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Preliminary Study on the Effect of Artificial Lighting on the Production of Basil, Mustard, and Red Cabbage Seedlings

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Abstract: The use of artificial lighting in a total or supplementary way is a current trend, with growing interest due to the increase in the global population and climate change, which require high-yield, quality, and fast-growing crops with less water and a smaller carbon footprint. This experiment aimed to evaluate the effect of light-emitting diode (LED) lighting on the production of basil, mustard, and red cabbage seedlings under controlled artificial conditions and in a greenhouse as a supplementary lighting regime. Under controlled conditions, the experiment was conducted with basil seedlings, comparing LED light with two wavelengths (purple and white light). In a greenhouse, mustard and red cabbage seedlings were evaluated under natural light (regular photoperiod) and with supplementary purple lighting of 3 h added to the photoperiod. The variables assessed were aerial fresh mass (AFM), aerial dry mass (ADM), root dry mass (RDM), plant length (PL), and leaf area (LA). Basil seedlings grown under purple light showed greater length and AFM than those grown under white light, with no effect on the production of secondary metabolites. In the greenhouse experiment, red cabbage seedlings showed an increase in AFM, ADM, and DRM with light supplementation, with no effect on LA. AFM showed no statistical difference in mustard seedlings, but the productive parameters LA, ADM, and DRM were higher with supplementation. None of the evaluated treatments influenced the production of phenolic compounds and flavonoids in the three species evaluated. Light supplementation affected red cabbage and mustard seedlings differently, promoting better development in some production parameters without affecting the production of phenolic compounds and flavonoids in either plant. Thus, light supplementation or artificial lighting can be considered a tool to enhance and accelerate the growth of seedlings, increasing productivity and maintaining the quality of the secondary metabolites evaluated. Thus, this technology can reduce operational costs, enable cultivation in periods of low natural light and photoperiod, and cultivate tropical species in temperate environments in completely artificial (indoor) conditions.

Keywords: *Ocimum basilicum* L.; light-emitting diode; *Brassica oleracea*; *Brassica juncea*

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1. Introduction

Brazil has diverse soil and climate conditions conducive to producing various vegetables yearly [1]. Brazilian production in 2021, according to data from the Food and Agriculture Organization of the United Nations (FAO), was 857 million tons in a total area of 350 thousand hectares, responsible for a large portion of the country's agribusiness and agriculture [2].

Red cabbage (*Brassica oleracea* var. capitata f. Rubra) has great economic importance, standing out among brassicas [3]. The cultivated area of this vegetable worldwide is approximately 2.45 million hectares, with a global production of 71.7 million tons in 2021 and 467.6 thousand tons produced in Brazil during this period [2]. This species is cultivated year-round in Brazil and available to the consumer market throughout the year [4].

Mustard (*Brassica juncea*) is a vegetable used in cooking and traditional medicine worldwide. It is a source of vitamins, minerals, dietary fiber, and other biologically active compounds. This species has been used for centuries to treat various diseases, including obesity, diabetes, depression, and cataracts [5]. According to data from the Brazilian Institute of Geography and Statistics (IBGE), 158 were produced in the state of Rio Grande do Sul, valued at an estimated value of BRL 719,000, with the region of Viamão, in the metropolitan area of the State of Rio Grande do Sul, standing out as the largest mustard producer in the southern region of Brazil [6]. This species is cultivated in autumn, winter, and spring, preferring temperatures between 15 °C and 25 °C [7].

Basil (*Ocimum basilicum* L.) is an annual or perennial plant, depending on the region, and can be used for culinary purposes, as raw material for the extraction of essential oils, and for ornamental use [8]. This vegetable was introduced to Brazil by Italian immigrants at the end of the 19th century [9]. The main ingredient in basil oil, linalool, has been widely studied as a miticide, bactericide, and fungicide. This terpene is also used as a raw material in synthesizing chemical products of industrial and pharmaceutical interest, including linalyl acetate. There are reports of anticancer, antibacterial, neuroprotective, anxiolytic, depressive, hepatoprotective, and protective properties of the lungs and kidneys associated with linalool [10,11].

Traditional agricultural farming methods depend heavily on climate and seasonality. With increasing changes to the environment and farming practices due to climate change, protected cultivation is essential for producing high-quality, value-added food in the current scenario of adverse weather conditions. In addition to protecting against climate adversity, it allows the producer greater flexibility in planting and choosing the species to be cultivated, aiming for greater productivity and financial return [12]. As commented by Kozai [13], growing vegetable crops under controlled conditions, including artificial light sources, may enhance productivity and allow for shorter crop development times, with both economic and quality benefits. In this sense, studying artificial light in crop production is paramount to developing techniques and procedures for achieving effective crop performance, especially considering that each species has an optimum wavelength combination and light intensity, showing the need to explore further the response of different horticultural species to artificial lighting.

One of the leading environmental elements that affect plants is solar radiation, which directly influences the plants' basal biological processes, including transpiration, photosynthesis, and the rate of development, depending on the type of cycle and growing season of plant species [14].

Plants must be exposed to photosynthetically active radiation (PAR) to perform photosynthesis. PAR corresponds to photons with a wavelength between 400 and 720 nm, called visible spectral light. Within this spectrum, chlorophylls show PAR absorption maxima corresponding to blue (400–520 nm) and red (610–720 nm) light, while other accessory pigments can show absorption maxima at different wavelengths, such as carotenes, being considered accessory pigments [15,16].

Artificial lighting in agriculture is currently gaining prominence, especially in mitigating the problem of a lack of solar radiation in specific locations or periods of the year. This technology can be used in different ways, such as light supplementation to increase the photoperiod or in indoor cultivation by artificially providing all the light necessary for production [17]. Regardless of the climate, additional artificial lighting can increase crop yields and ensure consistent output throughout the year, irrespective of climate or crop cycle constraints [18–20].

Over the years, several light technology sources were tested and used to provide artificial lighting for plant growth. Such technologies include incandescent, fluorescent, metal halide, high-pressure sodium, and LED lamps [20,21]. Oliver et al. [21] tested fluorescent, metal halide, induction, and LED lamps to provide artificial lighting to grow *Beta vulgaris* (Swiss chard) and *Brassica oleracea* (kale). The authors reported that the plants of both species grown under LED light had a higher weight and production per unit area;

the same authors also commented on the better performance of LED light over the other tested light sources, which did not differ among themselves.

Light-emitting diodes (LEDs), among other lighting sources, can be adjusted to emit the most relevant wavelengths for each crop, contributing to plant development. LEDs are characterized as low-power, high-efficiency light sources that provide energy savings and negligible heat emissions, unlike incandescent and fluorescent lamps, which were widely used before the popularization of LEDs [19].

Studies have shown that different light spectrums can affect the morphology and physiology of plants differently, depending on the specific reaction of each species to lighting [20]. According to Poudel et al. [22], red LED lights can effectively maximize photosynthesis, increasing plant height, internode length, and rooting. Blue light also acts on photosynthesis, rooting, and development, mainly on stomatal control. Hogewoning et al. [20] commented that blue light influences photosynthetic parameters, the formation of chlorophyll, and the development of chloroplasts and can increase the photosynthetic potential of plants exposed to this type of radiation.

Several vegetable species such as lettuce, tomato, and strawberry have been studied relative to the use of artificial light, with the main parameters evaluated being the photoperiod and wavelength, mainly proportions of blue and red, and light intensity, the demand for which depends on each species and cultivar [23–27].

Zou et al. [28] assessed the effect of photoperiod, light intensity, and quality (wavelength) on the growth of spinach (*Spinacia oleracea*). The authors observed that the photoperiod had the highest effect on plant development, followed by light intensity; light quality was the least important factor affecting plant growth. However, the light quality used in this study encompassed only variations in purple light, with different blue-to-red ratios (450 nm and 660 nm).

Yang et al. [29] assessed the growth of cucumber (*Cucumis sativus* L.) seedlings exposed to increasing white light intensities (50–400 $\mu mol \cdot m^{-2} \cdot s^{-1}$) provided by LEDs. The authors reported that a photosynthetic photon flux density (PPFD) of 260 $\mu mol \cdot m^{-2} \cdot s^{-1}$ is optimal for growing this species under controlled/artificial conditions. Such results indicate the need to determine the optimal growth parameters for each plant species.

As commented by Darko et al. [30], applying light from different wavelengths may affect plant metabolism, both primary and secondary. Thus, using different wavelengths as artificial lighting may be a strategy to modulate plant metabolism. However, it is important to point out that each species responds differently, and each species must be assessed experimentally.

In addition to the effects on primary metabolism and plant development, supplementary lighting and modification of the spectral content of light can alter the concentration of specific bioactive chemical substances, such as phenolic compounds, flavonoids, and anthocyanins, which have antioxidant action and play a protective role in the plant and are associated with a lower risk of degenerative diseases when consumed and incorporated into human metabolism [31,32].

The phenolic compounds present in plants are secondary metabolites whose primary role is to defend against different types of stress, helping plants to resist situations such as excess light, low temperatures, infection by pathogens, defense against herbivory and nutrient deficiency, which can cause increases in the production of free radicals and other oxidative species, tissue damage, and the impairing of plant homeostasis [33]. In this sense, evaluating these compounds in light of the changes in the cultivation system is extremely important.

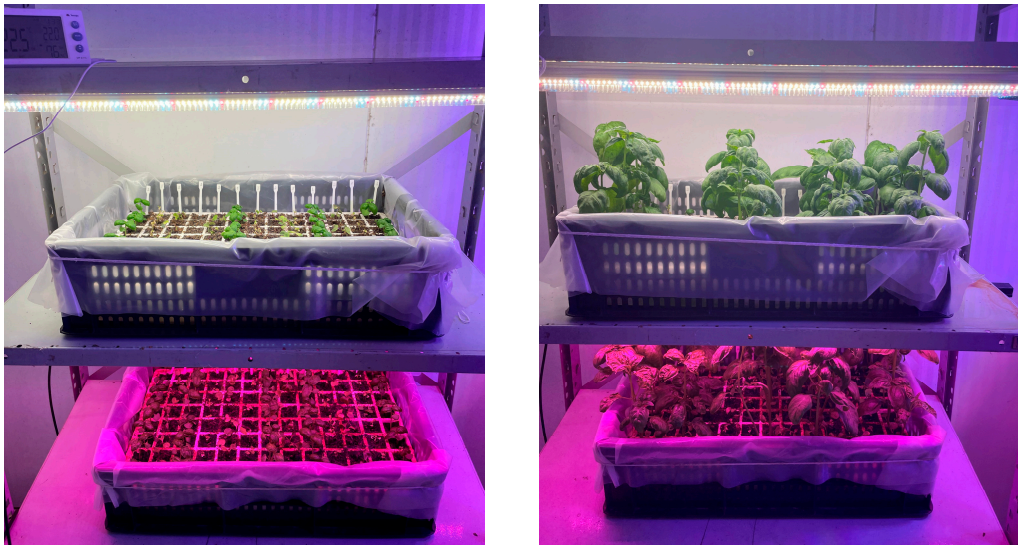
Given the above, the objective of this work was to evaluate the effect of using artificial LED light on the production of basil seedlings in a completely artificial environment and of mustard and red cabbage seedlings in a greenhouse with light supplementation.

2. Materials and Methods

2.1. Plant Material and Treatments

To carry out this experiment, we used seeds of basil (*Ocimum basilicum*) variety 'Italian Basilic', smooth mustard (*Brassica juncea*), and red cabbage (*Brassica oleracea* var. capitata f. Rubra) variety M'ammouth Red Rock', all supplied by the company Feltrin Sementes (Farroupilha, Brazil).

The treatments for the experiment under controlled conditions were T1—purple light (87.5 % red—670 nm + 12.5 % blue—430 nm) and T2—white light (40 % red—670 nm + 10 % blue—430 nm + 50 % green—530 nm). The experimental setup under controlled conditions with basil is shown in Figure 1.



(**A**) (**B**)

Figure 1. Experimental setup for the experiments with basil seedlings in controlled conditions and exposed to different wavelengths. (**A**) Seedlings seven days after sowing; (**B**) seedlings at collection time, 27 days after sowing. Caxias do Sul, 2023.

Both treatments were applied with a PPFD of 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$, with two 1.0 m long LED bars being arranged at 20 cm above the plants, with a photoperiod of 14 h of light and 10 h of dark, corresponding to a daily light integral (DLI) of 5.04 $mol \cdot m^{-2} \cdot day^{-1}$ for both treatments.

For the greenhouse experiment, two treatments were also used, T1—natural light and T2—natural light plus light supplementation with purple light (red—670 nm + blue—430 nm) for 3 h, activated by a timer from 18:00 to 21:00 daily. The experimental setup for the greenhouse experiments is shown in Figure 2.

Considering natural lighting only (T1), the average PPFD was 391.4 $\mu mol \cdot m^{-2} \cdot s^{-1}$, corresponding to a DLI of 16.9 $mol \cdot m^{-2} \cdot day^{-1}$, according to data from CRESESB [34]. For the treatment with light supplementation (T2), a PPFD of 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ was maintained during the period of light supplementation, corresponding to a DLI of 1.08 $mol \cdot m^{-2} \cdot day^{-1}$ additional to the natural photoperiod. A 1.0 m long LED bar which provided supplementary light was placed 20 cm above the plants.

(**A**) (**B**)

Figure 2. Experimental setup for the greenhouse experiments with mustard and red cabbage seedlings. (**A**) Experiment on the sowing day. (**B**) Aspect of seedlings at the end of the experiment, 27 days after sowing. Caxias do Sul, 2023.

2.2. Plant Cultivation

Basil, red cabbage, and mustard seeds, all provided by the company Feltrin Sementes (Farroupilha, Brazil), were sown in plastic trays containing commercial substrate Carolina Soil® (Santa Cruz do Sul, Brazil) maintained in a floating system. The plants were kept in the Hoagland nutrient solution, with pH 5.5 ± 0.3 and EC 2.0 ± 0.2 dS·m^{-1}, prepared as described by Sarruge [35]. Sowing was carried out on 4 October 2023, and nine days after germination, thinning was conducted, leaving one plant per cell, with seedlings being evaluated on 31 October 2023.

Two experiments were carried out, one under fully controlled conditions with basil seedlings and the other in a greenhouse with additional light supplementation with red cabbage and mustard seedlings. The first experiment was conducted in a growth chamber (Fitotron, ISB Industries, Porto Alegre, Brazil) with a daytime temperature of 25 °C and a nighttime temperature of 15 °C.

For the second experiment, carried out in a greenhouse, the climatic elements were monitored by a Vantage Pro II station (Davis Instruments, Hayward, CA, USA) installed inside the greenhouse. During the experiment, the average temperature and relative humidity were 17.6 °C and 85 %, respectively, with a temperature variation between 7.3 °C and 30.7 °C.

2.3. Seedling Assessment

After 27 days, the seedlings were collected, and the biometric variables evaluated were plant length (PL), aerial fresh and dry mass (AFM, ADM), root dry mass (DRM), and leaf area (LA). Plant length was determined with a 30 cm ruler. Fresh mass was measured immediately after collection using an AL500C semi-analytical balance (Marte, São Paulo, Brazil). The aerial and root dry masses were determined after drying the plant material for 48 h at 55–60 °C in a DeLeo forced air circulation oven (Porto Alegre, Brazil). Leaf area measurements were performed using an AM350 leaf area meter (ADC Bioscientific Ltd., London, UK).

Phenolic compounds and flavonoids were extracted with a hydroalcoholic solution (ethanol 70 % v/v) in a proportion of 5 g of plant material for 30 mL of solution. The content of total phenolic compounds was determined by spectrophotometry according to the Folin–Ciocalteu method [36], and the results were expressed in milligrams of gallic acid equivalents (EAG) per 100 g of plant material on a wet basis.

The total flavonoid content was determined by the aluminum chloride method according to the methods proposed by Matic et al. [37], and the results were expressed in milligrams of quercetin equivalents (EQ) per 100 g of plant material on a wet basis.

2.4. Experimental Design and Statistical Analysis

The experiments followed a completely casualized design, with two treatments and four replications per treatment. Each replication consisted of one plot, with eight plants kept per plot, totaling 32 plants per treatment. Treatment means were evaluated using Student's *t*-test at a 5 % significance level using the Microsoft Excel® 365 program (Microsoft, Redmond, WA, USA).

3. Results

3.1. Experiment with Basil in a Controlled Environment

The results regarding the biometric parameters of the basil seedlings grown indoors are compiled in Table 1.

Table 1. Biometric parameters of basil (*O. basilicum*) seedlings grown with LED artificial lighting with different wavelengths. Caxias do Sul, 2023.

Treatment	PL (cm)	AFM (g)	ADM (mg)	DRM (mg)	LA (mm^2)
T1—purple light	17.0 ± 1.8 *	3.74 ± 0.72	250 ± 60	140 ± 20 ^{ns}	5848 ± 1095 ^{ns}
T2—white light	13.5 ± 1.0	5.16 ± 0.45 *	340 ± 20 *	100 ± 40	9808 ± 2870
CV (%)	14.93	21.15	20.10	28.66	33.63

PL: plant length; AFM: aerial fresh mass; ADM: aerial dry mass; DRM: root dry mass; LA: leaf area. *: significant by Student's *t*-test at a 5 % significance level; ^{ns}: not significant by Student's *t*-test. CV: coefficient of variation.

For basil grown under controlled conditions, a statistical difference was observed between the two treatments, with PL being higher in treatment T1 and AFM and ADM being higher in T2. The DRM and LA parameters were not influenced by the type of light (purple or white).

Figure 3 shows the aerial parts of basil seedlings grown under artificial LED lighting in purple (T1) and white (T2) lights.

(**A**) (**B**)

Figure 3. Images of the aerial part of basil seedlings (*Ocimum basilicum* L.) grown under artificial LED lighting in purple ((**A**)—87.5 % red—670 nm + 12.5 % blue—430 nm) and white light ((**B**)—40 % red—670 nm + 10 % blue—430 nm + 50 % green—530 nm), 27 days after sowing. Caxias do Sul, 2023.

According to a study with lettuce carried out by Zhang et al. [38], exposing plants to red LED light (600–650 nm) increased fresh mass, suggesting a higher photosynthetic rate and, consequently, a higher rate of the production of photoassimilates. Furthermore, works in the literature comment on the role of red light in elongating plant stems, which could explain the greater plant length observed in T1 (purple light), the proportion of which in red light is greater than in T2 (white light) [20]. However, Rahman et al. [39] commented that exposure to blue light (400–450 nm), regardless of the presence of other

wavelengths, promotes the development of the leaf area, while radiation in the red range (600–700 nm) and far-red range (>700 nm) stimulates the plant's reproductive development to the detriment of vegetative growth. In a meta-analysis, Ma et al. [40] highlighted that blue light reduces leaf area. However, the same authors emphasized that more studies are needed to verify whether this behavior is generic or associated with cultivation practices. Some authors also found that white light affected the growth parameters of basil plants, such as dry mass and leaf area, and may have a stimulating effect on plant growth [41,42].

The greater aerial fresh mass in T1 may also be a result of the greater proportion of radiation in the blue color range (430 nm), as this stimulates the opening of the stomata, increasing the flow of water through the plant tissues, promoting transpiration, even without associated photosynthetic activity [43,44]. Considering that the plants were in an environment with a water supply (floating), there was no water stress, allowing the seedlings to transpire and, consequently, capture water to maintain tissue hydration and without a major effect on the accumulation of dry matter, such as can be observed for RDM, which was not influenced by the tested wavelength ratios.

Table 2 presents the results regarding the total phenolic compounds and flavonoid levels in basil seedlings exposed to purple and white LED light in a controlled environment.

Table 2. Contents of total phenolic compounds and flavonoids in basil seedlings grown in a controlled environment exposed to artificial purple and white LED lighting. Caxias do Sul, 2023.

Treatment	Total Phenolic Compounds ($mg_{EAG} \cdot 100\ g^{-1}$)	Flavonoids ($mg_{EQ} \cdot 100\ g^{-1}$)
T1—purple light	632.6 ± 111.9^{ns}	881.4 ± 228.5^{ns}
T2—white light	523.5 ± 100.0	736.8 ± 221.9
CV (%)	19.76	27.49

EAG: gallic acid equivalent; EQ: quercetin equivalent; ^{ns}: not significant by Student's *t*-test at a 5 % significance level. CV: coefficient of variation.

It can be observed that the wavelength did not influence the levels of phenolic compounds and flavonoids present in the seedlings. According to Dou et al. [45], the low flux density of photosynthetic photons and the lack of ultraviolet (UV) radiation can decrease phenolic compounds in basil plants kept in controlled environments. Rahman et al. [39] reported on the stimulating effect of RFA in the blue region (400–500 nm) on the synthesis of phenolic compounds, especially anthocyanins. On the other hand, Ma et al. [40] observed that, although the presence of blue light tends to increase the anthocyanin content, this does not have a major effect on the levels of phenolic compounds and flavonoids in general, which would explain the statistically similar levels in both treatments.

3.2. Luminous Supplementation of Mustard and Red Cabbage in a Greenhouse

The results regarding the biometric parameters of mustard and red cabbage seedlings grown in an artificial environment are compiled in Table 3.

The production of red cabbage and mustard seedlings in a greenhouse was influenced by light supplementation, making it possible to observe the effect of the treatments on the biometric parameters in both species. Light supplementation promoted an increase in AFM, ADM, and DRM in red cabbage. For mustard, light supplementation increased ADM and DRM, as occurred with red cabbage seedlings, and stimulated the development of LA and PL.

Figure 4 shows the root and aerial parts of red cabbage and mustard seedlings grown under natural light (T1) and with purple LED light supplementation (T2).

Table 3. Biometric parameters of red cabbage (*B. oleracea*) and mustard (*B. juncea*) seedlings grown under natural light and with purple LED light supplementation (87.5 % red—670 nm + 12.5 % blue—430 nm). Caxias do Sul, 2023.

Species	Treatment	PL (cm)	AFM (g)	ADM (mg)	DRM (mg)	LA (mm^2)
Red cabbage	T1	14.2 ± 2.4 ^{ns}	1.95 ± 0.37	110 ± 30	50 ± 7	4150 ± 1224 ^{ns}
	T2	16.0 ± 1.4	2.76 ± 0.19 *	180 ± 10 *	70 ± 2 *	5894 ± 750
CV (%)		10.44	14.17	24.42	30.54	28.65
Mustard	T1	17.4 ± 0.4	4.26 ± 0.28 ^{ns}	310 ± 20	80 ± 7	8242 ± 815
	T2	20.2 ± 1.9 *	4.82 ± 0.82	460 ± 80 *	130 ± 22 *	13,174 ± 2286 *
CV (%)		13.87	21.59	27.70	12.40	26.36

T1—natural lighting; T2—light supplementation for 3 h with purple light. PL: plant length; AFM: aerial fresh mass; ADM: aerial dry mass; DRM: root dry mass; LA: leaf area. *: significant by Student's *t*-test at a 5 % significance level; ^{ns}: not significant by Student's *t*-test. CV: coefficient of variation.

Red cabbage

Figure 4. *Cont.*

Mustard

Figure 4. Images of the root and aerial parts of red cabbage (*Brassica oleracea*) and mustard (*Brassica juncea*) seedlings grown under natural light (T1) and with purple LED light (T2—87.5 % red—670 nm + 12.5 % blue—430 nm) supplementation for 3 h daily, 27 days after sowing. Caxias do Sul, 2023.

Rizzon et al. [46], working with purple LED light supplementation (87.5 % red—670 nm + 12.5 % blue—430 nm) on curly lettuce and cauliflower seedlings in a greenhouse, observed that the biometric parameters of ADM, DRM, root length, and LA evaluated were positively influenced by light supplementation in both species. The same author commented that the use of lighting promoted the faster development of seedlings, indicating a shorter nursery time and, consequently, increased productivity compared to systems without supplementary lighting.

It is important to note that, in greenhouse conditions, seedlings are more subject to variations in temperature and humidity, which can negatively affect their development, than when grown in fully controlled conditions [47]. In this sense, light supplementation can also be used as a stimulating agent for plant development to accelerate seedlings' development and promote their resistance to different sources of stress, both of biotic and abiotic origin [48].

The results regarding total phenolic compounds and flavonoid contents in red cabbage and mustard seedlings are compiled in Table 4.

Table 4. Contents of total phenolic compounds and flavonoids in red cabbage (*B. oleracea*) and mustard (*B. juncea)* seedlings grown under natural light and with purple LED light supplementation (87.5 % red—670 nm + 12.5 % blue—430 nm). Caxias do Sul, 2023.

Treatment	Purple Cabbage		Mustard	
	TPC ($mg_{EAG} \cdot 100\ g^{-1}$)	**Flavonoids** ($mg_{EQ} \cdot 100\ g^{-1}$)	**TPC** ($mg_{EAG} \cdot 100\ g^{-1}$)	**Flavonoids** ($mg_{EQ} \cdot 100\ g^{-1}$)
T1	1157.5 ± 78.0^{ns}	661.9 ± 32.6^{ns}	1151.2 ± 162.8^{ns}	739.9 ± 184.2^{ns}
T2	1058.9 ± 75.5	730.0 ± 84.7	1129.9 ± 67.4	754.0 ± 117.1
CV (%)	7.98	10.01	10.16	19.16

T1—natural lighting; T2—light supplementation for 3 h with purple light. TPC: total phenolic compounds; EAG: gallic acid equivalent; EQ: quercetin equivalent; ^{ns}: not significant by Student's *t*-test at a 5 % significance level. CV: coefficient of variation.

Regarding the levels of total phenolic compounds and flavonoids, no significant effect of light supplementation was observed in either red cabbage or mustard. Rizzon [36] observed that lettuce plants supplemented with purple light showed higher values of phenolic compounds and flavonoids. Etae et al. [49] observed that the content of phenolic compounds in lettuce was influenced by the light type, which was higher in LED than in fluorescent light. However, cauliflower seedlings showed higher values of phenolic compounds in the treatment without light supplementation, and the treatments did not influence flavonoid levels. As discussed by Rahman et al. [39] and Ma et al. [40], this

fact demonstrates that each species presents a distinct response concerning secondary metabolism and exposure to artificial/supplementary lighting, with the response also depending on the wavelength used.

4. Conclusions

According to the results observed, the biometric parameters of the seedlings under investigation were influenced by exposure to artificial LED light, whether in full or supplementary lighting. Under artificial lighting under controlled conditions, basil seedlings exposed to purple light had an increase in plant length, while white light favored an increase in aerial fresh mass. These results demonstrate the effect of different spectral compositions on promoting the specific characteristics of the species studied. The basil seedlings under white light generally presented a more suitable size, morphology, and commercial standard. For the greenhouse experiments, red cabbage seedlings under light supplementation showed biomass accumulation, suggesting an increase in the photosynthetic rate. Similarly, mustard seedlings under supplementary lighting showed better development of the aerial part, showing that light supplementation stimulated the growth of seedlings of this species. Despite the effect of supplementary light and different wavelengths on biometric parameters, these did not significantly influence the synthesis of the secondary metabolites studied in any of the species evaluated, maintaining the phytochemical characteristics of the species.

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