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Comparing the Behavior and Growth of Red and Black Tilapia in the Same Pond

Anggi R. Margolang [1], Tulus I. Nasution [1*], Hesti Wahyuningsih [2], Aprima A. Matondang [3], Winda Y. Yohana [1]

[1] Postgraduate Physics Study Program, Faculty of Mathematics and Natural Sciences, University of Sumatera Utara, Medan 20155, North Sumatera, Indonesia, Indonesia.
[2] Department of Biology, Faculty of Mathematics and Natural Sciences, University of Sumatera Utara, Medan 20155, North Sumatera, Indonesia, Indonesia.
[3] Department of Information and Technology, Universal Academic Of Informatic and Computer , Medan 20155, North Sumatera, Indonesia, Indonesia.
[*]Corresponding author e-mail: tulusikhsan@usu.ac.id

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Abstract

This study compared the growth of red and black tilapia in a shared pond. It examined environmental factors, including temperature, pH levels, dissolved oxygen (DO), and total dissolved solids (TDS). The study employed a solitary water pump system to monitor fish growth and water quality over 36 days. Although there was a decline in dissolved oxygen (DO) levels on day 18, red tilapia exhibited accelerated growth and higher survival rates, suggesting enhanced environmental adaption compared to black tilapia. The feeding parameters were of utmost importance, and Prima Feed (PF 1000) performed a critical role by offering the ideal levels of protein (39-41%), fat (5%), fiber (6%), ash (16%), and water content (10%). Water quality assessments indicated varying dissolved oxygen (DO) levels, which were affected by temperature fluctuations caused by unpredictable weather conditions. Although the TDS range of 0.5-1.0 ppm was deemed suitable for tilapia cultivation, the total water quality remained suboptimal throughout the investigation. However, the findings indicated that red tilapia exhibited a greater growth rate than black tilapia under identical pond conditions. This can be related to the red tilapia's improved capacity to withstand fluctuations in temperature and retain a higher level of physiological stability. This study offers significant findings regarding the disparities in the two tilapia species' behavior, growth, and survival. These findings can be used to enhance pond management and maintenance procedures to achieve better outcomes in aquaculture.

Keywords: Tilapia, Growth, Water Quality

1. Introduction

Based on data from the Food Agriculture Organization (FAO), fish demand by 2030 is predicted to reach 172 million tons, of which around 8 percent will depend on aquaculture products. In this case, meeting the shortage of fish supply can be met by cultivating freshwater fish (Khairuman, & Amri 2008). High amounts of fish production are closely related to people's consumption levels of fish animal protein sources, because apart from having high nutritional value, consuming fish can also improve intelligence and memory. The average standard need for fish consumption is 14.3 kg per capita every year or 1.2 kg per capita every month (BPS, 2015).

This means that the amount of production available is still very insufficient to meet people's needs for fish consumption. The need for fish for the community is very important so it is natural that fisheries businesses must be developed (Murtidjo, 2005). Tilapia is one of the freshwater commodities that is easy to cultivate due to its ability to adapt very well, and its growth is fast with low production costs, therefore tilapia has received quite a lot of attention from governments related to efforts to improve public nutrition in developing countries. Tilapia has the potential for animal protein that can be accessed by the community and the aquaculture industry that can be exported (Khairuman and Amri, 2003; Iskandar, 2015).

There are several types of tilapia, one of which is black tilapia and red tilapia. Genetically, black tilapia has been proven to have higher growth and productivity advantages compared to other types of tilapia (Bastiawan & Wahid, 2008). Meanwhile, according to Sucipto & Prihartono (2007) red tilapia has a shape that resembles red snapper and has a meat taste that resembles red snapper, which tends to be savory.

In the fisheries cultivation business, there are several obstacles that many farmers complain about, one of which is the development of tilapia fish growth which is not significant due to several factors that influence the growth of these fish. There are several factors that influence water quality for the growth of tilapia, namely pH, temperature, dissolved oxygen (DO), and total dissolved solids (TDS).

Temperature affects fish activities such as fish growth and behavior (Hueet, 1972). Based on data from the National Standardization Agency (2009), the optimum temperature for keeping tilapia in ponds is around 25-32°C. According to Effendie (2004), temperature changes exceeding 3 - 40C will cause metabolic changes which result in changes in temperature, increasing the toxicity of dissolved contaminants, reducing DO and increasing fish mortality. Hidayat (2008), stated that for fish to live well in successful fish farming activities, the dissolved oxygen content should not be less than 4 mg/l. Apart from that, the PH value in pond water also greatly influences the growth and survival of tilapia fish, where the optimal water pH for tilapia habitat is between 6.5 – 8.5. The level of turbidity in pond water can also affect the growth and behavior of tilapia fish. The recommended limit for turbidity levels is a maximum of 50 NTU (Sunarso, 2008). According to Masyahoro and Annisa (2022) light is an external factor that can influence the physiological response, reproduction and growth of fish. Optimal brightness for tilapia cultivation ranges between 30-40 cm. Small tilapia fish are more resistant to changes in the aquatic environment compared to large tilapia fish. The appropriate ammonia level for tilapia habitat is between 0-2.4 ppm (Tri Widodo at al, 2020).

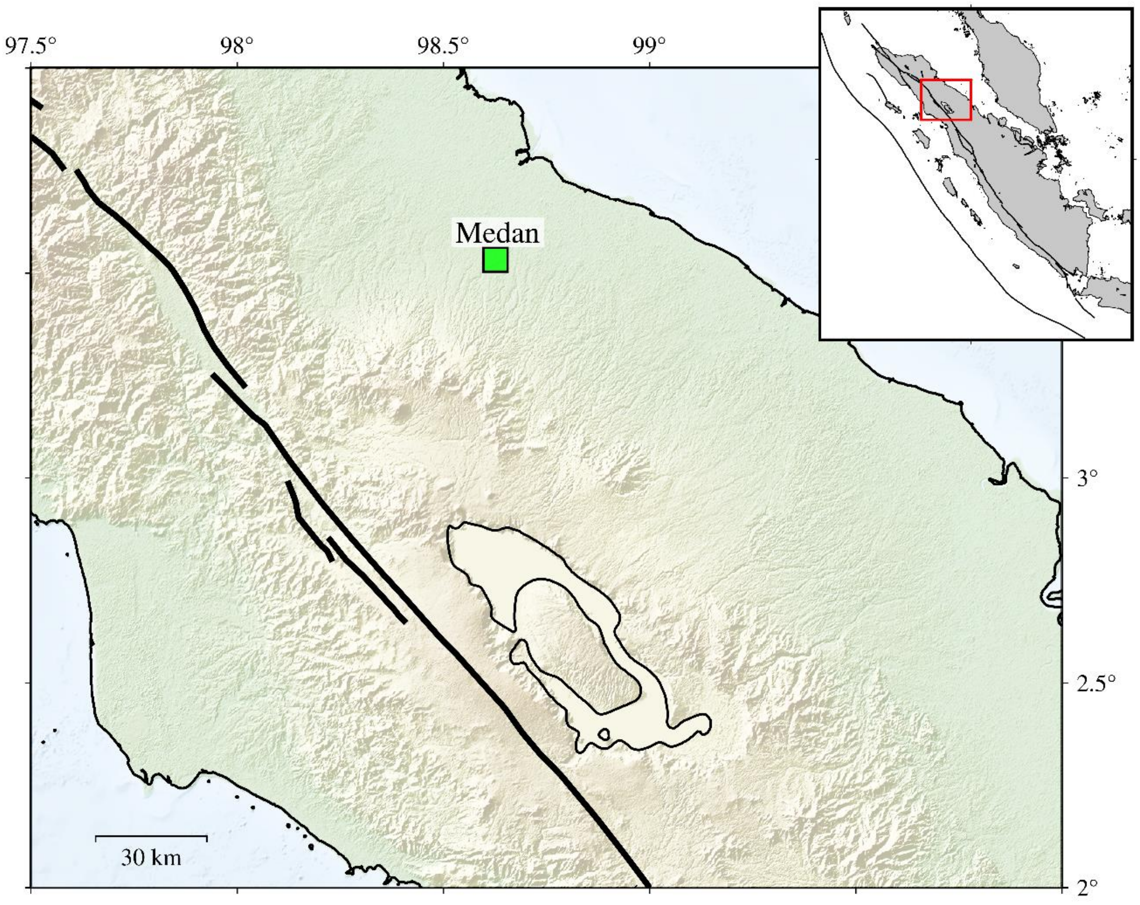

Figure 1. Map shows the location of study research.

Based on the problems above, it is necessary to carry out research to compare the growth and behavior of red tilapia and black tilapia using the pH, temperature, DO and TDS parameters of cement ponds.This research aims to see which tilapia fish grow better, from the types of red tilapia and black tilapia that are kept in the same pond by taking samples for 36 days in the morning or evening.

2. Research Methodology

2.1 Place and Time

This research was carried out in a cement pool measuring 2 meters x 0.87 meters located in Medan, North Sumatra, with a pool height of around 0.65 meters and parapet was made around the pool. This research was carried out for 36 days starting from the end of January to the beginning of March 2024.

2.2 Materials and Tools

The fish seeds used were red tilapia seeds and black tilapia seeds which were obtained from a tilapia seed seller on Jl Garu V No 13D Harjosari I, Medan Amplas District, Medan City with a seed size of around 3-5 cm and a body weight of 2-3 grams. per head. The feed used is Prima Feed floating fish feed with the trademark PF 1000 which has a protein content of 39-41%, fat 5%, fiber 6%, ash 16% and water content 10%. Feeding tilapia fish is done 3 times a day in the morning, afternoon and evening.

In this research, water quality parameters were measured using standard measuring instruments, namely: (1) Dissolved Oxygen Meter with type AZ 8403, (2) pHmeter, (3) TDSmeter, (4) HTC-2 Thermometer, (5) Digital Scales, (6) Measuring Cup, (7) Stopwatch, (8) Tanggok, (9) Water Pump, (10) Pipe, (11) Bucket, (12) Hose, (13) Tissue.

2.3 Water Quality

In aquaculture, water quality plays an important role in the life of biota maintained in the water. Fish are very sensitive to changes in their environment. Water quality is very important for the survival and growth of fish (Ahmad, 2004).

Water quality checks in tilapia cultivation during the research included checking temperature, pH, DO, and Total Dissolved Solid (TDS), which was carried out using WQC (Water Quality Checker).

2.4 Research Methods

The method used in this research is by taking water samples at different times at 10.00 WIB or 17.00 WIB. Sampling was carried out 2 times over a period of 3 times in 1 week for each sampling.

Fish growth data was obtained from taking data on fish weight, fish survival, and fish survival. As supporting data, water quality is measured using parameters such as pH, temperature, dissolved oxygen and Total Dissolved Solid (TDS). Water samples were taken using the manual sampling method. The types of fish that will be the object of this research are red tilapia and black tilapia with a fish stocking density of 150 tilapia fish consisting of 75 red tilapia (Oreochromis sp) and 75 black tilapia (*Oreochromis niloticus*).

The results of the data obtained were then analyzed to review the growth rate and behavior of red tilapia and black tilapia in comparing the growth of the two types of tilapia.

3. Measured Parameters

3.1 Fish Growth

Fish growth rate is measured based on the absolute weight of the fish. Weight growth the average can be calculated using the Effendie (1979) formula, with:

$$Pbm = Wt - Wo$$

Where :
Pbm = Absolute weight gain (gr)
Wt = Average weight at the end of the study (g)
Wo = Average weight at the start of the study (g)

3.2 Survival Rate

Survival rate (SR) is calculated from data on the number of fish at the beginning and end. Survival data is calculated using the Effendie (1978) formula, with:

$$SR = (Nt / No) \times 100\%$$

Where :
SR = Survival degree (%)
Nt = Number of fish at the end of the study (tails)
No = Number of fish at the start of the study (tails)

3.3 Data Analysis

The data obtained was explained statistically using the t-test with the help of Microsoft Excel, then the data was presented descriptively in the form of tables and graphs, then the data was interpreted to explain the relationship between the measured air quality parameters.

4. Research Results and Discussion

4.1 Fish Growth

After taking samples from each red tilapia and black tilapia as much as 26% of all the fish kept and by feeding them 2 times every day with a ratio of 2%, data on average fish growth (grams) was obtained. which is shown in the graph in figure 2 below.

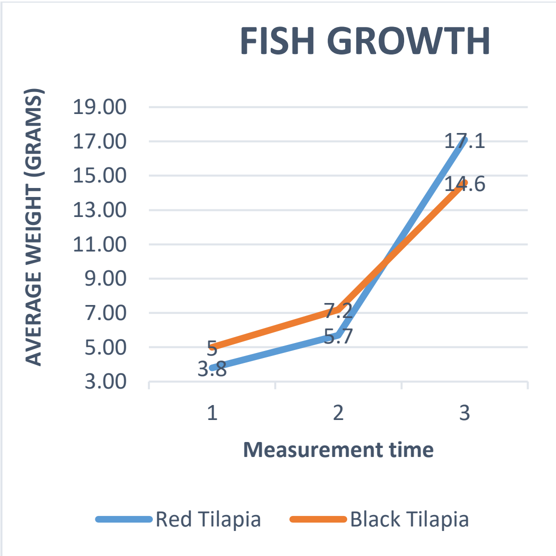

Figure 2. Graph of Average Weight Growth of Red and Black Tilapia.

According to the collected data on the average weight growth of fish, it is evident that red tilapia exhibits superior growth compared to black tilapia. The data shown in Figure 1 indicates a disparity in the average weight gain between red and black tilapia fish. On the first day, the average weight of red tilapia fish was 3.8 grams less than that of black tilapia fish, which was 5 grams. On the 18th day, the average weight of red tilapia fish increased to 5.7 grams, while the average weight of black tilapia fish increased to 7.2 grams. By the end of the 36-day research period, the average weight of red tilapia had climbed to 17.1 grams, which was higher than that of black tilapia, 14.6 grams.

From the data obtained above, it can be seen that the growth of red tilapia increased drastically on the 36th day. This is influenced by the values of the water quality parameters in the pond which affect the average weight of the fish.

Growth in tilapia is greatly influenced by the quantity and quality of feed. Efficient use of nutrients in feed is the most important factor in increasing fish growth. According to Craig and Helfrich (2009) commercial feed contains protein (18%-50%), fat (10%-25%), carbohydrates (15%-20%), ash (>8.5%), phosphorus (> 1.5%), water (<10%), vitamins and minerals. Based on the results of research that has been carried out on the growth of tilapia which is measured every 18 days, it can be seen in Figure 1 that red tilapia has a greater average weight increase than black tilapia. This is caused by several influencing factors, such as response to environmental conditions and genetic factors. Red tilapia is more adaptive to changes in environmental conditions that occur. It can be seen that red tilapia is more resistant to environmental stress, such as temperature fluctuations, dissolved oxygen concentration, pH, and dissolved solids (TDS). From table 1 it can be seen that the water quality parameter data which influences the growth of red tilapia fish is more significant than black tilapia fish. This is in accordance with the graph of the average weight growth of tilapia fish in figure 1 where red tilapia fish have a greater average weight gain. compared to black tilapia.

Table 1. Water Quality Parameter Data

Parameter	Day-1	Day-18	Day-36
Temperature (˚C)	30.2	30.9	30.6
DO (%)	93.7	43.6	72.1
pH	8.4	7.5	7.3
TDS (ppm)	0.5	0.8	1.0

From the water quality parameter data above, it can be seen that the average temperature value on day 1 was 30.2˚C, on day 18 it was 30.9˚C, and on day 36 it was 30.6˚C. This is in accordance with the standard value for raising tilapia fish by the Directorate General of Aquaculture (2020) which has a range of 25˚C-32˚C. Tilapia need dissolved oxygen to support growth and life processes. Dissolved oxygen concentration greatly influences metabolic processes and physiological processes in fish. Fish that receive low oxygen will cause the fish's appetite to decrease and this will affect their physiological processes (Huisman, 1986). From the parameter data above, it can be seen that the average dissolved oxygen concentration on day 1 was 93.7%, on day 18 it was 43.6%, and on day 36 it was 72.1%. There was a significant decrease in dissolved oxygen concentration on the 18th day. This is not in accordance with the standard value for raising tilapia fish by the Directorate General of Aquaculture (2020) which has a standard value of around 75-85%. According to Fauzia and Suseno (2020), the ideal pH value for freshwater biota life and fish growth is 7-8. A pH value that is too low or too high can disrupt fish life. From the data in table 1, the average pH value for the growth of red tilapia and black tilapia fish on day 1 is 8.4, on day 18 it is 7.5, and on day 36 it is 7.3. The pH value obtained is in accordance with the standard value for keeping tilapia fish, which is around 6.5-8.5 (Directorate General of Aquaculture, 2020). The average concentration of Total Disloved Solid (TDS) in rearing red tilapia and black tilapia during rearing took place on day 1, namely 0.5 ppm, then on day 18, namely 0.8 ppm, and on day 36, namely 1.0 ppm which shows it is good for tilapia cultivation. The low concentration of Total Dissolved Solids (TDS) during cultivation results from constant pond cleaning every week. According to the water quality regulations outlined in Government Regulation No. 82 of 2001 (class II), the acceptable limit of Total Dissolved Solids (TDS) for fish farming activities is less than 1000 parts per million (ppm). This implies that lower concentrations of TDS in the water are more favorable for fish farming.

4.2 Survival Rate

Based on the data from the average weight of fish growth above, it was found that the growth of red tilapia fish is better than black tilapia fish, because red tilapia fish are better able to adapt to changes in temperature and are better at adapting to changes in temperature degrees and dissolved oxygen concentrations in the pond. . Red tilapia fish kept in concrete ponds with the same treatment show better behavior, this can be seen from maximum feed utilization, which causes good growth. This is different from black tilapia fish which tend to gather in groups and move to the surface of the air around the edge of the pond. This behavior shows symptoms of stress, because the fish is trying to adapt to recognize the new environment. When fish are under stress, they tend not to want to eat and the energy supply in the body will be used to restore homeostatic conditions. These conditions will have an impact on the growth rate of fish and the survival of fish.

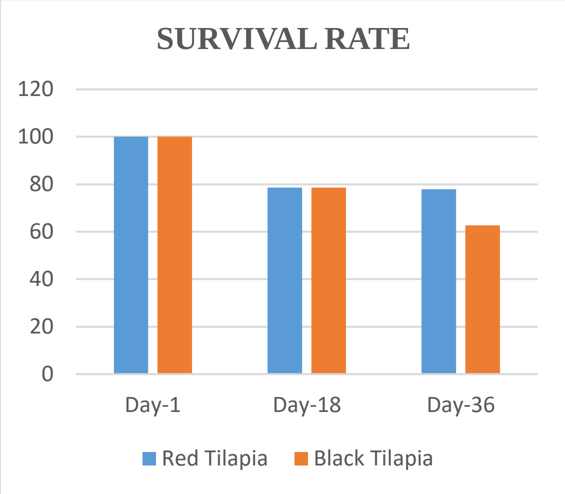

Figure 3. Graph of Survival Rates of Red and Black Tilapia.

Based on the graph in Figure 3, it shows that the survival rate of red tilapia and black tilapia on day 1 was 100%, then on day 18 the survival rate of red tilapia and black tilapia was 78.6%, and on on the last day, namely day 36, red tilapia experienced an increase in survival, namely 77.9%, higher than black tilapia which was only 62.7%. The high survival rate of red tilapia is due to the fact that this fish has a better level of adaptability than black tilapia. This is supported by several water quality parameters to monitor environmental conditions in waters.

The research on the average growth of tilapia indicates a notable disparity between the growth rates of red tilapia and black tilapia. The findings indicated that the growth rate of red tilapia fish surpassed that of black tilapia fish. Red tilapia exhibited greater tolerance to variations in water quality parameters, including pH, temperature, dissolved oxygen (DO), and total dissolved solids (TDS). Red tilapia have greater resilience to specific environmental stressors, such as variations in temperature and suboptimal water conditions. Additionally, they display a higher level of competitiveness in acquiring resources and living space, which can impact their growth and survival. According to Suyanto's explanation in Dahril et al. (2017), suboptimal acidity (pH) can induce stress in fish, making them more vulnerable to diseases and reducing their productivity and growth.

4.3 Water Quality Conditions in Cultivating Red and Black Tilapia in the Same Pond

Water quality data was obtained from the results of water sampling using the manual sampling method. Water quality measurements were carried out every day for 36 days with measurement times in the morning at 10.00 WIB in situ. The water source used came from groundwater, and during the research the water was changed every week. The water quality parameters observed in this research are temperature, DO, pH, and TDS. At the time the research took place, the water quality was less than optimal for the growth and survival of tilapia. From the water quality parameters observed, the water quality factor that most dominantly influences the growth and survival of tilapia in concrete ponds is DO, and can be seen in the following description.

DO (Dissolved Oxygen)

The dissolved oxygen (DO) content in ponds generally changes over time. The lowest oxygen content during the study was on day 18, namely 43.6%, and the highest on day 1, namely 93.7%. DO experiences changes because it is influenced by temperatures that change all the time because the weather at that time is very uncertain. As stated by Effendi (2003), waters intended for fishing purposes should have a dissolved oxygen content of no less than 5 mg/L. If the dissolved oxygen is not balanced, it will cause stress in the fish because the brain does not receive sufficient oxygen supply, as well as death due to lack of oxygen (anoxia) which is caused by body tissues being unable to bind oxygen dissolved in the blood (Dahril et al., 2017).

Temperature

The pond water temperature significantly impacts the behavior and feeding habits of fish during cultivation. The pool temperature during the investigation ranged from 30.2 to 30.9 ˚C. According to Sucipto and Prihartono (2007), water temperature influences fish life and growth. The absorption and subsequent release of heat from solar radiation primarily cause fluctuations in temperature in a body of water. Fluctuating temperatures can impact the development of phytoplankton and organisms in these aquatic environments (Irianto, 2003).

pH

The research results showed that the pH value in the fish pond at the time of the research ranged between 7.3 – 8.4. The pH value is an indicator of the acidity of water. According to Fauzia and Suseno (2020), the ideal pH value for freshwater biota life and fish growth is 7-8. A pH value that is too low or too high can disrupt fish life. A decrease in pH generally occurs when heavy rain falls, but will return to normal levels when the dissolved oxygen concentration is sufficient.

TDS (Total Dissolved Solids)

The TDS value observed during the research fell within the 0.5 – 1.0 ppm range. This value is deemed suitable for tilapia cultivation as it remains significantly below the threshold TDS value specified in the water quality standards PP No. 82 of 2001 (class II). According to these standards, the TDS range for fish farming should be below 1000 ppm. Therefore, a lower concentration of TDS in the water is more favorable for fish farming. Variations in Total Dissolved Solids (TDS) levels can pose a risk as water density governs the movement of water into and out of an organism's cells. Elevated levels of Total Dissolved Solids (TDS) can diminish the transparency of water, leading to a decline in the process of photosynthesis. TDS values indicate the concentration of nutrients present in a solution. The nutrients present in TDS will influence fish's appetite, promoting their growth and survival. Total Dissolved Solids (TDS) consist of dissolved substances, including minerals, salts, metals, and organic molecules. The ideal mineral composition in water can impact the development of organisms within it, influencing the type of food that will be provided. Nevertheless, the mineral content in TDS during this investigation was inadequate to facilitate fish growth. Therefore, providing the fish with feed containing an appropriate mineral content was necessary to fulfill their nutritional requirements.

Feeding

Feeding factors have a very important role in the growth and survival of fish. To stimulate optimal fish growth, it is necessary to have sufficient quantity and quality of food available and in accordance with the conditions of the waters in cultivation. In this study, Prima Feed was given with the PF 1000 type which has a protein content of 39-41%, fat 5%, fiber 6%, ash 16% and water content 10%. This is in accordance with the operational standards for tilapia rearing procedures according to the Directorate General of Aquaculture (2020) that artificial feed has a minimum protein content of 25% and has not expired. Feeding is done 3 times a day in the morning, afternoon and evening.

5. Conclusions

The research results show that red tilapia has a better growth rate than black tilapia in the same pond conditions. This is proven through analysis of water quality parameters such as pH, temperature, DO, and TDS. Red tilapia has the ability to tolerate temperature changes better, resulting in higher physiological stability compared to black tilapia. This research provides important insights into differences in behavior, growth and survival between the two tilapia species that can be useful in pond management and maintenance.

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