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Growing Red Spinach Microgreens with Various LED Colors and Planting Media

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ABSTRACT

Red spinach microgreens are green plants that are consumed by their leaves in 14 days harvest time. This study aimed to examine the effects of LED light color and various planting media on the growth of red spinach microgreens. This research was conducted from June 1 to July 22, 2023, at Sendangguwo, at the Laboratory of Plant Ecology and Production, Faculty of Animal Husbandry and Agriculture, Diponegoro University, and at the Chem-mix Pratama Laboratory, Yogyakarta. The experimental design was a divided plot design with triplicates. The main plot was the LED light color treatment with four levels: white, red, blue, and green. The subplots were planting media treatments with 3 levels: soil, cocopeat, and vermiculite. The parameters observed included plant height, root length, wet weight, chlorophyll content, carotenoid content, and vitamin C content. The collected data were analyzed using analysis of variance and further tested using Duncan's Multiple Range test. The results showed that the color of white LED lights can increase chlorophyll and carotenoid contents, and in soil planting media, it also increased chlorophyll and carotenoid contents in red spinach microgreens. Cocopeat planting medium increased plant height, and vermiculite planting medium increased wet weight and vitamin C content. In conclusion, the color treatment of white LED lights and soil growing media increased chlorophyll and carotenoid content in red spinach microgreens.

Keywords: LED, microgreens, planting media, red spinach

INTRODUCTION

Every year, the population grows, and as a result, the need for vitamins and nutrients for growth is also increasing. With the increasing population growth, the residential area is currently expanding, and agricultural land is narrowing. Narrow agricultural land can hinder the production of vegetables that can support human vitamin and nutritional requirements. The World Health Organization (WHO) revealed that at least 400 g of vegetables and 8 fruits per day are beneficial for warding off free radicals (Bhatt and Sharma 2018). Plant cultivation involves planting and caring for plants to produce agricultural products in the form of fruits, vegetables, flowers, and medicines. Microgreen cultivation is included in the production of plant products in the form of vegetables. Microgreen cultivation is a solution for growing food crops that was created to meet the nutritional needs of humans in urban areas. The microgreen cultivation method is highly effective and efficient. The harvest time of microgreen plants is approximately 7–21 days after planting (DAP). The harvest size of microgreen plants is usually approximately 3–10 cm in height (Febriani *et al.* 2019).

Microgreens are one of the plants that are included in young plants because they can be harvested at a young age. Microgreens can be harvested when the cotyledons shed two leaves. During their growth period, microgreens do not require fertilizers or additional nutrients in their growing medium. The addition of fertilizers slows down the growth of microgreens (Weber 2017). Microgreens generally contain high amounts of calcium, iron, magnesium, and zinc. Microgreens contain 4–40× more bioactive compounds, such as pigments, enzymes, vitamins, and other phytochemicals, than mature plants because the existing compounds have not been used for organ differentiation (Kusumah and Murjasmi 2021). Microgreens have high nutritional and vitamin content. If stored for too long, the nutritional and vitamin content may decrease. Microgreens are often consumed by being added to salads and sandwiches and used to add flavor to soups, stews, and other dishes.

Microgreen red spinach (*Amaranthus tricolor L.*) is a plant that can be used as an urban farm. Microgreens grown indoors do not receive sunlight for photosynthesis. Therefore, artificial irradiation using light-emitting diodes (LEDs) is required. The light in LED lights that plants need is visible with a spectrum of 400–700 nm. LED lights provide light energy that is captured by chlorophyll so that microgreens can photosynthesize. The red and blue colors emitted by

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LED lights can support photosynthesis (Lindawati *et al.* 2015). Microgreen plants have a good radiance distance of approximately 10–20 cm from the plant. For microgreens that grow with the help of LED lights so that they can grow healthily, it is recommended to irradiate them for a total of 14–16 h every day (Haryadi *et al.* 2017). The irradiation needs of microgreen plants are also influenced by electrical power. LED lights used for the growth of microgreens do not require excessive power. Microgreens simply use LED lights with lamp powers of 12–16 W.

In addition to using LED lights, cultivating microgreens indoors requires growing media. Planting media that can be used includes, among others, volcanic soil, cocopeat, and vermiculite. Volcanic soil planting media are derived from volcanic activity. The occurrence of weathering materials from the mountains causes volcanic soil to be very fertile and suitable for use as a planting medium in plantations and agriculture. The volcanic soil has a C-organic value content of 4.593%, which indicates a high level, as found on the central slopes of Mount Dieng (Gani *et al.* 2021). Cocopeat is a planting medium derived from organic matter in coconut coir powder. Cocopeat is a growing medium with a high water absorption capacity and can store more water than ordinary soil. *Cocopeat* is a light growing medium and can store as much water as 73% of its weight (Charitsabita *et al.* 2019). Cocopeat planting medium has a pH of 5–6.8, making it excellent for the growth of any plant.

Vermiculite planting media are sterile planting media produced from rocks heated at high temperatures. Vermiculite growing media have higher water absorption and heavier weight. In addition, vermiculite is an excellent alternative planting medium for plant seedlings and growth. Vermiculite growing media have a higher cation exchange capacity, especially under solid and wet conditions. Vermiculite does not contain nitrogen but has a high water-storage capacity. Therefore, vermiculite can obtain more N elements (Sisriana *et al.* 2021). Element N in conventional cultivation is obtained from fertilizers that are not easily washed in vermiculite planting media, which can be stored and released slowly. Meanwhile, the cultivation of microgreens does not use fertilizers but requires a growing medium with high absorbency, such as vermiculite planting media.

This study aimed to examine the effect of LED light color irradiation on the growth of red spinach microgreens, the influence of various types of planting media on the growth of red spinach microgreens, and the interaction of LED light color irradiation and various kinds of planting media on the growth of red spinach microgreens.

METHODS

Materials and Research Design

The tools and materials used in this study were a *25* cm × 10 cm microgreens tray*,* a 10 W LED light (white, red, blue, and green), tray racks, spectrophotometer, mortar and pestle, red spinach seeds of the Pertiwi variety, soil, cocopeat, and vermiculite. This research was carried out from June 1, 2023, to July 22, 2023, in Sendangguwo, Tembalang, Semarang, at the Laboratory of Plant Ecology and Production, Faculty of Animal Husbandry and Agriculture, Diponegoro University, and Chem-mix Pratama Laboratory, Bantul, DI Yogyakarta.

This study used a Divided Plot Design with the main plot of LED lights and the subplot of planting media. The main tiles represent the color of the LED lights, namely white LED (L1), red LED (L2), blue LED (L3), and green LED (L4). The plots were the planting medium, namely soil (M1), cocopeat (M2), and vermiculite (M3). Each combination of treatments was carried out in triplicate, resulting in 36 experimental units, with each tray unit measuring 25 cm × 10 cm.

Implementation Procedure

The preparation stage included the preparation of tools and materials used for research in the form of seed preparation, preparation of planting media, preparation of shelves for placing trays of microgreens, and a place to irradiate LED lights 20 cm above the planting medium and LED lights.

The microgreen seeds were red spinach of the Pertiwi variety, spread on trays at 10 g/tray. Spraying used 20 sprays so that each tray received the same water supply. Thus, the planting medium was always in a humid state. The colors used for LED light irradiation were white, red, blue, and green every day for 14 h. Plants were watered regularly, that is, spraying using a sprayer 20 × until the soil conditions were moist. This stage was carried out twice a day, in the morning and evening, until the red spinach microgreens were ready for harvest at 14 DAP.

Data were collected by taking observation parameters of red spinach microgreens plants, in the form of plant height (cm), root length (cm), wet weight (g/250 cm^2), chlorophyll content (mg/g), carotenoid content (mg/g), and vitamin C content (mg/g).

Observed Parameters

Observations were performed daily for 14 DAP. Plant height was measured using a ruler, and the 5 tallest plants in each tray were selected. Root length (cm) was measured at the time of harvest at 14 DAP using a ruler. Root length was measured from the base of the root to the tip of the root using 5 random samples in each tray. Wet weight (g/250 cm^2) was measured in each tray with a tray size of 25 cm × 10 cm, which has a tray area of 250 cm^2. Observations were made after harvest (14 DAP) using a digital scale. Leaves, stems, and roots were weighed while the microgreens were fresh.

The chlorophyll content of the red spinach microgreens was determined using a spectrophotometer. The leaves of red spinach microgreens were sampled as much as 0.25 g, which were then mashed and dissolved with 15 mL of acetone. The dissolved extract was filtered using Whatman paper. The extract was placed in a 3 mL cuvette to measure its chlorophyll content using a spectrophotometer. The Arnon method (1949) used an 80% acetone solvent and measured the absorbance of chlorophyll at 663 nm and 645 nm on a spectrophotometer. The absorbent yield was calculated using the following formula:

$$\text{Total chlorophyll (mg/g)} = ((8.02 \times A663) + (20.2 \times A645)) \times \frac{V}{1000} \times \frac{1}{W}$$

where:
A645 = absorbance at 645 nm wavelength
A663 = absorbance at wavelength 663 nm
V = volume of the extract (mL)
W = sample weight (g)

The carotenoid content of red spinach microgreens was analyzed using a spectrophotometer. Samples of red spinach microgreen leaves (0.25 g) were mashed, dissolved in 80% alcohol (15 mL), and filtered using Whatman paper. The extract was placed in a 3 mL cuvette, and its absorbance was measured at 480, 645, and 663 nm. The total carotenoid content was calculated using the equation proposed by Gross (1991):

$$\text{Total carotenoid (mg/g)} = \frac{(A480 + 0.114 \times A663 - 0{,}638 \times A645) \times V \times 1000}{112.5 \times W}$$

where:
A480 = absorbance at 480 nm wavelength
A645 = absorbance at 645 nm wavelength
A663 = absorbance at wavelength 663 nm
V = volume of the extract (mL)
W = sample weight (g)

Vitamin C content was measured using iodometric titration. Samples of red spinach microgreens plants were mashed (5 g) and dissolved with water in a 100 mL flask. The solution was filtered, and the filtrate was pipetted to a volume of 25 mL. A few drops of starch indicator were added, and titration was performed quickly using a 0.01N iodine solution until a blue color appeared. Vitamin C levels were calculated using the iodimetry method (AOAC 1995) and the following formula:

$$\text{Vitamin C level (mg/g)} = \frac{V \text{ titrated iodine} \times 0.88 \times \text{dilution factor}}{\text{Sample weight (g)}}$$

where:
V = volume of iodine (mL)
0.88 = 0.88 mg of vitamin C is equivalent to 1 mL of 0.01 N solution

Data Analysis

The design used was a plot design divided into the main plot in the form of LED light colors with 4 levels and a subplot in the form of planting media with 3 levels, in triplicates. The additive linear model that explains each value of influence is as follows:

$$Y_{ijk} = \mu + \alpha_i + \delta_{ik} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

The data obtained were analyzed in a variety of ways at a level of 5% to determine the effects of the treatments. The analysis of the 5% variety, which showed a significant effect, was followed by Duncan's Multiple Range Test (DMRT) at the 5% level to determine the differences between treatments.

RESULTS AND DISCUSSION

Plant Height

For the color treatment of LED lights with planting media, there was no interaction with the height of the red spinach microgreens. The color treatment of LED lights had no significant effect, whereas the treatment of the planting medium had a significant effect on plant height (Table 1). DMRT showed that the color treatment of LED lights did not have a noticeable effect on the height of red spinach microgreens. The color of the LED lights provides light to the microgreens instead of sunlight. Microgreens are grown using LED light bulbs. Each color of the bulb has a different intensity that affects the growth of the plant, such as its height. LED bulbs with high light intensity in the study by Kurniaty *et al.* (2010) affected the activity of leaf stomatal cells in reducing transpiration, resulting in the inhibition of plant growth. The color of the LED light had no effect on the height of the red spinach microgreens. This may be due to the use of a single color in LED lights and a 14-hour illumination ratio. Factors that affect plant morphological disturbances such as plant height in plants are one of which is the single color of LED lights. Alfarykky (2021) showed that a single factor of irradiation time had no effect on the height parameters of spinach plants.

The treatment of the planting medium had a significant effect on the height of the red spinach microgreens (Table 1). The effect of cocopeat planting medium on height was significantly different from that of soil and vermiculite planting media. The plant height results showed that the cocopeat plant media played an important role in influencing plant height growth.

Cocopeat planting media have good water absorption because they contain pores that can be used for air exchange in plants. Juliana *et al.* (2022) showed that cocopeat planting media can absorb water and store and release nutrients that can be used for plant growth. The treatment of volcanic soil planting media produced the lowest height of red spinach plants. The soil planting medium used was volcanic soil originating from volcanic eruptions. Its characteristic is dark brown soils in the topsoil layer, where there is a large amount of organic matter. The use of volcanic soil on red spinach microgreens allows the use of soil from the lower layer, which leads to low plant height of red spinach microgreens. Gani *et al.* (2021) showed that volcanic soils experienced a decrease in C-organic and nitrogen along with soil depth with a pH between 4.5 and 6.0.

Root Length

The color treatment of LED lights and planting media had no significant effect on the root length of red spinach microgreens (Table 2). The results showed that the color treatment of LED lights had no significant effect on root length. The color treatment of LED lights cannot accelerate the growth of plant root lengths because LED lights generate heat energy. The heat energy of LED lights is emitted indoors, which makes the room 34 °C warmer than the temperature recommended by Sustainable Research (2009), which shows that the indoor air temperature needed for plants ranges from 17 to 32 °C and the air humidity is 50–60%. The root length in the color treatment of red spinach microgreens under LED light was 1.33–1.47 cm in 36 units. The average number of root lengths in the color treatment of LED lights was lower than the results of Pangestika *et al.* (2022) study on red cabbage microgreens with an average root length of 7.7 with 48 units of red LED lights.

The treatment of the planting medium did not significantly affect the root length of red spinach microgreens. The planting medium is where plant roots develop and nutrient interactions with plants occur. Red spinach microgreens are grown in small trays with limited growth media. Limited planting medium causes the nutrients absorbed by plants to be limited. According to Jumiyatun *et al.* (2019), nutrients in the soil of a closed indoor planting system are absorbed by plants for growth. The root length of red spinach microgreens in this planting medium treatment was 1.33–1.42 cm in 36 units. The average number of root lengths in the treatment of red spinach mycogreen planting media was lower than the results of Panjaitan's finding (2022), namely in the treatment of mustard microgreen planting media, which had an average root length of 3.99 cm in 15 units.

Wet Weight

The color treatment of LED lights had no significant effect, in contrast to the treatment of the planting media on the wet weight of red spinach microgreens (Table 3). The results showed that the color treatment of LED lamps did not significantly affect the wet weight of red spinach microgreens. Wet weight is related to plant growth, including that of leaves. Polii (2009) reported that the wet weight of kale plants can increase due to the number of leaves. There are not many leaves on red spinach microgreens, only two leaves on each plant; therefore, the wet weight becomes ineffectual. The wet weight under different color treatments of LED lights was also related to the length of illumination of LED bulbs. The color treatment of LED lamps with a radiation time of 14 h showed that a relatively long illumination time could inhibit the growth of red spinach microgreens. Red spinach microgreens with 14 h of irradiation had shorter stems, which can also affect the wet weight. Al Ifah *et al.* (2022) reported that on

Table 1 Plant height of red spinach microgreens under LED light color and planting media treatments at 14 DAP

LED color	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	--------------------(cm)--------------------			
White	5.07	6.77	5.47	5.77
Red	5.23	8.40	5.97	6.53
Blue	5.10	7.13	5.70	5.99
Green	5.77	7.77	5.87	6.47
Average	5.29^{c}	7.52^{a}	5.75^{b}	

Remaks: *Different superscripts on the average line show a significant difference (p<0.05).

Table 2 Root length of red spinach microgreens under LED light color and planting media treatments at 14 DAP

LED color	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	--------------------(cm)--------------------			
White	1.34	1.47	1.43	1.41
Red	1.36	1.42	1.42	1.40
Blue	1.32	1.38	1.39	1.36
Green	1.30	1.27	1.43	1.33
Average	1.33	1.38	1.42	

microgreen red spinach plants, plant height can affect the wet weight of a plant.

The treatment of the planting medium had a significant effect on the wet weight of the red spinach microgreens (Table 3). The treatment of vermiculite planting media was significantly different from that of the soil and cocopeat planting media. Sisriana *et al.* (2021) showed that vermiculite planting media produced the best growth. This was observed in the optimal wet weight of the lettuce microgreens. The treatment of soil planting media and cocopeat showed equally low yield. The wet weight of a plant is related to its ability to absorb water from the planting medium. With a low wet weight, the amount of water absorbed from the growing medium is low because the soil's ability to bind water is low. The wet weight of a plant reflects the amount of water absorbed by the plant, which is used for the growth and development of the roots, stems, and leaves. Soil and cocopeat planting mediums have limited nutrients for the growth of red spinach microgreens. The wet weight of plants in soil and cocopeat planting media had the lowest wet weight in trays measuring 25 cm × 10 cm of 4.35 g/250 cm^2. The wet weight in this study was higher than that in the previous study. Krisdianto and Suhardjono (2022) found the lowest wet weight of red spinach plants in the treatment of soil planting media and cocopeat planting media on a tray measuring 25 cm × 25 cm was 0.59 g/625 cm^2.

Chlorophyll Content

The color treatment of LED lights and planting media had a significant effect on the chlorophyll content of red spinach microgreens (Table 4). The color treatment of LED lights significantly affected chlorophyll content. The color treatment of white LED lights was not significantly different from that of blue LED lights, but was significantly different from that of red and green LED lights. The color treatment of white and blue LED lights had a greater influence on the chlorophyll content of red spinach microgreens than that of PPFD. White LED lights have a wide spectrum. This is because white LEDs produce the wavelengths required by plants of 351.4–698.2 nm, which can be absorbed by chlorophyll. Abundant chlorophyll increases photosynthesis, thereby increasing plant growth. Chlorophyll also absorbs blue light, which can regulate stomatal opening. Blue light at the opening of the stomata plays a role in controlling carbon dioxide absorption. Vastakaite *et al.* (2015) found that blue light affects the growth and antioxidant properties of microgreen red lettuce. Based on the results of this study, the chlorophyll content under green LED light treatment was the lowest. Photosynthesis requires the absorption of light at specific wavelengths to produce energy. According to Syafriyudin and Ledhe (2015), not all lights with a certain color are suitable for photosynthesis. For example, green light is not suitable for photosynthesis.

The treatment of planting media had a significant effect on the chlorophyll content of red spinach microgreens (Table 4). The treatment of soil planting media was significantly different from the treatment of vermiculite and cocopeat planting media. The difference in chlorophyll content indicates that the soil planting medium affects the chlorophyll content of red spinach microgreens. Dewandini and Wijayanti (2021) stated that if the soil is too moist (more than 80%) or dry (less than 30%), microgreens do not grow perfectly. The treatment of cocopeat planting media with the lowest chlorophyll content resulted in the lowest yield. The chlorophyll content of the cocopeat planting medium was, on average, 0.38 mg/g lower than that of the soil and vermiculite planting media because it tends

Table 3 Wet weight of red spinach microgreens under LED light color and planting media treatments at 14 DAP

LED color	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	-------------------(g/250 cm^2)-------------------			
White	4.24	4.35	5.07	4.55
Red	4.34	4.19	4.59	4.37
Blue	4.74	4.43	4.93	4.70
Green	4.09	4.45	4.89	4.48
Average	4.35^b	4.35^b	4.87^a	

Remaks: *Different superscripts on the average lines showed a significant difference (p<0.05).

Table 4 Chlorophyll content of red spinach microgreens under LED light color and planting media treatments at 14 DAP

LED color	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	-------------------(mg/g)-------------------			
White	0.64	0.41	0.57	0.54^a
Red	0.51	0.35	0.48	0.45^c
Blue	0.57	0.49	0.52	0.53^{ab}
Green	0.42	0.29	0.42	0.38^c
Average	0.54^a	0.38^c	0.50^b	

Remaks: *Different superscripts on the average lines showed a significant difference (p<0.05).

to have a lower pH. The results of this study were lower than those of Sisriana *et al.* (2021), who found that the cocopeat microgreen lettuce planting medium produced the lowest chlorophyll content of other planting media at 0.42 mg/g.

Level of Carotenoid

The color treatment of LED lights and planting media significantly affected the carotenoid content of the red spinach microgreens (Table 5). The results of the Multiple Distance test showed that the color treatment of LED lights had a significant effect on the carotenoid content of red spinach microgreens. The color treatment of white LED lights was not significantly different from that of blue LED lights, but it was significantly different from that of red and green LED lights. The difference in carotenoid content indicates that the color of the white LED lights had the greatest effect on the carotenoid content of red spinach microgreens. White LEDs produced the highest carotenoid content because of their balanced wave proportions. Alfarykky (2021) showed that white light is a combination of all colors that create all the waves that plants need in white light. The color treatment of green LED lights resulted in a lower carotenoid content of 9.35 mg/g compared to the white and blue LED lights because the carotenoids do not absorb the green color. Carotenoids do not absorb green color but red and blue; Naomi (2018) stated that the energy in the blue color spectrum is not only absorbed by chlorophyll but also by carotenoids.

The treatment of planting media significantly affected the carotenoid content of red spinach microgreens (Table 5). The treatment of soil planting media was not significantly different from that of vermiculite but was significantly different from that of cocopeat planting media. Kustiani *et al.* (2021) showed that the carotenoid content in red spinach microgreens was influenced by the planting medium containing sufficient nutrients to promote plant growth. The treatment of cocopeat planting media produced a lower carotenoid content in the leaves of red spinach microgreens than the average of 8.78 mg/g compared to the treatment of soil and vermiculite planting media. This study showed that the cocopeat planting medium had a higher carotenoid content. In contrast, Sisriana *et al.* (2021) reported that the lowest carotenoid levels were produced by lettuce microgreens in cocopeat planting medium, with an average of 0.062 mg/g of carotenoid content.

Vitamin C Content

The color treatment of LED lights had no significant effect, whereas the treatment of the planting media affected the vitamin C content of red spinach microgreens (Table 6). The color treatment of LED light did not significantly affect the vitamin C content of red spinach microgreens. Vitamin C is a secondary metabolite produced in plant parts, such as leaves. According to Paciolla *et al.* (2019), in the same organ or tissue, vitamin C content is influenced by the stage of plant development and environmental changes. LED lights are one of the light sources that signal the environment to plants. The vitamin C content in red spinach microgreens was due to the lack of intensity of the color of the LED light, which had no significant effect. The color treatment of LED lights on red spinach microgreens produced a vitamin C content of approximately 16.87–23.43 mg/g. As'adiya (2020) stated that irradiation of kale microgreens did not have a significant effect on vitamin C content.

The treatment of planting media significantly affected the vitamin C content of red spinach microgreens (Table 6). The treatment of vermiculite

Table 5 Carotenoid content of red spinach microgreens under LED light color and planting media treatments at 14 DAP

LED color	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	-------------------(mg/g)-------------------			
White	13.34	9.64	12.07	11.68^{a}
Red	11.69	8.33	10.84	10.29^{c}
Blue	12.33	9.10	12.97	10.79^{ab}
Green	9.66	8.03	10.37	9.35^{c}
Average	11.76^{a}	8.78^{c}	11.56^{ab}	

Remaks: *Different superscripts on the average lines showed a significant difference (p<0.05).

Table 6 Vitamin C content of red spinach microgreens in LED light color treatment and planting media treatment at 14 DAP

Warna Lampu LED	Planting media			Average
	Soil	Cocopeat	Vermiculite	
	-------------------(mg/g)-------------------			
White	13.09	16.81	20.71	16.87
Red	20.44	25.43	24.41	23.43
Blue	19.23	22.44	25.81	22.50
Green	23.15	21.98	24.99	23.37
Average	18.98^{c}	21.67^{b}	23.98^{a}	

Remaks:*Different superscripts on the average lines showed a significant difference (p<0.05).

planting media was significantly different from that of cocopeat and soil planting media. The difference in vitamin C content in red spinach microgreens indicates that vermiculite planting media has a vitamin C content of 23.98 mg/g, which has the most effect on the vitamin C content of red spinach microgreens. The average vitamin C content across all the planting media was 21.54 mg/g. The yield of red spinach microgreens was lower than that reported by Susanto *et al.* (2022), who reported that the average vitamin C content of sunflower microgreens was 183.04 mg/g. The vitamin C content in microgreens can vary according to the plant type and genetics. Choosing the right planting medium can increase plant growth because it can provide nutrients and sufficient oxygen availability. The treatment of soil planting media resulted in the lowest vitamin C content of red spinach microgreens because the treatment of soil planting media does not use fertilizer, so the nutrient content is not met. The planting medium is one of the factors that affects the vitamin C content of plants. Saputra (2023) indicated that vitamin C can be influenced by the environment in which it grows and the use of various types of planting media.

CONCLUSION

White LED lights provided good results for the chlorophyll and carotenoid contents of red spinach microgreens. The treatment of volcanic soil planting media yielded good results for the chlorophyll and carotenoid contents of red spinach microgreens.

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