# Biofloc-Aquaponic Floating System Technology for Striped Snakehead Fish (Channa striata) Rearing

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**Abstract.** In the application of Biofloqua technology (Biofloc-Aquaponic), the addition of swamp bacteria can increase fish growth and affect survival, feeding efficiency and productivity of farmed fish, and also be environmentally friendly. The objective of this study is to determine the effectiveness of using Biofloc technology and floating aquaponics in increasing striped snakehead fish culture productivity using swamp probiotics. This study used a completely randomized design with three replicates and two treatments for rearing snakeheads using a floating aquaponics of water spinach system with Biofloc and a system with Biofloc only. Striped snakehead fish were kept in a pond with a density of 100 fish m-3 and molasses were added every week. The results of this study show that the aquaponic Biofloc system with probiotics from swamp can maintain the water quality of the rearing medium, increase the efficiency of fish feed, fish growth and survival rate. The integration of Biofloc and aquaponics technology with probiotic swamp starter can be used as an integrated aquaculture system with continuous vegetable production.

**Keyword:** Biofloc-Aquaponic Floating System, Technology Striped Snakehead Fish, Channa striata, Rearing

## 1. Introduction

The striped snakehead fish (Channa striata) is a freshwater fish species native to Indonesia that has been successfully domesticated and bred. The snakehead fish is one of several swamp fish species that is popular in South Sumatra, especially in the city of Palembang [1]. Snakehead fish farming was developed to increase production and meet the high market demand. One way to increase the production of snakehead fish is to apply aquaculture technology.

The application of Biofloc and aquaponics technology for snakehead fish farming is the right solution to increase production and meet the high market demand, especially in South Sumatra. The application of biofloc and aquaponics technology has shown good results in other fish species such as catfish. According to the research conducted by [2], the rearing of catfish using the Biofloqua system showed better growth and survival rate of 96% with FCR of < 1.00.

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The combination of Biofloc and aquaponics with the addition of swamp bacteria will help in maintaining water quality in fish farming to optimize stocking density in aquaculture, as well as in research to optimize distribution density of catfish with Biofloc and Nitrobacter systems that support the highest specific growth rate and lowest FCR[3], as with the snakehead Biofloc at laboratory scale in a Biofloc study with a probiotic swamp starter [4].

The combination of biofloc and aquaponics can provide advantages that ensure the sustainability of the enterprise, as it is profitable and environmentally friendly [5][6][7]. However, there are also disadvantages in combining cultivation techniques between biofloc and aquaponics, which often still require additional water pumps in the aquaponics system. The biofloc method could be combined with the floating system aquaponics to remove the water pumps. The swamp probiotics are Bacillus sp. and Streptomyces sp. The isolates were selected from swamp sediments in Lebung Karangan, Ogan Ilir Regency, South Sumatra [8]. Bacillus sp. and Streptomyces sp. are used as probiotic bacteria in aquaculture that can improve feed efficiency, survival and growth of snakehead fish while maintaining water quality[4]. The objective of this study is to determine the efficacy of using Biofloc technology and floating aquaponics in increasing snakehead fish culture productivity using swamp probiotics.

## 2. Materials and methods

The study was conducted in the Aquaculture and Experimental Pond, Fisheries Fundamentals Laboratory, Aquaculture Study Program, and the Microbiology-Biochemistry-Fishery Products Laboratory, Fishery Products Technology Study Program, Department of Fisheries, Faculty of Agriculture, University of Sriwijaya.

This study used a Completely Randomized Design (CRD) consisting of 2 treatments and 3 replications. The treatments were: P1 = Maintenance of 100 ind.m-3 using a floating biofloc-aquaponics (biofloqua) system and P2 = Maintenance of 100 ind.m-3 using a biofloc system.

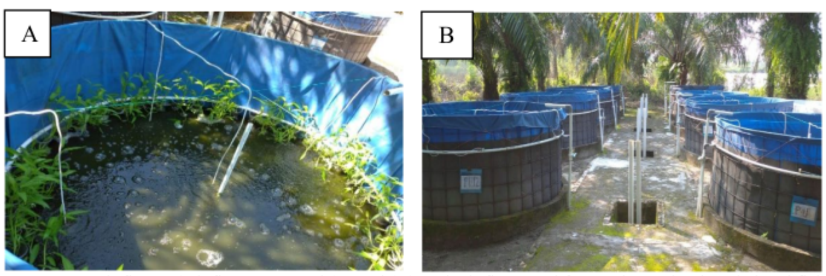


**Figure 1.** Biofloqua (Biofloc-Aquaponic) pond (A) and Biofloc pond for rearing striped snakehead fish (B)

The maintenance vessel used is a circular planted pond with a diameter of 2 m, a height of 1 m, and a water level of 0.5 m. A rope and wire are attached to the top of the pond, which is attached to a cup of charcoal and water spinach (Ipomea aquatica ) (Figure 1). The wire itself has the function of reinforcement, keeping it in position when exposed to rain and wind. In each pond, it was aerated with 5 points. Molasses and swamp probiotics were added to the medium as starters of 10 mL m-3 with a bacterial density of 105 CFU mL-1. Striped snakehead fishes were stocked and acclimated for 10 days. Fish were fed a commercial 40% protein diet three times daily for satiation. Snakehead fish were maintained for 42 days after treatment, and fish weight and length were measured each week. Molasses was added every week in an amount of 100 mL.m-3.

The seeds of water spinach were sown in rock wool in a humid room without sunlight for 14 days. After the roots and some leaves appeared on the rockwool substrate, they were planted in aquaponics containers. Aquaponic media was stocked after three days of fish stocking in the nursery pond. Water spinach plants were harvested after 21 days.

Parameters in this study included survival rate, absolute weight gain of fish, absolute length gain of fish, feed efficiency, absolute weight gain of water spinach, absolute length gain of water spinach, floc volume, and water quality in rearing snakeheads (pH, TDS, BOD, and DO). Data on water quality, floc volume, survival, growth, and feeding efficiency were analyzed by T-test.

## 3. Results and Discussion

The pH in pond P1 or Biofloqua was between 6.1and 7.7, while the pH in pond P2 or Biofloc was between 6.0 and 7.7. The determined pH indicated that the pH of the rearing medium was still within the tolerance range for the maintenance, survival and growth of snakehead fish. Snakeheads as a swamp fishery product usually have an acidic to neutral pH of 4-7 [9]. Culturing Biofloc and Biofloqua systems, which utilize the activity of bacteria and other aquatic microbes in the formation of flocs, have been shown to maintain water pH within the tolerance level of snakehead culture. The activity of bacteria in breaking down organic materials can form organic acids that cause the pH to decrease. The increase in pH is due to a decrease in bacterial activity, so the organic acids produced are low. This has an impact on the increase of pH in the maintenance medium [10].

The range of DO or dissolved oxygen in the rearing media ranged from 4.45±0.10 - 5.95±0.36 mg L-1. P1 or Biofloqua treatment ranged from 4.45±0.10 - 5.90±0.12 mg L-1 and P2 or Biofloc ranged from 5.25±0 - 5.95±0.17 mg L-1. It is believed that the difference between DO and dissolved oxygen is caused by photosynthesis and respiration of fish and microbes in the water, which differ between Biofloqua and Biofloc ponds, but the tolerance for dissolved oxygen is more than 3-5 mg L-1for freshwater fish [11]. DO is not only used by fish, but also needed by deep water microbes to form flocs [12]. DO also plays an important role in the cultivation of Biofloqua and Biofloc systems in the process of decomposition of organic material by probiotic bacteria, so that organic material in the medium is reduced.

The TDS value of the rearing medium ranged from 284.50±163.25 to 488.17±420.59 mg L-1. Treatment with P1 or Biofloqua ranged from 416±233.50 - 488.17±420.59 mg L-1 and P2 or Biofloc ranged from 284.50±163.25 - 328.67±301.31 mg L-1. The difference in TDS in Biofloc ponds is believed to be due to differences in nutrients derived entirely from nitrogenous fish excreta. Plants require nitrogen as a natural fertilizer for their growth and development. The results of the T-test analysis (Table 1) show that total dissolved solids (TDS) were not significantly different between treatments P1 and P2 on days 0, 7, 14, 21, 28, 35, and 42 (P<0.05). Based on the water quality standards in PP No. 82 of 2001 (Class II), the TDS concentration of less than 1000 mg L-1 achieved during maintenance is suitable and safe for fish culture.The pH value at P1 or biofloqua pond ranged from 6.1–7.7 while the pH value at P2 or biofloc pond ranged from 6.0–7.7.

The range of DO or dissolved oxygen in the rearing media ranged from 4.45±0.10 - 5.95±0.36 mg L-1. Treatment of P1 or biofloqua ranged from 4.45±0.10 - 5.90±0.12 mg L-1 and P2 or biofloc ranged from 5.25±0 - 5.95±0.17 mg L-1. The difference in DO levels or dissolved oxygen is thought to be caused by photosynthesis and respiration of fish and microbes in the water that differs between biofloqua and biofloc ponds, but the dissolved oxygen tolerance for freshwater fish is more than 3-5 mg L-1 [11]. DO is not only used by fish but is also needed by deep water microbes to form flocs [12]. DO also plays an important role in the cultivation of biofloqua and biofloc systems in the process of decomposition of organic matter by probiotic bacteria, so that organic matter in the media is reduced.

The range of TDS obtained in the rearing medium ranged from 223 - 479 mg L-1. Treatment of P1 or biofloqua ranged from 386.25 – 479.75 mg L-1 and P2 or biofloc ranged from 223 – 244 mg L-1. The difference in TDS in biofloc ponds is thought to be due to differences in nutrients obtained in full from fish feces containing nitrogen. Plants need nitrogen as a natural fertilizer for growth and development. The results of the T-test analysis (Table 1), Total Dissolved Solid (TDS) on days 0, 7, 14, 21, 28, 35, and 42 were not significantly different in treatment P1 and P2 (P<0.05). Based on the water quality standards in PP No 82 of 2001 (class II), the concentration of TDS obtained during maintenance is appropriate and safe for fish farming activities, which is less than 1000 mg L-1.

**Table 1.** TDS value in rearing media of striped snakehead for 42 days (mg.L-1)

| Rearing days | Treatment P1 (Biofloqua) | P2 (Biofloc) |
|---|---|---|
| 0 | 386.25+73.25 | 231.50±9.00 |
| 7 | 377.50±86.50 | 241.75±5.75 |
| 14 | 474.50±58.00 | 223.25±7.75 |
| 21 | 366.75±53.75 | 234.00±3.75 |
| 28 | 383.75±60.25 | 244.50±13.00 |
| 35 | 479.75±60.75 | 242.25±10.75 |
| 42 | 389.00±33.50 | 237.50±6.00 |

The range of BOD obtained in the rearing medium ranged from 0.48 ± 0.12 – 0.68 ± 40.25 mg L-1. Treatment of P1 or biofloc ranged from 0.48 ± 0.12 – 0.68 ± 40.25 mg L-1 and P2 or biofloc ranged from 0.50±0 – 0.68 ± 0.23 mg L-1. The results of the T-test analysis (Table 2) showed that the Biochemical Oxygen Demand (BOD) on days 0, 7, 14, 21, 28, 35, and 42 were not significantly different between treatments P1 and P2 (P<0.05). BOD during maintenance ranged from 0.48±0.12 mg L-1 – 0.68±0.25 mg L-1.

**Table 2.** BOD value in rearing media of striped snakehead for 42 days (mg.L-1)

| Treatment | Rearing days 0 | 7 | 14 | 21 | 28 | 35 | 42 |
|---|---|---|---|---|---|---|---|
| P1 | 0.63±0.38 | 0.53±0.15 | 0.55±0.17 | 0.48±0.12 | 0.68±0.25 | 0.68±0.21 | 0.48±0.15 |
| P2 | 0.67±0.15 | 0.50±0.0 | 0.62±0.12 | 0.62±0.15 | 0.65±0.20 | 0.55±0.20 | 0.68±0.23 |

According to [13], the BOD value can be influenced by temperature, plankton density, the presence of microbes, and the type of organic matter content. BOD values in natural waters ranged from 0.5 to 7.0 mg L-1. The low BOD value during this study is probably due to the fact that the microbes in probiotics and plants can use organic matter as a source of nutrition.

Bernal et al [14] stated that the combination of Streptomyces sp. and Bacillus sp. has a synergistic effect, i.e., the bacteria give benefits to each other by producing various extracellular enzymes (Bacillus sp.) and antibiotic compounds (Streptomyces sp.) that can increase fish survival, growth, and resistance to disease. Bacillus sp. can produce natural antimicrobial compounds that can suppress colonies of pathogenic bacteria [15]. Streptomyces sp. has the potential to control pathogenic bacteria through competition, parasitism, or production of secondary metabolites [16] and can produce various biologically active compounds, such as antibacterial, antifungal, antiparasitic, and antiviral [17].

T-test analysis showed that the volume of flocs in treatment P1 and P2 were significantly different on days 14, 28,35, and 42 (P<0,05), it is showed at Table 3.

**Table 3.** Floc volume in rearing media of striped snakehead for 42 days

| Rearing days | Floc volume (ml.L-1) | | | | | |
|---|---|---|---|---|---|---|
| | P1 | | | P2 | | |
| 0 | 0.13 | + | 0.06 | 0.05 | + | 0.05 |
| 7 | 0.40 | + | 0.00 | 1.10 | + | 0.50 |
| 14 | 0.87 | + | 0.15 | 16.00 | + | 2.00 |
| 21 | 2.37 | + | 0.65 | 21.50 | + | 1.50 |
| 28 | 4.77 | + | 0.25 | 28.00 | + | 3.00 |
| 35 | 3.00 | + | 0.50 | 19.00 | + | 5.00 |
| 42 | 6.00 | + | 0.50 | 23.00 | + | 5.00 |

According to [18], the more aquaculture waste is contained in the medium used by the heterotrophic bacteria, the more flocs are formed. The floc formed can provide nutrients such as proteins, amino acids, lipids and fatty acids in various microbial forms [19]. Biofloc is a good source of vitamins and minerals, especially phosphorus and microbial protein as an additional food source for fish and plants [20].

The results of T-test analysis showed that the survival rate of snakehead fish was not significantly different between P2 and P1 treatments ($P < 0.05$). Maintaining with Biofloc technology and aquaponics resulted in SR or a survival rate of 100±0.00%. The maintenance of snakehead fish with Biofloc technology was 99.78±0.38%. It showed that Biofloqua and Biofloc treatment can maintain water quality under optimal conditions. The use of probiotics in aquaculture can keep the microbial population in balance and control pathogens in the digestive tract [21], water and aquatic environment through the biodegradation process [22].

**Table 4.** Feed Efficiency and Growth of Fish for 42 days

| Treatment | Feed efficiency (%) | Growth of Total Weight (g) | Growth of Total Length (cm) |
|---|---|---|---|
| P1 | 179 ± 31.66 | 7.39 ± 1.51 | 2.61 ± 0.42 |
| P2 | 147 ± 36.10 | 6.10 ± 1.44 | 2.27 ± 0.27 |

The results of the study show that the feeding efficiency of P1 (179%) is not significantly comparable to that of P2 (147%) (Table 4). The bacteria enter the digestive tract through respiration during meals. Snakeheads may benefit from flocculation in the optimal environment. Thus, the bacteria in P1 and P2 can act in the digestive tract and increase digestibility. Although the average feeding efficiency of fish in P1 and P2 was not significant, the Biofloqua system showed better performance than the Biofloc system. High digestibility can increase nutrient uptake, so when the nutrient requirement of the fish is met, the fish grow well and the value of feeding efficiency increases [23].

The growth of water spinach plants was good. At the beginning of care, the initial height of the plants was 7-8 cm. 7 days after planting on Biofloqua media, the size of the plants was 15-19 cm. 21 days after planting the height of the plants reached 35.60-46.73 cm. The height of water spinach plants at the age of 9 days after planting was 16 cm and 18 days after planting was 47.24 cm [24]. The development of water spinach plants in aquaponic systems may be influenced by the availability of sufficient nutrients in the form of nitrates and phosphates, which are taken up by the plants in the aquaponic system [25].

## 4. Conclusion

Application of Biofloc technology or aquaponics with Biofloc and floating systems on culture media for snakehead fish (Channa striata) can produce water quality in maintenance media that can be tolerated by snakehead fish, pH 6.1-7.7, dissolved oxygen 4.45-5.95 mg L-1, TDS 284.50-488.17 mg L-1, BOD 0.48-0.68 mg L-1, feed efficiency 179%, and fish survival 100%. The integration of biofloqua technology can be used as a simple cultivation system by producing fish and vegetables.

## 5. Acknowledgment

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