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Tomato Fruit Color Changes During Ripening On Vine

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***Abstract*—**Tomato (*Lycopersicon esculentum* Mill.) hybrid 'Brooklyn' was investigated at the LRCAF Institute of Horticulture. For investigation, five green tomatoes, which were grown on vine, were selected. Color measurements were made in the greenhouse with the same selected tomato fruits (fruits were not harvested and were growing and ripening on tomato vine through all experiment) in every two days while tomatoes fruits became fully ripen. Study showed that color index L has tendency to decline and established determination coefficient (R^2) was 0.9504. Also, hue angle has tendency to decline during tomato fruit ripening on vine and it's coefficient of determination (R^2) reached – 0.9739. Opposite tendency was determined with color index a*, which has tendency to increase during tomato ripening and that was expressed by polynomial trendline where coefficient of determination (R^2) reached – 0.9592.

***Keywords*—**Color, color index, ripening, tomato.

I. Introduction

TOMATO ripening confers positive and negative attributes to the resulting commodity. Although ripening imparts desirable flavor, color, and texture, considerable expense and crop loss result from negative ripening characteristics. For example, ripening-related increase in fruit pathogen susceptibility is a major contributor to fruit loss both before and after harvest. This genetically regulated change in fruit physiology currently necessitates the use of pesticides, post-harvest fumigants, and controlled atmosphere storage and shipping mechanisms in attempts to minimize loss. In addition to being wasteful of energy and potentially harmful to the environment, such practices represent major expenses in fruit production. Finally, it is important to reiterate that ripening imparts numerous quality and nutritional characteristics upon a significant component of the human diet, fruit [1].

Fruit color is one of the most important and complex attributes of fruit quality. The complexity of tomato color is due to the presence of a diverse carotenoid pigment system with appearance conditioned by pigment types and concentrations, and subject to both genetic and environmental regulation. Red color is the result of chlorophyll degradation as well as synthesis of lycopene and other carotenoids, as chloroplasts are converted into chromoplasts [2].

Human identification of colors is quite complex where sensations like brightness, intensity, lightness and others modify the perception of the primary colors (red, blue, yellow) and their combinations (orange, green, purple, etc.), meaning that in many cases color definition is a matter of subjective interpretation. In 1931 the Commission International de l'Eclairage (CIE) made possible to express color in exact quantitave and numerical terms. An improvement of this system was developed in 1976 by CIELAB, which defines color better related to human perception and where all conceivable colors can be located within the color sphere defined by three perpendicular axes, L* (from white to black), a* (green to red) and b* (blue to yellow) [3], [4].

Tomatoes are usually consumed at their maximum organoleptic quality, which takes place when they reach the full red color stage but before excessive softening. This means that color in tomato is the most important external characteristic to assess ripeness and post harvest life and is a major factor in the consumer's purchase decision [5].

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II. Materials and Methods

Edible tomato (*Lycopersicon esculentum* Mill.) hybrid 'Brooklyn' was investigated at the LRCAF Institute of Horticulture. Tomatoes were grown in the natural soil in not heated greenhouse covered with polymeric film. For investigation, five green tomatoes, which were grown on vine, were selected. Color measurements were made in the greenhouse with the same selected tomato fruits (fruits were not harvested and were growing and ripening on tomato vine through all experiment) in every two days while tomatoes fruits became fully ripen.

Color indexes in the space of even contrast colors were measured with spectrophotometer MiniScan XE Plus (Hunter Associates Laboratory, Inc., Reston, Virginia, USA). In the regime of light reflection there were measured parameters L*, a* and b* (correspondingly lightness, indexes of redness and yellowness according to scale CIE L*a*b*) and calculated chroma (C = (a*2+b*2)1/2) and hue angle (h° = arctan(b*/a*)). The volumes L*, C, a* and b* are measured in NBS units, hue angle ho – in degrees from 0 to 360°. NBS unit is a unit of USA national Standard Bureau and corresponds to one threshold of color distinction power, i. e. the least distinction in color, which the trained human eye can notice [4]. Before each series of measurements spectrophotometer was calibrated with light catcher and standard of white color, the color coordinates XYZ of which in color space are X = 81.3; Y = 86,2; Z = 92.7.

The data are presented as the averages of five measurements. Color indexes are processed by program Universal Software V.4–10. For the evaluation of data significance statistical software ANOVA was used.

III. Results and Discussion

For fresh tomatoes, the main attribute that the most important to buyers and consumers is tomato color. Human identification of colors is quite complex where sensations like brightness, intensity, lightness and others modify the perception of the primary colors (red, blue, yellow) and their combinations (orange, green, purple, etc.) [3]. Thompson and colleagues [6] made comparison of the color readings taken from tomatoes at the equatorial region with those of the homogenate prepared from the same region showed that the hue of tomato homogenate was a better indicator of lycopene content than tomato surface hue. The previous colorimetric study showed that the ratio between the chromatic co-ordinates of the CIELAB system (a*/b*) separated the fruits of the different varieties as a function of their external color better than the tomato color index [7], [8], [9].

The tree coordinates CIE L*a*b* represent: the lightness of the color L* = 0 means black and L* = 100 indicates diffuse white; negative value of a* indicate green while positive values indicate red; negative values of b* indicate blue and positive values indicate yellow. Also, chroma value (C) shows color pureness and hue angle – color tone [4].

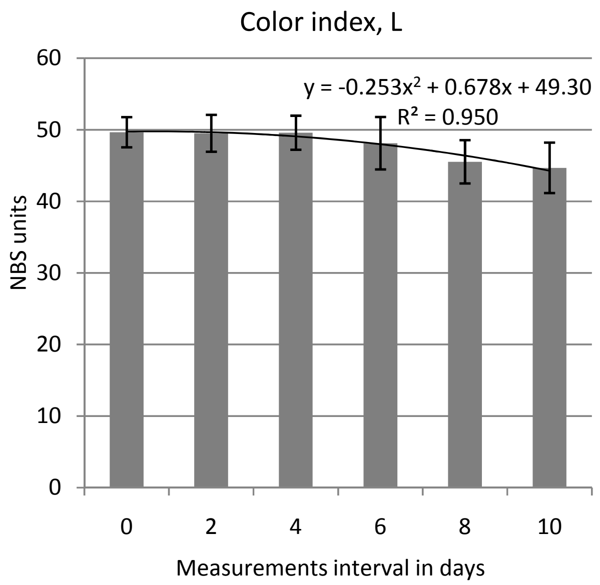

Fig. 1 Color index L changes during tomato fruit ripening on vine

Study showed that during tomato fruit ripening on vine color index L has tendency to decline (Fig. 1) from 49.5 (at the beginning and after two days) till 44.7 (after 10 days). Polynomial trendline of color index L and fruit ripening time showed that coefficient of determination (R^2) reached –0.9504.

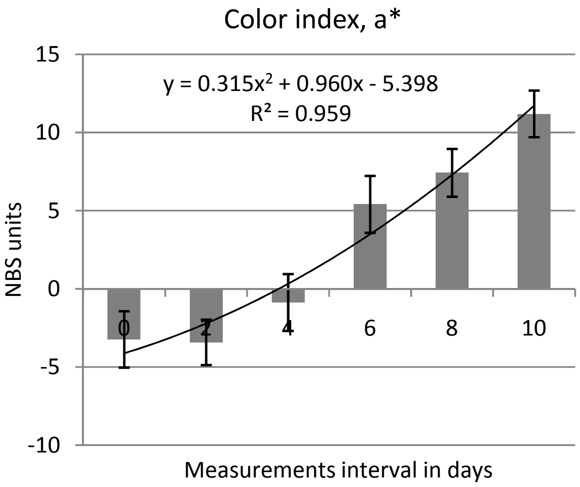

Fig. 2 Color index a* changes during tomato fruit ripening in vine

The data presented in Fig. 2 showed that color index a* was negative at the beginning of tomato ripening ant positive value of index a* was detected only on the 6th day of experiment. So color index a* has tendency to increase during tomato ripening and that was expressed by polynomial trendline where coefficient of determination (R^2) reached –0.9592.

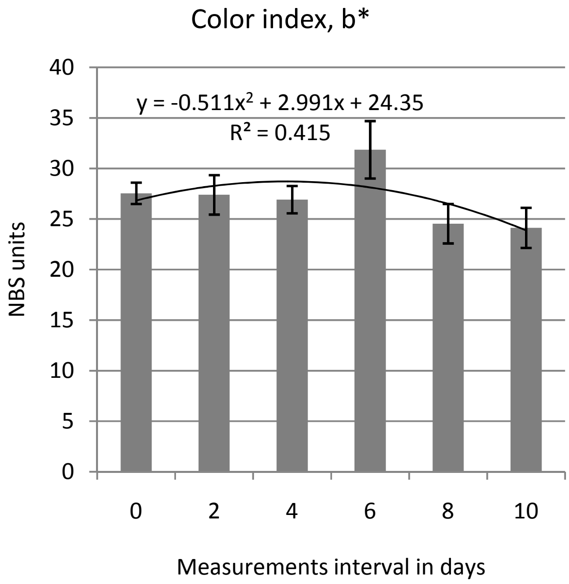

Fig. 3 Color index b* changes during tomato fruit ripening on vine

In this study (Fig. 3) color index b* has distinguished on the 6th day when reached 31.9 value, but there were no significant differences between the rest measurements.

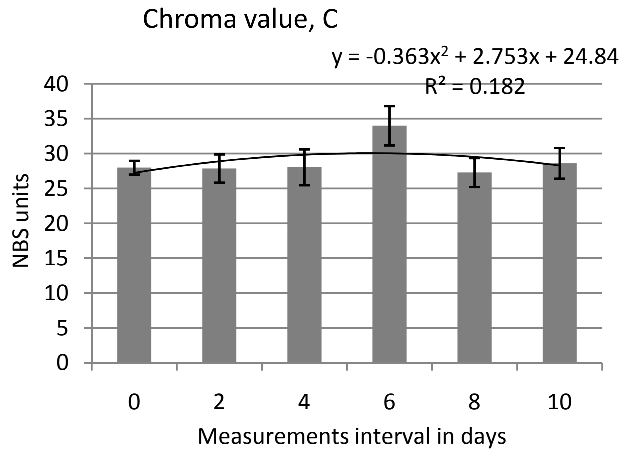

Fig. 4 Chroma value changes during tomato fruit ripening on vine

According to Fig. 4, it was established significant increase in chroma value (C) on the 6th day and it reached 34.0. Comparison of the rest measurements showed that chroma had varied in small range and there were no big differences.

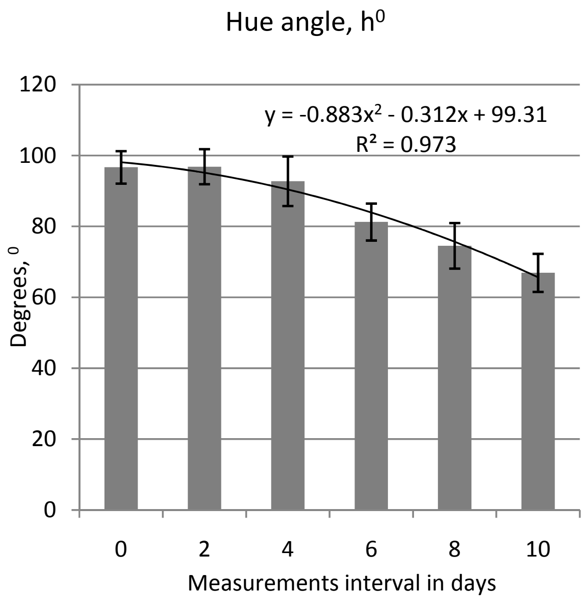

Fig. 5 Hue angle changes during tomato fruit ripening on vine

Experiment showed (Fig. 5) that hue angle has tendency to decline during tomato fruit ripening on vine from 96.8^o till 66.9^o. It was expressed by polynomial trendline where coefficient of determination (R^2) reached –0.9739.

Previous studies established that tomato fruit lightness (L*) range from 42.3 ('Tocayo H') till 50.7 ('Saint Pierre'), color index a* (redness) varied from 12.9 ('Brooklyn H') till 26.1 ('Tolstoi H'), color index b* (yellowness) – from 28.8 ('Rutuliai') till 36.5 ('Benito H'), chroma (C*) – from 32.5 ('Brooklyn H') till 44.1 ('Benito H') and hue angle (h^o) – from 49.3 ('Tolstoi H') up to 66.6 ('Brooklyn H') [10].

IV. Conclusion

Study of tomato fruit color changes during tomato fruit ripening on vine showed that color index L has tendency to decline and established determination coefficient (R^2) was 0.9504. Also, hue angle has tendency to decline during tomato fruit ripening on vine and it's coefficient of determination (R^2) reached –0.9739. Opposite tendency was determined with color index a*, which has tendency to increase during tomato ripening and that was expressed by polynomial trendline where coefficient of determination (R^2) reached –0.9592.

Color index b* and chroma value (C) had distinguished on the 6th day, when was established sharp increase but there were no significant differences between the rest measurements.

Hue angle has tendency to decline during tomato fruit ripening on vine and it's coefficient of determination (R^2) was –0.9739.

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