Original Research Article

Effect of Use of Different Light Spectrum on Growth Performance and Color Brightness Level of Tiger Barb (*Puntius tetrazona*).

ABSTRACT

This study aims to evaluate the effect of light spectrum on growth performance and brightness level of tiger barb (*Puntius tetrazona*). The research was conducted in January – March 2022 at the Laboratory of Aquatic Animal Physiology, Faculty of Fisheries and Marine Sciences, Padjadjaran University. This study used an experimental method of Completely Randomized Design (CRD) with five treatments and three replications. The treatment consisted of five treatments, namely control (without LED lights), white LED lights (B), red (C), green (D) and blue (E) lights with 12 hours of irradiation. The treatment was given for 60 days. Parameters observed included growth in length and absolute weight, color brightness level, survival rate and water quality (temperature, pH and DO). The results of the study for 60 days of maintenance showed that the best growth parameter was the red LED light treatment with an absolute length growth of 0.57 cm and an absolute weight growth of 0.49 g. The best color quality parameter for tiger barb (*Puntius tetrazona*) was obtained in the red LED light treatment with an increase in the color score in the Toca color finder (TCF) reaching 1.7 on the body; 2,3 on the pectoral fins; and 2.4 on the tail. The water quality parameter values are in normal conditions (temperature ranges from 27.3-27.9 ◦C; DO ranges from 4.2-5 mg/l; and pH ranges from 6.97-7.65;) so that it is good for the survival rate of tiger barb, namely 100%.

Keywords : Puntius tetrazona, light spectrum, LED lights, color brightness level

1. INTRODUCTION

Tiger barb (*Puntius tetrazona*) is one of the freshwater ornamental fish native to Indonesia that is in demand by the public because it has beautiful colors and agile movements so it is suitable to be kept in an aquarium (Umar et al. 2018). The better the color and body shape, the higher the selling value (Nafsihi 2016). However, in tiger barb farming, there are problems faced, namely the quality of the red and black colors that fade, when compared to natural catches (Sembiring et al. 2013).

Color is an aesthetic value in ornamental fish that affects its selling value. The appearance of color on the fish body is caused by color pigment cells or chromatophores scattered in the dermis tissue of fish scales. Chromatophores or color pigment cells are found in the epidermis of fish skin, which can adapt to the environment and sexual activity, while the number and distribution of chromatophores affect the brightness of the color in fish (Lesmana and Satyani 2002). Factors that affect color brightness in fish are genetic, environmental and feed nutrition factors.

One of the environmental engineering that can be done to improve the color quality of fish is to engineer lighting. Physiological responses and fish growth can be influenced directly or indirectly by wavelength, intensity and photoperiod (length of exposure) (Karakatsouli et al. 2008). Manipulation of light in the cultivation system with the right combination of wavelengths can produce a good number and distribution of chromatophores, thus making the color more brilliant (Tume et al. 2009). Based on research to determine the effect of the use of light with different wavelengths on the color quality of botia fish (*Chromobotia macracanthus* Bleeker), it was found that the use of red LED lights had a significant effect ($P<0.05$) on color quality, absolute length, and absolute weight of fish. botia, but had no significant effect (P>0.05) on survival (SR) (Virgiawan et al. 2020). This study aims to evaluate the effect of light spectrum on growth performance and brightness level of tiger barb (*Puntius tetrazona*).

2. MATERIAL AND METHODS

This research was carried out from January 2022 to March 2022. The place of research was carried out at the Aquaculture Laboratory, Building 2, Faculty of Fisheries and Marine Sciences, Padjadjaran University. The test fish used were tiger barb with an average body weight (BT) of 1.08±0.03 g fish-1, total length (PT) 3.85±0.04 cm. Fish were kept in an aquarium measuring 39.8 x 25.4 x 28 cm3 with a density of 10 fish/15 L of water.

The method used is an experimental method with a completely randomized design (CRD) consisting of five light spectrum treatments and three replications with the following treatments:

Treatment A : Control (room light)
Treatment B : Use of White LED
Treatment C : Use of Red LED : 620-630 nm
Treatment D : Use of Green LED : 520-539 nm
Treatment E : Use of Blue LED : 460-470 nm

2.1 Research Procedures

Newly arrived fish were acclimatized for 7 days so that the fish could adapt and be in good health when treated. During the acclimatization process, the fish were fed twice a day without LED light treatment. The treatment of the LED light spectrum was given with an irradiation time of 12 hours and a light intensity of 550 lux referring to Nurdin's research (2014). The LED light starts turning on at 07.00 and turns off at 19.00 (Shin et al. 2013). Checking the light intensity is done with a lux meter on the surface of the water. The treatment was given for 60 days. During the experiment, the test fish were fed a special feed for ornamental fish using the ad satiation method of feeding and the frequency of feeding was twice a day, at 08.00 and 16.00. During the study, water quality was maintained by changing water and taking fish manure

2.2 Data Analysis

Survival and growth data are analyzed with analysis of variance (ANOVA) test F with a confidence level of 95%, then if there is a difference between treatments followed by duncan double distance test. The color improvement data was analyzed using the Kruskal-Wallis analysis, then if there was a difference between treatments, the Z test was conducted with a confidence level of 95%. Water quality data is analyzed descriptively.

Parameters observed in this study were absolute length growth, absolute weight, survival rate, color brightness, and water quality. Observations were made every 10 days including:

2.2.1 Absolute length growth

Absolute length growth is the difference between the length of the fish between the tip of the head to the tip of the tail of the body at the end of the study and body length at the beginning of the study. The absolute length growth was calculated using the Effendie (1997) formula:

$$\mathbf{P = P_t - P_0}$$

Information :
P : Average length growth (cm)
P_t : Final length growth (cm)
P_0 : Initial length growth (cm)

2.2.2 Absolute weight growth

Absolute weight growth is the difference between fish body weight at the end of the study and body weight at the beginning of the study. The formula used to determine the growth of fish weight is based on the Effendie (1997) formula:

$$\mathbf{W = W_t - W_0}$$

Information :
W : Average weight growth of fish (grams)
W_t : Final fish weight growth (grams)
W_0 : Early fish weight growth (grams)

2.2.3 Survival Rate (SR)

Observation of the survival of goldfish fry can be observed by counting the number of live carp fry at the beginning and end of the study. The percentage of survival of carp fry can be obtained using the Effendie (1997) formula :

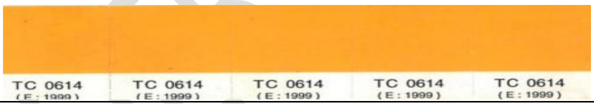
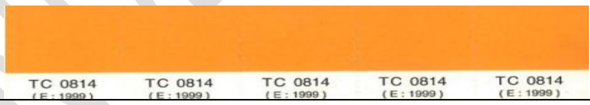
$$SR = \frac{\mathbf{Nt}}{\mathbf{No}}\, x\, 100\%$$

Information :
SR : Survival Rate (%)
N_t : Number of fish that live at the end time (tail)
N_0 : Number of fish that lived at the beginning (tail)

2.2.4 Color brightness

Color measurement is carried out every 10 days using an assessment method by determining the color scale of the test fish based on the TCF color standard compared to the color of the test fish (Aras et al. 2015). The color standard was set by 5 panelists to avoid bias in making the assessment. The selected panelists are panelists who are not color blind. Color assessment on the test fish included body color, pectoral fins, and tail fins. After the panelists gave an assessment of the color of the tiger barb, the color assessment data was converted into ratings. The color scale used in this study is listed in Table 1.

Table 1. TCF Color Scale used

No.	Gambar TCF	Keterangan
1.		Skor 1 Kode TCF 0614
2.		Skor 2 Kode TCF 0814
3.		Skor 3 Kode TCF 0615
4.		Skor 4 Kode TCF 0815
5.		Skor 5 Kode TCF 0616

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Kode TCF 0916</td></tr>
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2.2.5 Water Quality

The water quality observed at the time of the study for supporting materials was DO, pH and Temperature. Observations were made on the 0th, 10th, 20th, 30th, 40th, 50th and 60th days.

3. RESULT AND DISCUSSION

3.1 Pertumbuhan

The results of observations of the average length and weight of tiger barb during the 60 days of the study can be seen in the following table (Table 1). The results of the analysis of variance of the F ANOVA test (Analysis of Variance), showed that the use of the LED light spectrum for 60 days did not have a significant effect on absolute length and absolute weight growth in tiger barb (Fcount <Ftable at 5% confidence level) as shown in Table 2. The use of red LED which has a high wavelength spectrum range of 620-630 nm is the best spectrum for absolute length growth and absolute weight. Although the results of the analysis of variance stated that the results of growth data between control treatments, white, red, green, and blue LEDs on absolute length and absolute weight growth did not show significant results (P> 0.05), but the growth data on red LED treatments had the highest value. The growth data on red LED treatment with the highest values included absolute length growth of 0.57 cm and absolute weight growth of 0.49 g.

Table 2. Measurement Results of Average Absolute Length and Absolute Weight of Tiger Barb.

Treatment	Absolute weight growth (g)	Absolute length growth (cm)
A	0,45 ± 0,04*^{a}	0,55 ± 0,07*^{a}
B	0,46 ± 0,03*^{a}	0,55 ± 0,02*^{a}
C	0,49 ± 0,02*^{a}	0,57 ± 0,02*^{a}
D	0,43 ± 0,04*^{a}	0,47 ± 0,01*^{a}
E	0,41 ± 0,08*^{a}	0,47 ± 0,05^{*a}

Notes: Different notations show a significant effect P<0.05 (Z multiple distance test).

Tiger barb are thought to have adapted to the red LED light spectrum and make it easier to see and eat feed in the form of pellets. Visual sight is the main sensory used by diurnal fish in foraging activities. The ability of fish to respond to the light spectrum is influenced by the arrangement of photoreceptor cells in the retina of the eye. Photoreceptor cells consist of cones and rods. Con are cone cells that are responsible for bright vision and color discrimination, while rods are rod cells responsible for low light vision (Cronin et al. 2014). This is in line with Boeuf & Le Bail (1999) who said that light affects fish growth and also stimulates the rate of feed consumption. Another study showed that the use of the red spectrum gave the highest average final weight for rainbow trout (*Onchorhyncus mykiss*) and had the best feed conversion in trout (Karakatsouli et al. 2008).

3.2 Survival Rate (SR)

Based on Figure 1, it was found that the LED light spectrum treatment did not provide a significant difference to the survival rate of fish, namely the survival rate of tiger barb in each treatment of 100% as based on the results of the variance test, it was found that statistically the five treatments did not have a significant effect on tiger barb survival rate.

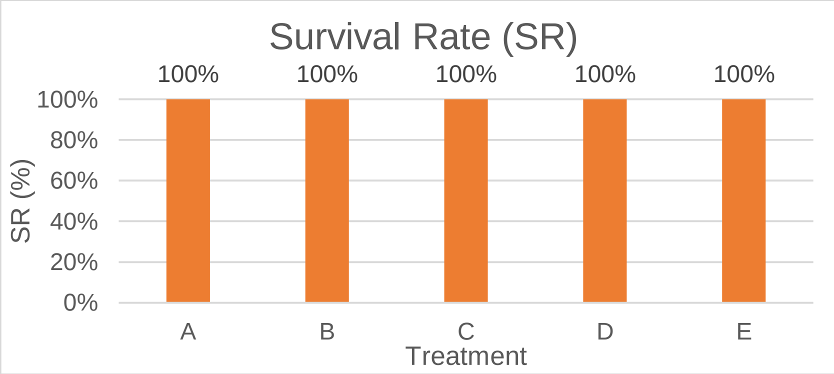

Fig 1. Tiger barb Survival Rate

This study showed that the LED light treatment did not affect the survival rate of tiger barb. This is in line with the research of Aras et al. (2015) who reported that the LED light spectrum treatment had no significant effect on juvenile botia fish survival. The high survival rate is because the fish rearing media environment supports the survival of the fish. Factors that affect the level of survival are abiotic and biotic factors, including: competitors, population density, age and the ability of organisms to adapt to the environment. The survival of fish is not completely determined by feed, but is also determined by the culture environment (Karimah et al. 2018).

3.3 Color brightness

The increase in the level of color brightness in tiger barb showed that the use of LED lights with a white light spectrum, a red light spectrum, a green light spectrum|, and a blue light spectrum had an effect on color changes. As shown in Figure 2 and Table 3.

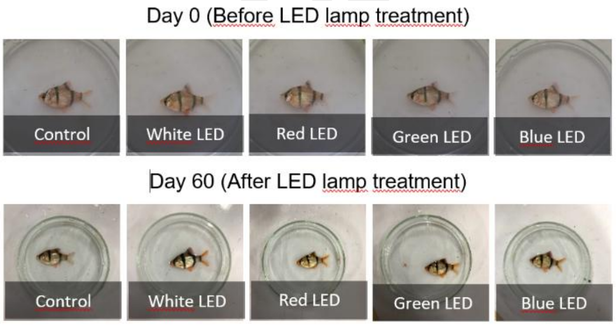

Fig 2. Visual observations of the brightness level of the Tiger Barb *Puntius tetrazona*

Based on Table 3, it was found that the value of the highest increase in fish color brightness was found in the use of red LED lights (Treatment C) which was 1.7 on the body, 2.3 on the pectoral fins, and 2.4 on the tail fins. the lowest was found in the treatment without LED light (control) which was 0.8 on the body, 1.0 on the pectoral fins, and 0.6 on the caudal fins.

Table 3. Average Result of Increase in TCF Score for Body Color, Chest Series, and Tail Fin of Tiger Barb for 60 Days

Treatment	Improved Color TCF Score (H60-H0)		
	Body	Pectoral Fin	Caudal Fin
A	0,8 ^{c}	1,0 ^{c}	0,6 b
B	0,9 ^{bc}	1,2 ^{bc}	1,7 ^{ab}
C	1,7 ^{a}	2,3 ^{a}	2,4 ^{a}
D	1,4 ^{ab}	1,5 ^{abc}	2,0 ^{a}
E	1,3 ^{abc}	1,8 ^{abc}	2,1 ^{a}

Notes: Different notations show a significant effect $P<0.05$ (Z multiple distance test).

The results of the Kruskal-Wallis test analysis showed that the LED light spectrum treatment for 60 days had a significant effect ($P<0.05$) on increasing the color brightness of tiger barb. The highest increase in color brightness was obtained by the use of red LEDs (Treatment C) with an increase in TCF scores of 1.7 on the body, 2.3 on the pectoral fins, and 2.4 on the tail fins, but not significantly different ($P > 0.05$) with treatment using green LEDs (Treatment D) with an increase in TCF score of 1.4 on the body, 1.5 on the pectoral fins, and 2.0 on the tail fins and treatment with the use of blue LEDs (Treatment E) with an increase in TCF scores of 1.3 on the body, 1.8 on the pectoral fins, and 2.1 on the tail fins. This is due to the treatment with the use of red LED light (Treatment C) is the best light spectrum length so that the chromatophore cells are expressed more optimally than other treatments.

The yellow and red body parts of tiger barb are the result of erythrophore and xanthophoric pigment cells (Hawkes 1974). Fish with erythrophore and xanthophore pigments are less effective at white light and room light (control) so that the response of the chromatophores is dispersion (Oshima 2001). The red LED light treatment (Treatment C) produced fish with the best color quality as shown in Table 3 and Figure 2. The same results were also obtained by Aras et al. (2015) who proved that the treatment of red LED light (M) was able to increase the appearance of red color in botia fish (*Chromobotia macracanthus*) by increasing the percentage of red color in the RGB component. The color development of tiger barb based on TCF from the beginning of the study to the end of the study can be seen in the graph below (Figure 3).

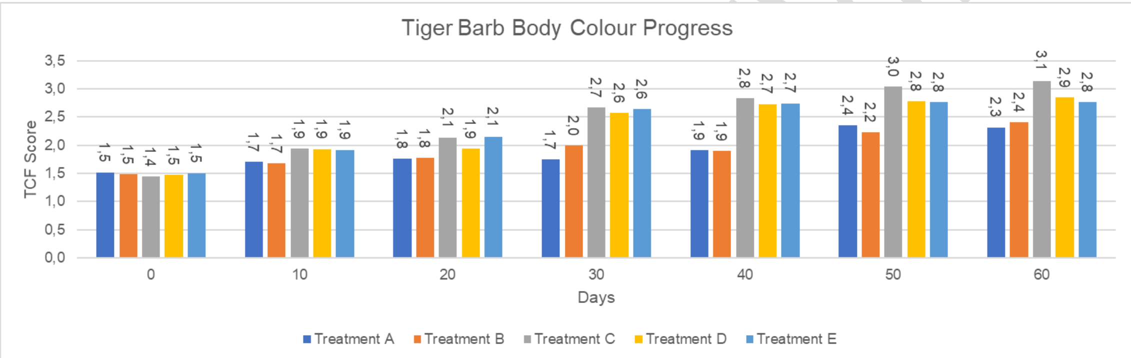

Fig 3. Graph of Increase in TCF Color Score of Tiger Barb Body for 60 Days

Based on the graph above (Figure 3), it is known that the TCF score of fish color in each treatment has increased from the beginning of the study to the end of the study, this is because the fish adapt and the chromatophores cells in the fish skin are well expressed. It was seen that the color pigmentation in fish increased after the study was running for ten days, the maximum color was after 50 days, and then the color tended to be constant according to the statement of Satyani and Sugito (1997), that the increase in bar was seen after twenty days and the increase in color was still visible until 40th day.

According to Oshima (2001), the wavelength of light that is effective for fish that have erythrophore and xantophore pigment cells is the wavelength of blue, green and red light. Each species of fish has a different ability to respond to stimuli in the spectrum of light received. According to Oshima (2001) the response ability is divided into two responses, namely primary responses and secondary responses. The primary response can be said to be a nonvisual response, which means that the chromatophores respond directly, while the secondary response that acts is visual vision controlled by the nervous system (Fingerman 1965). The following is a graph of the development of TCF scores on the pectoral fins of tiger barb (Figure 4).

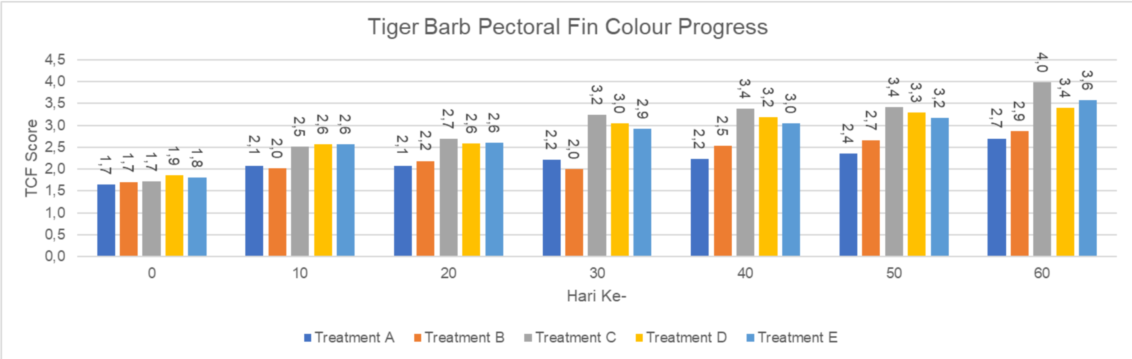

Fig 4. Graph of Increase in TCF Color Score of Tiger Barb Pectoral Fins for 60 Days

Chromatophores are pigment cells that are responsible for color changes in various species. The chromatophores found in fish include melanophores for black or brown pigmentation, xanthophores for yellow pigmentation, erythrophores for red pigmentation, leucophores for white pigmentation, iridophores for metallic pigmentation and associated color changes, and cyanophores for blue pigmentation (Fujii 2000). Chromatophores are located in the dermis, in the upper and lower layers. Each species has a color capacity that can change with several combinations of chromatophores cells and different proportions aimed at adapting to the environment or called the camouflage process (Tume et al. 2009). Light is one of the environmental factors that can affect the migration of fish pigment patterns (Kusumawati 2011). Evans et al. (2014), that the movement of pigment cells caused by the light spectrum on the maintenance medium can cause color changes. Based on Figure 5, it can be seen that the use of LED lamps in the maintenance of tiger barb has increased while the maintenance without the use of LED lamps does not provide a significant increase in color brightness (tends to stagnate).

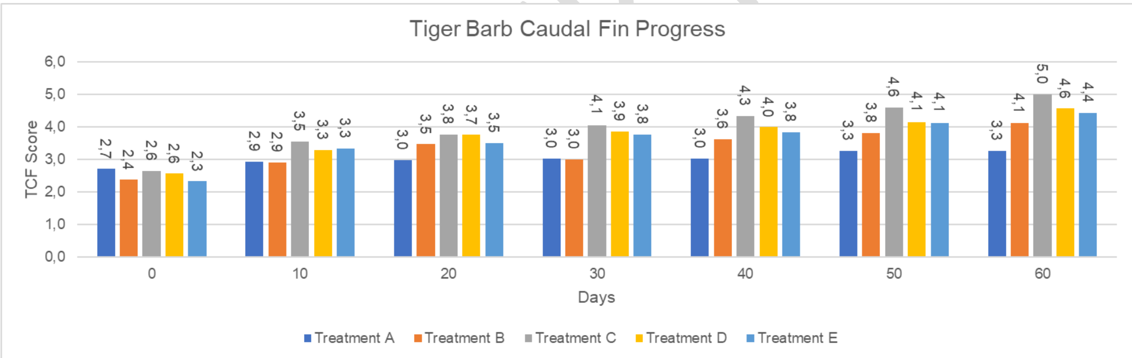

Fig 5. Graph of Increase in TCF Color Score of Tiger Barb Caudal Fins for 60 Days

The red LED treatment is remembered as the best light spectrum, making it easier for tiger barb to see the feed given. In addition, the treatment of red LED light spectrum which has a length range of 550-700 nm and a wave peak of 625 nm is able to minimize potential damage to the astaxanthin content in fish pigments from ultraviolet light and there is no hydrolysis of carotenoid content. This is in accordance with the statement of Tume et al. (2009), that conditions under bright light will cause chromatophoric cells formed from carotenoids in the form of astaxanthin to be hydrolyzed from astaxanthin to derivatives with one fatty acid and form mono esters, so that chromatophoric cells look faded.

3.4 Water Quality

The range of water quality in the tiger barb rearing media for 60 days of rearing including temperature, pH, and dissolved oxygen showed results that were not too volatile, namely temperatures ranging from 26.6-27.9°C; dissolved oxygen 4.0-6.0 mg/L; and pH ranged from 6.97 to 7.90 (Table 4). The following is the result of measuring water quality during the 60 day maintenance period (Table 4).

Table 4. Water Quality

Treatment	Water Quality Parameter Range		
	Temperature (°C)	DO(mg/L)	pH
A	27,1-27,5	4,3-5,0	7,27-7,70
B	27,3-27,7	4,3-6,0	7,03-7,56
C	27,3-27,9	4,2-5,7	6,97-7,65
D	27,2-27,6	4,0-5,5	7,00-7,90
E	26,6-27,6	4,0-5,2	7,53-7,64

Water quality during maintenance is still in a decent condition (Table 4). This condition is due to periodic siphoning of maintenance media so that water quality can be maintained. The temperature values in the measured maintenance media ranged from 26.6-27.9°C. The dissolved oxygen value measured is above the recommended value, which is above 4 mg/L. According to SNI (2000), the growth rate of fish will be good in the optimum temperature range of 25-30°C and generally fish can live with a pH range of 6.5-8.6. The optimal dissolved oxygen content for fish should be 3-5 mg/l (Madinawati et al. 2011).

4. CONCLUSION

Based on the results of the study, it can be concluded that the use of a red LED light spectrum gives an absolute length growth of 0.57 cm and an absolute weight growth of 0.49 g and the survival rate of tiger barb is 100%. In addition, the use of a red LED light spectrum can increase the brightness of Tiger Barb (Puntius tetrazona) by increasing the color score in the Toca color finder (TCF) reaching 1.7 on the body; 2,3 on the pectoral fins; and 2.4 on the tail. The water quality parameter values were in normal conditions (temperature ranged from 27.3-27.9°C; DO ranged from 4.2-5.7 mg/l; and pH ranged from 6.97-7.65).

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