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Water Quality Analysis of Nile Tilapia Hatchery Ponds at the Fish Hatchery Center in Tepas Sepakat Village, West Sumbawa Regency

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Abstract: This research was conducted to evaluate the water quality of Nile tilapia (*Oreochromis niloticus*) hatchery ponds at the Fish Seed Center (Balai Benih Ikan, BBI) located in Tepas Sepakat Village, West Sumbawa Regency. Water quality is a critical factor that directly influences the success of aquaculture, particularly in hatchery operations where the survival and growth rates of fish fry are highly dependent on optimal environmental conditions. The study assessed key water quality parameters including temperature, dissolved oxygen (DO), pH, ammonia concentration, and water transparency. Measurements were carried out quantitatively through direct sampling from three hatchery ponds containing fry of different ages and sizes, with data collected over three consecutive days during morning and afternoon sessions. The results indicated that all measured parameters remained within the acceptable ranges established by the Indonesian National Standard (SNI 7550:2009) for freshwater aquaculture. Water temperature ranged between 25.9°C and 27.9°C, DO levels varied from 3.9 to 5.2 mg/L, pH values ranged from 7.5 to 8.2, ammonia concentration was consistently below 0.1 mg/L, and water clarity ranged from 40 to 46 cm. Although water clarity slightly exceeded the standard threshold, it was still within a tolerable range that could support sufficient light penetration for photosynthesis without posing risks to the aquatic ecosystem. These findings suggest that the water quality at the BBI Tepas Sepakat hatchery ponds is generally suitable for supporting healthy and productive tilapia breeding. However, continuous monitoring and adaptive water quality management, particularly concerning dissolved oxygen and light penetration, are recommended to maintain optimal rearing conditions and ensure long-term sustainability of the hatchery operations. These findings can serve as a useful reference in promoting sustainable aquaculture practices and can be used in aquaculture training programs to improve water quality management.

Keywords: Aquaculture; Fish Seed Center; Hatchery; Nile Tilapia; Water quality.

Introduction

The strategic role of Nile tilapia (*Oreochromis niloticus*) aquaculture in improving national fisheries productivity is of great importance, particularly in meeting the growing demand for affordable and nutritious protein sources among the population. This improvement can be achieved through the application of efficient aquaculture techniques, such as selective breeding, water quality management, and the use of high-quality feed, as well as the development of adequate supporting infrastructure, including hatcheries, cold storage facilities, transportation networks, and access to local and international markets. Moreover, policies supporting the fish feed industry and providing superior broodstock are key factors in enhancing the competitiveness of tilapia farming [1].

Water quality is a critical factor in the success of fish hatchery operations [2] as it directly affects fish fry's growth and survival rates. Optimal water quality promotes healthy growth and improves the survival rate of fish larvae, which is essential in aquaculture development [3]. Water quality that meets appropriate physical and chemical parameters significantly influences the success of freshwater fish farming [4]. The benefits of good water quality include improved fish health and immunity, optimal growth performance, better feed efficiency, reduced production costs, minimized waste and toxin accumulation, ecological balance in culture systems, and easier harvest and production management [5]. For example, research by Boyd and Tucker [6] emphasized the importance of dissolved oxygen, pH, and temperature in maintaining productive aquaculture systems. Similarly, Baihaqi et al. [7] found that maintaining nitrate and ammonia levels within tolerable limits significantly enhanced the growth rate and survival of Oreochromis niloticus**.** Hence, regular monitoring and management of water quality are essential to ensure optimal growth conditions.

Poor water quality poses several risks, including: (1) Temperature: excessively low temperatures slow metabolism and appetite, while excessively high temperatures lead to dissolved oxygen depletion, heat stress, and fish mortality; (2) Dissolved Oxygen: low levels cause surface gasping, stress, stunted growth, and mass mortality; (3) pH: low pH may cause gill irritation and stress, while high pH increases ammonia toxicity and tissue damage; (4) Ammonia (NH_3): elevated concentrations lead to gill damage, appetite loss, and mortality; (5) Nitrite (NO_2^-): high levels interfere with oxygen transport in blood; (6) Turbidity: excessive turbidity disrupts fish respiration, reduces light penetration, and inhibits phytoplankton photosynthesis [8].

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The Tepas Sepakat Fish Hatchery (Balai Benih Ikan, BBI) in West Sumbawa Regency is one of the regional technical implementation units (UPTD) under the Department of Fisheries. The main duties of this unit include producing quality seed and broodstock to supply local hatcheries and fish for consumption, particularly tilapia and carp. The hatchery utilizes water from the Brang Rea River, which is diverted through irrigation channels into the hatchery and grow-out ponds.

However, the direct use of river water as a culture medium requires careful consideration due to the potential for pollution from surrounding environmental activities. A study by Syahrul et al. [9] revealed that although the overall water quality of the Batetangnga River in West Sulawesi falls within the suitable range for aquaculture, variations in ammonia and phosphate levels across stations, as well as pollution from community waste, pose a risk to long-term water quality. Furthermore, suboptimal aquaculture practices may also contribute to water quality degradation. Therefore, evaluating the water quality at the Tepas Sepakat Hatchery is crucial as part of a monitoring and evaluation process to support successful aquaculture operations. Periodic monitoring is necessary to ensure the aquatic environment remains within the optimal range to sustain fish growth and survival.

The objective of this study is to assess the water quality in the fish hatchery ponds at the Tepas Sepakat Hatchery, West Sumbawa, and to compare it with the Indonesian National Standard (SNI) for hatchery water quality to determine the suitability and feasibility of the culture environment.

This study is the first documented review of compliance with SNI standards in the Tepas Sepakat hatchery system using a multi-parameter approach. The findings of this study have the potential to have important implications for the development of hatchery training curricula, the formulation of water quality management policies, and continuous improvement in local aquaculture practices based on national standards.

Research Methods

Time and Location

This research was conducted from April to May 2025 at the Fish Hatchery Center (Balai Benih Ikan/BBI) in Tepas Sepakat Village, Brang Rea Subdistrict, West Sumbawa Regency, Indonesia.

Figure 1. Map of the Research Location and Sampling Ponds: Research Method

This study employed a quantitative research method by measuring water's physical and chemical parameters in Nile tilapia hatchery ponds at the Fish Hatchery Center (Balai Benih Ikan/BBI) in Tepas Sepakat Village. Observations were carried out in three selected ponds (Table 1).

Table 1. Number of Observation Ponds

Pond A	Pond A	Pond A
Age: 1 Month Seed Size: 2–3 cm	Age: 2–3 Months Seed Size: 5–6 cm	Age: 4 Months Seed Size: 8–10 cm

The water quality parameters measured in this study included Dissolved Oxygen (DO), pH, temperature, ammonia, and water transparency. Measurements were conducted for three days, both in the morning and afternoon. The instruments used were as follows: a DO meter to measure dissolved oxygen levels, a pH meter for pH levels, a thermometer for water temperature, an ammonia test kit for ammonia concentration, and a Secchi disk to measure water transparency.

The sampling technique used in this study was purposive sampling, which is the deliberate selection of samples based on specific characteristics. Ponds A, B, and C were selected based on differences in seed age, namely 1 month, 2–3 months, and 4 months, respectively. Water sampling was conducted in each pond at two different times, namely in the morning and afternoon, which were chosen to represent differences in natural light intensity that could affect water quality parameters. The sampling and testing were conducted over three consecutive days to obtain more representative data.

Dissolved oxygen (DO) parameters are measured using a DO meter immersed directly into the pond water. This device simultaneously provides readings for DO, pH, and water temperature. Before use, the DO meter is calibrated to ensure the accuracy of the measurements. Water clarity (transparency) parameters are measured using a Secchi disk, which is also submerged into the pond until the disk is no longer visible from the surface, and the depth is recorded as the water transparency value. Meanwhile, ammonia parameters are measured by taking pond water samples using sample bottles. The sample is then analyzed at the Tepas Sepakat Fish Seed Center (BBI) laboratory using an Ammonia Test Kit to determine the ammonia concentration in the water.

All measurement results were recorded and documented for further analysis.

Data analysis

The data analysis technique used in this study was descriptive analysis. Descriptive analysis is a statistical method used to summarize and present sample data in a form that is easier to interpret. The data obtained from water quality measurements were presented in graphical form. These data were then described and compared with the water quality standards for freshwater aquaculture based on the Indonesian National Standard (SNI) 7550:2009.

The results of water quality parameter measurements and SNI quality standards were compared using a comparison approach with SNI by matching the measurement values of each parameter with the SNI 7550:2009 quality standard range. If the value is within that range, it meets water quality standards.

Results and Discussion

Temperature

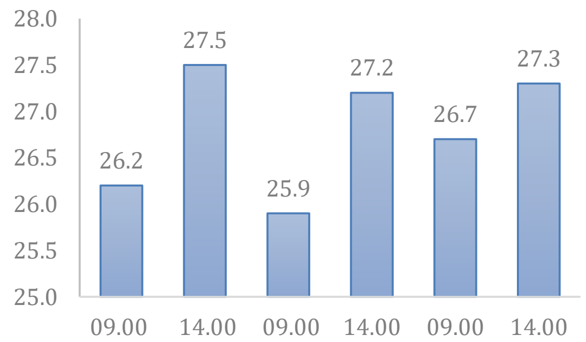

Figure 2. Water Temperature Pond A

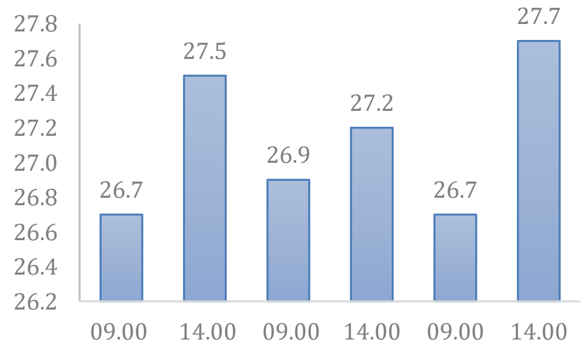

Figure 3. Water Temperature Pond B

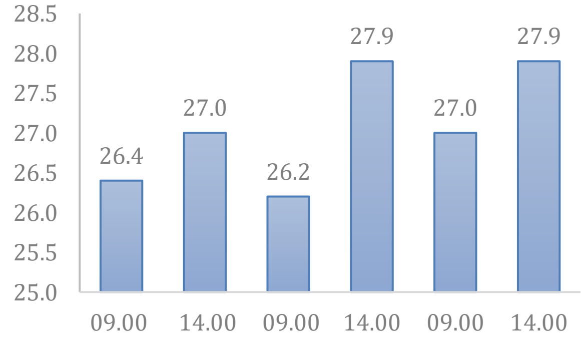

Figure 4. Water Temperature Pond C

Observations of water temperature over three days indicated that the temperature in all three ponds was within the acceptable range based on the Indonesian National Standard (SNI), which is between 25°C and 32°C. Pond A recorded temperatures ranging from 25.9°C to 27.5°C, Pond B from 26.7°C to 27.7°C, and Pond C from 26.2°C to 27.9°C. These temperature values suggest that the thermal conditions in each pond were suitable to support the physiological functions, growth, and survival of Nile tilapia during the observation period. Temperatures tended to increase during midday. This pattern is in line with the results of Muarif's [10] research, which reported that the water temperature in aquaculture ponds during the day is higher than in the morning or evening, and this difference is statistically significant**.** According to Deqita and Sudarti [11], increased temperature during the day is a natural phenomenon caused by increased solar radiation. A stable and appropriate temperature is essential, as it directly affects Nile tilapia's metabolic activity and growth [12].

Dissolved Oxygen (DO)

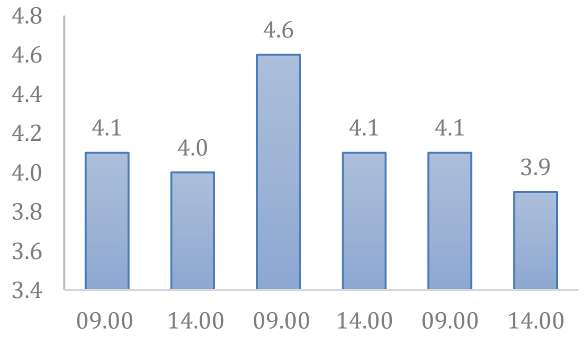

Figure 5. Dissolved Oxygen (DO) Pond A

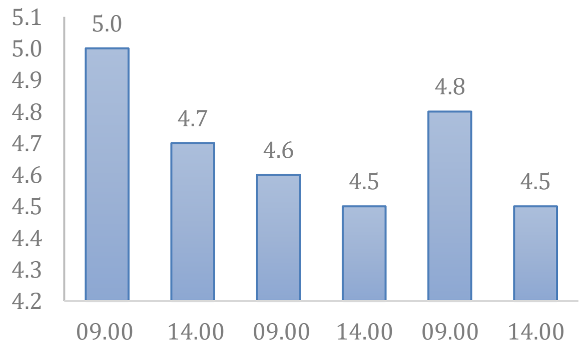

Figure 6. Dissolved Oxygen (DO) Pond B

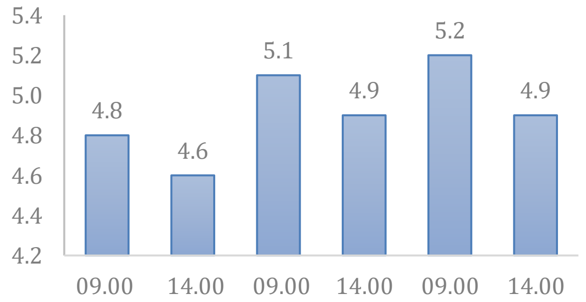

Figure 7. Dissolved Oxygen (DO) Pond C

Dissolved oxygen (DO) levels in all ponds were found to be within adequate ranges. Measurements showed that DO in Pond A ranged from 3.9 to 4.6 mg/L, Pond B from 4.5 to 5.0 mg/L, and Pond C from 4.6 to 5.2 mg/L. All values exceeded the minimum standard set by the Indonesian National Standard (SNI), which is ≥3 mg/L. These results indicate that the oxygen availability in all ponds was sufficient to support metabolic processes, maintain fish health, and ensure optimal growth conditions for Nile tilapia.

Adequate DO levels are also essential for maintaining aerobic microbial activity that contributes to water quality stability. Dissolved oxygen is a critical factor for fish respiration and the activity of microorganisms, as it directly influences the metabolic functions, growth, and survival of aquatic organisms. Adequate levels of dissolved oxygen are essential to ensure efficient energy production in fish through aerobic respiration, while also supporting the activity of beneficial microorganisms involved in the decomposition of organic matter and nutrient cycling within the aquatic environment. Low oxygen levels can lead to stress, reduced growth rates, and increased susceptibility to disease, making DO one of the most important parameters in aquaculture water quality management [13,14,15]. A slight decrease in DO was observed during midday in most ponds, which may be attributed to increased temperature and oxygen consumption by aquatic organisms [16]. Research by Alam and Al-Hafedh [17] shows that dissolved oxygen (DO) levels in tilapia farming systems fluctuate daily, with a tendency to decrease at night and increase in the morning to midday due to photosynthetic activity. However, high oxygen consumption by aquatic organisms and increased temperatures can cause a relative decrease in DO during the day, even though photosynthesis is still ongoing. These findings support the pattern observed in this study.

pH

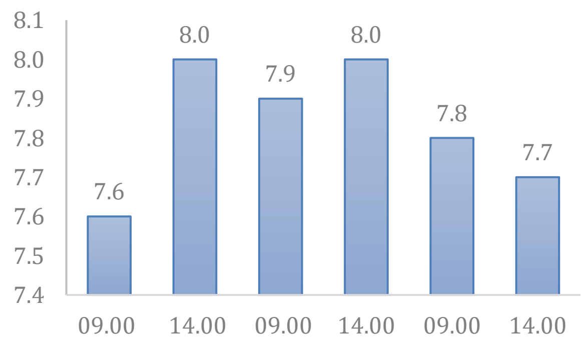

Figure 8. pH Pond A

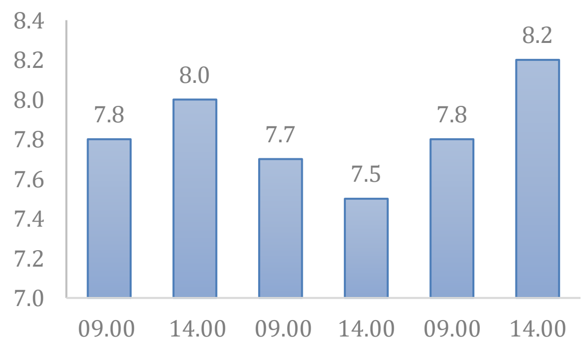

Figure 9. pH Pond B

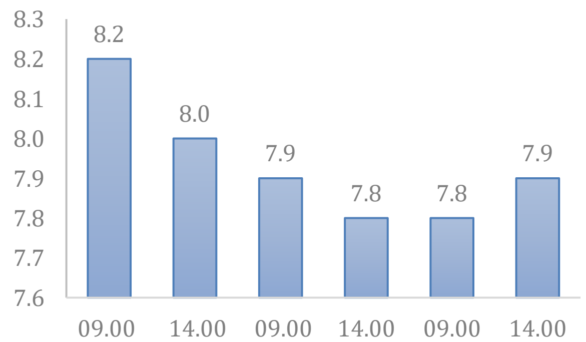

Figure 10. pH Pond C

The pH values in all ponds were within the acceptable range according to water quality standards, specifically between 6.5 and 8.5. Pond A recorded pH values ranging from 7.6 to 8.0, Pond B from 7.5 to 8.2, and Pond C from 7.8 to 8.2. An increase in pH during the afternoon was observed, which may be attributed to phytoplankton photosynthesis reducing CO_2 concentrations in the water, thereby making the water more alkaline [18, 19]. This observation is consistent with the findings of Islam et al., [20] who reported that the pH value of water in multi-trophic aquaculture systems increased from morning to evening. This increase in pH is negatively correlated with carbon dioxide concentration, which decreases as photosynthetic activity increases during the day. This mechanism indicates that the photosynthetic process by phytoplankton absorbs CO_2, causing the water to become more alkaline. The stable pH levels within the ideal range indicate water conditions that support fish health and growth.

Ammonia

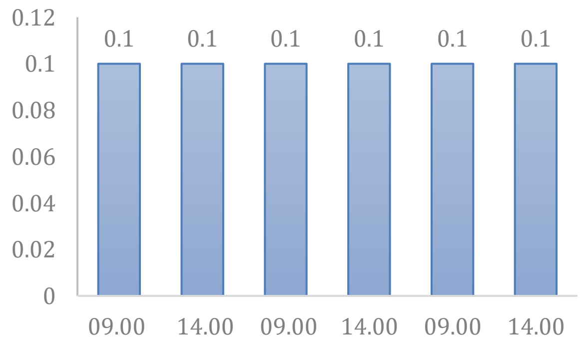

Figure 11. Ammonia Pond A

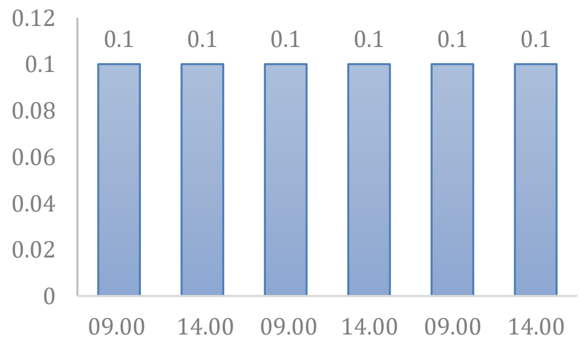

Figure 12. Ammonia Pond B

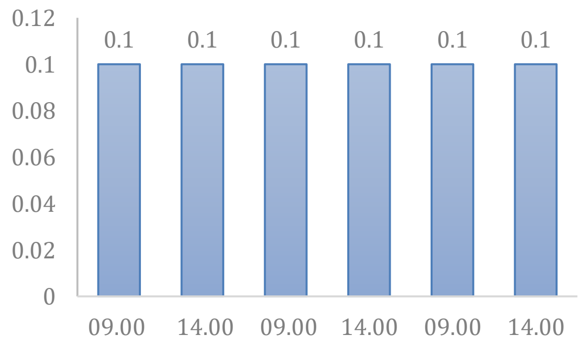

Figure 13. Ammonia Pond C

Ammonia levels were consistent across all ponds, with concentrations measured at 0.01 mg/L well below the SNI threshold of <0.02 mg/L. This indicates that ammonia levels remained within a safe range for aquaculture activities. Low ammonia levels may be caused by continuous water changes. Based on research by Wahyuningsih and Arbi [21] in Ammonia in Fish Farming Systems, water changes of up to 25–50% of the pond volume per day have been proven effective in reducing ammonia concentrations in small-scale fish ponds. These routine water changes have a positive impact on overall water quality and support a more stable farming environment.

Low concentrations suggest effective management of organic waste and a balanced microbial environment, particularly the activity of nitrifying bacteria that convert toxic ammonia into less harmful compounds. Maintaining low ammonia levels is crucial, as elevated concentrations can lead to water quality deterioration, stress in fish, and impaired physiological functions such as respiration and excretion. Ammonia is a toxic compound for fish, capable of damaging gill tissues, disrupting respiration, and causing stress and decreased immunity. If left unmanaged, high concentrations of un-ionized ammonia can lead to fish mortality. Therefore, although current levels are safe, continuous monitoring is necessary [22].

Water Transparency

Transparency measurements in the three ponds ranged from 40 to 46 cm. Pond A showed transparency of 40–46 cm, Pond B 40–45 cm, and Pond C 40–46 cm. According to SNI standards, the ideal water transparency range is 30–40 cm. Therefore, most values slightly exceeded the upper limit. This indicates that the water is relatively clear, which can enhance light penetration necessary for photosynthesis [23]. However, excessive water clarity may lead to increased water temperature or algal blooms. The high transparency might be due to the continuous inflow of river water, which dilutes suspended solids in the pond.

The high transparency of the water in this study is thought to be due to the continuous replacement of pond water, which reduces suspended particles and organic waste. Research reported by Mohanty et al. [24] found that continuous water changes reduced suspended sediments and improved visual clarity.

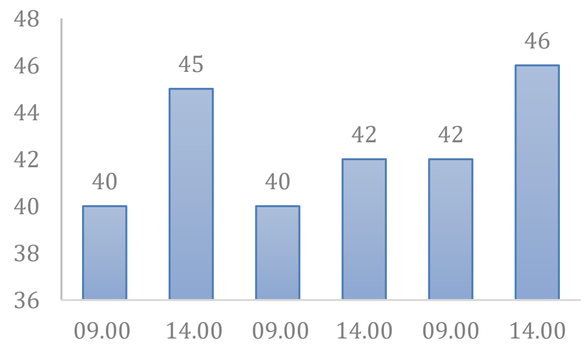

Figure 14. Water Transparency Pond A

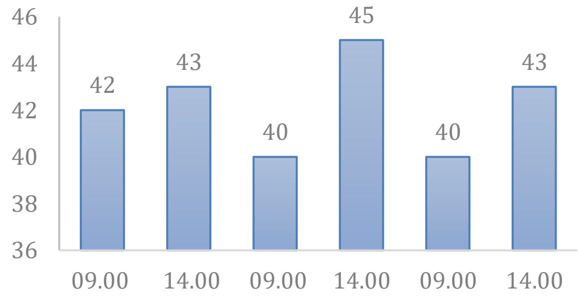

Figure 15. Water Transparency Pond B

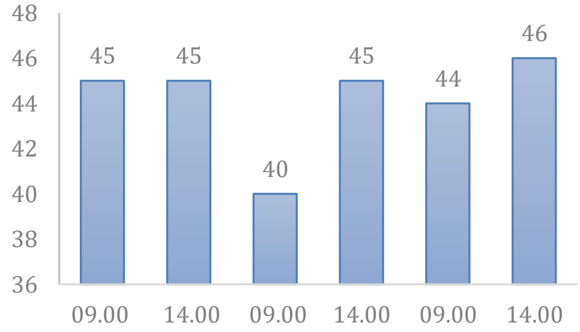

Figure 16. Water Transparency Pond C

Conclusion

Based on the research results, the water quality in ponds A, B, and C at the Tepas Sepakat Fish Seed Center (BBI) is generally within the range specified by Indonesian National Standard (SNI) 7550:2009 for freshwater aquaculture. Key parameters such as temperature, dissolved oxygen (DO), pH, and ammonia concentration show values that support the growth and survival of Nile tilapia (Oreochromis niloticus) fry. Although water transparency values slightly exceed the standard threshold, the clarity remains within acceptable limits and can support photosynthesis in the ponds. As a practical follow-up, it is recommended that the hatchery unit implement a structured and sustainable water quality monitoring protocol. Routine monitoring will help detect early changes in environmental parameters and enable more precise management decisions. This step is crucial for maintaining pond ecosystem stability and consistently improving seed production success. Additionally, the findings of this study have the potential to be integrated into technical training curricula for hatchery operations to enhance human resource capacity in the field of aquaculture. Further research is also needed to explore seasonal trends in water quality parameters, thereby supporting adaptive aquaculture strategies that are more responsive to environmental changes throughout the year.

Author's Contribution

A. Rahman: played a role in the data collection and analysis process. Jamiatul Aulia: drafted the article. Andi Maria Ulfa: co-authored the article and did the final editing. Amir Hamzah & Ari Apriani: responsible for designing the research and collecting data related to water quality parameters.

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