NH_4^+–N) and un-ionized ammonia–nitrogen (NH_3–N) of both. In aquaculture system ammonia is an end product from protein content of feed or it can be produced from uneaten feed or dead organisms which breakdown by heterotrophic organisms. Culture animal intake the feed and protein catabolism occurred and finally ammonia excreted as un-ionized ammonia across the gills. Therefore, the biofloc system applied additional carbon sources with C-N ratios of 10 to maintain heterotrophic growth (Crab *et al.*, 2012; De Schryver *et al.*, 2008). In biofloc system, removal occurred through ammonia oxidizing bacteria and they intake their energy by catabolizing un-ionized ammonia to nitrite while nitrite-oxidizing bacteria (NOB) oxidize nitrite to nitrate. These nitrification performed by chemosynthetic autotrophic and heterotrophic bacteria while they intake energy from inorganic and organic compound (Ebeling *et al.*, 2006). In biofloc system, removal of nitrogenous compound such as ammonia-N, nitrite-N and nitrate-N are well and end nitrite-N documented. The present reviewed found that the mean ammonia-N ranged from 0.06 to 3.42, 0.08 to 2.77, 0.01 to 3.8 and 0.29 to 7.61 mgL^{-1} for white leg shrimp, giant freshwater prawn, tilapia and African catfish respectively. The mean nitrite-N varied from 0.02 to 10.28, 0.019 to 0.38, 0.01-3.51 and 0.03 to 0.47 mgL^{-1} while the mean nitrate-N ranged from 0.38 to 96.1, 3.22, 0.14 to 321.0 and 5.49 to 38.8 mgL^{-1} for white leg shrimp, giant freshwater prawn, tilapia and African catfish reared in biofloc system respectively.

2.2.5 Biofloc volume

Biofloc volume is the core in biofloc aquaculture system. Based on the present review the mean floc volume fluctuated of 5.7 to121.72 ml L^{-1} and 33.3 to 103.0 ml L^{-1} for white leg shrimp and tilapia respectively. Optimum level of biofloc volume provides better growth, survival, and productivity. In addition, Peixoto *et al.* (2017) stated the minimum floc volume (2.0 ml L^{-1}) and maximum (27.0 ml L^{-1}) for *Litopenaeus vannamei* nursery phase and these volumes found suitable for growth and survival. According to Emerenciano *et al.* (2013) floc volume 17 ml L^{-1} lead mortality at the end of study by gill clogging of *Farfantepenaeus duorarum*. Emerenciano *et al.* (2017) commented that higher biofloc volume reduced oxygen level owing to heterotrophic microorganisms' growth and it also clogging the gills therefore they suggested floc volume 5–15 ml L^{-1} for shrimp and 5–20 ml L^{-1} for tilapia fingerlings respectively. Hargreaves (2013) recommended 10 to 15 ml L^{-1} floc volume while Samocha *et al.* (2007)< 10 ml L^{-1} and Taw (2010) 15 ml L^{-1} for shrimp in particularly *Litopenaeus vanammei* culture in biofloc system.

Chapter 3
Methodology of the study

3.1 Study area and duration

This experiment was conducted in the two tanks of fish culture and breeding department at Lakshmipur technical school and college, Bangladesh during December 2019 to July 2020.The following materials were used during the experiment.

Circular tank	P^H meter
Overhead tank	Dissolve oxygen(DO) meter
Gate valve	Refractometer
Aerator and air stone	TDS meter
Hapa	Ammonia testing kit
Scope net	Electronic weighing scale
Bucket	Thermometer
Mug	Imhoff cone

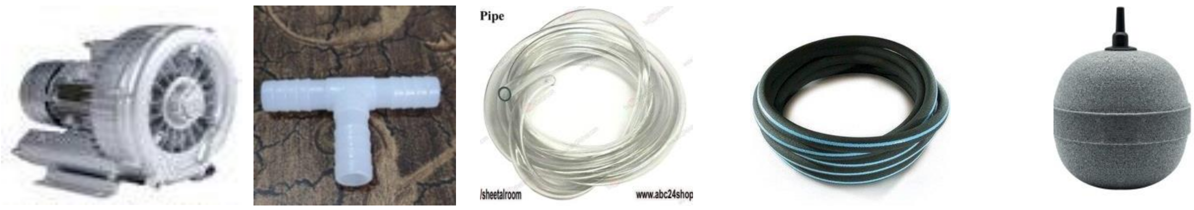

Fig. 1 List of biofloc materials

3.2 Tank size and preparation

The diameter of the both tank was 3.5 meter and depth of the tank was 1.5 meter. The holding water capacity of the both tank was 10,000 liter (10 m^3).Prior to experiment, tanks were cleaned, dried and filled with freshwater at a volume of 1.0 meter water depth. Aeration was provided by an air blower model no. ACO-006 and installed at 8lines in each tank for the experiment. In order to stimulate biofloc growth in biofloc treatments, two tanks were prepared one week prior to the experiment as the biofloc source of inoculants and 25 mg/L of N, molasses (53% of C) as the organic carbon source at a C/N(carbon/nitrogen) ratio of 15 were added in the study. No water replacement was carried out in the whole study period. However, water addition was performed to replace water loss due to evaporation. Due to the limited availability of tank, there was no replicate applied for the treatments.

Fig. 2 Experimental tank and students activities

3.3 Experimental fish and stocking density

Mono-sex tilapia (*Oreochromis niloticus*) with an average body weight 2.5 ± 1.71g was used as the experimental fish. Two densities were applied in this study as T_1 (50 fish/m^3) and T_2 (100 fish/m^3) treatments in the experimental tank.

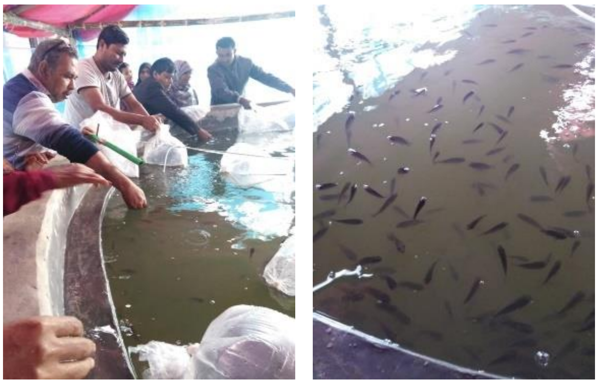

Fig . 3 Fish Fingerling release

3.4 Rearing of fish and feeding

The tilapia fingerlings collected from a commercial hatchery, Mymensingh, Bangladesh. After acclimatizing the fingerlings were stocked in the rearing tank. After one day of stocking fish in the tank, commercially made floating pellets for mono-sex tilapia from Nourish feed limited, Bangladesh were fed twice a day up to harvest period. The amount of feed per feeding time was determined based on fish feeding response, i.e. feeding was stopped whenever the fish showed no response to feed. As an external organic C source, molasses was added daily 500 ml in each tank. The amount of molasses addition per day was determined based on the calculation described in Avnimelech (1999). Proximate composition of floating pellets according to manufacturer and laboratory analysis are shown in below (Table 1).

Table 1. Feed granule size and composition of floating fish feed used in the study

Feed	Granule siege (mm)	Moisture (maximum)%	Protein (minimum)%	Fat (minimum) %	Ash (minimum) %
Floating nursery (Oil coated)	1.0	12.0	36.0	6.0	6.0
Floating pre- starter (Oil coated)	1.5	12.0	30.0	5.0	8.0

Fig .4 Floating nursery fish feed

3.5 Monitoring of water quality parameters

The water quality parameters such as temperature, dissolved oxygen (DO), pH, total ammonia nitrogen (TAN), total suspended solids (TSS) and floc volume (FV) were measured from fish growing tanks were fortnightly during the study period. Water temperature (^{0}C) was recorded using Celsius thermometer (digital-thermo WT-2) at the experimental site. Dissolved oxygen (DO) and pH were measured using digital oxygen meter (HANNA) and pH meter (Hunna pocket P^H meter), respectively. Ammonia level was measured fortnightly using HACH kits (HACH Co., Love land, Colorado and ammonia testing kit). Floc measurement were recorded by imhoff conical flask .For observing the floc concentration, one liter water were taken from fifteen centimeter depth of the water tank and then it put in a imhoff con to settle for 15 minutes. Then it was observed by necked eye. Floc ratio maintain by the adding of commercial probiotics (pond care).

3.6 Fish sampling and growth performance

Sampling was done by 15 days interval. Fingerlings were not fed in the afternoon before the sampling day and in the morning of the sampling day before sampling. This was to allow the fish to empty their gut for accurate weight and also reduce stress due to handling during sampling. Collective weighing of the fingerlings was done to obtain the average weight. However, only ten fingerlings were picked randomly and measured for total weight in order to reduce stress due for handling .In order to assess the growth performance of the experimental fish, fishes weights were recorded from each tank. A sensitive electronic balance (KERN-EB 2-200) was used to weight the sampled fish. All the fish were weighed and returned to their respective tanks. Specific growth rates and food conversion rate was calculated on 15 days interval after each sampling .Specific growth rates assumes that fish weight increases exponentially and it was recommended for reporting the growth of small fish cultured for short periods such as in this study .By the end of the experimental period, total fish number and biomass were counted and calculated to determine survival, growth, total yield, and feed efficiency. All data were further statistically analyzed using S. Plus version 8.0.At the end of 180 days of rearing period, all fish from each tank were counted, measured weight to observe survival and growth performances. The following formulas were used to observe the growth performances of the fish-

- $\text{Weight gain} = \text{Mean final weight} - \text{Mean initial weight}$
- $\text{Biomass of fish} = \text{Number of fish caught x (Av. final weight of fish} - \text{Av. intial weight of fish)}$
- $\text{SGR (\%)} = \frac{\text{(Final body weight} - \text{Initial body weigh)}}{\text{Cultured period}} \times 100$
- $\text{Feed conversion ratio (FCR)} = \frac{\text{Feed consumed(g dry weight)}}{\text{Live weight gain (g wet weight) of fish}}$

Fig. 5 Fish sampling and observe growth performance

3.7 Economic analysis

Economic analysis of the different treatments was calculated on the basis of purchasing prices of tilapia fry, feed, probiotics , raw salts , molasses , lime, transport cost and the revenue from the sale of tilapia. At the end of the study, all fish were sold at local market. Tilapia were sold at a rate of Tk. 150.0/kg. The analysis was performed based on market prices in Bangladesh for fish and all other items expressed in Bangladeshi taka (Tk.).The net profit and cost benefit ratio (BCR) were calculated using the following formula:

- $\text{Net profit (Tk)} = \text{Total return in Tk} - \text{total cost in Tk.}$
- $\text{Benefit cost ratio (BCR)} = \frac{\text{Total return in Tk.}}{\text{Total cost}}$

3.8 Statistical analysis

Data variables were analyzed using one way analysis of variance (ANOVA) to compare the treatments means. If the main effect was found significant, the ANOVA was followed by Duncan's Multiple Range Test (DMRT). All ANOVA were tested at 5% level of significance using SPSS (Statistical Package for Social Science) version 23.

3.9 Overview flow chart of the study

T_1 treatment(Tank 1)	T_2 treatment(Tank 2)
Tank diameter-12 feet	Tank diameter-12 feet
Depth-4.5 feet	Depth-4.5 feet
Holding water capasity-10,000L	Holding water capasity-10,000L

↓

Cement action remove by banana tree and tamarind

↓

Tank drying by air

↓

Fill up the tank 1 and tank 2 with water

↓

Continuous aeration

↓

Dewatering

↓

Tank drying by air

↓

Use of disinfectant to clean the tank

↓

Tank drying by air

↓

Fill up the tank 1 and tank 2 with water

↓

Remove iron by use of potash alum

↓

Continuous aeration

↓

Settle the sediment at the bottom of the tank

↓

Succession of the sediment

↓

Check water quality parameter

↓

Add FCO(fermented carbon organic)

↓

Wait for floc concentration

↓

Release fish fingerling

↓

Continue feed supply , aeration, add FCO, check water quality parameter

↓

Sampling

↓

Fish harvest

Chapter 4

Results and Discussion

Growth performance of mono-sex tilapia fingerling in different treatments during experimental period, mean weight gain, specific growth rate (SGR% per day), food conversion ratio (FCR) and biomass (Kg/10 m^3/180 days) were calculated. The findings were presented following the sequence of specific objectives in three major sections.

A. Growth performance of mono-sex tilapia in biofloc system in relation to water quality parameters.

B. Suitable stocking density in biofloc system

C. Profitability of tilapia culture in biofloc system

4. A Growth performance of experimental fish

In the present study, the initial average weight of the mono-sex tilapia fishes were 2.5±0.21 and 2.5±0.29g in T_1 and T_2 treatments respectively. The study showed that average initial weight of the fishes were more or less similar in the both treatments, while at the end of experiment there were significant different among the treatments in terms of weight gain and total biomass ($P < 0.05$). The mean final weight of the fishes were 161.0±16.81g and 118.10±13.85g in T_1 and T_2 treatments respectively. The final biomass of the fishes were 80.50± 2.09 kg and 118.10±1.38 kg in T_1 and T_2 respectively. Fish yield were observed 8.05 kg m^{-3} and 11.81 kg m^{-3} in T_1 and T_2 (Table 2).

Table 2 : Growth, biomass, food conversion ratio (FCR) and specific growth rate (SGR)of mono-sex tilapia (*Oreochromis niloticus*) at different densities in biofloc system during the study period

Growth parameters	Treatments	
	T_1 (50 individuals m^{-3})	T_2 (100 individuals m^{-3})
Average initial weight (gm)	$2.5±0.21^a$	$2.5±0.29^a$
Average final weight (gm)	$161.0± 16.81^a$	$118.10±13.85^b$
Weight gain (gm day^{-1})	$0.88±0.08^a$	$0.64±0.51^b$
Food conversion ratio (FCR)	$1.17±0.11^a$	$1.25±0.09^a$
Specific growth rate (SGR% per day)	88.05^a	64.17^b
Total biomass (kg)	$80.50± 2.09^a$	$118.10±1.38^b$
fish yield m^{-3} (kg)	8.05	11.81
Survival rate (%)	98.0±0.35	97.0±0.70

Mean values ± SD with different superscripts were significantly different ($p < 0.05$) and same letter did not differ significantly ($p > 0.05$). The fish yield in T_1 treatments were (50 individuals m^{-3}) 8.05 kg and T_2 treatments (100 individuals m^{-3}) 11.81 kg.

The fish yield of the present study is mostly closed to the yield (7.7 to 9.4 kg m^{-3} and 6.35 to 8.82 kg m^{-3}) recorded by Alam *et al*. (2014) and Begum *et al.* (2017). Ahmed *et al.* (2014) obtained 9.93 to

11.63 kg m^{-3} of tilapia in cages at 50 m^{-3} density, which is higher than the yield of the present study. The production performance of the tilapia fishes in the present study comparatively low in T_1 treatments and high in T_2 treatments.

4.A.1 Weight gain

There was no significant ($p > 0.05$) difference in initial weight of fish in different treatment. After 180 days of rearing the weight gain of fish was 161.0± 16.81and 118.10±13.85g for T_1 and T_2 treatments respectively. The significantly ($P<0.05$) highest weight gain observed 118.10 kg was found in fish having T_2 treatment and lowest weight gain 80.50 kg was found in fish having T_1 treatment .

Dev (2015) reported the final weight of tilapia as 167.15–189.67 g for 99 days rearing in nylon net cages applying floating feed without probiotics at pond of Sylhet Agricultural University (SAU), Sylhet, Bangladesh, which supports the present findings. Male tilapia attained an average weight of 176.20 g after rearing of 240 days in pond system reported by Dagne (2013) and Alam *et al*. (2014) estimated mean final body weight as 50.0 to 93.5g using commercial Mega feed twice daily at a density of 100–200 no. m^{-3} in cage at old Brahmaputra river, Mymensingh, which are much lower than the present findings. Average final and initial weight (161.0 ± 16.81g and 2.5 ± 0.21 g) and (118.10 ±13.85 and 2.5±0.29g) of T_1 and T_2 treatment recorded in present study was lower than that of Ahmed *et al*. (2014), who reported an average final weight of 207.90–271.48 g with 33.66 g of initial weight at density of 50 m^{-3} for 120 days rearing of mono-sex tilapia in the suspended cages applying feed supplemented with probiotics at Dakatia river, Chandpur, Bangladesh. In the present study, daily weight gain of mono-sex tilapia in T_1 and T_2 treatments respectively were 0.88±0.08 g and 0.64±0.51 g by rearing for 180 days at different densities with supplemented floating feed. Alam *et al*. (2014) measured daily weight gain 0.35 to 0.67 g by culturing of 135 days at 100 to 200 fish m^{-3} density and applying floated Mega feed in cages at Brahmaputra river. On the contrary, Hussain *et al*. (2000) reported daily weight gain of 0.71 g for GIFT reared for a period of 180 days and fed with rice bran. So daily weight gain of tilapia in the present study is higher compared to above-mentioned researchers. But the findings of the study is slightly lower than the finding of Ahmed *et al.* (2014) and Ahmed *et al.* (2013), who obtained daily weight gain of 1.45-1.98g using commercial floated feed with probiotics in cages at Dakatia river and 1.56g using prepared feed and 1.78g using commercial feed only for mono-sex tilapia reared for 70 days in the earthen ponds.

4. A.2 Specific growth rate (SGR percentage per day)

The values of specific growth rate (SGR % per day) of fish was 88.05 % for T_1 treatment and 64.17 % for T_2 treatment respectively .The significantly ($P < 0.05$) highest specific growth rate was 88.05%

observed in T_1. The lowest specific growth rate 64.17 % was observed in T_2 treatment. Might be because the density of T_1 treatment (50 individual's m^{-3}) was less than T_2 treatment (100 individuals m^{-3}) which directly affect the growth rate of fish.

Dev (2015) recorded SGR of 4.60–4.72% using commercial floated diet twice a day for tilapia in small cages at SAU pond. In earthen pond, Diana *et al*. (1996) demonstrated SGR of *O. niloticus* as 3.10% using feed and fertilizer in Thailand, and Ahmed *et al*. (2013) reported SGR of mono-sex tilapia as 3.09% using prepared feed (55.24% protein) and 2.97% using commercially available feed in Bangladesh. The findings of above-mentioned workers are higher than the present findings.

4. A.3 Production (kg/10 m^{-3}/180 days)

The production was observed 80.50±2.09 and 118.1±1.38 kg/10m^3/180 days in T_1 and T_2 treatment, respectively. The significantly($P<0.05$) highest fish production was obtained 118.10±1.38 kg/10 m^3 /180 days in T_2 treatment under 100 individuals m^{-3} stocking densities and production was decreased 80.50± 2.09 kg/10 m^3 /180 days in T_1 treatment under 50 individuals m^{-3} stocking densities . The lowest fish production 80.50± 2.09 kg/10 m^3 /180 days ware observed in T_1 treatment under 50 individuals m-^{3} stocking densities.

4. A.4 Water quality parameters: Water quality parameters (water temperature, dissolved oxygen, pH, total dissolved solids, ammonia, and floc concentration) of the study are presented in Table 3.

Table 3 : Water quality parameters recorded from biofloc system under different treatments during the study period

Water quality parameters	Treatments	
	T_1 (Range)	T_2 (Range)
Temperature (^{0}C)	25.63±5.90 (19.70 -31.50)	25.53±5.91 (19.60 -31.40)
Dissolved oxygen (mg L^{-1})	5.90±0.75 (5.00 -6.60)	5.80±0.95 (4.80 -6.70)
pH	7.50±0.65 (6.80 -8.15)	7.90±0.91 (6.90 -8.80)
Total dissolved solids (mg L^{-1})	551.20±50.23 (500.90 -601.40)	581.20±60.20 (521.00 -640.40)
Ammonia (mg L^{-1})	0.03±.01 (0.01 -0.04)	0.04±.02 (0.02 -0.06)
Biofloc volume ((ml L^{-1})	35.20±3.41 (31.70 -38.60)	40.10±5.21 (34.80 -45.30)

Mean (±SD) values of water quality parameters in all treatments throughout the study period

4. A.4.1 Temperature (°C)

During the study period, the water temperature varied from 19.70 to 31.50 in T_1 and 19.60 to 31.40 in T_2 treatments respectively. The maximum temperature 31.50°C was recorded in T_1 treatment on 10 July whereas the minimum 19.60°C was in T_2 on 14 February .The mean values of water temperature in treatments T_1 and T_2 were 25.63±5.90 and 25.53±5.91 respectively.

Dev (2015) and Begum *et al*. (2017) in ponds of SAU Campus found to 28.5°C and 28.7°C, respectively. FAO (1981) and DoF (2009) reported the optimum water temperature for aquatic production as 23–31°C and 25–30°C, respectively. These findings support the findings of the present study.

4. A.4.2 Dissolved Oxygen

The dissolved oxygen content of the water was found to vary from 5.00 to 6.60 mg L^{-1} in T_1 and 4.80 to 6.70 mg L^{-1} in T_2 treatment. The mean values of dissolved oxygen content of the water in T_1 and T_2 treatment were 5.90±0.75 and 5.70±0.95, respectively. The highest value of dissolved oxygen content 6.70 mg L^{-1} on 31st May and lowest value 4.80 mg L^{-1} of dissolved oxygen content was found on 10th July in T_2 treatments. No significant variation of dissolved oxygen was observed among the treatments.

The mean value of the dissolved oxygen concentration of the T_1 and T_2 treatment was supported by Begum *et al. (*2017). Alim (2013) recorded the dissolved oxygen content as 4.80 to 5.9 mg L^{-1} . Hasan (2007) and Maghna (2012) reported dissolved oxygen (mg L^{-1}) in ponds of BAU Campus, Mymensingh as 4.15 to 8.60 mg L^{-1} and 4.8 to 5.4 mg L^{-1} , respectively. These are in agreement with the findings of the present study.

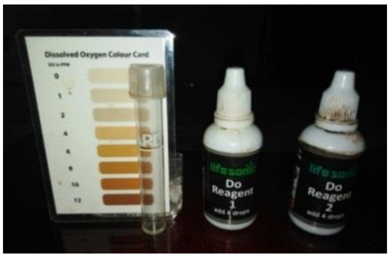

Fig .6 Dissolved Oxygen testing HACH kits

4. A.4.3 pH

Variation in the pH values under different treatments were revealed during study period. The range of pH values recorded in T_1 and T_2 treatment were found to vary between 6.80 to 8.15 and, 6.90 to 8.80 respectively. The mean values of pH content of the water in T_1 and T_2 treatment were 7.50±0.65 and 7.90±0.91, respectively. The highest pH 8.80 obtained with the treatment T_2 on10th June whereas the lowest pH value 6.90 was recorded in T_2 on 28 February. There was no significant variations of pH values under different treatments during the study period (Table 3).

Alim (2013) and Haque (2014) reported that pH varied from 6.56 to 8.71 and 7.03 to 7.57, respectively. Begum *et al.* (2017) found water pH from 7.0 to 7.5 in SAU pond. The present findings are consistent with the above findings.

Fig .7 Digital pocket pH meter

4. A.4.4 Total dissolved solids (mg L^{-1})

During the study period the total dissolved solids varied from 551.20±50.23 to 581.20±60.20 mg L^{-1} in T_1 and T_2 treatments were respectively. There was no significant difference observed in T_1 and T_2 treatments ($P > 0.05$).

Fig. 8 Digital TDS meter

4. A.4.5 Ammonia (mg L^{-1})

Total ammonia concentrations varied from 0.01±.01 to 0.05±.02 and 0.01±.01 to 0.03±.01mg L^{-1} in T_1 and T_2 treatments, were respectively. The average ammonia concentration was 0.03±.01 and 0.04±.02 in T_1 and T_2 treatments, respectively. There was no significant difference observed in T_1 and T_2 treatments ($P > 0.05$).

It should also be noted that the highest TAN concentrations observed in BFT treatments at 50 fish/m^3 (0.75 mg/l) and 100 fish/m^3 (1.04 mg/l) in this experiment were comparable to that reported from red tilapia culture in RAS with similar stocking densities and culture period (1.41 and 1.13 mg/l, respectively) (Suresh & Lin 1992). A different result however noticed with tilapia culture with BFT application in indoor tanks (Azim & Little 2008) where the inorganic nitrogen concentrations in RAS system was lower and more stable than that of BFT treatments. Concentrations of ammonia nitrogen in all treatments were varied from 0.01 to 0.02 mg L^{-1}. Begum et al. (2017) and Dev (2015) recorded

0.010 to 0.013 mg L^{-1} and 0.011 mg L^{-1} ammonia concentration, respectively in SAU pond, which are coincided with the present findings. Meade (1985) stated that the maximum safe concentration of ammonia level was unknown but he concluded that the permissible level was higher than the value of 0.012 mg L^{-1} commonly accepted by fish culturists. These findings support the findings of the present study.

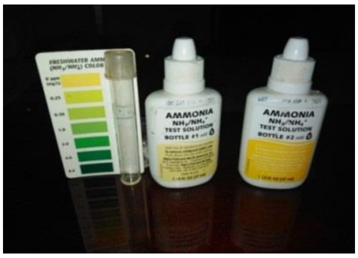

Fig . 9 Ammonia testing HACH kits

4. A.4.6 Biofloc volume (ml/L)

In the present study, biofloc volume varied from 31.70 to 38.60 and 34.80 to 45.30 ml/L in T1 and T_2 respectively. The average floc volume was 35.20±3.41 ml/L and 40.10±5.21 ml/L in T_1 and T_2 treatments respectively .There was no significant difference observed in T_1 and T_2 treatments ($P > 0.05$).

Biofloc volume is the core in biofloc aquaculture system. Based on the present review the mean floc concentration fluctuated of 5.7 to121.72 ml L^{-1} and 33.3 to 103.0 ml L^{-1} for white leg shrimp and tilapia respectively. Optimum level of biofloc volume provides better growth, survival, productivity. In addition, Peixoto *et al.* (2017) stated the minimum floc volume (2.0 ml L^{-1}) and maximum (27.0 ml L^{-1}) for *Litopenaeus vannamei* nursery phase and these volumes found suitable for growth and survival.

Fig. 10 Floc measurement imhoff cone

4.A.5 Food conversion ratio (FCR)

Food conversion ratio (FCR) is an important indicator of the quality of fish feed and a lower FCR indicates better utilization of the fish feed (Mugo-Bundi, 2013).The FCR at different densities in T_1 and T_2 treatment were found as 1.17 and 1.25, respectively . The mean least FCR value 1.17 was found in T_1 treatment where the fish density was lower (50 individual's m^{-3}). The highest mean FCR value 1.25 was found in T_2 treatments where the fish density was 100 individuals m^{-3} (Table 2). These findings were in agreement with Hossain *et al.* (2005) who found FCR of 1.58 ± 0.04 and 1.64 ±0.02 for male mono-sex and mixed sex *O. niloticus*, respectively. Their studies suggesting that the fingerling (mono-sex tilapia) of T_1 treatment had a significantly higher growth rate than the fingerling in mixed sex.

FCR of the present study is lower than that of 1.71 to 1.77 for GIFT and 1.81 to 2.05 for mono-sex tilapia in cage culture, respectively as reported by Hossain *et al*. (2004) and Moniruzzaman *et al.* (2015). The obtained FCR is slightly higher than the findings of Dev (2015) and Ahmed *et al*. (2014), who recorded FCR of tilapia in cage culture as 1.18 to 1.25 and 1.11 to 1.41, respectively. Ahmed *et al.* (2013) found FCR of mono-sex tilapia as 1.40 to 1.51, which is more or less matched with the present findings.

4.A.6 Survival rate (%)

The survivability of mono-sex tilapia was observed as 98.0 and 97.0 % in T_1 and T_2 treatment, respectively. The highest survivability was recorded in T_1 treatment and the lowest survivability was in T_2 treatment. The little variation of survivability was occurred due to environmental condition and stocking density. In T_1 treatment stocking density was low so the feed utilization rate was high and the survivability was also high.

A more or less similar survival rate was observed by Rahman MM [20] who recorded survival rate ranged from 94 to 95%.Survival rate of male tilapia ranged between 91.40 to 96.10%. (Ahmed *et al*., 2014), 95.39 to 95.87% (Dev, 2015) and 83.1 to 96.8% (Moniruzzaman *et al.*, 2015*)* but higher than the reported value in earthen pond of 75.55 to 90.37% (Ahmed *et al*., 2013).

4. B. Suitable stocking density in biofloc system

Stocking density play a vital role in the culture system .The study was a one factorial in which two stocking densities likeT_1(50 individuals m^{-3}) and T_2(100 individuals m^{-3}). In the present study, the initial average weight of the mono-sex tilapia fishes were 2.5±0.21 and 2.5±0.29g in T1 and T2 treatments respectively. Before stocking the fingerling were carefully acclimatized to the tank water for one hour. Initial average weight of fishes were measured by digital top loading balance and kept into record before stocking in the tank.

The study showed that average initial weight of the fishes were more or less similar in the both treatments, while at the end of experiment there were significant different among the treatments in terms of weight gain and total biomass ($P < 0.05$). The mean final weight of the fishes were 161.0±16.81gm and 118.10±13.85gm in T_1 and T_2 respectively. so the stocking density play a vital role in the culture system. 100 individuals m^{-3} stocking density was suitable for biofloc culture system.

Ahmed *et al*. (2014), who reported an average final weight of 207.90–271.48 g with 33.66 g of initial weight at density of 50 m^{-3} for 120 days rearing of mono-sex tilapia in the suspended cages applying feed supplemented with probiotics at Dakatia river, Chandpur, Bangladesh.

In the present study, daily weight gain of mono-sex tilapia in T_1 and T_2 treatments were 0.88±0.08 g and 0.64±0.51 g respectively by rearing for 180 days at different densities with supplemented floating feed . Alam *et al*. (2014) measured daily weight gain 0.35 to 0.67 g by culturing of 135 days at 100 to 200 fish m^{-3} density and applying floated Mega feed in cages at Brahmaputra river. The weight gain of mono-sex tilapia in present study were higher than Alam *et al*. (2014).

4.C Profitability and Production cost of tilapia culture in biofloc system

Profitability, production cost & economics analysis of different treatments in biofloc culture system during the study period are shown in Table 4.

Table 4 : Production cost of mono-sex tilapia (*Oreochromis niloticus*) at different treatments in biofloc culture system during the study period

Description	Treatments	
	T_1	T_2
Tank preparation (Tk.)	500.00	500.00
Cost of fingerlings (Tk.)	1000.00	2000.00
Feed cost (Tk.)	4410.00	6635.00
Operational cost (Tk.)	1100.00	1100.00
Total cost (Tk.)	7010.00	10235.00
Production(kg/treatment)	80.50	118.00
Gross income for sale per treatment	12075.00	17700.00
Net profit/treatment/180 days	5065.00	7465.00

Table 5: Economics analysis of different treatments in biofloc culture system during the study period

Particulars	Treatments	
	T_1(50 individuals m-^{3})	T_2 (100 individuals m^{-3})
Total gross return (Tk. m^{-3})	1207.50	1770.00
Total cost (Tk. m^{-3})	701.00	1023.50
Net profit (Tk. m^{-3})	506.50	746.50
Benefit cost ratio (BCR)	1.72	1.73

4. C.1 Cost analysis: A simple economics analysis at T_1 and T_2 treatments were performed during the study period. Total gross return 1207.50, total cost 701.00, and net profit 506.50 in T_1 treatments. and on the other hand, total gross return 1770.00, total cost 1023.50, and net profit 746.50 in T_2 treatments were respectively. The benefit cost ratio (BCR) of T_1 and T_2 treatment, were 1.72 and 1.73 respectively. The results of the present study suggested that the net profit of individuals of T_2 were better than T_1.

Chapter 5

Major findings, challenge and limitation

5.1 Major findings

This research findings that , the initial average weight of the mono-sex tilapia were 2.5±0.21 and 2.5±0.29g in T_1 and T_2 treatments respectively. The study showed that average initial weight of the both treatments were more or less similar , no significant ($p > 0.05$) difference. But at the end of the experiment there were significant different among the treatments in terms of weight gain and total biomass ($P < 0.05$). The specific growth rate (SGR % per day) of fish was 88.05 % for T_1 treatment and 64.17 % for T_2 treatment respectively .The significantly ($P < 0.05$) highest (88.05%) specific growth rate was observed in T_1 and lowest (64.17 %) specific growth rate was observed in T_2 treatment. The density of T_1 treatment (50 individual's m^{-3}) was less than T_2 treatment (100 individuals m^{-3}) which directly affect the growth rate of fish. After 180 days of rearing the weight gain of fish was 161.0± 16.81and 118.10±13.85g for T_1 and T_2 treatments respectively. The significantly ($P<0.05$) highest (118.10 kg) weight gain and lowest (80.50 kg) weight gain observed in T_2 treatment and T_1 treatment . Profitability, production cost & economics analysis of different treatments in biofloc culture system during the study period are shown in Table 4 and Table 5 .Total gross return 1207.50, total cost 701.00, and net profit 506.50 in T_1 treatments , on the other hand, total gross return 1770.00, total cost 1023.50, and net profit 746.50 in T_2 treatments were respectively. The benefit cost ratio (BCR) of T_1 and T_2 treatment, were 1.72 and 1.73 respectively. The results of the present study suggested that the net profit of individuals of T_2 were better than T_1.

5.2 Challenge and limitation

5.2.1 Infrastructure Development

Conducting experimental research in tvet institute need to set up or develop infrastructure and others associate facilities. Therefore need appropriate budget for experimental research. Lack of investment replication number was minimized.

5.2.2 Tools and Raw material

Availability of appropriate tools and raw materials was a big challenge. Covid-19 period also hampered to collected raw materials in research period.

5.2.3 Power Supply

Uninterrupted power supply is essential for biofloc practice. Also ensure alternative sources of power supply in experimental period.

5.2.4 Water Quality

Iron free water is vital element for confined area aquaculture. Here water sources was not iron free so need a special treatment. Proper probiotics culture is also challenge for biofloc culture system

5.2.5 Time and season

The experiment took place in winter season. In winter season productivity of aquaculture normally slow down.

5.2.6 Cooperation

Startup institute level research need to ensure all facilities and also involved local authority for proper guidance and facilitation. For promoting production based experimental research in tvet institute take initiate to engaged all trade which are related to our curriculum. Without skills manpower total water quality management, feed management, floc management is very difficult.

Chapter 6

Conclusion and Recommendations

6.0 Conclusion and Recommendations

It might be concluded that stocking density played a vital role on the growth and production performance of mono-sex tilapia *(Oreochromis niloticus).* In conclusion, fish density as well as biofloc technology application appears to have some influences on water quality and fish production performances. These study primarily indicates that higher fish stocking density resulted in higher production but lower fish survival and growth. For better conclusion in bicfloc technology incase fish stocking density demand further research in several treatments.

Therefore, the following recommendations are needed to adapt the biofloc technology in the field level.

- Suitable species and stocking densities of the fish species can be selected for better growth in biofloc system.
- Further studies are needed to know the C:N ratios of the biofloc system
- Details studies are needed of proximate nutrients composition of the cultured species
- Determination of suitable carbon source and biofloc volume to optimize the production of the fishes
- More studies related to FCR, cost benefit ratios are needed to fine tune the biofloc technology
- In the present study recommended that it is possible to start up production related activities in tvet institute by using existing facilities which may be motivated our enrolled tvet students, tvet graduates self-employment based practices.

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Appendix

Table 6 : Sampling of fish in a cement tank T_1 treatment

Sl. No .	Date	Individual initial Ave. Weight(gm)	Total Weight (kg)	Individual last Ave. weight (gm)	IndividualAve. Weight gain(gm)	Total wt.gain (kg)	Total biomass (kg)	Remarks
01	15.02.20	2.5	1.25	10.5	8.0	4.0	5.25	Total fish 500 pc
02	29.02.20	10.5	5,25	17.0	6.5	3.25	8.50	
03	15.03.20	17.0	8.50	30.0	13.0	6.5	15.0	
04	31.03.20	30.0	15.0	43.0	13.0	6.5	21.50	
05	15.04.20	43.0	22.50	57.0	14.0	7.0	28.50	
06	30.04.20	57.0	28.50	70.0	13.0	6.5	35.0	
07	15.05.20	70.0	35.0	85.	15.0	7.5	42.50	
08	31.05.20	85.0	40.5	100.0	15.0	7.5	50.0	
09	15.06.20	100.0	50.0	115.0	15.0	7.5	57.50	
10	30.06.20	115.0	57.50	130.0	15.0	7.5	65.00	
11	15.07.20	130.0	65.0	145.0	15.0	7.5	72.50	
12	31.07.20	145.0	72.50	161.0	16.0	8.0	80.50	

Table 07 : Feed intake in a cement tank T_1 treatment

Sl. No	Duration	Total feed intake (kg)	Remarks
01	02.02.20 - 15.02.20	2.10	Total fish 500 pc
02	16.02.20 - 29.02.20	3.30	
03	01.03.20 - 15.03.20	4.05	
04	16.03. 20 - 31.03.20	6.45	
05	01.04.20 -15.04.20	5.55	
06	16.04.20 - 30.04.20	7.72	
07	01.05.20 - 15.05.20	6.90	
08	16.05.20 - 31.05.20	8.28	

09	01.06.20 - 15.06.20	7.62	
10	16.06.20 -30.06.20	9.30	
11	01.07.20 - 15.07.20	8.52	
12	16.0720 - 31.07.20	11.25	
	Total	**81.04**	

Table 08: Summary of biomass increase(per day/fish) and FCR T_1 treatment

Date	Total Initial wt.(kg)	Last wt.(kg)	Weight gain(kg)	Feed intake(kg)	FCR	Culture period (days)	Biomass increase (per day)	Com.
31.07.20	1.25	80.50	79.25	81.04	1.02	180	0.88 gm	Total fish 500 pc

Table 09: Sampling of fish in a cement tank T_2 treatment

Sl. No	Date	Individual initial Ave. Weight(gm)	Total Weight (kg)	Individual last Ave. weight (gm)	Individual Ave.Weight gain(gm)	Total wt.gain (kg)	Total biomass (kg)	Remarks
01	15.02.20	2.5	2.5	8.5	6.0	6.0	8.5	Total fish was stocking 1000 pc
02	29.02.20	8.5	8.5	15.0	6.5	6.5	15.0	
03	15.03.20	15.0	15.0	23.0	8.0	8.0	23.0	
04	30.03.20	23.0	23.0	33.0	10.0	10.0	33.0	
05	15.04.20	33.0	33.0	41.0	8.0	8.0	41.0	
06	30.04.20	41.0	41.0	50.0	9.0	9.0	50.0	
07	15.05.20	50.0	50.0	61.0	11.0	11.0	61.0	
08	31.05.20	61.0	61.0	73.0	12.0	12.0	73.0	
09	15.06.20	73.0	73.0	84.0	11.0	11.0	84.0	
10	30.06.20	84.0	84.0	94.0	10.0	10.0	94.0	
11	15.07.20	94.0	94.0	106.0	12.0	12.0	106.0	
12	31.07.20	106.0	106.0	118.0	12.0	12.0	118.0	

Table 10 : Feed intake in a cement tank T_2 treatment

Sl. No	Duration	Total feed intake (kg)	Remarks
01	02.02.20 - 15.02.20	4.50	Total fish 1000 pc
02	16.02.20 - 29.02.20	6.60	
03	01.03.20 - 15.03.20	8.10	
04	16.03. 20 - 31.03.20	11.70	
05	01.04.20 -15.04.20	10.65	
06	16.04.20 - 30.04.20	14.O7	
07	01.05.20 - 15.05.20	11.55	
08	16.05.20 - 31.05.20	14.52	
09	01.06.20 - 15.06.20	13.08	
10	16.06.20 -30.06.20	16.30	
11	01.07.20 - 15.07.20	14.43	
12	16.0720 - 31.07.20	19.20	
	Total	**144.71**	

Table 11: Summary of biomass increase(per day/fish) and FCR value of T_2 treatment

Date	Total Initial wt.(kg)	Last wt.(kg)	Weight gain(kg)	Feed intake(kg)	FCR	Culture period (days)	Biomass increase (per day)	Com.
31.07.20	2.5	118.0	115.50	144.71	1.25	180	0.64gm	Total fish 1000 pc

Table 12 :Comparative statement of the T_1 treatment &T_2 treatment

Sl no.	Statement	T_1 treatment	T_2 treatment
1	Initial weight	2.5±0.21g	2.5±0.29g
2	Stocking density of fish	50 individual's m^{-3}	100 individuals m^{-3}
3	Initial biomass	1.25 kg	2.50 kg

4	Final biomass (production)	80.50 kg	118.00 kg
5	Biomass increase	79.25 kg	115.50 kg
6	Total feed was given	81.04 kg	144.7 kg
7	FCR Value	1:1.02	1:1.25
8	Total production cost(m^{-3})	701.00	1023.50
9	Total price in fish	1207.50	1770.00
10	Net profit (m^{-3})	506 .50/ tank/1 cycle	746.50/ tank/1 cycle
11	Production cost per kg	88.45	88.57
12	Net profit per kg	61.55	61.43
13	Total culture period	180 days	180 days

FCR = Feed given/Fish weight gain

Table 13 : Observation of water quality parameter throughout the study period in T_1**&**T_2 treatment

Sl. No.	Date	Parameters							
		pH	D.O (ppm)	Tem. (°c)	TDS (ppm)	NH3 (ppm)	Salinity (ppt)	Floc con. (ml/liter)	Com.
01	14/02/20	8.3	5.0	18.0	600	0.02	0.5	55.0	
02	28/02/20	8.6	6.0	22.3	630	0.03	0.4	50.0	
03	14/03/20	8.3	5.0	24.5	580	0.01	0.2	60.0	
04	31/03/20	8.0	5.5	26.0	670	0.03	0.2	50.0	
05	15/04/20	8.3	5.0	27.3	590	0.04	0.5	50.o	
06	30/04/20	8.4	5.0	27.0	600	0.02	0.6	50.0	
07	15/05/20	8.0	5.0	27.5	600	0.04	0.6	45.0	
08	31/05/20	8.5	6.0	28.5	580	0.03	0.6	50.0	
09	10/06/20	8.0	5.5	29.0	590	0.04	0.6	50.0	
10	30/06/20	8.0	5.5	29.5	600	0.04	0.6	40.0	
11	10/07/20	8.5	4.5	30.0	625	0.05	0.6	50.0	
12	30/07/20	8.5	5.0	30.0	600	0.03	0.6	60.0	

Table 14 : Production cost per cycle (6 months) in T_1 treatment

Sl. no.	Item	Quantity	Price/Item	Total price
01	Probiotic	250 gm	350	350.00
02	Mollases	5 kg	60	300.00
03	Calcium Carbonet	2 kg	25	50.00
04	Raw salt	5 kg	20	100.00
05	Fish Fingerling	500 pc	2.0	1000.00
06	Feed	80 kg	50	4000.00
07	Elcetric bill	50 unit	6	300.00
08	Miscellaneus			910.00
			Total	7010.00

Total Production cost = 7010.00

Total fish production = 80.50 kg (1 cycle)

Price in fish (80.50 kg x 150.0) = 12075.00

Net profit = 12075.00 -7010.00

= 5065.00/ tank/1 cycle

Production cost per kg = 87.08

Net profit per kg = 62.92

Table 15 : Production cost per cycle (6 months) in T_2 treatment

Sl. no.	Item	Quantity	Price/Item	Total price
01	Probiotic	250 gm	350	350.00
02	Mollases	5 kg	60	300.00
03	Calcium Carbonet	2 kg	25	50.00
04	Raw salt	5 kg	20	100.00
05	Fish Fingerling	1000 pc	2.0	2000.00
06	Feed	144.7 kg	50	7035.00
07	Elcetric bill	50 unit	6	200.00
08	Miscellaneous			200.00
			Total	**10235.00**

Total production cost = 10235

Total fish production = 118 kg (1 cycle)

Price in fish (118 kg x 150) = 17700.00

Net profit = 17700.00 -10235.00

= 7465.00/ tank/1 cycle

Production cost per kg = 86.73.00

Net profit per kg = 63.27

Table 16 :Summary of water quality parameter throughout the study period

Sl. no.	Months	Parameters			
		pH	D.O(ppm)	Tem.(°c)	NH_3(ppm)
01	December	8.20	5.00	17.27	0.05
02	January	8.05	5.08	18.13	0.02
03	February	8.23	4.95	20.10	0.04
04	March	8.38	4.98	24.50	0.03
05	April	8.30	5.00	26.83	0.04
06	May	8.25	4.90	29.30	0.03
07	June	8.15	5.25	32.60	0.02
08	July	8.50	5.20	33.50	0.01

Table 17 : Information of stocking fish species in a cement tank T_1 treatment &T_2 treatment

Tank no 1(T_1 treatment)

Sl. No.	Stocking Date	Species	No. of fish(pc)	Ave. Stocking wt.(gm)	Total wt. (Kg)	Com.
01	01.02.20	mono-sex tilapia	1000	2.5	2.5	

Tank no 2(T_2 treatment)

Sl. No.	Stocking Date	Species	No. of fish(pc)	Ave. Stocking wt.(gm)	Total wt. (Kg)	Com.
02	01.02.20	mono-sex tilapia	500	2.5	1.25	

Table18 : Feed intake in T_1 treatment &T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank 1 (gm)	Tank 2 (gm)	Total feed (gm)	Com.
01	02.02.20	500	350	150	500	10% of the body wt.
02	03.02.20	500	350	150	500	10% of the body wt.
03	04.02.20	500	350	150	500	10% of the body wt.
04	05.02.20	500	350	150	500	10% of the body wt.
05	06.02.20	500	350	150	500	10% of the body wt.
06	07.02.20	500	350	150	500	10% of the body wt.
07	08.02.20	--	**2100**	**900**	**3000**	**Interval**
08	09.02.20	600	400	200	600	9% of the body wt.
09	10.02.20	600	400	200	600	9% of the body wt.
10	11.02.20	600	400	200	600	9% of the body wt.
11	12.02.20	600	400	200	600	9% of the body wt.
12	13.02.20	600	400	200	600	9% of the body wt.
13	14.02.20	600	400	200	600	9% of the body wt.
14	15-02.20	--	2400	1200	3600	Interval for sampling
15	16.02.20	750	500	250	750	8% of the body wt.
16	17.02.20	750	500	250	750	8% of the body wt.
17	18.02.20	750	500	250	750	8% of the body wt.
18	19.02.20	750	500	250	750	8% of the body wt.
19	20.02.20	750	500	250	750	8% of the body wt.
20	21-02.20	750	500	250	750	8% of the body wt.
21	22.02.20	--	**3000**	**1500**	**4500**	**Interval**
22	23.02.20	900	600	300	900	7% of the body wt.
23	24.02.20	900	600	300	900	7% of the body wt.
24	25.02.20	900	600	300	900	7% of the body wt.
25	26.02.20	900	600	300	900	7% of the body wt.

26	27.02.20	900	600	300	900	7% of the body wt.
27	28.02.20	900	600	300	900	7% of the body wt.
28	29.02.20	--	3600	1800	5400	Interval for sampling
Total Feed intake in a month			**11100**	**5400**	**16.50 kg**	

Table19 : Feed intake in T_1 treatment &T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank 1 (gm)	Tank 2 (gm)	Total feed (gm)	Com.
01	01.03.20	975	650	325	975	6% of the body wt.
02	02.03.20	975	650	325	975	6% of the body wt.
03	03.03.20	975	650	325	975	6% of the body wt.
04	04.03.20	975	650	325	975	6% of the body wt.
05	05.03.20	975	650	325	975	6% of the body wt.
06	06.03.20	975	650	325	975	6% of the body wt.
07	07.03.20	--	**3900**	**1950**	**5850**	**Interval**
08	08.03.20	1050	700	350	1050	5% of the body wt.
09	09.03.20	1050	700	350	1050	5% of the body wt.
10	10.03.20	1050	700	350	1050	5% of the body wt.
11	11.03.20	1050	700	350	1050	5% of the body wt.
12	12.03.20	1050	700	350	1050	5% of the body wt.
13	13.03.20	1050	700	350	1050	5% of the body wt.
14	14.03.20	--	**4200**	**2100**	**6300**	Interval for sampling
15	15-03.20	1150	750	400	1150	4% of the body wt.
16	16.02.20	1150	750	400	1150	4% of the body wt.
17	17.03.20	1150	750	400	1150	4% of the body wt.
14	18.03.20	1150	750	400	1150	4% of the body wt.
19	19.03.20	1150	750	400	1150	4% of the body wt.
20	20.03.20	1150	750	400	1150	4% of the body wt.
21	21-03.20	--	**4500**	**2400**	**6900**	**Interval**

22	22.03.20	1250	800	450	1250	3% of the body wt.
23	23.03.20	1250	800	450	1250	3% of the body wt.
24	24.03.20	1250	800	450	1250	3% of the body wt.
25	25.03.20	1250	800	450	1250	3% of the body wt.
26	26.03.20	1250	800	450	1250	3% of the body wt.
27	27.0320	1250	800	450	1250	3% of the body wt.
28	28.03.20	1250	800	450	1250	3% of the body wt.
29	29.03.20	1250	800	450	1250	3% of the body wt.
30	30.03.20	1250	800	450	1250	3% of the body wt.
31	31.03.20	--	7200	4050	11250	Interval for sampling
Total feed intake in a month			**19800**	**10500**	**30.300kg**	

Table 20: Feed intake in T_1 treatment &T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank no.1 (gm)	Tank no.2 (gm)	Total (gm)	Com.
01	01.04.20	1300	850	450	1300	2% of the body wt.
02	02.04.20	1300	850	450	1300	2% of the body wt.
03	03.04.20	1300	850	450	1300	2% of the body wt.
04	04.04.20	1300	850	450	1300	2% of the body wt.
05	05.04.20	1300	850	450	1300	2% of the body wt.
06	06.04.20	1300	850	450	1300	2% of the body wt.
07	07.04.20	--	**5100**	**2700**	**7800**	**Interval**
08	08.04.20	1400	925	475	1400	2% of the body wt.
09	09.04.20	1400	925	475	1400	2% of the body wt.
10	10.04.20	1400	925	475	1400	2% of the body wt.
11	11.04.20	1400	925	475	1400	2% of the body wt.
12	12.04.20	1400	925	475	1400	2% of the body wt.
13	13.04.20	1400	925	475	1400	2% of the body wt.
14	14.04.20	--	**5550**	**2850**	**8400**	**Interval for sampling**

15	15-04.20	1425	925	500	1425	2% of the body wt.
16	16.04.20	1425	925	500	1425	2% of the body wt.
17	17.04.20	1425	925	500	1425	2% of the body wt.
18	18.04.20	1425	925	500	1425	2% of the body wt.
19	19.04.20	1425	925	500	1425	2% of the body wt.
20	20.04.20	1425	925	500	1425	2% of the body wt.
21	21-04.20	--	**6475**	**3500**	**9975**	2% of the body wt.
22	22.04.20	1475	950	525	1475	2% of the body wt.
23	23.04.20	1475	950	525	1475	2% of the body wt.
24	24.04.20	1475	950	525	1475	2% of the body wt.
25	25.04.20	1475	950	525	1475	2% of the body wt.
26	26.04.20	1475	950	525	1475	2% of the body wt.
27	27.04.20	1475	950	525	1475	2% of the body wt.
28	28.04.20	1475	950	525	1475	2% of the body wt.
29	29.04.20	1500	950	550	1500	2% of the body wt.
30	30.04.20	--	**7600**	**4225**	**11825**	**Interval for sampling**
Total Feed intake(kg) in a month			**24575**	**13425**	**38.0 kg**	

Table 21 : Feed intake in T_1 treatment & T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank no.1 (gm)	Tank no. 2 (gm)	Total (gm)	Com.
01	01.05.20	1500	950	550	1500	2% of the body wt.
02	02.05.20	1500	950	550	1500	2% of the body wt.
03	03.05.20	1500	950	550	1500	2% of the body wt.
04	04.05.20	1500	950	550	1500	2% of the body wt.
05	05.05.20	1500	950	550	1500	2% of the body wt.
06	06.05.20	1500	950	550	1500	2% of the body wt.
07	07.05.20	--	**5700**	**3300**	**9000**	**Interval**
08	08.05.20	1550	975	575	1550	2% of the body wt.

09	09.05.20	1550	975	575	1550	2% of the body wt.
10	10.04.20	1550	975	575	1550	2% of the body wt.
11	11.05.20	1550	975	575	1550	2% of the body wt.
12	12.05.20	1550	975	575	1550	2% of the body wt.
13	13.05.20	1550	975	575	1550	2% of the body wt.
14	14.05.20	--	**5850**	**3450**	**9300**	**Interval for sampling**
15	15-05.20	1600	1020	580	1600	2% of the body wt.
16	16.05.20	1600	1020	580	1600	2% of the body wt.
17	17.05.20	1600	1020	580	1600	2% of the body wt.
18	18.05.20	1600	1020	580	1600	2% of the body wt.
19	19.05.20	1600	1020	580	1600	2% of the body wt.
20	20.05.20	1600	1020	580	1600	2% of the body wt.
21	21-05.20	--	**6120**	**3480**	**9600**	2% of the body wt.
22	22.05.20	1650	1050	600	1650	2% of the body wt.
23	23.05.20	1650	1050	600	1650	2% of the body wt.
24	24.05.20	1650	1050	600	1650	2% of the body wt.
25	25.05.20	1650	1050	600	1650	2% of the body wt.
26	26.05.20	1650	1050	600	1650	2% of the body wt.
27	27.05.20	1650	1050	600	1650	2% of the body wt.
28	28.05.20	1650	1050	600	1650	2% of the body wt.
29	29.05.20	1650	1050	600	1650	2% of the body wt.
30	30.05.20	--	**8400**	**4800**	**13200**	**Interval for sampling**
Total Feed intake(kg) in a month			**26070**	**15030**	**41.10 kg**	

Table 22 : Feed intake in T_1 treatment &T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank no. 1 (gm)	Tank no. 2 (gm)	Total (gm)	Com.
01	01.06.20	1700	1080	620	1700	2% of the body wt.
02	02.06.20	1700	1080	620	1700	2% of the body wt.
03	03.06.20	1700	1080	620	1700	2% of the body wt.
04	04.06.20	1700	1080	620	1700	2% of the body wt.
05	05.06.20	1700	1080	620	1700	2% of the body wt.
06	06.06.20	1700	1080	620	1700	2% of the body wt.
07	07.06.20	--	**6480**	**3720**	**10200**	**Interval**
08	08.06.20	1750	1100	650	1750	2% of the body wt.
09	09.06.20	1750	1100	650	1750	2% of the body wt.
10	10.06.20	1750	1100	650	1750	2% of the body wt.
11	11.06.20	1750	1100	650	1750	2% of the body wt.
12	12.06.20	1750	1100	650	1750	2% of the body wt.
13	13.06.20	1750	1100	650	1750	2% of the body wt.
14	14.06.20	--	**6600**	**3900**	**10500**	**Interval for sampling**
15	15-06.20	1800	1150	650	1800	2% of the body wt.
16	16.06.20	1800	1150	650	1800	2% of the body wt.
17	17.06.20	1800	1150	650	1800	2% of the body wt.
18	18.06.20	1800	1150	650	1800	2% of the body wt.
19	19.06.20	1800	1150	650	1800	2% of the body wt.
20	20.06.20	1800	1150	650	1800	2% of the body wt.
21	21-06.20	--	**6900**	**3900**	**10800**	2% of the body wt.
22	22.06.20	1850	1175	675	1850	2% of the body wt.
23	23.06.20	1850	1175	675	1850	2% of the body wt.
24	24.06.20	1850	1175	675	1850	2% of the body wt.
25	25.06.20	1850	1175	675	1850	2% of the body wt.

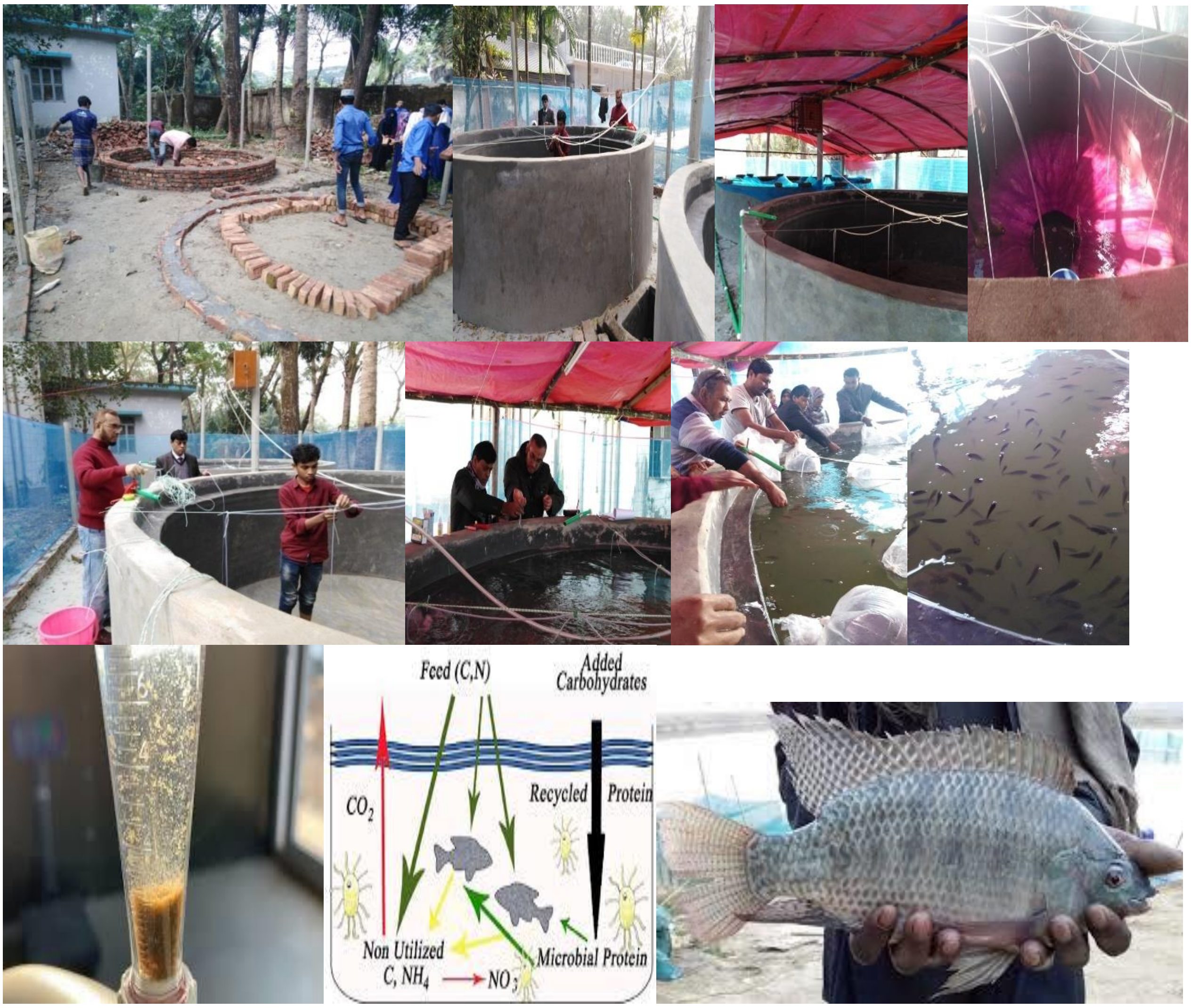
26	26.06.20	1850	1175	675	1850	2% of the body wt.
27	27.06.20	1850	1175	675	1850	2% of the body wt.
28	28.06.20	1850	1175	675	1850	2% of the body wt.
29	29.06.20	1850	1175	675	1850	2% of the body wt.
30	30.06.20	--	**9400**	**5400**	**14800**	**Interval for sampling**
Total Feed intake(kg) in a month			**29380**	**16920**	**46.30 kg**	

Table 23 : Feed intake in T_1 treatment & T_2 treatment

Sl. No.	Date & Time	Quantity of feed(gm)	Tank no. 1 (gm)	Tank no. 2 (gm)	Total (gm)	Com.
01	01.07.20	1900	1200	700	1900	2% of the body wt.
02	02.07.20	1900	1200	700	1900	2% of the body wt.
03	03.07.20	1900	1200	700	1900	2% of the body wt.
04	04.07.20	1900	1200	700	1900	2% of the body wt.
05	05.07.20	1900	1200	700	1900	2% of the body wt.
06	06.07.20	1900	1200	700	1900	2% of the body wt.
07	07.07.20	--	**7200**	**4200**	**11400**	**Interval**
08	08.07.20	1950	1230	720	1950	2% of the body wt.
09	09.07.20	1950	1230	720	1950	2% of the body wt.
10	10.07.20	1950	1230	720	1950	2% of the body wt.
11	11.07.20	1950	1230	720	1950	2% of the body wt.
12	12.07.20	1950	1230	720	1950	2% of the body wt.
13	13.07.20	1950	1230	720	1950	2% of the body wt.
14	14.07.20	--	**7380**	**4320**	**11700**	**Interval for sampling**
15	15-07.20	2000	1250	750	2000	2% of the body wt.
16	16.07.20	2000	1250	750	2000	2% of the body wt.
17	17.07.20	2000	1250	750	2000	2% of the body wt.
18	18.07.20	2000	1250	750	2000	2% of the body wt.
19	19.07.20	2000	1250	750	2000	2% of the body wt.
20	20.07.20	2000	1250	750	2000	2% of the body wt.

21	21-07.20	--	**7500**	**4500**	**12000**	2% of the body wt.
22	22.07.20	2050	1300	750	2050	2% of the body wt.
23	23.07.20	2050	1300	750	2050	2% of the body wt.
24	24.07.20	2050	1300	750	2050	2% of the body wt.
25	25.07.20	2050	1300	750	2050	2% of the body wt.
26	26.07.20	2050	1300	750	2050	2% of the body wt.
27	27.07.20	2050	1300	750	2050	2% of the body wt.
28	28.07.20	2050	1300	750	2050	2% of the body wt.
29	29.07.20	2050	1300	750	2050	2% of the body wt.
30	30.07.20	2050	1300	750	2050	2% of the body wt.
31	31.07.20	--	**11700**	**6750**	**18450**	**Interval for sampling**
Total Feed intake(kg) in a month			**33780**	**19770**	**53.55 kg**	

Students involves different activities in biofloc culture system



Annexure 1. Tank set up,floc measurement imhoff cone, nitrification system and fingerling release in biofloc tanks.