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Submission title:	Effect of Time of LED Lights Irradiation on Aquascape Perfor...
File name:	Journal_Of_Aquaculture_Development_And_Environment_Ha...
File size:	476.02K
Page count:	9
Word count:	4,554
Character count:	22,112
Submission date:	11-Sep-2023 02:58PM (UTC+0700)
Submission ID:	2162968109

Journal of Aquaculture Development and Environment — *Volume 3 No. 1, Maret 2020*

Effect of Time of LED Lights Irradiation on Aquascape Performance

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Abstract

This study aims to determine the length of time the irradiation of LED lights is suitable for aquascape ornamental plant performance, fish survival and water quality in aquascape media. This research was conducted on 22 April 28 May 2019 in collaboration with Fisheries Faculty of Agriculture, Animal Husbandry, University of Muhammadiyah Malang. This research uses 2 types of low light aquascape plants, namely Cryptocorine Wenti and Hidrocotyle Leucepala. This research is an experimental study using RAL with 4 treatments P0 (control 12 hours of indirect sunlight), P1 (LED lights with a long exposure time 8 hours), P2 (LED lights with a long exposure time of 10 hours), P3 (LED lights with a long exposure time of 12 hours) repeated 3 times. The parameters observed include aquascape ornamental plants such as plant length, stem diameter, wet weight. In the observation of water quality including temperature, pH, DO, dissolved CO_2, and water hardness. In aquascape ornamental fish in the form of survival rate and growth of ornamental aquascape fish. Analyzed with ANOVA and continued with the Least Significant Difference Test on parameters that obtained significant differences.The results showed that the irradiation time of 10 hours had a significant influence on the stem diameter of the plant, namely P (0.037) <0.05 and the LSD test showed that the length of time the irradiation of 10 hours of LED lights had a significant effect on the diameter of the aquascape stem. In the length and wet weight of aquascape ornamental plants did not show significantly different results. On the parameters of water quality, growth and graduation of fish life also did not show significantly different results from the treatment of the long exposure time given.

Keywords: *Long Exposure Time, LED Lights, Aquascape Ornamental Plants*

Introduction

Aquascape is the art of arranging aquatic plants that produce a natural garden in an aquarium. Aquascape provides a description of the meaning of life from natural miniature that is full of synergy, such as plants that need food from plant media, fish release CO2 needed by plants, and vice versa plants produce O2 that is needed by fish, and all components that need each other between one the other (Widjaja, 2013).

Diversity of organisms that live in aquascape media, of course it is necessary. According to Hariyanto et al., (2018) so that life in the aquarium becomes balanced and in accordance with the waters in nature. The balance in the aquascape media depends on nutrition, dissolved carbon dioxide and lighting.

Lighting in aquascape media is not just aesthetics, but is one of the main factors that is the key to success in aquascape maintenance (Nursaiful, 2017). Lighting is one of the main factors in the balance of aquascape media. If the light received by aquatic organisms is not optimal, various problems will arise. The effect of lighting on aquascape media is determined by two things, namely quantity and quality. The quantity of light is determined by the amount of wattage, while the quality of light is determined based on the amount of color temperature and duration of irradiation given (Yulianto, 2001).

The range of long irradiation needs in aquascape media is certainly different when equated with the needs of plants that are in the wild. Aquascape media are limited in extent and the distance of the lights to the waters

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The range of long irradiation needs in aquascape media is certainly different when equated with the needs of plants that are in the wild. Aquascape media are limited in extent and the distance of the lights to the waters close to produce the need for different irradiation duration.

Long irradiation time that is not known with certainty will lead to various problems. Therefore the researchers intend to find out the influence of the length of time the irradiation of LED lights on the performance of Aquascape.

Materials and Methods

1 This research is an experimental study conducted at the Laboratory of Fisheries, University of Muhammadiyah Malang in April to May 2019. The equipment used in the study is a 40 x 25 x 28 cm aquarium, 5 Watt LED lights, a ruler, calipers, 2 bottles of aqua responsibility and large , aerator pipe, thermometer, filter, CO2 test, O2 test, kH test, pH test. While the materials used in the study include poor sand, aquagizi fertilizer, starter bacteria, yeast, sugar, warm water, ornamental fish, Sumatran, Hydrocotyle Leucocephala and Cryptocoryne Wenditii plants.

6

Research design

The study used 4 treatments with 3 replications

1. PO = *Hydrocotyle Leucocephala* and *Cryptocoryne Wenditii* + indirect sunlight (without 5 Watt LED lights)
2. P1 = *Hydrocotyle Leucocephala* and *Cryptocoryne Wenditii*+ LED light 5 Watt until 8 hour
3. P2 = *Hydrocotyle Leucocephala* and *Cryptocoryne Wenditii*+ LED light 5 Watt until 10 hour
4. P3 = *Hydrocotyle Leucocephala* and *Cryptocoryne Wenditii*+ LED light 5 Watt until 12 hour

The treatment uses a different transmission time which is randomized according to Figure 1. P = Treatment, U = replication

P3U3	P3U2	P2U3	P3U1
P2U2	P1U1	P0U2	P2U1
P0U1	P1U2	P0U3	P1U3

Figure 1. Research design

Data analysis

1 The data obtained were then analyzed by variance (ANOVA) to determine the effect of the treatment given on plant growth, water quality and survival and growth of fish. If there are differences will be further tested (BNT) to see the best treatment.

Result and Discussion

Effect of Long Irradiation Time on Aquascape Ornamental Plant Growth

Length of the Cryptocoryne Wenditii Plant

In figure 2 it can be seen that the lowest plant length was obtained in the 12-hour irradiation treatment with 7.94 ± 1.05 and the highest growth was in the control treatment which was 10.24 ± 2.37. Whereas in the treatment of 8 hours of irradiation and 10 hours of irradiation obtained 8.45 ± 1.23 and 8.05 ± 1.64. The results of the analysis of 2 variance showed that there were no significant differences in each treatment $P > 0.05$. Then H0 is accepted, that is, there is no real effect of irradiation time on the increase in aquascape plant length.

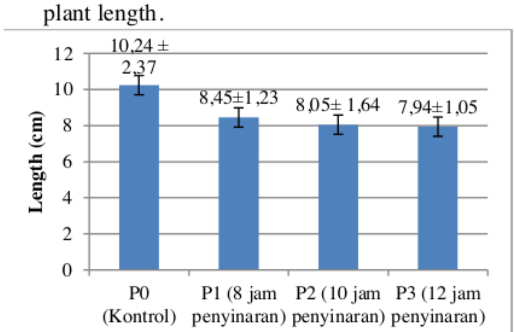

Figure 2. Length of *Cryptocoryne Wenditii*

The high growth in the control treatment indicates an etiolation event, where this event is an attempt by the plant to lengthen its torso to obtain the needed light. It has been explained by Salisbury and Ross (1995) that the increase in plant length that occurs in treatments with low light intensity is thought to be due to an etiolation event that is the extension of the stem due to reduced auxin degradation with the aim that the plant can catch the light in the amount needed. So that makes the plant's morphology look bad because the stems are not sturdy, and easily broken. Sitompul and Bambang (1995) also explained that the less light obtained, the elongation of plants would be higher than plants that get full intensity.

The lowest growth was found in the P3 treatment with a 12-hour irradiation period of 7.94 ± 1.05 which should be greater than the other treatments. The low growth is due to the occurrence of algae explosion in P3 treatment aquascape media, which can be seen in the aquascape media observation table in figure 8. So that plants are not able to absorb light completely due to competition for light competition and are blocked by algae that have filled the surface of the water. This is explained by Gunawan (2012) that algae plants can flourish if there is sufficient sufficiency of dissolved CO2, nutrients, and light in the waters. Optimum lighting conditions can make algal plants absorb CO2 up to 10%. With the increase in the intensity of the light provided, it will show an increasing growth rate. This happens due to the higher light intensity contributing more electrons (e-) to join the H + and O2 atoms to produce energy.

Length of *Hydrocotyle Leucocephala* plant

In figure 3 it can be seen that the lowest plant length was obtained in the control treatment with 5.69 ± 2.77 and the highest growth was found in the treatment time of 10 hours irradiation time which was 12.42 ± 5.44. Whereas in the treatment of 8 hours of exposure and 12 hours of exposure obtained 11.9 ± 4.88 and 10.35 2 4.96. The results of the analysis of variance showed that there were no significant differences in each treatment P> 0.05. Then H0 is accepted, that is, there is no real effect of irradiation time on the increase in aquascape plant length.

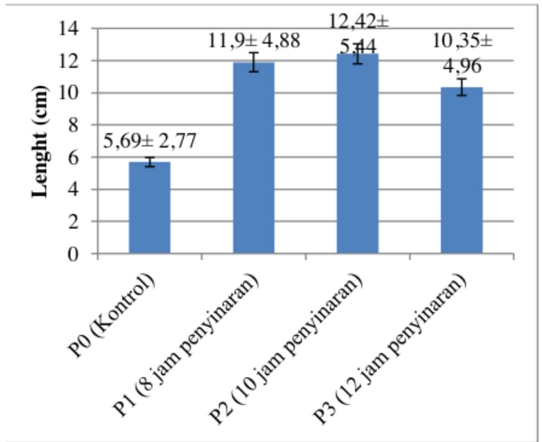

Figure 3. Length of *Hydrocotyle Leucocephala*

The high growth shows that with a long irradiation time of 10 hours, plants will absorb more light for the growth process. This is in accordance with the research of Muchammad et al (2013) that As the intensity of the light given increases, the water plants will show a higher growth rate.

The lowest growth was found in the control treatment that only uses indirect sunlight that is 5.69 ± 2.77. This was explained by Parson and Chapman (2000) that plants which received a short irradiation period and low light intensity, would cause a reduced supply of crude material from photosynthesis to be reduced, so the plants would experience slow growth. The same thing is explained by (Soepandie et al., 2003) that the condition of lack of light results in disruption of metabolism, causing a decrease in the rate of photosynthesis and carbohydrate synthesis.

Cryptocoryne Wenditii stem diameter

In figure 4. it can be seen that the lowest stem diameter of the plant was obtained in the control treatment with 1.85 ± 0.38 and the highest stem diameter was found in the treatment time of 10 hours irradiation time which was 2.10 ± 0.57. Whereas in the treatment of 8 hours of irradiation and 12 hours of irradiation obtained 8.45 ± 0.41 and 1.91 ± 0.45. The results of the analysis of variance showed that there were no significant differences in each treatment $P > 0.05$. Then H0 is accepted, that is, there is no significant effect of irradiation time on the stem diameter of aquascape plants.

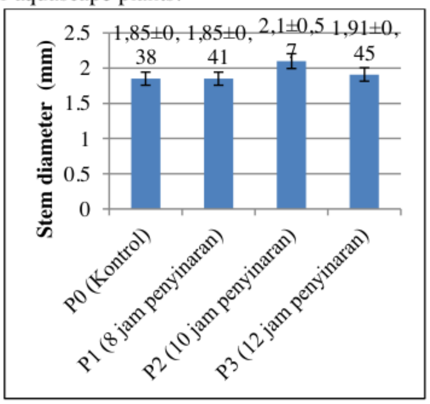

Figure 4. Stem diameter *Cryptocoryne Wenditii*

The size of the diameter obtained indicates that with a long irradiation time of 10 hours, the plant will absorb more light for the growth process. This is in accordance with the research of Muchammad et al (2013) that As the intensity of the light given increases, the water plants will show a higher growth rate.

The lowest stem diameter growth was found in the control treatment that only uses indirect sunlight that is 1.85 ± 0.38. The small diameter of the stem obtained in the control treatment is caused by the etiolation event or the effort of the plant in lengthening the trunk to get the needed light. This event certainly affected the stems of plants that are not sturdy and small. It has been explained by Salisbury and Ross (1995) that when the etiolation event occurs, stem extension due to reduced auxin degradation with the aim that plants can capture the required amount of light, will make the plant's morphology look bad because the stem becomes unstable, and easy broken.

Stem Diameter of *Hydrocotyle Leucocephala*

In figure 5 it can be seen that the lowest stem diameter of the plant was obtained in the control treatment with 1.32 ± 0.37 and the highest stem diameter was found in the treatment of the irradiation time of 10 hours ie 2.65 ± 0.68. Whereas in the treatment of 8 hours of exposure and 12 hours of exposure obtained 1.82 ± 0.81 and 2.35 ± 0.75. The results of the analysis of variance showed that there were significant differences in the treatment of P2 and P3 against other treatments $P < 0.05$. Then accept H1, that is, there is a significant influence on the irradiation time of the stem diameter of the aquascape plant.

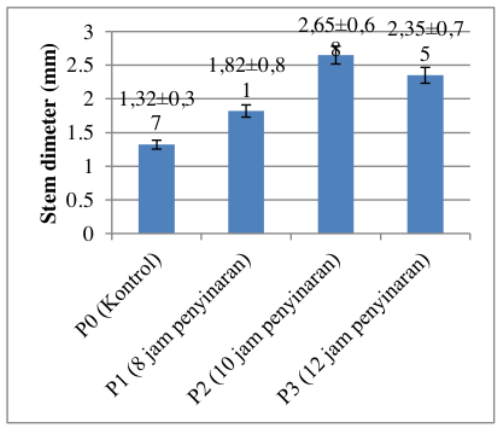

Figure 5. Stem diameter of *Hydrocotyle Leucocephala*

The size of the diameter obtained indicates that with a long irradiation time of 10 hours, the plant will absorb more light for the growth process. This is in accordance with the research of Muchammad et al (2013) that As the intensity of the light given increases, the water plants will show a higher growth rate.

The lowest stem diameter growth was found in the control treatment that only used indirect sunlight, which was 2.35 ± 0.75. The small diameter of the stem obtained in the control treatment is due to the lack of light received by the plant. This situation is similar to the length of the plant obtained. This was explained by Parson and Chapman (2000) that plants which received a short irradiation period and low light intensity, would cause a reduced supply of crude material from photosynthesis to be reduced, so the plants would experience slow growth. The same thing is explained by (Sapandie et al., 2003) that the condition of lack of light results in disruption of metabolism, causing a decrease in the rate of photosynthesis and carbohydrate synthesis.

Wet Weight of Cryptocoryne Wenditii Plant

In figure 6. it can be seen that the lowest wet weight of plants was obtained in the treatment P1 with 1.45 ± 0.74 and the highest wet weight was found in the treatment time of 10 hours irradiation time which was 2.05 ± 0.51. While in the control treatment and 12 hours of irradiation 1.56 ± 0.97 and 2.01 ± 0.61 obtained. The results of the analysis of variance showed that there were no significant differences in each treatment P> 0.05. Then H0 is accepted, that is, there is no significant effect of irradiation time on the wet weight of aquascape plants.

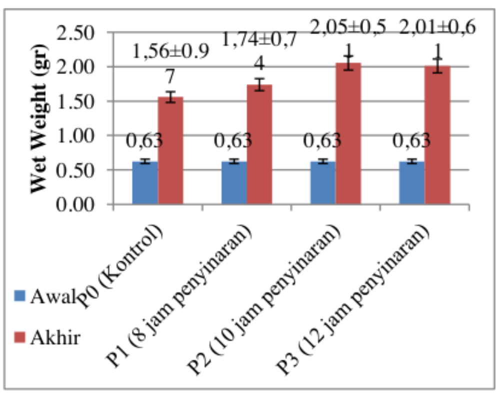

Figure 6. Wet weight of *Cryptocoryne Wenditii*

The high wet weight obtained indicates that the plant gets the right amount of light needed for its growth. This is in accordance with the research of Muchammad et al (2013) that As the intensity of the light given increases, the water plants will show a higher growth rate.

The lowest wet weight was found in the control treatment which only uses indirect sunlight as the lighting source, which is 1.56 ± 0.97. According to Dovrat (1993) Photosynthesis is a fundamental factor in the process of producing plant weights, a decrease in plant weight occurs with a marked decrease in carbohydrates that are formed in treatments that get low light intensity. If the lower intensity of irradiation obtained by plants, the lower the wet weight value.

Wet Weight of *Hydrocotyle Leucocephala* plant

In Figure 7. it can be seen that the lowest wet weight of the plant was obtained in the control treatment with 0.84 ± 0.81 and the highest wet weight was found in the treatment of 10 hours irradiation time period which was 1.36 ± 0.62. Whereas in the treatment of 8 hours of exposure and 12 hours of exposure obtained 0.89 ± 0.44 and 1.11 ± 0.37. The results of the variance analysis showed that there were no significant differences between all treatments P> 0.05. Then H0 is accepted, that is, there is no significant effect of irradiation time on the wet weight of aquascape plants.

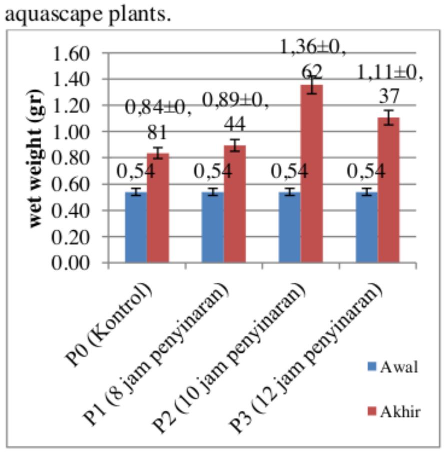

Figure 7. Wet weight of *Higrocotyle Leucepala*

The high wet weight obtained indicates that the plant gets the right amount of light needed for its growth. This is in accordance with the research of Muchammad et al (2013) that As the intensity of the light given increases, the water plants will show a higher growth rate.

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Effect of Long Time of Irradiation on Sumatran Ornamental Fish (Puntius tetrazona)

Growth of *Puntius tetrazona*

In figure 8. That the lowest increment of ornamental fish length was obtained in the control treatment with 3.22 ± 0.19 and the highest increment of length was found in the treatment time of 10 hours irradiation time of 3.56 ± 0.24. While in the treatment of 8 hours of irradiation and 12 hours of irradiation obtained 3.41 ± 0.10 and 3.52 ± 0.13. The results of the variance analysis showed that there were no significant differences between all treatments P> 0.05. Then H0 is accepted, that is, there is no real effect, long exposure time on the growth of ornamental aquascape fish.

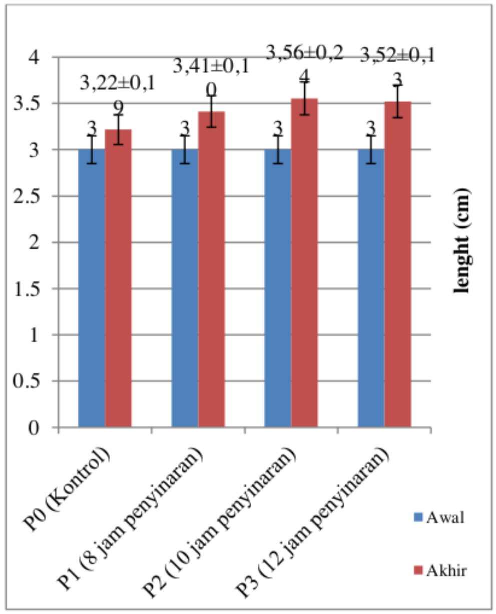

Figure 8. Growth

The highest growth was found in P2 treatment with a long irradiation time of 10 hours that was equal to 3.56 ± 0.24. The results were higher than the P3 treatment with a 12-hour irradiation period. This is because the aquscape media of P3 treatment algae explosion event that filled the entire aquarium space, thus making the fish space is limited and at night there is competition between fish and plants in the struggle for oxygen. This condition makes the growth of ornamental fish in the 12-hour irradiation treatment not too high. This is reinforced by the statement of Nurlaela et al., (2010) that in general it can be said that the higher the density of organisms applied to the aquatic media, the lower growth will occur, because there will be competition both space, dissolved oxygen and feed that affect the growth

Survival Rate Puntius Tetrazona

In Figure 9. It can be seen that the lowest survival rate of Sumatran ornamental fish was obtained in the control treatment with 60.00 ± 11.55 and the highest survival rate was in the treatment of the 10-hour irradiation time period which was 86.67 ± 11.55. Whereas in the treatment of 8 hours of irradiation and 12 hours of irradiation obtained 73.33 ± 46.19 and 66.67 ± 11.15. The results of the variance analysis showed that there were no significant differences between all treatments P> 0.05. Then H0 is accepted, that is, there is no significant effect of irradiation time on the growth of ornamental aquascape fish.

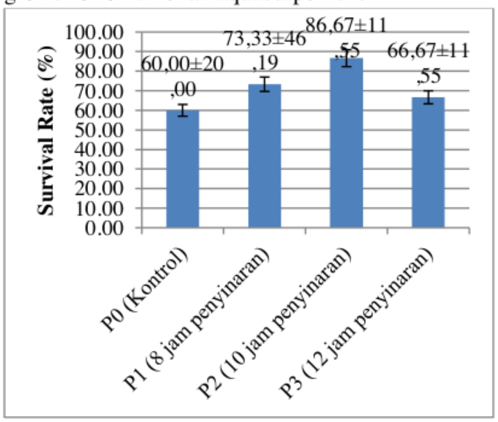

Figure 9. Survival Rate

In the observation results the highest survival rate is seen in the P2 treatment that is equal to 86.67 ± 11.55. Such conditions indicate that the long exposure time affects the survival rate of Sumatran ornamental fish. This has been explained by Barahona and Fernandes (1979) that light intensity and irradiation duration cannot be separated. Light can affect the behavior, survival and metabolism of fish. In general, fish need sufficient light intensity for normal development and growth. While the low survival rate obtained in the control treatment that is equal to 60.00 ± 20.00 indicates the lowest survival rate. This is presumably because the length of time irradiated greatly affects the survival or survival of fish, this result is in accordance with the opinion of Zonneveld et al., (1991) stating that the high or low survival rate of fish is greatly influenced by external factors such as irradiation.

Table 1. Water Quality

Effect of Long Irradiation Time on Water Quality Parameters

The results of measurements of water temperature, pH, and dissolved oxygen (DO) at the time of the study still showed an optimal range for the growth of aquatic plants. This was explained by Yulianto (2001) that plant growth would be more optimal if supported by appropriate environmental conditions. In general, plants can live and grow well under environmental conditions pH 6.5-7, kH 4-8, water temperature 24-26 oC and CO2 10-20 ppm

The content of dissolved carbon dioxide shows a different range in each treatment, this shows the use of CO2 by plants for the process of photosynthesis. This is reinforced by Salih (2011) that the decreased CO2 value in the 1st week is thought to be caused by the use of CO2 by aquatic plants for photosynthetic activity. CO2 is one of the raw material for photosynthesis besides water.

Whereas the parameter kH or mineral content in the aquacape media shows a range that is suitable for plant growth. The amount of kH obtained is due to the high activity of photosynthesis in aquascape media, which occurs as a result of the emergence of many algae disturbing plants. This is in accordance with the explanation of Sumeru and Suzy (1992) that in public waters with all photosynthetic activity and respiration of living organisms in it to form bicarbonate chain reactions. The more photosynthetic events that occur will require a lot of CO2 ions, thus causing the kH of water to rise.

Parameter	Treatment				Optimum range
	P0	P1	P2	P3	
Temperature (^{0}C)	23,5-24,5	24,5-26,4	23,7-26	24,5-26	24-26[A]

pH	7,3-8	7,3-8,5	7-8,6	7,7-9	6,5-7[A]
kH (kH)	7,0-10,0	8,0-11,0	6,0-12,0	7,0-13,0	4-8[A]
CO_2 (mg L^{-1})	1,2-1,9	1,0-3,4	1,0-2,7	1,3-2,5	10-20[A]
DO (mg L^{-1})	5,4-5,9	5,4-7,6	5,4-7,8	5,6-8,4	>3[B]

CONCLUSION

The treatment with different irradiation time results in increased growth in ornamental aquascape plants, and shows significantly different plant stem diameters. After being tested, it can be seen that the exposure time of 10 hours is significantly different and gives the best growth compared to other treatments.

SUGGESTION

Further suggestions are expected to be carried out research related to the use of artificial CO2 in aquascape media to determine the level of effectiveness and its effect on aquacape performance.

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