Influence of Illumination with LEDs on Some Biochemical Compounds

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The experiment was carried out to study the effect of different light conditions on lettuce (Lactuca sativa L.) development. There have used two varieties of lettuce namely Lollo Rosa and Markies. Both of varieties have higher content of chlorophyll, vitamin C and carbohydrates in the case of LED luminaries compared with those developed under neon light. The masses obtained for both varieties were similar in value for all three types of light used.

Key ords: lettuce, light emitting diodes, biochemical compounds

Light emitting diodes (LED) are the newest light source and can be developed to produce specific wavelengths, such as blue and red into a single LED lamp [1]. The development of LEDs technology has been led to the provision of numerous options for supplemental lighting for plant growth in greenhouses. Compared to other light sources used for plant production, LEDs have several properties which are potentially useful in relation to horticulture. For example, electric costs for LEDs are smaller than those for incandescent lamps, no wasted energy or extra cooling equipment needed, have a significant effect on photosynthesis, the nutritional qualities of food crops is influenced by the illumination spectrum used [2, 3]. Some studies indicate that light quantity and quality interact to determine plant morphology. Thus, it have shown that some blue light is necessary for normal growth and development, but the effects of blue light appear to be species-dependent and may interact with other wavelengths of light as well as photosynthetic photon flux.

In a study which followed the development of radishes, soybean and wheat in light of LEDs with different percentages of blue light was observed that blue light did not affect total dry weight in any species but significantly altered plant development. So, the low blue light from warm white LEDs increased stem elongation and leaf expansion, whereas the high blue light from cool white LEDs resulted in more compact plants. Regarding the dry weight the largest percentage differences among light sources occurred in low light. Also, the optimal amount of blue light likely changes with plant age because plant communities balance the need for rapid leaf expansion [3]. Red and blue light are basal in the lighting spectra for green vegetables, tomato, cucumber and pepper. Different light spectra have variable effects on different plant species and different physiological indices [4].

Lettuce (*Lactuca sativa L.*) is a species commonly cultivated in protected areas especially during the autumn-winter-spring worldwide. For lettuce external factors such as light and temperature can influence the quality leaves or heads. Producing lettuce under artificial lighting could be a solution for food safety, environmental impact and efficient energy usage in horticulture. The lettuce grown under different light treatments shown a leaf chlorophyll content greater under blue LED and the fluorescent light treatments than the red LED treatment [5]. The growth, protein content and pigment synthesis in lettuces are significantly enhanced by exposure to mixed radiation from blue and red LEDs [6]. In addition, for different species of lettuce, overall results shown that for a report of red: blue light of 50%:50% was an increase of chlorophyll content. The reaction of plants to light, counts both the quantity and quality of radiation incidents as well as length of the lighting period, respectively photoperiod [7, 8].

When plants of *Vicia faba* were illuminated by blue light on a red light background for 30 minute it was observed a significant increase of sugars, but sugar levels decreased significantly after 1 h. This decline in sugar content without no decrease in aperture, it was suggested that sugars were converted to other compounds [9].

The study aimed to identify the best light spectrum to produce higher vitamin C, carbohydrates and chlorophyll in lettuce.

Experiemntal part

The study was conducted in a common greenhouse with glass walls and roof, under controlled environment, ensuring a temperature of 22°C day and 20°C night, a constant atmospheric humidity of 65%. The duration of lighting was 16 hours / day light and 8 hours dark, during the winter 2014-2015. Have been sown seeds of lettuce varieties Lollo Bionda and Markies, 150 seeds for each varieties, in three repetitions. It used two type of LEDs: LED1 – 40% Blue in 60% Red and LED2 – 30% Blue in 70% Red. The control light was white light (Ne). After a period of 24 days, lettuce crops were harvested and analysed. The salads weight was determined by accurately weighing to 4 decimal. The chlorophylls content was determined by the method of Moran [10]. Pigment concentrations were calculated using the equations adapted from Moran and

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Inskeep and Bloom [11]. Reducing sugars determination was performed by the DNS method [12].

Results and discussions

At harvest, lettuces obtained had similar aspects regardless of the light used. All plants were vigorous, healthy green and appropriate sizes. However, analyzes had shown that similar look of plants should not be associated with similar concentrations of some biochemical compounds that give fruit quality.

Determinations of lettuce masses (fig. 1) shown that the light used do not influenced too much the weight of the end-products. It was found that mass differences depended rather by the variety of lettuce than light used to grown its up. However, the differences are very small considering on the on hand that were achieved triple crops in the same conditions and for each was assessed the average value of the masses, and finally it was calculated the averages of the three crop categories.

Chlorophyll is an extremely important biomolecule, occupying a central place in photosynthesis so in metabolic processes. Thus it is important to know if the illumination systems used influence total chlorophyll content in plants. The results obtained in our experiences regarding the chlorophyll content are presented in figure 2.

Thus highest total chlorophyll content was found in the Markies varietiy grown under LED1 followed closely by the Markies varietiy reared under LED2 illumination. The same evolution had the Lolo Bionda variety, but with lower amounts than the variety Markies. Both lettuce varieties had lower chlorophyll content when grown under white light. So, at least for lettuce the blue light has a favorable effect on chlorophyll accumulation. In our experience the surplus of 10% of blue light participation in LED 1 against LED2 had an effect of increasing the chlorophyll content of 9.96% for Lolo Bionda and of 5.96% for Markies. At the same time, the chlorophyll content in two varieties of lettuce grown under blue and red color report of 1 to 1.5 (40% blue in 60% red) against the lettuce grown under white light was higher with 13.5% for Lolo Bionda respectively with 15.5% for Markies. So, our results confirm some results obtained for lettuce by other authors.

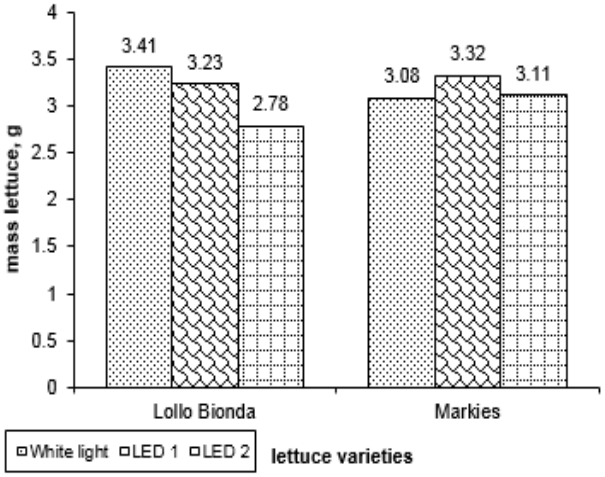

Fig. 1. Influence of illumination type on lettuce masses

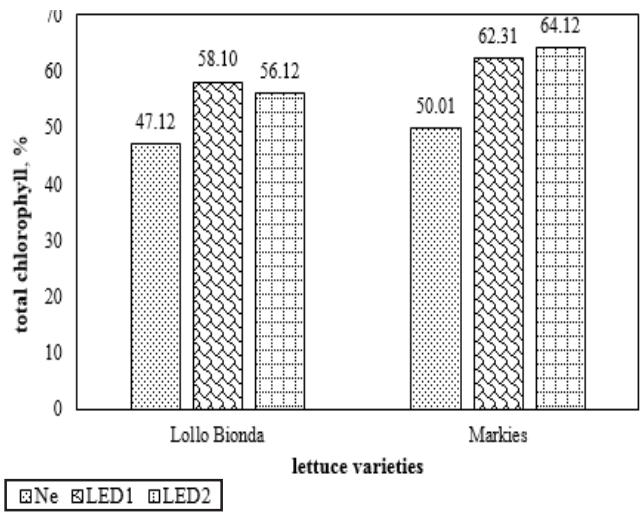

Fig. 2. Influence of illumination type on total chlorophyll content

For a good taste of lettuce it is essential that between vitamin C and carbohydrates content to be a report of around 1 to 2. In this context it was analyzed the content of vitamin C and carbohydrates in the two varieties of lettuce grown under different illumination. Results are presented in figures 3 and 4. For both varieties of lettuce the vitamin C content grown under LEDs illumination is higher than in plants grown under white light. So, for LED 1 the vitamin C content was with 52.3% for Lollo Bionda and with 36.2% for Markies higher than the values obtained for plants grown under Ne light. For LED 2, the vitamin C content was with 22.43% for Lolo Bionda and with 33.3% for Markies higher than the values obtained for plants grown under Ne light. Our data clearly show that the vitamin C is better accumulate when plants grow under illumination with 40 % blue in 60 % red (LED1) than under 30% blue in 70 % red (LED2) or white light (Ne).

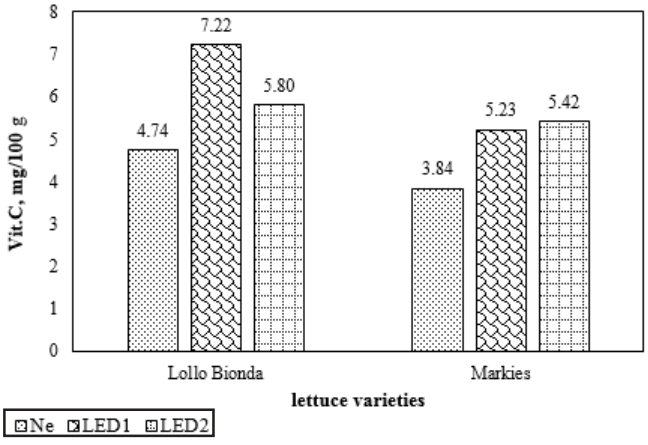

Fig.3. Influence of illumination type on vitamin C content

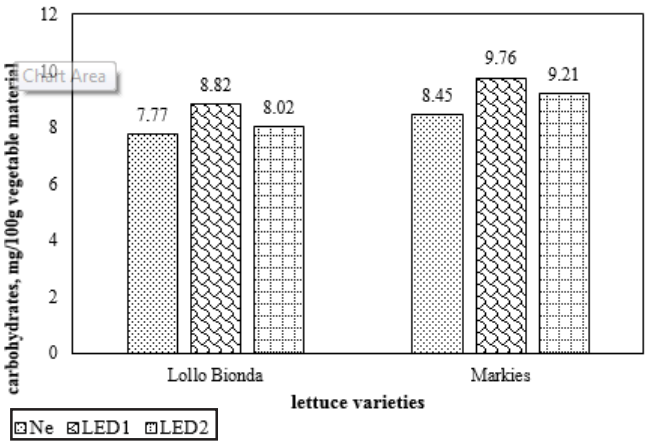

Fig. 4 Influence of illumination type on carbohydrates content

The similar results were obtained to carbohydrate content analysis. The highest content of carbohydrates has been identified in both varieties grown under LED1 light followed by LED2 light and then under white light. Relationship between vitamin C and carbohydrate content

varied between 1/1.2 down to 1/2.2 being in the normal relations for lettuce. The difference in ratios from 1 / 1.2 to 1 / 1.6 for Lollo Bionda and 1 / 1.8 to 1 / 2.2 Markies is determined by the specifics of each variety.

Conclusions

The results obtained clearly confirmed the scientific literature by the fact that blue LEDs are more efficient in biochemical compounds synthesis. For both varieties have seen an increase in content of nutrients (vitamin C and carbohydrates) when using LED with 40% blue light in 60% red light. In addition the combination of red and blue LEDs is an effective source for photosynthesis taking into account the higher content of chlorophyll in plants grown under LEDs light compared with plants grown under Ne light. A very important things besides a better nutritional quality of plants is that LEDs are ecological and reduced energy consumption, proprieties which determine a lower greenhouse warming phenomenon compared to overheating caused by neon lighting.

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