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Guppy Fish (*Poecilia reticulata*) Behavior and Growth Are Affected by Variations in Light Color

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ABSTRACT This study aims to determine the effect of different colors of light on the behavior and growth of guppy fish (*Poecilia reticulata*). This research was conducted experimentally using a completely randomized design (CRD) with four treatments and five replications. The treatment used was treatment A with a white light color, treatment B with a red light color, treatment C with a yellow light color, and treatment D with a blue light color. The parameters observed were growth in absolute weight, fish behavior, and water quality (temperature and pH). Data analysis with One Way Anova and further test with LSD using SPSS 25. Based on the statistical hypothesis test with One Way ANOVA showed F count (3.828) > F table (3.24) 5% level for guppy fish growth parameters so that the results are the effect of different light colors on the growth of guppy fish in each treatment. Fish behavior in all treatments gave a positive phototaxis response. The quality of the water in the experimental medium was within acceptable limits for guppy fish cultivation, 26-28°C for water temperature and 7 for the degree of acidity (pH) of water.

Keywords: Absolute weight growth; behavior; influence of light; water quality

INTRODUCTION

Guppy fish is a type of ornamental fish that belongs to the Order Cyprinodontiformes. This fish has a variety of attractive colors, including blue, yellow, red, and other colors. The tail is shaped like a fan, rounded, or widened (Pratama, 2018). *Poecilia reticulata* or sometimes known as guppy fish is a type of freshwater ornamental fish which is also very simple to care for and maintain. This fish has a very attractive appearance, especially on the tail fin of the male guppy (To'bungan, 2019). The wide caudal fin, has a contrasting color with various patterns, and the striking red color is very eye-catching. Guppies are small freshwater fish native to Trinidad and the North Coast of South America (Kent & Ojanguren, 2015). Guppy fish continue to spread through the pet trade and can also be used to control mosquito larvae around their rearing medium (Aztisyah *et al*., 2021).

Guppy fish have a very economical selling price compared to other freshwater ornamental fish (Nugroho *et al*., 2021). Due to high market demand, guppy cultivators are under pressure to produce high-quality guppy fish in order to compete with production in the global market (Pratama *et al*., 2018). The survival of guppies can be influenced by environmental factors, especially the habitat environment (Nugroho *et al*., 2021). In caring for guppies, the main determinant is the quality of the water. Poor water quality will have a negative impact, causing fish to become stressed, sick more often, and can even cause the death of guppies (Aztisyah *et al*., 2021).

One of the things that need to be learned when raising fish is the use of light. This is because fish are one of the animals that are able to detect the color of light as a determinant in choosing partners when mating, choosing a safe living environment, choosing food, and efforts to recognize predators (Utomo *et al*., 2017) . Light has an important role for various activities in fish, such as foraging, communication, and mating (Reeve *et al*., 2014). Based on a number of previous publications, it shows how the color of light can gradually affect the growth rate of fish, fertility, and other physiological reactions (Tamazouzt *et al*., 2000; Han *et al*., 2005; Utomo *et al*., 2017). Research on the use of different colors of light in the process of cultivating guppy fish is necessary because there has been no research on the effect of various colors of light on the behavior and growth of guppy fish.

MATERIALS AND METHODS

Materials

The research container that will be used in the study is an aquarium measuring 10.5cm x 10cm x 16cm and each container is filled with water as high as 12 cm. Before use, the aquarium is washed with dish soap and a sponge and then rinsed thoroughly. Aquarium that has been washed and then dried using a cloth.

In this study, the test animals used were guppies that were approximately 1-2 weeks old and weighed 0.1-1 g. Prior to treatment, the fish were accommodated first in jars to select the uniformity of fish weight according to research needs. The selected guppies were then put into the research aquarium at a density of 5 fish/aquarium.

The feed used in this research is in the form of fish pellets which can serve as nutritional intake for fish. Feeding is done 3 times a day at 07.00 am, 12.00 noon and 17.00 pm.

Methods

This research was carried out for 45 days from June 2022 to July 2022 at the Zoology Laboratory for Biology Education, FKIP, Sebelas Maret University. The study was con-

ducted experimentally using a completely randomized design (CRD) with four treatments and five replications. The treatment used was treatment A by giving white light color, treatment B by giving red light color, treatment C by giving yellow light color, and treatment D by giving blue light color.

Data analysis with *One Way* Anova using SPSS 25. Data is collected as parameters, which are then entered into tables and homogeneity tests are carried out. Data analysis uses the ANOVA diversity test if it is homogeneous. Continue with the LSD test to determine whether the treatment gives the best light color to the fish if the statistical test shows a significant difference where F count > F table.

The movement of fish towards (positive phototaxis) or away from (negative phototaxis) light will be used to determine the behavior of guppies. Temperature and pH measurements are used to measure water quality. A rod thermometer will be used to measure the temperature of the water, and the pH will be determined using pH meter paper.

Statistical analysis

Parameters observed were absolute body weight growth, fish behavior, and water quality (temperature and pH). Fish weight will be weighed once a week for four weeks, so there are four measurements in total. Fish activity, water quality, and weight were all measured once a week. When fish are fed, their behavior is observed, and the response that arises, whether good or negative, is recorded. The temperature and pH of the water are used to determine water quality. Water temperature is measured with a thermometer rod, while pH is measured with litmus paper. To find out the absolute growth of guppy fish seeds after research, it is determined by the formula:

$$W = Wt - Wo$$

where:
W = absolute growth (g)
Wt = biomass weight at the end of the study (g)
Wo = biomass weight at the beginning of the study (g)

RESULTS AND DISCUSSION

Absolute weight growth

Two elements, namely internal and external factors can have an impact on fish growth. External influences include the environment and media, while internal factors include the physiological state of fish and genetic characteristics (Utomo *et al*., 2017). Absolute weight of guppies was determined using measurements made four times during the 45-day study. Table 1 shows the absolute weight of guppies at the end of the study.

Tabel 1. Absolute weight growth of guppies during the study.

Replications	Treatments (g)			
	A	B	C	D
1	-0.12	-0.21	0.02	-0.3
2	-0.15	-0.21	0.03	-0.27
3	-0.14	-0.24	0.01	-0.07
4	-0.19	-0.08	0.02	-0.02
5	0.04	-0.04	0	-0.1
Amount	-0.56	-0.78	0.08	-0.76
Average	-0.112	-0.156	0.016	-0.152

The total weight of guppies based on the results of the study in Table 1 shows that the highest average absolute weight growth of fish was in treatment C, namely 0.016 g, then treatment A with an average absolute weight growth of -0.11 g, treatment D with an increase in average absolute weight -0.15 g, and finally treatment B with an average absolute weight gain of -0.16 g. Treatments A, B, and D decreased growth while treatment C was the best growth even though there was no growth in repetition 5.

Based on statistical analysis using the Liliefors test, it was found that the data were normally distributed with a significance value of 0.20 > 0.05, and the homogeneity test using One Way Anova showed homogeneous data with a significance of 0.105 > 0.05. One Way Anova hypothesis testing displays the calculated F value > F table. F table is 3.24 (5% level), while the calculated F value is 3.828. Based on the results of the study, the effect of each treatment of light color variations on the growth of guppy fish was significantly different. This shows that the parameter of fish weight has a large influence on the results of each treatment. The LSD (Least Significant Difference) test is the additional test used in the ANOVA analysis. Summary of LSD-based ANOVA additional test results are presented in Table 2.

Tabel 2. Summary of LSD-based ANOVA additional test results.

Light Color	Average	LSD Notation
B light	15.600	a
A light	-11.200	a
D light	-8.000	a
C light	1.600	b

The summary results of the BNT test with LSD are presented in Table 2 shows that the color treatment of lights A, B, and D is different from treatment C. In lights B, A, and D the average is different but not significantly different so the notation must be the same. In lamp C the results are significantly different, meaning the notation must be different. This means that the C lamp is preferred by guppies because it can provide the best growth.

The results of this study show that guppies treated with yellow light have an absolute weight with a higher average than fish treated with other light colors. This can happen because in this study did not use an aerator so that the fish scrambled for oxygen in the aquarium. According to (Ardiyanti *et al*., 2022). the function of the aerator is to assist the aeration process, namely the process of adding oxygen-containing air to water. In addition, the average growth in the treatment of white light compared to yellow light is due to the white light that looks so bright that it can interfere with the fish's vision in selecting the available feed. While the average was low in the treatment of red and blue light colors because during the research period many fish in this treatment died. This is caused by the dark and dim light making it difficult for fish to distinguish between food and their own feces. Difficulties that arise in fish in seeing and choosing feed can result in sub-optimal growth due to insufficient feed intake (Utomo *et al*., 2017) . In contrast to the statement of Xu *et al*., 2022 that the growth rate is higher

Tabel 3. Fish behavior.

Treatments	Behavior	Information
White light	Positive Phototaxis	Active, agile, swimming from the surface to the bottom of the aquarium, approaching the light source
Red light	Positive Phototaxis	Actively swimming calmly from the surface to the bottom of the aquarium
Yellow light	Positive Phototaxis	Active, very agile, swimming from the surface to the bottom of the aquarium
Blue light	Positive Phototaxis	Actively swims calmly from the surface to the bottom of the tank, approaching the light source

Tabel 4. Water quality parameters.

Water Quality	Treatment				Quality Standards*
	A	B	C	D	
Temperature (°C)	26-28	26-28	26-28	26-28	25-32
pH	7	7	7	7	6-9

Description: *(Pratama *et al*., 2018).

under short wavelength light (blue light) and has a higher frequency of predation behavior and catches more prey in blue light than light of other colors.

Guppy fish can grow in tropical temperatures ranging from 27-30 and pH 6.5 to 7.2. Water quality is the main determinant in guppy fish cultivation because it can affect its growth (Azhari & Tomasoa, 2018). In this study, it was found that many fish died due to the water factor in the aquarium which was easily dirty. If the water quality is poor, it will cause guppy fish to become stressed, susceptible to disease, and die (Aztisyah *et al*., 2021). Mortality in guppy can be influenced by feed factors and whether or not the water quality is good during rearing. Fish growth can be affected by the amount of protein. This is because protein is a food source that can become the energy and nutrients needed for fish growth (Nugroho *et al*., 2021). The type of food fish eat and the healthy environment in which hydrogen ions, carbon dioxide, oxygen, nitrate, ammonia and hydrogen sulfide are all present can also have a significant impact on their survival and growth. Fish survival can also be affected by the number and density of fish in the rearing medium (Nurlina & Zulfikar, 2016).

Environmental factors have an important role in the growth and physiology of fish. The non-specific fish response to adverse stimuli from external environmental factors is called the stress response. The stress response is an abnormal state of fish when tolerance to adverse environmental factors reaches or approaches a limit, such as increased activity, panic avoidance, and non-stop swimming. The avoidance response is one of the most common stress responses, which is manifested by changing the original swimming behavior and leaving the area (Xu *et al*., 2022).

Excessive feed residue in fish farming will cause ammonia levels to rise. Ammonia itself is the end result of metabolic processes. Ammonia can be toxic if not ionized. Although fish can adapt to the presence of ammonia in their habitat, the rapid change will damage the gill tissue. Ammonia in the water can also reduce the oxygen holding capacity of the blood droplets. This can make the fish's appetite decrease (Siegers *et al*., 2019).

Fish behavior

Light, water flow, and temperature are considered to be the three main factors influencing fish behavioral responses (Xu *et al*., 2022) . The behavior of the fish to be observed during the study includes positive phototaxis or negative phototaxis. Fish are attracted to light for many reasons, including the way the brightness of the light changes depending on how well the fish's eyes perceive light. In this sense, there is great variation in how well fish are attracted to light sources. There are fish that thrive in low light conditions, and there are fish that thrive in low light conditions (Erlangga & Mawardi, 2017). Fish behavior data during the study are presented in Table 3.

Fish phototaxis is a typical response mechanism in aquatic animals to light stimulation which refers to movement toward or away from the light source. Positive phototaxis refers to movement towards the light source, while negative phototaxis refers to movement away from the light source (Xu *et al*., 2022). Based on the fish behavior table, it is known that all treatments showed fish behavior that gave a positive phototactic response. The benefits of phototaxis are not only to avoid predators, it can also be used in searching for food. Internal factors such as age, sex, and decomposition of stomach contents as well as external factors such as water temperature, environmental light levels, intensity and color of light sources, availability of food, and presence of predators, cause fish to swim toward the light source (phototaxis) (Lestari *et al*., 2020). People have varying degrees of expertise in their fascination with light sources. Fish prefer different levels of light intensity: some prefer high light levels, some prefer low light levels. There are other fish that are attracted to light with varying intensities, from low to high (Imansyah, 2021).

Water quality

Temperature and pH measurements will be taken as indicators of water quality throughout the project. One of the main media that plays a role in the survival of fish is water. Fish growth will be affected if the water used in the rearing pond is polluted (Apriyani *et al*., 2019). Water quality data during the study are presented in Table 4.

The measurement results during the study for each treatment were temperatures between 26 and 28°C. These conditions were included in the normal category for the survival and development of guppies because they corresponded

to the recommended temperature range in the maintenance of tropical ornamental fish, which was between 25 to 32°C (Pratama *et al*., 2018). Physiologically, temperature can affect the number of muscle fibers, muscle performance, endurance, growth, and metabolic rate (Kent & Ojanguren, 2015). Fish have an ideal temperature for their life processes because temperature can affect their growth and hunger (Apriyani *et al*., 2019). Temperatures that are too high or too low can stress fish and interfere with their growth, while temperatures that are too high or too low will cause fungi to attack fish (Pratama *et al*., 2018) . The pH range is based on Government Regulation no. 82 of 2001 concerning permissible water requirements, which are between 6 and 9, so the pH value of the water obtained during the study, 7, is still included in the normal group (Muftiadi *et al*., 2019).

The pH value has a significant effect on the chemical reactions that occur in water. Fish with too acidic or alkaline pH will lose color and move more slowly (Pratama *et al*., 2018). If the pH is low, it will result in a decrease in fish appetite. In addition, fish growth will be hampered if the pH of the water experiences large and prolonged changes (Apriyani *et al*., 2019). Guppy fish can adapt to where they live, namely tropical temperatures ranging from 27-30°C and water pH ranging from 6.5-7.2 (Aztisyah *et al*., 2021).

CONCLUSION AND RECOMMENDATION

Conclusion

The results showed that different colors of light had a significant effect on the growth and behavior of guppies. Guppy fish (*Poecillia reticulata*) likes yellow light color compared to other colors of light because it can provide the best behavior and growth. Fish behavior in all treatments gave a positive phototaxis response. The quality of the water in the experimental medium is still within the proper range for guppy fish cultivation, 26-28 °C for water temperature and 7 for the degree of acidity (pH) of water.

Recommendation

In future studies, similar research can be carried out by adding variables of different types of feed and also calculating the survival rate of guppies.

AUTHOR'S CONTRIBUTIONS

AFA is doing research, ideas, data generation, written manuscript, and manuscript preparation. H is mentor, written manuscript, and data analyze.

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