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THE PROSPECTS OF BIOFLOC TECHNOLOGY FOR SUSTAINABLE DOMESTIC LEVEL AQUACULTURE DEVELOPMENT FOR ROHU (*LABEO ROHITA*)**

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ABSTRACT

Over a period of ten weeks, this research explored the effects of Bio-floc technology (BFT) on key aspects of Rohu (*Labeo rohita*) aquaculture, including water quality, growth performance, feed utilization, and overall fish health within a zero-water exchange tank system. The results demonstrated positive outcomes, reinforcing the effectiveness of BFT in sustaining ideal conditions for rohu cultivation. The system successfully regulated essential water quality parameters within recommended limits. The Specific Growth Rate (SGR) reached 7.22% per day, indicating significant growth efficiency, while the fish exhibited an average daily length increase of 18.7%. Key water quality factors, including total ammonium nitrogen (TAN), nitrite, nitrate, and chlorine, were maintained at safe levels, ensuring a conducive environment for fish growth. TAN remained consistently below 1.3 mg/L, nitrite levels did not exceed 0.5 mg/L, and nitrate concentrations stayed well below the harmful threshold of 50 mg/L, supporting efficient nutrient absorption. Additionally, no traces of harmful chlorine compounds were detected. The system also sustained dissolved oxygen levels above 4 mg/L, ensuring adequate oxygen supply for the fish. These findings highlight the potential of BFT as an eco-friendly and effective method for developing Rohu aquaculture conditions.

Keywords: Bio-floc Technology, water quality, aqua culture, Rohu, specific growth rate.

INTRODUCTION

One of the major challenges facing humanity is the critical task of meeting the dietary requirements of an anticipated worldwide population of eight billion people by 2030. To work toward a sustainable future, various organizations, including the United Nations (UN) General Assembly, have introduced the Sustainable Development Goals (SDGs) under Agenda 2030. The second goal within these SDGs, often referred to as "zero hunger," aims to eradicate hunger worldwide by 2030. This ambitious objective focuses on eliminating hunger, ensuring comprehensive food security and nutrition, and promoting sustainable agricultural practices on a global scale (Bennich *et al*., 2023).

Aquaculture often releases large volumes of untreated water, which can lead to water shortages and environmental contamination. Bio-floc Technology (BFT) is heralded as a transformative "blue revolution" due to its capacity to continuously recycle and reuse nutrients within the culture medium, significantly reducing or even eliminating the need for water exchange. This sustainable approach is based on the intensive cultivation of fish and shrimp in confined environments. Bio-fl naturally form in these systems shortly after the accumulation of organic waste, as microbial cells undergo a complex flocculation process governed by physical, chemical, and biological mechanisms, leading to the creation of matrix flocs. Bio-floc technology (BFT) is a sustainable aquaculture method that enhances water quality by regulating carbon and nitrogen while also producing proteinaceous feed on-site (James *et al*., 2008). BFT is an environmentally friendly technology that promotes the large-scale cultivation of microorganisms within their natural environment. ocs. The microbial communities are central to establishing and stabilizing a heterotrophic ecosystem. These microorganisms play key roles in various aspects of the system, including: (i) maintaining water quality by absorbing nitrogen compounds and producing microbial protein on-site (ii) enhancing culture feasibility by improving feed conversion ratios (FCR) and lowering feed costs (iii) competing with pathogens, thereby reducing disease risks (iv) ensuring favorable water conditions (v) contributing to biosecurity measures (vi) supporting the sequestration of greenhouse gases (GHGs). This integration of microbial activity and sustainable aquaculture practices makes BFT a pioneering approach to modern aquaculture (Rizvi and Ahmed, 2025).

This study focuses on growth performance, feed efficiency, nitrogen retention, water quality, hematological profile, bio-floc nutritional composition, and the high production rates of Rohu (*Labeo rohita*) under minimal or no water exchange conditions.

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MATERIALS AND METHOD

Materials and Chemicals

The experiment involved no water exchange in the BFT system following the method as reported by Rizvi and Ahmed (2025).

Fish, Experimental Conditions, And Feeding Cycle

Rohu (*Labeo rohita*), was utilized in our experiment due to its notable characteristics, which include an omnivorous diet, resistance to nutrient cycling diseases, rapid growth rate, and ability to thrive in diverse environmental conditions (Rizvi and Ahmed, 2025).

Calculations And Statistics

Calculations and statistics were used to calculate the survival cycle and growth cycle of Rohu as reported in literature (Martins *et al*., 2019).

Assessment Of Water Quality Parameters

Water parameter measurements were conducted every three days, covering total ammonia nitrogen (TAN), pH, nitrite, dissolved oxygen, chlorine, and water hardness. These tests were performed using materials supplied by Wuhu Jinghui Biotechnology Co., Ltd. and were consistently carried out throughout the 10-week study. (Rizvi and Ahmed, 2025)

Bio-floc reactor and Cultivation Unit

We utilized approximately one hundred liters of water in the cultivating device for the experiment, resulting in a Bio-floc-to-water ratio of 1%. 120 grams of molasses, 12 grams of aquatic microorganisms, and 1.2 grams of sodium comprised the Bio-flocs (Azim and Little, 2008; Rizvi and Ahmed, 2025).

Cultivation Unit

The Unit for Bio-floc reactor effectively utilized following three days of forming multicultivation flocs; these flocs were introduced to the cultivating unit (Fig. 1). The unit dedicated to cultivation was Rohu.

Fig 1. Bio-floc Cultivation Unit, The Figure indicates the Bio-floc introduced in the Cultivating Unit.

RESULTS AND DISCUSSION

Growth & sustainability

Along with a nutritionally balanced diet, biomass-based feeding rates were implemented for the Rohu *(Labeo rohita)* to optimize growth while maintaining water quality and preventing overfeeding. The feeding regime was adjusted to ensure efficient use of resources. The weight and length of the fish were recorded weekly, and the condition factor (K) was calculated. Additionally, the Specific Growth Rate (SGR) was computed based on the gathered data. The calculated SGR was approximately 7.22% per day on average identified which signifies substantial rates of growth. The aforementioned value illustrates the efficacy of the zero-water exchange system in facilitating the growth of Rohu. The Rohu within the system demonstrated significant expansion in length, averaging around 18.7 % weekly growth (Fig 2, 3). This result highlights the efficacy of the system in facilitating the development of fish. The condition factor of the Rohu varied between 1.4 and 2.1, Fig.4 suggesting that the fish maintained a body mass that was comparatively greater than their length. This range is consistent with optimal conditions for aqua cultured Rohu. Moreover, it was demonstrated that the zero-water exchange system functioned exceptionally well in preserving water quality parameters at acceptable levels. The calculated Specific Growth Rate (SGR) is approximately 7.22% per day based on the provided data. This indicates the average daily growth rate of the fish during the 70-day experimental period. Varying growth and sustainability were reported in literature (Martins *et al*., 2019).

Survival rate

A ten-week experimental study evaluated (Fig. 5) the viability of Rohu *(Labeo rohita)* cultivation in a zero-water exchange tank system, using a stocking density of approx. one fish per liter. Weekly survival rates ranged between 90% and 100%, indicating generally favorable outcomes. However, the final survival rate, calculated at 59% after ten weeks, highlights both the challenges and the potential benefits of this cultivation approach. Notably, the discrepancy between weekly and overall survival rates suggests that mortality associated with handling and measurements may have influenced the aggregate survival rate. It is essential to consider that these measurement-related losses could have introduced potential errors in the recorded survival rate (Rizvi and Ahmed, 2025).

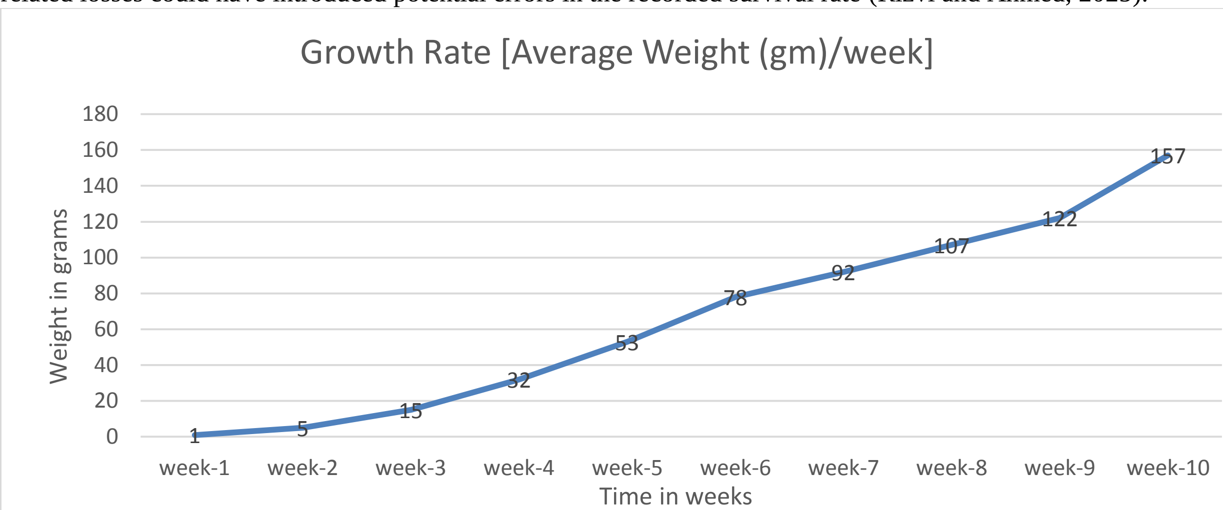

Fig 2. Depicts the graph illustrating increasing trends for weight gained/week.

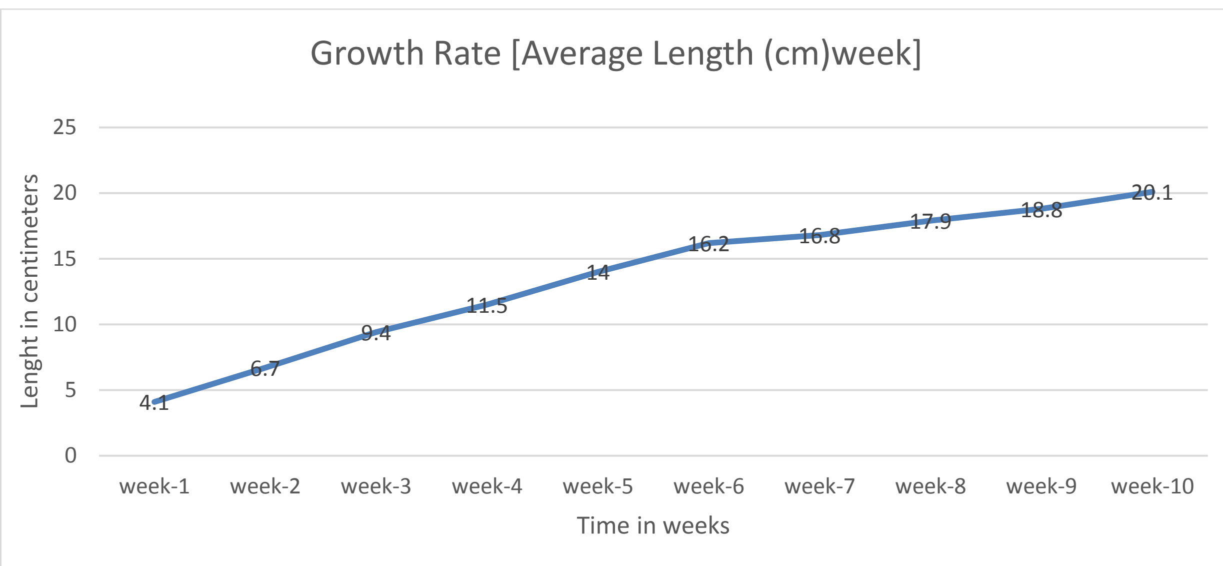

Fig 3. Depicts the graph illustrating increasing trends for length gained/week.

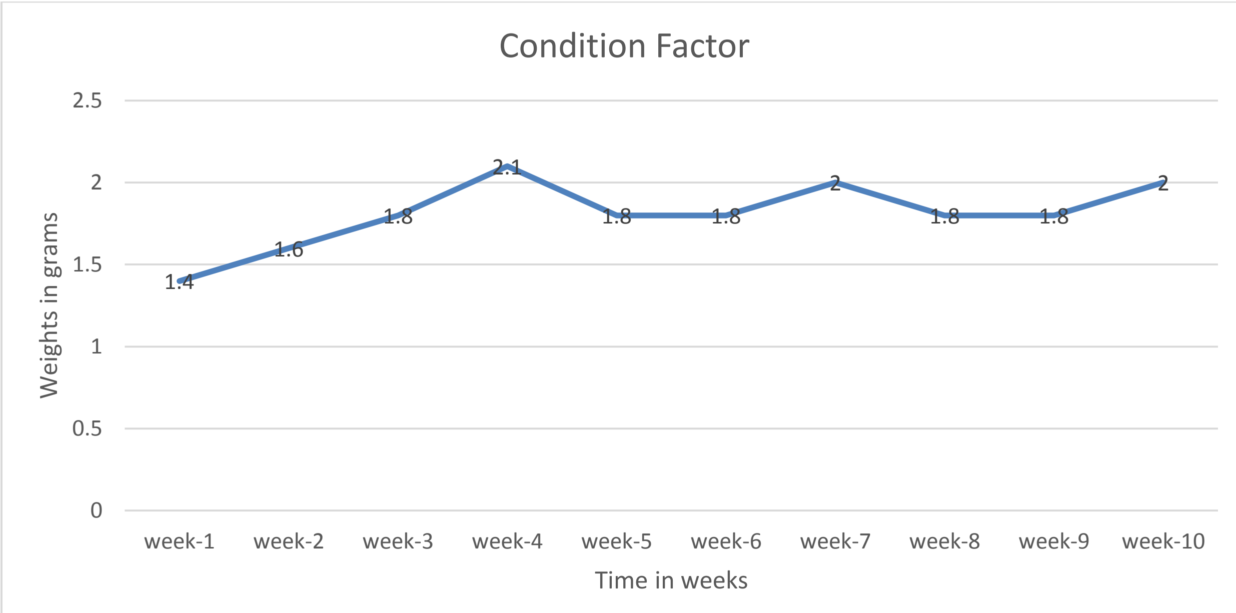

Fig 4. Depicts the graph illustrating increasing trends for Condition factor. As condition factor increase the 1.5 marks it indicates higher body mass for their length.

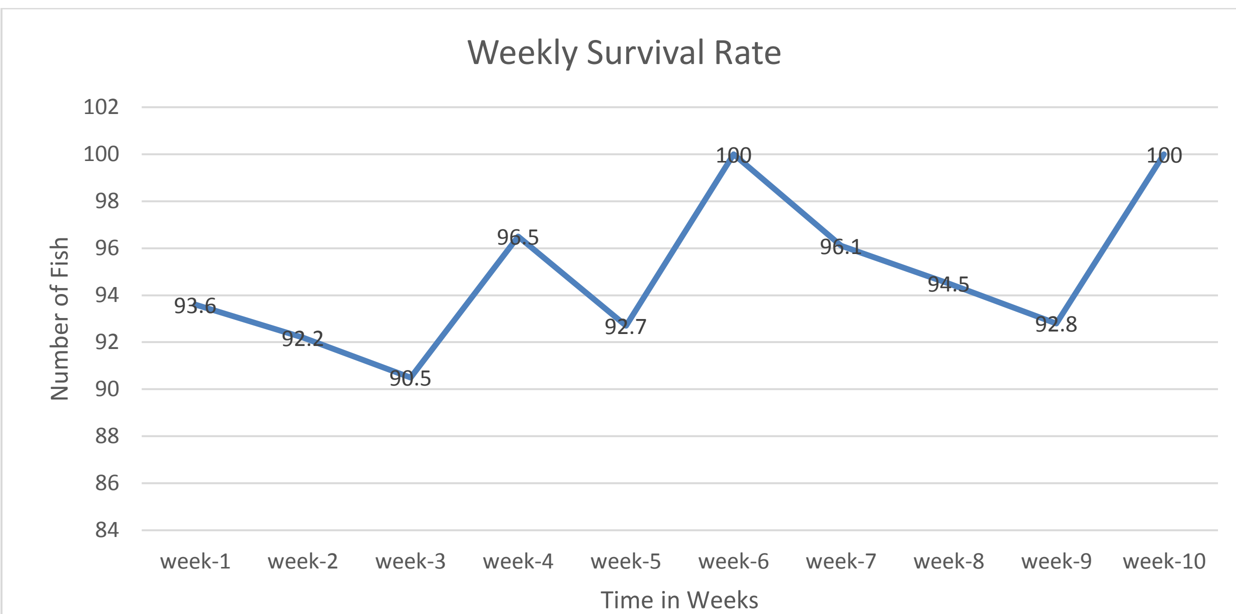

Fig 5. Illustrates the graph of survival rate per week.

Targeted Approach Water Dynamics

Throughout the experiment, key water quality parameters (Fig. 6, 7, 8, 9, 10, 11) were consistently maintained within optimal ranges for Rohu *(Labeo rohita)* cultivation. pH levels were kept within the recommended range of 6.5–8.5. Total Ammonia Nitrogen (TAN) levels remained below the critical threshold of 0.5 mg/L, indicating effective management of ammonia production within the system. Nitrite levels were consistently under 0.5 mg/L, minimizing potential harm to fish health. Nitrate concentrations were maintained below 50 mg/L, promoting both fish well-being and efficient nutrient utilization. Chlorine levels were low, confirming the absence of harmful chlorine compounds. Dissolved oxygen levels exceeded the minimum requirement for Rohu, consistently above 5 mg/L, ensuring adequate oxygen for fish respiration (Rizvi and Ahmed, 2025). While Emerenciano *et al*. (2017)

reported that the normal ranges for water quality parameters matches with our result ranges which was applied on Rohu *(Labeo Rohita)* and the article's goal was on aquaculture sustainability.

pH

During the 10-week trial, pH levels were consistently maintained within the recommended range for Rohu *(Labeo rohita)* culture (6.5–8.5) as shown in fig 6, remaining stable between 7.0 and 7.6. This steady pH range was essential for supporting Rohu's overall health and growth, as it facilitated effective nutrient absorption and minimized stress on the fish. Additionally, maintaining a consistent pH created an optimal environment for beneficial bacteria, which play a crucial role in waste decomposition and sustaining water quality. By promoting proper nutrient uptake and metabolic activity, the controlled pH levels contributed to a healthier aquatic environment, reducing the risk of stress and disease within the fish population (Rizvi and Ahmed, 2025)

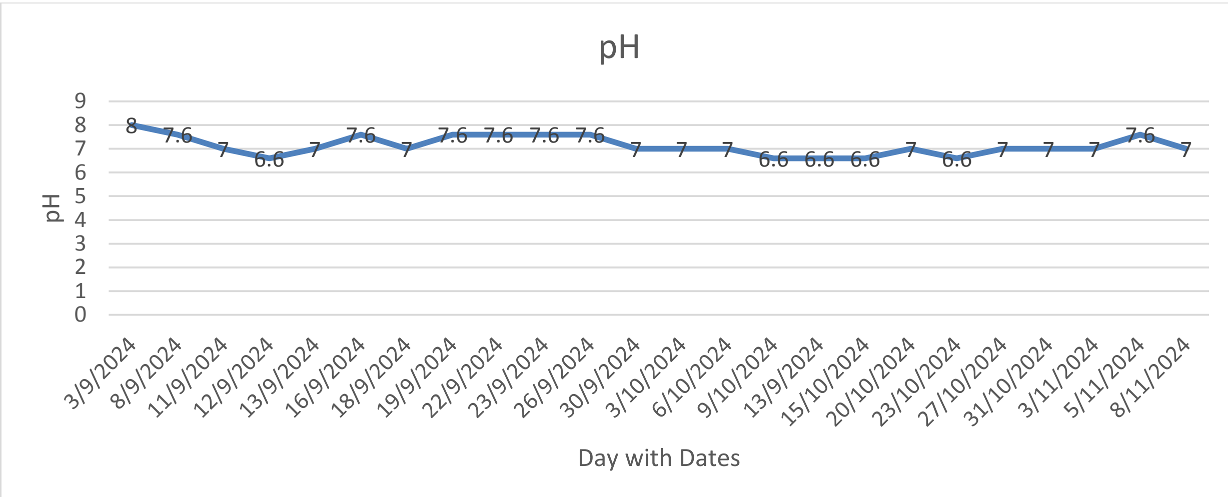

Fig 6. Depicts the graph illustrating the sampling conducted and the result documented from the pH test.

Total Ammonia Nitrogen

Total Ammonia Nitrogen (TAN), encompassing both ammonium ($NH4^{+}$) and ammonia ($NH3$), is a crucial parameter for monitoring and controlling ammonia toxicity in aquaculture systems. The optimal TAN range for Rohu *(Labeo rohita)* cultivation is typically 0.5–2.0 mg/L as demonstrated in fig 7, with lower concentrations being preferable. Unlike some other fish species, Rohu *(Labeo rohita)* demonstrate a notable tolerance to higher TAN levels, enduring concentrations up to 2.0 mg/L for extended periods. During the 10-week experiment, TAN levels were recorded between 0.6 mg/L and 1.2 mg/L, with an action threshold set at 1.0 mg/L. On two occasions, TAN levels rose to 1.2 mg/L. The study also highlighted that elevated temperatures increase the concentration of unionized ammonia ($NH3$), the more toxic form of ammonia, underscoring the importance of temperature management in mitigating ammonia toxicity (Rizvi and Ahmed, 2025).

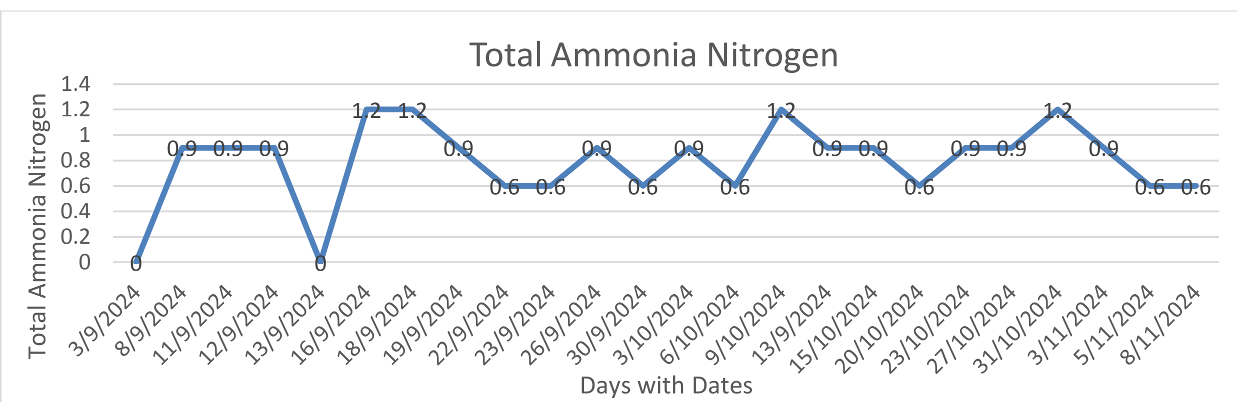

Fig 7. Depicts the graph illustrating the sampling conducted and the result documented from the TAN test.

Chlorine

In Biofloc Technology (BFT) systems used for Rohu *(Labeo rohita)* production, it is recommended to keep chlorine levels as close to zero as possible (Rizvi and Ahmed, 2025). While chlorine is commonly used as a disinfectant in water treatment processes, typical concentrations are observed within the range of 0.2 to 0.8 mg/L (Fig. 8).

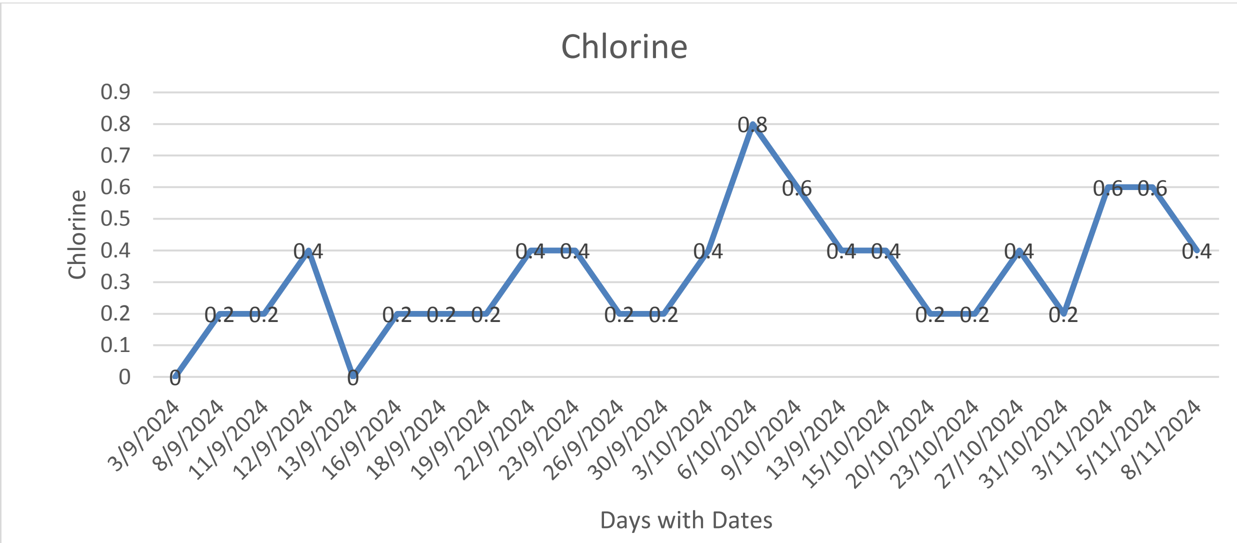

Fig 8. Depicts the graph illustrating the sampling conducted and the result documented from the Chlorine test.

Nitrite

In aquaculture systems, maintaining minimal or undetectable nitrite (NO_2^-) levels is essential for ensuring optimal conditions for Rohu, as nitrite can be toxic to fish. To protect the health and well-being of Rohu, it is recommended to keep nitrite levels below 0.2 mg/L. In biofloc systems, nitrite (NO_2^-) and nitrate (NO_3^-) are closely interconnected as key components of the nitrogen cycle. During our 10-week experiment, nitrite levels were generally traceable at approximately 0.1 mg/L (Fig. 9). However, there were three instances where nitrite levels exceeded the acceptable limit. Root cause analysis identified excessive feeding and the resulting depletion of oxygen as the primary factors behind these occurrences (Rizvi and Ahmed, 2025).

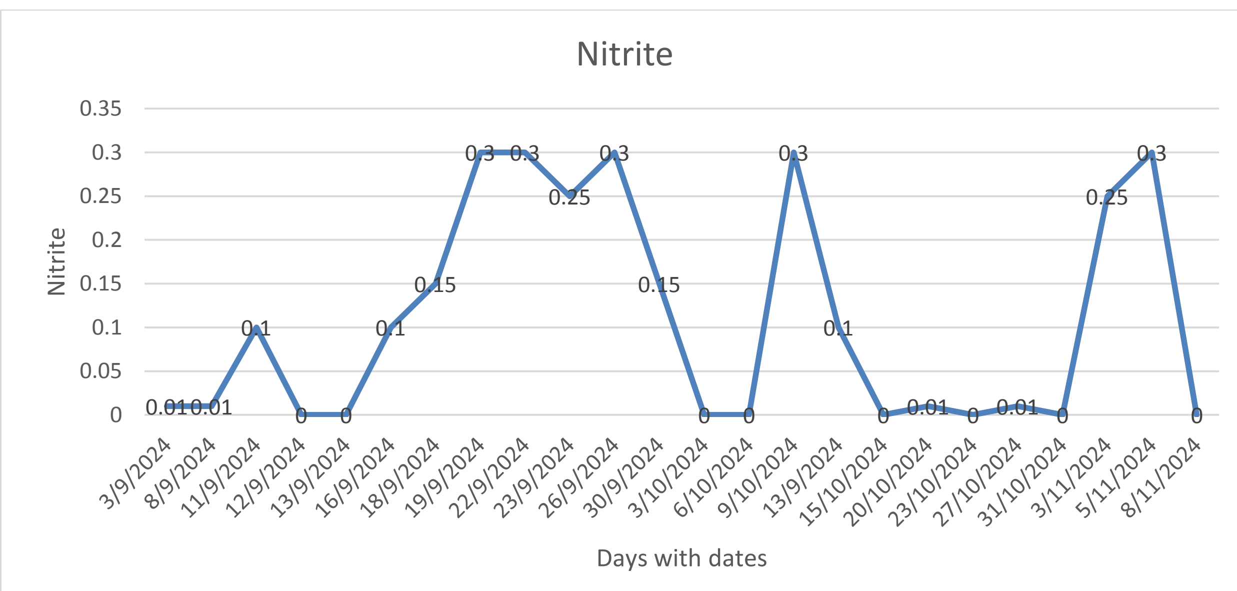

Fig 9. Depicts the graph illustrating the sampling conducted and the result documented from the nitrite test.

Nitrate

The optimal nitrate (NO_3^-) thresholds in a biofloc system utilized for Rohu *(Labeo rohita)* cultivation might exhibit variability contingent upon many aspects, including the precise objectives of the aquaculture enterprise, water quality characteristics, and the particular Rohu *(Labeo rohita)* species under cultivation. Nevertheless, it is commonly advised to maintain nitrate levels below 50 mg/L (milligrams per liter) in a biofloc system utilized for the cultivation of Rohu (Rizvi and Ahmed, 2025). During our 10-week study on Rohu *(Labeo rohita)* culture, the nitrate levels were consistently measured at 0-10 mg/L. Low oxygen levels were found to impede the denitrification process in the biofloc system, thereby leading to the accumulation of nitrate (Fig 10).

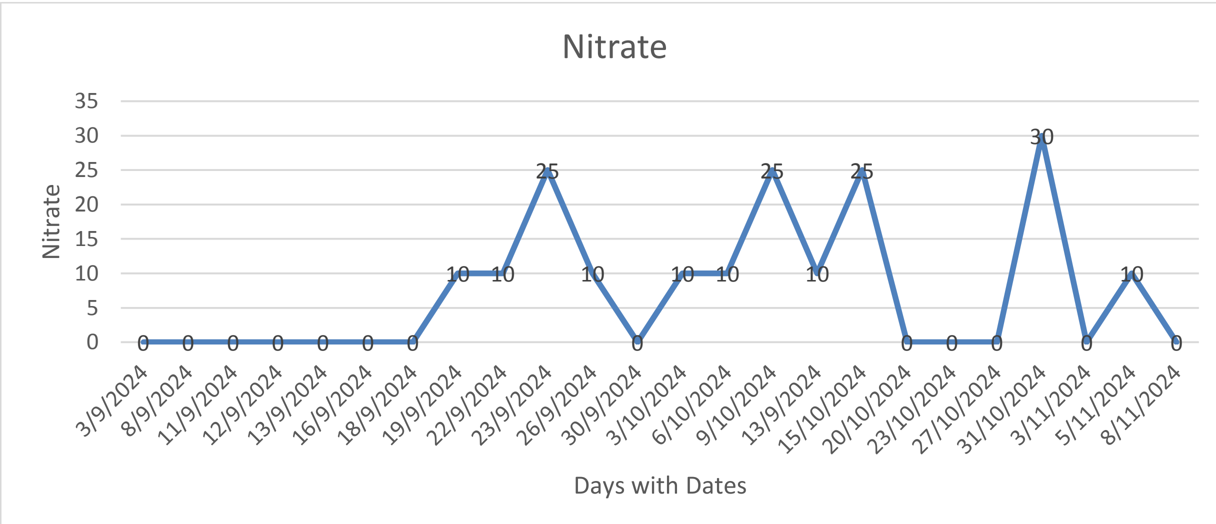

Fig 10. Depicts the graph illustrating the sampling conducted and the result documented from the nitrate test.

Dissolved Oxygen

During our 10-week experiment, dissolved oxygen (DO) levels were periodically measured using a tri-day sampling method, with concentrations generally ranging from 5-8 mg/L. At times, measurements approached 4 mg/L, the action threshold prompting stock density adjustments. To address this, additional aeration and oxygenation systems were introduced, successfully restoring and sustaining oxygen levels. Insufficient dissolved oxygen can lead to hypoxia, characterized by respiratory distress and, in severe cases, mortality (Rizvi and Ahmed, 2025). Proper oxygen levels also contribute to improved water quality and help prevent the growth of harmful algal colonies. Figure 11 illustrates the line graphs and recorded sampling data from the biofloc-based cultivation system.

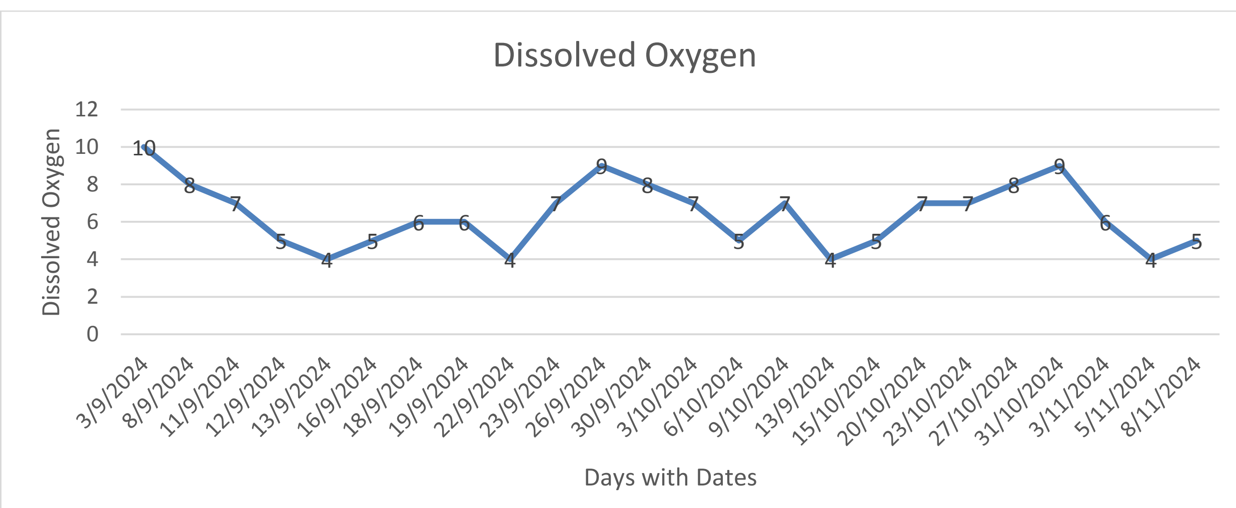

Fig 11. Depicts the graph illustrating the sampling conducted and the result documented from the dissolved oxygen test

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