



Modification of Light to the Photosynthesis Rate of Hydrilla Sp with CaCO₃ Concentration

Afrizal Fahd Fhadillah¹, Antonius Krisdianto², Muhammad Rafli Aldiansyah³, Siti Hafshoh Nurul Millah⁴

¹ University of Education Indonesia, Bandung, Indonesia. Email afrizal.fahd415@upi.edu

² University of Education Indonesia, Bandung, Indonesia. Email antoniuskrisdianto@upi.edu

³ University of Education Indonesia, Bandung, Indonesia. Email raflialdiansyah16@upi.edu

⁴ University of Education Indonesia, Bandung, Indonesia. Email sitihafshohnm06@upi.edu

Corresponding Author Email: afrizal.fahd415@upi.edu

Abstract. This study aims to examine the effect of light modification on the rate of photosynthesis in Hydrilla sp. with varying CaCO₃ concentrations. Light and calcium carbonate concentration are important factors that affect photosynthesis in aquatic plants. The study was conducted by modifying the intensity and duration of light and regulating the concentration of CaCO₃ in the growing medium of Hydrilla sp. Photosynthesis rate was measured using experimental methods. The results showed that light modification had a significant effect on the rate of photosynthesis, with optimal light intensity and duration increasing photosynthesis. In addition, increasing CaCO₃ concentration also increased the rate of photosynthesis, with a synergistic effect seen when light and CaCO₃ were optimized together. This study concludes that light modification and CaCO₃ concentration are important factors in increasing photosynthesis of Hydrilla sp., providing valuable insights for aquatic plant cultivation and aquatic ecosystem management.

Keywords: light intensity, photosynthesis, Hydrilla sp., CaCO₃ concentration.

INTRODUCTION

Living things need oxygen to breathe in order to continue their lives. Oxygen is produced by plants through the method of photosynthesis. Photosynthesis is the process of forming food in plants with the help of light (Astari & Sudarmilah, 2019). A process in which plants use light energy to convert carbon dioxide and water into glucose and oxygen. Environmental factors, such as light intensity and the availability of dissolved carbon greatly affect the productivity of photosynthesis. Adequate light intensity is needed to activate the photosynthetic bright reaction, while dissolved carbon, which is often a limiting factor, can be enhanced through chemical reactions with compounds such as calcium carbonate (CaCO₃). The addition of calcium carbonate (CaCO₃) can increase the availability of carbon through bicarbonate ions (HCO₃⁻) which are essential for photosynthesis.

Variations in the light spectrum affect the rate of photosynthesis of *Hydrilla* sp., with the red and blue spectra providing better results in improving the photosynthesis process compared to the green spectrum (Handoko & Fajariyanti, 2018). In addition, (Nurmaya, 2023) reported that the addition of CaCO_3 increases dissolved bicarbonate ions, supporting increased photosynthesis. (Patrick & Florentine, 2021) highlights the adaptation of *Hydrilla* sp. to light intensity, demonstrating the relevance of this plant in tropical research. However, there has been no research that has integrated light modification and CaCO_3 concentration to increase the rate of photosynthesis of aquatic plants, suggesting a research gap. This research has scientific novelty in integrating light intensity modification and the addition of CaCO_3 to increase the rate of photosynthesis of *Hydrilla* sp. The problem of this research is how does light color, light wavelength, and CaCO_3 affect the number of bubbles in the photosynthesis process in hydrilla plants? It is hypothesized that a combination of the optimal light spectrum (red and blue) and a certain concentration of CaCO_3 can significantly increase the rate of photosynthesis. This study aims to find out the intensity of light, which light color is the most effective in the photosynthesis process and to find out the usefulness of CaCO_3 in the photosynthesis process).

METHOD

This study uses an experimental method with a factorial design to evaluate the effect of light intensity variations and CaCO_3 concentrations on the photosynthesis rate of *Hydrilla* sp. The research is carried out in a laboratory with the control of environmental variables to ensure the accuracy of the results. The main tools and materials needed are colored lights, red, yellow, green and blue, 5 grams of CaCO_3 solution, and *Hydrilla* sp. This research was carried out in the laboratory of SMA Muhammadiyah Singaparna on Tuesday, November 3, 2024 at 07.00 until the research was completed. The research steps first prepare tools and materials, prepare *Hydrilla* plants as many as 1 hand, then tie them with thread at the end of the plant to make it easier to put into the funnel. Put the hydrilla plant into the funnel, then put it into the Becker glass and attach it to the hook in the Beker glass, the Becker glass is filled with water, the end of the Coruna is covered with a test tube that has been filled with water and there are no bubbles in it, then a dissolved CaCO_3 solution is added, put the series into a closed box for manipulation. Observations are made with 4 different lights. Each light must be observed to calculate the number of bubbles produced in a certain period of time, this method is done at each change of light. The data processing from this study was carried out by the author by

processing photosynthesis rate measurement data, calculating the average photosynthesis rate for each experimental group (control and treatment) at each light intensity level and then recording how many bubbles were produced by each lamp color. Then the analysis of the effect of CaCO₃ solution on photosynthesis, the analysis of the effect of CaCO₃ solution on the photosynthesis of Hydrilla sp. whether the changes that occur when the CaCO₃ solution is added, by looking at the number of bubbles produced, then the presentation of data, data analysis, namely by presenting data in the form of tables, diagrams or percentages.

DISCUSSION

We have two research results, the first is a study using ordinary water and the second is ordinary water with a 5 gram CaCO₃ solution.

Table 1 Plain Water

It	Light Color	The experimen	Time	Number of Bubbles
1	Yellow	1	10 Minute	16
		2	10 Minute	43
2	Blue	1	10 Minute	0
		2	10 Minute	2
3	Red	1	10 Minute	0
		2	10 Minute	5
4	Green	1	10 Minute	0
		2	10 Minute	2

Table 2 Water + CaCO₃

It	Light Color	The experimen	Time	Number of Bubbles
1	Yellow	1	10 Minute	72
		2	10 Minute	122
2	Blue	1	10 Minute	1
		2	10 Minute	2
3	Red	1	10 Minute	2
		2	10 Minute	4
4	Green	1	10 Minute	1
		2	10 Minute	

After we analyze the data above that CaCO₃ solution has an effect on the photosynthesis process, it is proven by the number of bubbles obtained from the data above where the number of bubbles produced by the addition of CaCO₃ solution is more than that using ordinary water.

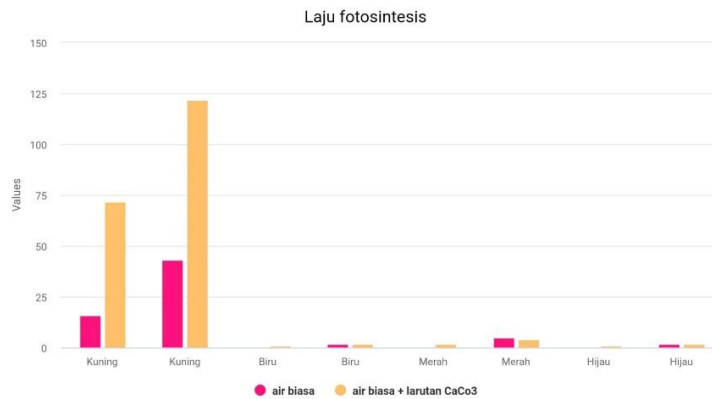


Figure 1
Comparison Chart of Bubble Number of Ordinary Water Solution and Water Solution + CaCO₃

In fact, the most effective light colors for the rate of photosynthesis are red and blue. This is because chlorophyll, the green pigment in plants responsible for photosynthesis, has the best ability to absorb light energy at the red and blue wavelengths of the light spectrum. While all colors of light can be used for photosynthesis, the intensity of absorption of light energy by chlorophyll is greater at red and blue wavelengths. This is referred to as the "spectrum of photosynthetic action." Other colors in the light spectrum, such as green, yellow, and orange, tend to be less effective at stimulating photosynthesis because chlorophyll absorbs light energy at certain wavelengths and reflects or absorbs energy at other wavelengths.

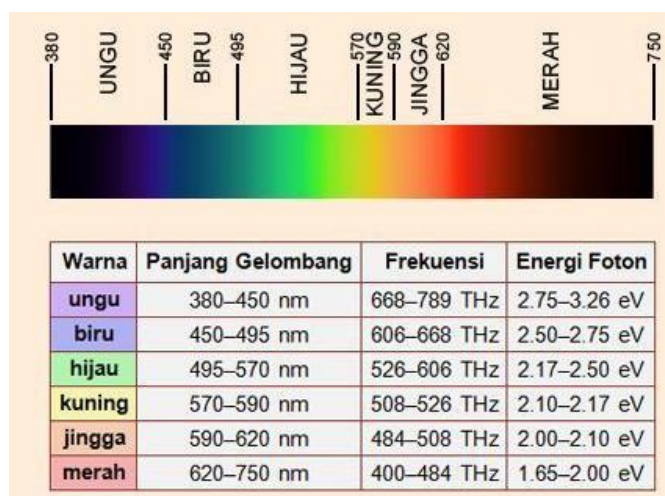


Figure 2

Colors in the Visible Light Spectrum

Red (about 620-750 nanometers) and blue (about 400-520 nanometers) wavelengths of light. So, to increase the rate of photosynthesis, a light source that gives high intensity to the red and blue wavelengths will be more effective.

But in contrast to the results of the practicum that we carried out where the most effective color for the rate of photosynthesis is yellow, as evidenced by the number of bubbles produced by the yellow color more than other colors. Blue and red colors have no effect on the rate of photosynthesis in the practicum because the lamps used are not originally blue and red, the lamps are originally white coated with stained glass, in contrast to yellow lamps where yellow lamps are coated with clear and colorless glass. Therefore, the light will be covered by a layer of color that makes the light not completely absorbed by chlorophyll, which is what causes the photosynthesis process to be slow. Then Calcium carbonate (CaCO_3) itself does not directly affect the rate of plant photosynthesis. Nevertheless, calcium is an essential element for plant growth and development, and the availability of calcium in the soil can affect the overall health of the plant, which in turn can affect the process of photosynthesis. Calcium has an important role in maintaining the pH balance of the soil and in the cell structure of plants. Plants need calcium for the formation of strong cell walls and healthy root development. If the soil is deficient in calcium, the plant may experience growth and development disorders that can affect their photosynthesis ability. In addition, calcium also plays a role in activating enzymes involved in the process of photosynthesis. However, the direct impact of calcium on the rate of photosynthesis may not be as large as the impact on overall plant health and development.

CONCLUSION

From the results of the research carried out, it was found that it was not in accordance with the existing hypothesis, the most effective light colors for the rate of photosynthesis are red and blue, because chlorophyll has the best ability to absorb light energy at that wavelength. Although all colors of light can be used for photosynthesis, the intensity of absorption of light energy by chlorophyll is greater at red and blue wavelengths, which is referred to as the "photosynthetic action spectrum." The wavelengths of red (about 620-750 nanometers) and blue (about 400-520 nanometers) light provide high intensity to stimulate photosynthesis. Nonetheless, the results of the practicum show that the most effective color for the rate of photosynthesis is yellow, which may be caused by the conditions of the lamps used in the

experiment. Calcium carbonate (CaCO₃) does not directly affect the rate of plant photosynthesis, but the availability of calcium in the soil can affect the overall health and growth of plants, which can ultimately affect the process of photosynthesis. Calcium has an important role in maintaining soil pH balance, plant cell structure, and activation of enzymes involved in photosynthesis. Because we use lamps that are painted with glass so the experimental results are not optimal, we recommend using lamps in accordance with the provisions to get maximum experimental results

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