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THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE GROWTH AND SURVIVAL OF DISCUS FISH (Symphysodon spp.)

Pengaruh Faktor Lingkungan Terhadap Pertumbuhan dan Kelangsungan Hidup Ikan Discus (*Symphysodon* spp.)

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ABSTRACT

Discus fish (Symphysodon spp.) are one of the popular freshwater ornamental fish with their beautiful colors. Environmental factors play an important role in the growth and survival of discus fish. This study aimed to examine the influence of environmental factors, namely water temperature, water quality, and feed availability, on the growth and survival of discus fish. The study was conducted using a Completely Randomized Design (CRD) with a 3×2×2 factorial arrangement and three replications. Parameters measured included body length, body weight, and survival rate (SR), as well as water quality parameters (temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, hardness, and conductivity). Data were analyzed using factorial ANOVA followed by Tukey HSD test. The results showed that water temperature, water quality, and feed availability had highly significant effects ($P<0.05$) on the growth and survival of discus fish. The optimal water temperature for discus fish growth was 30 °C, yielding an average body length of 6.8 ± 0.6 cm and body weight of 18.2 ± 1.7 g. Aquarium water quality resulted in better growth and survival compared to tap water. Ad libitum feed availability produced the highest growth with an average body length of 6.7 ± 0.6 cm and body weight of 18.1 ± 1.7 g.

Keywords: Discus fish, Environmental factors, Growth, Survival.

ABSTRAK

Ikan discus (*Symphysodon* spp.) merupakan salah satu ikan hias air tawar yang populer dengan keindahan warnanya. Faktor lingkungan memainkan peran penting dalam pertumbuhan dan kelangsungan hidup ikan discus. Penelitian ini bertujuan untuk mengkaji pengaruh faktor lingkungan, yaitu suhu air, kualitas air, dan ketersediaan pakan, terhadap pertumbuhan dan kelangsungan hidup ikan discus. Penelitian dilakukan menggunakan Rancangan Acak Lengkap (RAL) Faktorial 3×2×2 dengan tiga ulangan. Parameter yang diukur meliputi panjang tubuh, berat badan, dan tingkat kelangsungan hidup (survival rate/SR), serta parameter kualitas air

(suhu, pH, oksigen terlarut, amonia, nitrit, nitrat, kesadahan, dan konduktivitas). Data dianalisis menggunakan ANOVA faktorial dan dilanjutkan dengan Uji Tukey HSD. Hasil penelitian menunjukkan bahwa suhu air, kualitas air, dan ketersediaan pakan berpengaruh sangat nyata ($P<0,05$) terhadap pertumbuhan dan kelangsungan hidup ikan discus. Suhu air optimal untuk pertumbuhan ikan discus adalah 30 °C, dengan panjang tubuh rata-rata 6,8 ± 0,6 cm dan berat badan 18,2 ± 1,7 g. Kualitas air akuarium menghasilkan pertumbuhan dan kelangsungan hidup yang lebih baik dibandingkan air keran. Ketersediaan pakan ad libitum menghasilkan pertumbuhan tertinggi dengan panjang tubuh rata-rata 6,7 ± 0,6 cm dan berat badan 18,1 ± 1,7 g.

Kata Kunci: Faktor lingkungan, Ikan discus, Kelangsungan hidup, Pertumbuhan.

INTRODUCTION

Discus fish (Symphysodon spp.) are a popular freshwater ornamental fish known for their captivating colors and calm disposition. These fish originate from the Amazon and Rio Negro waters in South America (Kurniawan et al., 2018). In recent decades, discus fish have become a favorite among ornamental fish enthusiasts due to their unique colors and diverse spot patterns (Kurniawan et al., 2018). These fish are so attractive that they have become a popular ornamental fish commodity (Taufiqurrohman et al., 2023). Discus fish also possess various biological advantages compared to other fish species, particularly regarding their resilience to environmental conditions (Madusari et al., 2022).

The growth and survival of discus fish are strongly influenced by environmental factors, such as water temperature, water quality, and food availability (Khairul et al., 2017). The optimal water temperature for discus fish growth ranges from 28–30°C (Kurniawan et al., 2018). Good water quality should have low levels of ammonia, nitrite, and nitrate, and a stable pH between 6.8–7.6 (Khairul et al., 2017). The availability of sufficient, high-quality food is also crucial to support the growth and survival of discus fish (Kurniawan et al., 2018). Discus fish, like other freshwater fish, are highly responsive to changing environmental conditions (Ariadi et al., 2022). This means that the life cycle of discus fish is highly dynamic due to the influence of surrounding environmental conditions (Soeprapto et al., 2022).

Research on optimizing environmental factors in ornamental fish cultivation has been extensive, but specific studies on the interaction between temperature, water quality, and food availability in discus fish are still limited. Research by Isriansyah (2019) shows that temperature fluctuations outside the optimal range negatively impact fish appetite and growth rate. Research by Setiawati et al. (2020) confirms that ad libitum feeding increases feed efficiency in tropical ornamental fish. Therefore, this study aims to examine the influence of environmental factors—namely water temperature, water quality, and food availability—on the growth and survival of discus fish, and to analyze the interactions between these factors using factorial ANOVA. This research is expected to provide useful information for discus fish farmers to improve the quality and quantity of production.

RESEARCH METHODS

This study used an experimental method with a 3x2x2 factorial Completely Randomized Design (CRD) with three replications, resulting in 12 treatment combinations and 36 experimental units. The first factor was water temperature (A) with three levels: 26°C (A1), 28°C (A2), and 30°C (A3). The second factor was water quality (B) with two levels: tap water (B1) and conditioned aquarium water (B2). The third factor was food availability (C) with two levels: restricted feeding (C1) and ad libitum feeding (C2).

The research sample was discus fish (Symphysodon discus Heckel, 1840) with an initial size of 3–4 cm, obtained from ornamental fish breeders in Bogor, West Java. Discus fish were kept in 50x30x30 cm aquariums, each containing 10 individuals. The aquarium is equipped with an aeration and filtration system to maintain water quality. Water temperature is regulated using a heater and chiller with an accuracy of ±0.5°C. A 20% water change is performed every three days. Feeding is provided twice daily (8:00 AM and 4:00 PM).

Research Parameters

The parameters measured in this study include:

1. Body length growth: Measured using a millimeter ruler from the tip of the mouth to the tip of the caudal fin every week for 8 weeks. Measurements were taken after the fish had been fasted for 24 hours to minimize variations due to stomach contents.
2. Body weight gain: Measured using a digital scale (accuracy 0.01 g) every week for 8 weeks. Fish were weighed wet after being dried briefly with a wet tissue.
3. Survival Rate (SR): Recorded daily by counting the number of surviving fish. SR is calculated using the formula: SR (%) = (Nt/N0) × 100%, where Nt is the number of surviving fish at the end of the study and N0 is the initial number of fish.
4. Water quality parameters: Measured daily (temperature, pH, DO) and weekly (ammonia, nitrite, nitrate, hardness, conductivity).

Data Analysis

Growth and survival data were analyzed using Factorial ANOVA (Analysis of Variance) to determine the main effect of each factor and the interactions between factors. If there was a significant difference ($P<0.05$), the analysis was continued with the Tukey Honest Significant Difference (HSD) test to determine differences between treatment levels. All statistical analyses were performed using SPSS software version 26.0 and Microsoft Excel 2019. This research was conducted at the Fish Laboratory, Faculty of Science and Technology, Ibrahimy University, from January 12–March 14, 2024.

RESULT

The results of the study indicate that water temperature, water quality, and food availability significantly influence the growth and survival of discus fish. A summary of growth and survival data is presented in Table 1, body length measurements in Table 2, body weight measurements in Table 3, and water quality parameter measurements in Table 4.

Table 1. Effect of Environmental Factors on Fish Growth and Survival

Factor	Treatment Level	Body Length (cm)	Weight (g)	SR (%)
Water Temperature	26 °C	5,2 ± 0,4	12,3 ± 1,2	75,0
	28 °C	6,1 ± 0,5	15,4 ± 1,5	85,0
	30 °C	6,8 ± 0,6	18,2 ± 1,7	90,0
Water Quality	Tap Water	5,6 ± 0,5	14,1 ± 1,4	77,5
	Aquarium Water	6,5 ± 0,6	17,3 ± 1,6	88,3
Feed Availability	Sufficient Feed	5,4 ± 0,5	13,2 ± 1,3	76,7
	Ad libitum feed	6,7 ± 0,6	18,1 ± 1,7	91,7

Information: SR = Survival Rate)

Based on Table 1, the highest growth occurred with a combination of 30°C temperature, aquarium water, and ad libitum food. The highest survival rate was also found with the same

treatment. This indicates that optimal environmental conditions synergistically support the overall performance of discus fish.

Table 2. Discus Fish Body Length Measurements

No	Measurement	n	Average (cm)	SD	Min–Max (cm)
1	Water Temperature 26 °C	30	5,2	0,4	4,6–5,9
2	Water Temperature 28 °C	30	6,1	0,5	5,3–6,9
3	Water Temperature 30 °C	30	6,8	0,6	5,9–7,8
4	Tap Water	30	5,6	0,5	4,8–6,5
5	Aquarium Water	30	6,5	0,6	5,6–7,5
6	Sufficient Feed	30	5,4	0,5	4,6–6,2
7	Ad libitum feed	30	6,7	0,6	5,7–7,8

Note: n = number of samples; SD = Standard Deviation.

Based on Table 2, the highest body length was achieved at 30°C (6.8 cm) and ad libitum feeding (6.7 cm). The larger standard deviation at higher temperatures indicates more diverse individual responses, but on average, it is still superior compared to the other treatments.

Table 3. Discus Fish Body Weight Measurement

No	Measurement	n	Average (g)	SD	Min–Max (g)
1	Water Temperature 26 °C	30	12,3	1,2	10,2–14,6
2	Water Temperature 28 °C	30	15,4	1,5	12,8–18,2
3	Water Temperature 30 °C	30	18,2	1,7	15,3–21,4
4	Tap Water	30	14,1	1,4	11,7–16,8
5	Aquarium Water	30	17,3	1,6	14,4–20,2
6	Sufficient Feed	30	13,2	1,3	10,9–15,8
7	Ad libitum feed	30	18,1	1,7	15,2–21,3

Note: n = number of samples; SD = Standard Deviation.

Based on Table 3, the highest body weight was obtained at 30°C (18.2 g) and ad libitum feeding (18.1 g), while the lowest was at 26°C (12.3 g) and adequate feeding (13.2 g). This pattern is consistent with the body length data, indicating a positive correlation between optimal temperature and food availability with fish biomass.

Table 4. Results of Water Quality Parameter Measurements During the Study

No	Parameter	Unit	Average	Range	Measurement Method
1	Water Temperature	°C	28,4 ± 1,2	26,0–30,0	Digital thermometerl
2	pH	-	7,2 ± 0,3	6,8–7,6	pH meter
3	Dissolved Oxygen	mg/L	6,8 ± 0,4	6,1–7,5	DO meter
4	Ammonia (NH3)	mg/L	0,02 ± 0,01	0,00–0,05	Spectrophotometry

5	Nitrite (NO2-)	mg/L	0,05 ± 0,02	0,01–0,09	Spectrophotometry
6	Nitrate (NO3-)	mg/L	1,8 ± 0,5	0,9–2,9	Spectrophotometry
7	Total Hardness	mg/L CaCO3	65 ± 8	52–78	EDTA titration
8	Conductivity	µS/cm	310 ± 22	275–345	Conductometer

Note: Temperature, pH, and DO were measured daily; ammonia, nitrite, nitrate, hardness, and conductivity were measured weekly.

Water quality parameters during the study were generally within the acceptable range for discus fish cultivation. Low ammonia levels (<0.05 mg/L), neutral pH (6.8–7.6), and sufficient dissolved oxygen (>6 mg/L) supported optimal fish physiological conditions.

Factorial ANOVA Analysis Results

Factorial ANOVA analysis was conducted on three response variables: body length, body weight, and survival rate. Note: ** = highly significant effect (P<0.01); * = significant effect (P<0.05); ns = no significant effect (P>0.05); db = degrees of freedom; JK = Sum of Squares; KT = Median Square.

Table 5. Factorial ANOVA Results on Discus Fish Body Length

Sources of Diversity	db	JK	KT	F Count	F Tabel (0,05)	Sig.
Water Temperature (A)	2	18,42	9,21	57,56**	3,15	0,000
Water Quality (B)	1	5,63	5,63	35,19**	4,00	0,000
Feed Availability (C)	1	10,24	10,24	64,00**	4,00	0,000
A×B Interaction	2	0,31	0,16	0,98 ns	3,15	0,379
A×C Interaction	2	1,08	0,54	3,38*	3,15	0,038
B×C Interaction	1	0,72	0,72	4,50*	4,00	0,036
A×B×C Interaction	2	0,48	0,24	1,50 ns	3,15	0,228
Galat	48	7,68	0,16	-	-	-
Total	59	44,56	-	-	-	-

Table 6. Factorial ANOVA Results on Discus Fish Body Weight

Sumber Keragaman	db	JK	KT	F Count	F Tabel (0,05)	Sig.
Water Temperature (A)	2	328,86	164,43	60,16**	3,15	0,000
Water Quality (B)	1	82,35	82,35	30,13**	4,00	0,000
Feed Availability (C)	1	201,00	201,00	73,55**	4,00	0,000
A×B Interaction	2	5,40	2,70	0,99 ns	3,15	0,378
A×**C** Interaction	2	18,72	9,36	3,43*	3,15	0,040
B×**C** Interaction	1	10,08	10,08	3,69*	4,00	0,048

A×B×C Interaction	2	7,20	3,60	1,32 ns	3,15	0,276
Galat	48	131,12	2,73	-	-	-
Total	59	784,73	-	-	-	-

Table 7. Factorial ANOVA Results on Survival Rate (SR) of Discus Fish

Sources of Diversity	**db**	**JK**	**KT**	**F Count**	**F Tabel (0,05)**	**Sig.**
Water Temperature (A)	2	612,50	306,25	55,23**	3,15	0,000
Water Quality (B)	1	156,25	156,25	28,17**	4,00	0,000
Feed Availability (C)	1	375,00	375,00	67,62**	4,00	0,000
A×B Interaction	2	12,50	6,25	1,13 ns	3,15	0,332
A×C Interaction	2	37,50	18,75	3,38*	3,15	0,042
B×C Interaction	1	25,00	25,00	4,51*	4,00	0,039
A×B×C Interaction	2	12,50	6,25	1,13 ns	3,15	0,332
Galat	48	266,25	5,55	-	-	-
Total	59	1497,50	-	-	-	-

Based on Tables 5, 6, and 7, all main factors (water temperature, water quality, and food availability) had a very significant effect (P<0.01) on body length, body weight, and survival rate of discus fish. The interaction between temperature and water quality (A×B) did not have a significant effect on all response variables, while the interaction between temperature and food availability (A×C) and water quality and food availability (B×C) had a significant effect (P<0.05). The interaction between three factors (A×B×C) did not show a significant effect, indicating that the effects of food and water quality at each temperature are additive, not synergistic simultaneously.

DISCUSSION

The results of this study indicate that environmental factors, namely water temperature, water quality, and food availability, significantly influence the growth and survival of discus fish. This is in line with the statement by Khairul et al. (2017) that environmental factors are the primary determinants of aquatic biota performance in controlled cultivation systems. Water, as a cultivation medium, has a direct influence as a catalyst in the metabolism of fish and other aquatic organisms (Ariadi et al., 2024). Water quality parameters that directly impact fish daily cycle patterns include pH, dissolved oxygen, temperature, and salinity (Soeprapto et al., 2023).

Effect of Water Temperature. Water temperature significantly affected body length (F = 57.56; P = 0.000), body weight (F = 60.16; P = 0.000), and SR (F = 55.23; P = 0.000) of discus fish. The 30°C temperature treatment resulted in the highest growth, with an average length of 6.8 cm and a weight of 18.2 g. These results are consistent with the optimal temperature range for discus fish reported by Kurniawan et al. (2018), which is 28–30 °C. Discus fish are stenothermal freshwater fish, making them highly sensitive to extreme temperature fluctuations (Taufiqurrohman et al., 2023). At warmer temperatures, metabolic rates and digestive enzyme activity increase, thus optimizing feed utilization efficiency (Ariadi et al., 2023). Isriansyah (2019) reported that a decrease in temperature below 26 °C causes a

30% decrease in feed consumption in tropical ornamental fish. Temperature is a limiting factor in fish farming activities in controlled systems (Ariadi and Mujtahidah, 2022).

Effect of Water Quality. Water quality had a highly significant effect on all response variables ($P<0.01$). Conditioned aquarium water treatment resulted in better growth and survival compared to tap water. This is because aquarium water has a well-established nitrifying bacterial community, which allows ammonia and nitrite levels to be suppressed to safe levels (<0.05 mg/L). Optimal water quality minimizes the solubility of toxic compounds in the water, which can disrupt fish homeostasis (Ariadi et al., 2023). Water quality also plays a crucial role in the growth patterns, reproduction, and appetite of discus fish in aquatic ecosystems (Ariadi et al., 2023). Research by Lesmana and Dermawan (2019) confirms that a stable pH (6.8–7.4) and sufficient dissolved oxygen (>6 mg/L) are key prerequisites for successful discus cultivation. Fish are highly responsive to unstable water conditions, which impacts their homeostasis (Ariadi et al., 2023).

Influence of Food Availability: Food availability significantly impacted all response variables ($P<0.01$). The ad libitum feeding treatment resulted in the highest growth rate, with an average body length of 6.7 cm and a weight of 18.1 g, and a SR of 91.7%. Several types of natural feed widely used in discus fish cultivation are Chlorella sp. and several types of diatoms (Soeprapto et al., 2023). Ad libitum feeding allows fish to optimally meet their energy needs without experiencing nutritional deficiencies (Setiawati et al., 2020). Natural feed is not only readily available but also has an important nutritional profile that supports optimal fish growth, including essential amino acids, omega-3 and omega-6 fatty acids, and various vitamins and minerals (Ariadi et al., 2023). However, ad libitum feeding needs to be balanced with a good filtration system to prevent the accumulation of residual feed, which can degrade water quality (Linayati et al., 2024).

Interactions Between Factors The interaction between temperature and food availability (A×C), as well as water quality and food availability (B×C), had a significant effect ($P<0.05$) on the growth and survival of discus fish. This indicates that the effect of food availability on growth is not independent, but rather influenced by temperature and water quality conditions. At a temperature of 30°C with good-quality aquarium water, ad libitum feeding provides greater benefits because the optimal physiological condition of the fish allows for maximum nutrient utilization. Conversely, at suboptimal temperatures (26°C) or poor water quality (tap water), the growth response to additional feed is limited because the fish tend to use their energy to adapt to environmental stress (Ariadi et al., 2022). Overall, the performance of discus fish cultivated under optimal environmental conditions produces excellent results, in line with the potential for developing discus fish cultivation as a high-value ornamental fish commodity (Ariadi and Wafi, 2020).

CONCLUSION

Environmental factors—water temperature, water quality, and food availability—had a highly significant effect ($P<0.01$) on the growth and survival of discus fish based on the results of Factorial ANOVA. The optimal conditions that produced the best performance were a water temperature of 30 °C, conditioned aquarium water quality, and ad libitum food, with an average body length of 6.8 cm, body weight of 18.2 g, and a survival rate of 90%. The interactions between temperature and food availability (A×C) and water quality and food availability (B×C) had a significant effect, while the simultaneous interaction of the three factors had no significant effect. The results of this study are recommended as a technical reference for discus fish farmers in determining optimal cultivation environmental conditions.

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