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Application of blue light led in inactivation of pathogenic fungi on tomato fruit during natural storage

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Abstract

Significant losses of fresh horticultural crops occur during postharvest storage due to accelerated senescence and disease. Cooling and chemical preservation procedures are the typical postharvest techniques after harvest. Many researchers have lately used light-emitting diode (LED) therapy for postharvest storage of fruits and vegetables. Tomatoes are known as a superfood because they contain many compounds beneficial to human health. Tomato fruit contains a high proportion of lycopene, which increases as the fruit ripens to the breaker stage. LED systems have evolved as a clean and effective artificial lighting solution for use in horticulture. This research aimed to evaluate the influence of LEDs on postharvest and quality metrics. The impact on quality criteria varied greatly depending on the tomato fruit variety. Studies were conducted on timelines of LED light exposure per day throughout the postharvest fruit stage, which boosted commercial and organoleptic indices and lycopene concentrations. Overall, the results of this study indicated that postharvest exposure of tomato fruits to LED light causes lycopene synthesis, with a concentration of lycopene 41% greater than when subjected to light, dark, and 24% higher than when exposed to other LED lighting settings.

1 Introduction

Fruits and vegetables are widely known for their health-promoting effects due to their high vitamin, mineral, and antioxidant content, which reduces the risk of chronic disease and increasing their consumption in the consumer diet [1]. According to the Food and Agricultural Organization (FAO), fruits and vegetables are the most wasteful commodities [2]. The chief sources of this waste are inadequate postharvest infrastructure and poor harvesting and storage procedures [3]. The postharvest problem is a serious worldwide issue that affects both rich and poor countries. The tomato is a climacteric fruit that continues to mature even after it has been harvested. Carotenoids are generated as chlorophylls are destroyed during ripening [4]. Lycopene contents, the principal antioxidant in tomatoes, rise as they reach the breaker stage of ripeness [5] or when they change maturity stages (as described by the USDA (2005) ripeness scale) during the ripening process. This finding suggests that light has a substantial impact on lycopene production. Tomato antioxidant development is influenced by genetic and environmental variables, as well as maturity [6].

Currently, the techniques used for preserving fruits and vegetables are primarily chemical additives, such as the use of 1-methyl cyclopropane, ozone treatment, the application of a high oxygen atmosphere [7], chitosan coating, and physical techniques, such as controlled atmosphere storage (Skro As a consequence of technological limits in chemical additives, the food processing industries have switched toward nonthermal procedures such as irradiation, ultraviolet light (UV), pulsed light (PL), and high-pressure processing (HPP). The impact of LEDs (narrow-bandwidth lighting) on the postharvest preservation of fresh horticultural fruit has recently received more attention. LEDs have been shown to improve the traits of a wide range of postharvest fresh produce, including lettuce, cabbage, kale plants, white mustard, sweet pepper, cucumber, and blueberries, peaches, strawberries, tomatoes [8], citrus fruits, Chinese bayberries. Furthermore, several studies on the application of LEDs in the field of postharvest fruits and vegetables have been conducted, as well as various reviews on plant physiology [9].

LED integration in horticulture lighting systems has risen over the previous decade. LEDs, unlike other conventional lighting systems, are being created with technology that allows for the design of specific spectra, light direction, and light intensity. LEDs are also being developed as components of lighting systems with an energy efficiency ratio connected with higher plant development. There is a scarcity of data on the impact of LED lights on certain areas of horticulture, particularly the influence of the LED spectrum on the development of anticancer nutritional qualities [10] is limited. The goal of this study was to see how the light spectrum of three different types of LED lamps affected the organoleptic, commercial, and dietary aspects of tomato fruit at the postharvest stage in six distinct cultivars.

2 Materials and Methods

2.1 Plant materials

The tomato is ripe and was bought from a greenhouse in Vietnam. The experimental unit was made up of four fruits of each type, for a total of four replicates. On day 9, after the fruits had attained their red ripe state, samples were taken postharvest. The study's findings placed the terminal calyx down, and temperature and relative humidity were kept at 24°C and 85%, respectively. For one hour each day, the fruit was lighted with LEDs lights under continuous irradiation of blue light (440-450nm) and red light (650-660nm) using light emitting diodes (LEDs). The outcomes of each replication were recorded at the beginning and conclusion of the trial. The fruits of the control were kept in a chamber under the dark condition.

2.2 Experiments

The tomato group was separated into three groups: the control group, the red LED lighting group, and the blue LEDs lighting group. After 9 days, the experiment was repeated, and the findings were recorded at 0 days, 3 days, 6 days, and 9 days. Tomatoes were flipped over daily to guarantee equal light exposure on both fruit sides. In the treatment area, the light intensity was 3.7 kLux. At the end of the storage trial, samples were homogenised and kept frozen at 〖+ 3〗 ^0 C until analysed. Green tomato samples (n = 3) were also analysed as initial control (day 0).

3 Results and Discussion

After 9 days, the lighting conditions had a substantial impact on lycopene and b-carotene levels but had no effect on lutein. Figure 1 depicts the color and status of the tomato groups examined as reference groups, blue and red LEDs, including integrity and cross-sections. Mature green fruits treated with either red light or darkness developed a red color, while those treated with blue light developed a yellowish color. The different pattern of color development in the fruits indicated that different metabolic changes were induced by the treatments. In fruits treated with either darkness or red light for nine days. The yellow-colored pericarp of the fruits treated with blue light was coupled, indicating that the blue light delayed the maturation process. In general, tomato fruit ripening is reflected by the transition of color from green to red. The conversion which indicates reddening of the fruits is considered to mark the beginning of tomato fruit ripening. Aspartic acid (Asp) is an important amino acid that leads to synthesis of four other essential amino acids, Lys, Thr, Met, and Ile. The Asp content increased in fruits in all treatments, but those treated with blue light accumulated the smallest amount after three days. The increased Asp content may be related to the increased enzymatic activities of aspartate transaminase (AAT) in the ripening mature green fruits (Fig. 1). Conversion of Glu to Asp by AAT was shown to increase with the ripening of fruits therefore, ripening fruits accumulated high amounts of Glu and Asp.

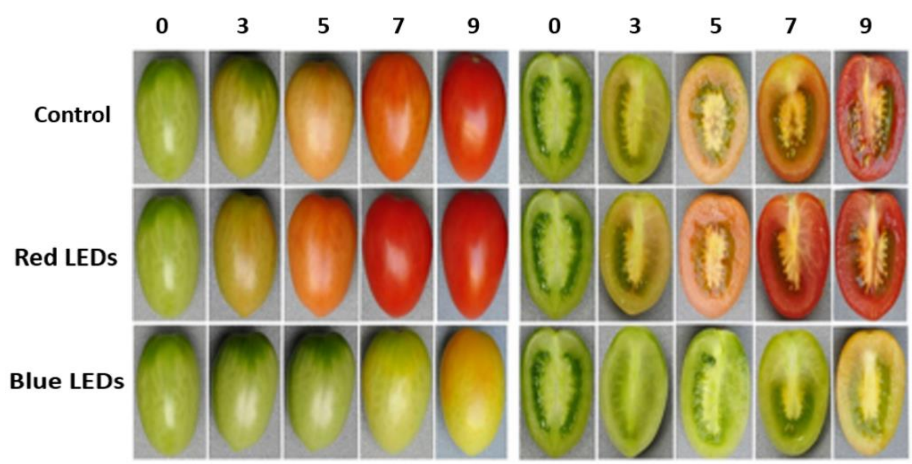

Figure 1. Images showed the color change of the fruits.

4 Conclusions

Growers and vendors currently face challenges in maintaining the quality of fresh produce after harvest. Possible ways to circumvent these challenges are to increase the production rate of fruits and vegetables and prevent waste to ensure the provision of quality and safe, fresh produce to consumers. LEDs play an essential role in agriculture and also crucial in the postharvest stage to fulfill the above requirements. The distinctive properties of LEDs make them an outstanding choice. Lights of different wavelengths regulate key photochemical processes in fruits and vegetables, such as photosynthesis and secondary metabolite yields. Similarly, the use of LEDs regulates senescence, controls ripening rates, affect the nutritional quality, and reduce pathogenic microbial spoilage in fresh produce during the postharvest period. The application of LEDs holds the potential for life-enhancing storage and handling during postharvest activities, also can assist growers and vendors in reducing waste as well as aid in the provision of long-term storage and transportation.

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