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Evaluation of Dissolved Oxygen Concentration in Different Circulation Systems on Water Quality in Fish Pond

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Abstract

This study aims to evaluate the impact of different circulation systems on water quality parameters in tilapia rearing. Good water quality is very important in tilapia rearing so that fish can grow healthily and optimally. This study compared three different circulation systems: one without a pump, one with one pump, and one with two pumps, all aimed at increasing the dissolved oxygen concentration in the pond. The results of this study showed that CS III was able to maintain an efficient and stable DO concentration of around 7.5 to 8 ppm, which also resulted in a stable pH value. In contrast, CS I had a low DO concentration of approximately 3 ppm, which had an inefficient impact on the pH value. Additionally, CS II demonstrated stable DO concentrations, despite a decrease in pH values. This shows that CS III can create more optimal environmental conditions for tilapia growth compared to other circulation systems. Furthermore, the consistent DO concentration influences other water quality parameters, such as pH, which is also consistent and stable, thereby promoting fish health.

Keywords: *Water Quality,* DO, pH, Tilapia

1. Introduction

Tilapia is one of the types of fresh fish that is widely popular with the Indonesian market. Tilapia has a good performance in making high protein with the ability to grow and high tolerance to its environment (Yunarty et al. 2021). Tilapia is mostly rearing by the community because it can live in maintenance media such as soil, fiber, and concrete ponds (Dewi et al. 2022). Tilapia rearing has the potential to be developed intensively to meet the needs of the community both for seed and consumption needs because of the relatively economical rearing method (Pratama et al. 2021).

The successful cultivation of tilapia is determined by several factors including seed quality, water quality, and the treatment technique (Puspitasari et al. 2022). The quality of tilapia can be observed by the length and weight of the tilapia seeds, the agility of the tilapia, its immunity to diseases and parasites (Dewi et al. 2022). Besides seed quality, water quality is important to the growth and success of tilapia farming, because water is a living media to provide nutrients such as soluble minerals and plankton organisms (Barqi et al. 2019).

The optimization of productivity is important to achieve high performance in the treatment process. The dynamics and treatment of water quality in the rearing media influence the productivity of the Tilapia (Yuliana et al. 2023). Water quality indicators are temperature, pH, dissolved oxygen (DO), and total dissolved solid (TDS) (Pratama et al. 2021). According to Direktorat Jenderal Perikanan Budidaya (2020), tilapia can survive at a pH ranging from 6.5 to 8.5 with dissolved oxygen levels ranging >5 ppm. In addition to pH and dissolved oxygen concentration, ammonia and temperature are also a common factor in tilapia aquaculture. Ammonia production is directly related to feeding, feed quality, and temperature (Idam et al. 2020).

Water quality can be as a reference in determining appropriate actions in tilapia cultivation. By paying attention to water quality, fish production can be increased meets standards during cultivation.

Therefore, this research was conducted to determine the impact of different circulation systems on tilapia production levels through measuring water quality parameters.

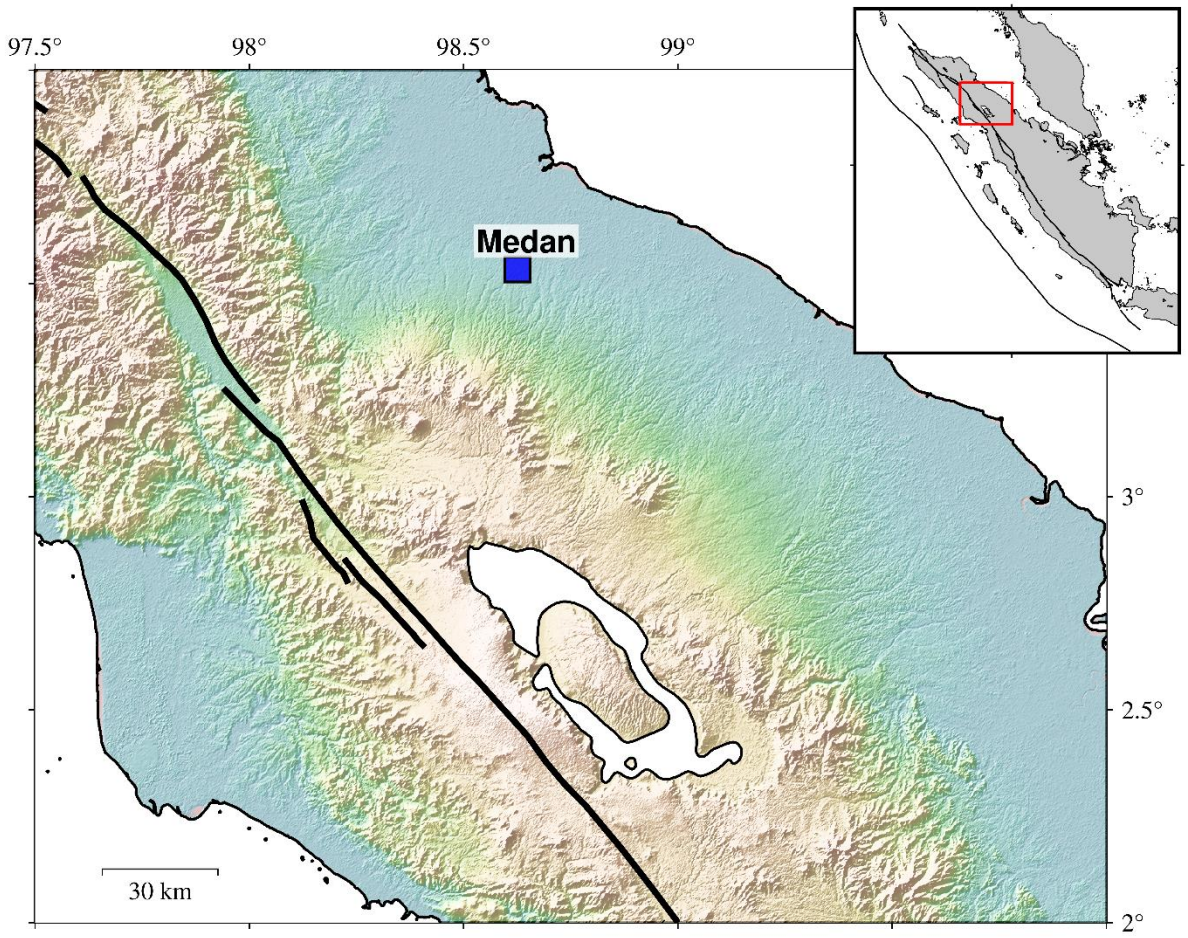

Figure 1. The location of research study in Medan city, Sumatra Utara.

2. Reasearch Methodology

This research was implemented at Pelajar Street and University of North Sumatra, Medan, North Sumatra. The aim of the research being to compare water quality parameters with the usage of water pump in tilapia rearing in concrete ponds for 21 days. The water pump was used to increase dissolved oxygen concentration with other parameters such as temperature, pH and TDS concentration. Changes and variables were measured to achieve an optimized result. A total of 150 tilapia seeds were used in this research. Tilapia seeds used were 3-5 cm sized, to complete the research on dissolved oxygen concentration with three different treatments. The feeding twice a day as much as 1gram which has 30% protein are given in the morning and evening. The research was implemented in a pond measuring 200 cm long, 85 cm wide and 65 cm high which was covered by nets as high as 2 meters from the bottom of the pond, using groundwater that had been stored in a water reservoir. The research used three circulation systems, which were the circulation system I (CS I) was maintenance without a pump, circulation system II (CS II) was maintenance with one pump with a maximum water flow rate of 1800 liters/hour and the pump turned on every day, and circulation system III (CS III) was maintenance with two pumps with a maximum water flow rate of 1800 liters/hour and the pump turned on every day, The circulation system implemented for 1 week.

The research is to compare the value of water quality parameters of the three treatments. Analysis of water quality parameter values in tilapia cultivation in concrete ponds is according to the Standard Operating Procedure for Tilapia Enlargement according to the Direktorat Jenderal Perikanan Budidaya (2020). Comparing tilapia production from each treatment based on the measured water quality parameter values.The research was implemented by measuring water quality based on parameters using standard tools with water sampling using manual sampling method. Water temperature was measured using HTC-2 Digital dipped in water, then the number shown on the Thermometer scale was recorded as data. Dissolved oxygen concentration was measured using a digital DO meter, total dissolved solids were measured using a digital TDS meter, water acidity was measured using a digital pH meter, by dipping it into the water and waiting for the value to appear on the screen. The collected data on water quality parameters with three circulation systems were

processed statistically using Ms.Word Office and ANOVA Test. The data were presented descriptively in table and graphical form, and then the data were interpreted to explain the relationship of measured water quality parameters to fish production.

3. Results and Discussion

In this research, temperature, pH, TDS and dissolved oxygen concentration were analyzed in tilapia cultivation in concrete ponds with in situ measurements. The results of each measured water quality parameter can be seen in Table. 1.

Table. 1 Parameters of water quality in tilapia cultivation (mean and deviation standar)

Parameter	CS I	CS II	CS III
Themperature (°C)	30.7±0.8	31.2±1.4	30.4±0.8
pH	7.4±0.4	7.0±0.3	7.5±0.2
DO (ppm)	2.9±0.4	4.7±0.4	7.2±0.8
TDS (ppm)	0.9±0.1	1.0±0.04	1.1±0.1

As shown in table 1, the DO concentration of the three treatments continued to increase with a significant increase. In CS I and CS II, the mean of DO concentration was below the standard value by the Directorate General of Aquaculture (2020), tilapia can survive dissolved oxygen levels ranging > 5 ppm. However, with the use of additional pumps, the average DO concentration increased to the standard value of 7.2. However, the oxygen concentration increased, the average TDS concentration also increased in each treatment with an increase in the mean of TDS value of 0.1 ppm during maintenance with temperature and pH values.

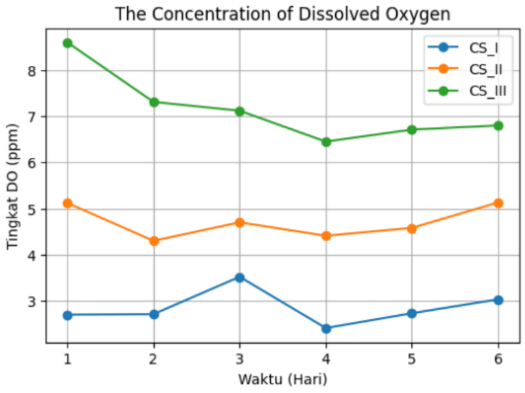

Figure 2. The concentration of dissolved oxygen at various circulation system

According to standard values based on the Kementerian Kelautan dan Perikanan Direktorat Jenderal Perikanan Budidaya (2020), tilapia can survive at pH ranging from 6.5 to 8.5. The mean of temperature value in CS II has increased from CS I, but for CS III the mean of temperature decreased which can be seen in Table 1. In this study, dissolved oxygen concentration was analyzed in tilapia cultivation in concrete ponds with in situ measurements. Based on the measurement of DO concentration in each circulation system, the difference can be seen in Fig. 2.

Based on the Fig.2, it shows that the DO concentration in CS I was very low at around 3 ppm and was stable for six days. The DO concentration indicates that the CS I system is not efficient in maintaining the oxygen levels required for fish farming. CS I experienced a significant decrease from day one to day two, after which the dissolved oxygen concentration stabilized at a lower level. CS II maintained a higher DO concentration of about 6 ppm and stabilized, indicating that this system is more efficient compared to CS I. CS II started from a lower dissolved oxygen concentration than CS I and CS III, but the dissolved oxygen concentration tended to increase slowly over time. CS III showed the highest DO concentration, around 7.5 to 8 ppm and was relatively stable, indicating that this system was most efficient in maintaining optimal oxygen levels for the fish. CS III showed the most consistent and high dissolved oxygen concentrations throughout the observation period, indicating that this system is more effective in maintaining optimal dissolved oxygen levels for fish farming. CS III appears to do a good job in maintaining the optimal dissolved oxygen concentration for fish farming.

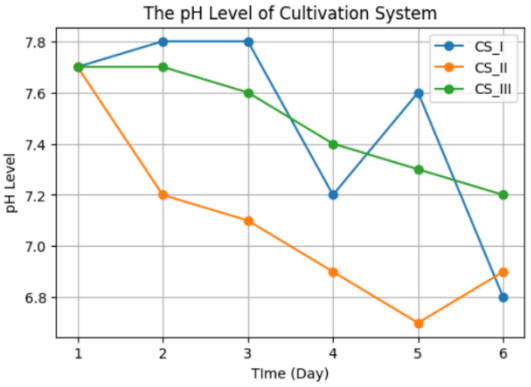

Figure 3. The pH level at various circulation system.

Based on the value of the standard operating procedure for tilapia enlargement by the Ministry of Maritime Affairs and Fisheries, Directorate General of Aquaculture (2020), the optimum DO concentration for tilapia growth is >5 ppm. Sri Andayani (2022) states, dissolved oxygen is needed by living organisms for breathing, metabolic processes, decomposition of organic matter and growth. According to Tatangidatu (2013), that in cultivation with concrete ponds oxygen production is produced through the process of photosynthesis during the day and at night it is formed by algae for the metabolic process because there is no light. According to Nabila et al (2023) states that dissolved oxygen in fish farming is useful for burning fuel (food) to produce activities, such as swimming, growth and reproduction as well as to support metabolic processes, respiration and fish survival. In fish farming, the concentration of dissolved oxygen also affects the pH value. water pH is one of the important parameters that affect the health and growth of

farmed fish. water pH that is too acidic or too basic can cause the death of farmed fish, either directly or indirectly. To prevent this, the pH value is measured to maintain water quality. Based on the pH parameter test, it can be seen as a treatment the pH value has a variation as shown in the Fig.3.

The Fig. 3 the difference in pH levels across the three different circulation systems in the six-day fish culture. This graph gives an idea of how each circulation system affects the pH of the water in the pond or culture container. In CS I, it can be seen that the pH started at around 7.6 on the first day and decreased slightly until day 4. On day 5, the pH experienced a sudden increase, then decreased again on day 6. The visible fluctuations indicate that CS I is not stable in maintaining the pH of the water, which could be due to circulation efficiency or external conditions. CD II showed a significant decrease in pH from day 1 to day 2, and this decrease continued until day 6. The steady decrease in pH suggests that Circulation System II may have weaknesses in maintaining water pH stability, which could have a negative impact on fish healthy.

The graph in CS III shows that the pH was fairly stable from day 1 to day 3, with a slight decrease occurring until day 4. There was a sudden increase on day 5, followed by a decrease again on day 6. Although there are fluctuations, Circulation System III tends to be more stable compared to CS I and CS II. pH stability is very important for fish health in aquaculture. CS III seems to provide the most consistent and stable results, while CS II shows issues that need to be corrected. CS I is in between but also require some adjustments to ensure better stability. More frequent monitoring and adjustments to the circulation system can help in achieving an optimal and stable pH for fish farming. According to Muhammad Alfian, et al (2021), the pH value of fish farming waters is influenced by dissolved oxygen, the tendency of pH will be alkaline and the opposite condition when dissolved oxygen is in large quantities. Unbalanced dissolved oxygen concentrations will cause stress in fish because they do not get enough oxygen supply and cause death due to lack of oxygen because the body cannot bind dissolved oxygen in the blood. Wahyuni T, et al (2018) stated that pH conditions that are too low can increase the solubility of metals in water and cause the death of aquatic organisms. Conversely, a high pH can increase the concentration of ammonia in water.

Rosemary Mramba, et al (2023) said Oxygen is essential for fish survival and the survival of healthy bacteria that decompose waste. Fish production increases at optimal oxygen levels through increased feeding and growth rates. However, fish production had a unimodal relationship with DO in this study, probably due to interactions with other variables such as water temperature. Since measurements were taken during the day, it is possible that aquatic plants with high photosynthetic rates increase DO during the day and decrease it through respiration at night. Low pH alters the structure and function of the gills, thus impairing the ability to maintain internal ion balance. As a result, fish expend extra metabolic energy on gill function at the expense of growth. The pH values of most ponds in this study were within the acceptable range between 6.5 and 7.3, and fish catch increased as pH increased. This finding is in line with previous studies that found a positive correlation between pH and fish harvest, fish weight and growth.

4. Conclusion

From the results of the research, it can be concluded that water quality parameters in tilapia rearing are very important, especially DO concentration. Fish farming with different circulation systems will have an impact on water quality. From the results, it can be seen that the DO concentration in CS I is very low at around 3 ppm, this concentration indicates an ineffective value in fish rearing. The DO concentration also affects the pH value, which shows that the pH value in CS I experiences unstable fluctuations. In contrast, CS II is able to maintain a DO concentration of around 6 ppm and is efficiently stable. Stable concentrations in CS II are seen to be unable to maintain the pH value which is seen to experience a significant decrease which will have a negative impact on fish health. In contrast, CS III shows a consistent DO concentration and effectively maintains the optimal DO concentration in fish farming around 7.5 to 8 ppm than CS I and CS II. The consistent of DO concentration has an impact on other water quality parameters, namely pH, which is also consistent and stable, which is good for fish health.

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