REFLECTANCE SPECTROSCOPY AS A USEFUL TOOL FOR MONITORING APRICOT FRUIT QUALITY AND RIPENING

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Aspectul vizual al fructelor este unul dintre primii determinanți ai calității, încurajând consumatorii să le cumpere. Adesea aspectul fructelor, în speță culoarea, este cel mai critic factor în vânzarea inițială. În trecut evaluarea culorii fructelor de cais a fost făcută subiectiv pe baza evaluării vizuale. Prezenta lucrare ilustrează folosirea sistemului colorimetric tristimulus CIELAB şi CIELCH pentru a caracteriza şi cuantifica obiectiv culoarea fructelor şi calitatea. În acest scop s-au analizat două soiuri noi de cais cu epocă de maturare extratimpurie (Rareş şi Valeria) în ceea ce priveşte culoarea, dar de asemenea şi conținutul de pigmenți, aciditatea şi substanța uscată solubilă. Valoarea luminanței (L) pentru soiurile de cais studiate nu variază semnificativ în timpul maturării fructelor. Valorile parametrilor a* şi b* cresc semnificativ, iar valoarea lui h° scade progresiv cu coacerea fructelor, având valori apropiate pentru ambele soiuri. Dintre parametrii cromatici CIELAB studiați, a* şi h° reprezintă indicatori fezabili atât pentru cuantificarea culorii fructelor, cât şi pentru distingerea între diferite stadii de maturitate ale fructelor de cais. Putem concluziona că determinarea atributelor cromatice, ca şi reprezentarea grafică, face posibilă identificarea diferitelor faze de maturare, ceea ce poate fi de un real interes pentru amelioratori şi producatori pentru a cuantifica coacerea şi calitatea fructelor.*

Fruit visual appearance is one of the first quality determinants, and encouraging consumers to buy them. Often the fruit appearance, especially color, is the most critical factor in the initial sale. In the past, the evaluation of apricot color has been subjective and based on visual ratings. The present paper illustrates the use of colorimetric tristimulus system CIELAB and CIELCH to objectively quantify and characterize fruit color and quality. To this aim, fruits of two new apricot cultivars with extra-early maturation (Rares and Valeria) have been analyzed for color, but also for pigments content, acidity and soluble solids. The lightness value (L) of apricot cultivars studied do not varied significantly during the fruit maturation. The a* and b* values significantly increased and the h° value progressively decreased with fruit ripening, having similar values for both cultivars. Among the chromatic CIELAB parameters studied the* and h^o represent feasible indicators, both for quantifying fruit color and for distinguishing different maturity*

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stages of the apricot fruit. One can conclude that the determination of chromatic attributes, as well as the plot of these, makes it possible to identify the different maturation phases, fact that should be of interest to breeders and growers in order to quantify the ripening and quality of fruit.

Keywords: chromaticity values, quality, apricot, CIELAB

1. Introduction

The external appearance of fruit, particularly their color is of major importance when considering the different attributes which define quality, and if fruit is destined for fresh consumption, a visual impression may cause refusal [1].

In what apricots concern, the advanced stage of ripeness is characterized by marked change of color, firmness, acidity and soluble solids content [2].

Various maturity indices, most of them including color, have been used to monitor fruit development [3, 4, 5].

The color of the skin fruit is usually considered to be closely associated with the ripening process during fruit development, color representing nowadays a key guide in order to choose the harvest date. It has been usually reported that total soluble solids and pigments content increase with fruit coloring and ripening.

As a consequence, it is of great interest to study the evolution of the principal color parameters during the ripening of apricot cultivars, beside other quality parameters as a uniform development and maturity grade at harvest, which should be mandatory.

The objective of this study was investigating a non-destructive, rapid instrumental method to measure fruit maturity and quality, specifically for two extra-early apricot cultivars.

2. Materials and Methods

Two extra-early maturation apricot cultivars (Rares and Valeria) from *Baneasa* Research Station for Pomiculture orchard have been evaluated during two seasons.

In order to determine the color parameters, work was performed on samples containing 10-15 fruits of each cultivar, fruit by fruit being analyzed upon two sides (in their equatorial zone): the more colorful, and the lesser colorful side, respectively. Each fruit was measured twice on each side, for establishing the color parameters average.

Objective color measurements were assessed using a HunterLab Mini Scan XE Plus Chroma Meter calibrated with a white standard reflective plate using Iluminant D65. Fruit color was expressed as CIELAB color space, where L^* value indicated lightness (black $L^*=0$ and white $L^*=100$), a^* values indicate redness-greenness (red a*=100 and green a*= -100) and b* values indicate yellowness-blueness (yellow b*=100 and blue b*= -100).

Chroma C* $= \sqrt{a*^2 + b*^2}$ measures the color saturation and the hue angle ho = arctan b*/a* determines the red, yellow, green, blue or intermediaries color between adjacent pairs of these basic colors.

Juice samples were obtained by squeezing half of the fruit slices through four layers of cheesecloth with a hand juicer.

Titrable acidity was determined by titrating the juice samples with 0,1N NaOH up to pH=8,2 and expressed as a percent of malic acid content.

Soluble solids content have been measured on fruit juice with temperature compensated hand refractometer Attago, previously calibrated with distilled water. The average SSC was expressed as percent.

The total carotenoids content was determinated from pulp and peel by measuring the absorbance of samples with UV-VIS spectrophotometer using the method of [6]. Results were expressed in mg%.

All the data obtained are means of four replicates composed of 10 fruits with standard deviation. The correlation coefficients between color parameters and carotenoids content, soluble solids, and acidity have been determined by Pearson's coefficients. Statistical analyses have been performed using SPSS 13.0 version.

3. Results and Discussion

Spectral reflectance curves obtained for the different stages of maturity of both cultivars are plotted in figure 3 and 4. We observed from the spectra shape a maximum at 550 nm for both cultivars in the green stage. As ripening progresses, the dominant wavelength increases until it reaches the final value of 570 nm and 600 nm. The ripe fruits spectra show a peak at 610 nm and a peak at 640 nm. Similar shapes and characteristics features of spectrum were obtained for fruits of both cultivars.

Thus, the shift of reflectance maxim is characteristic for both apricot cultivars and reflects the three stages of maturation.

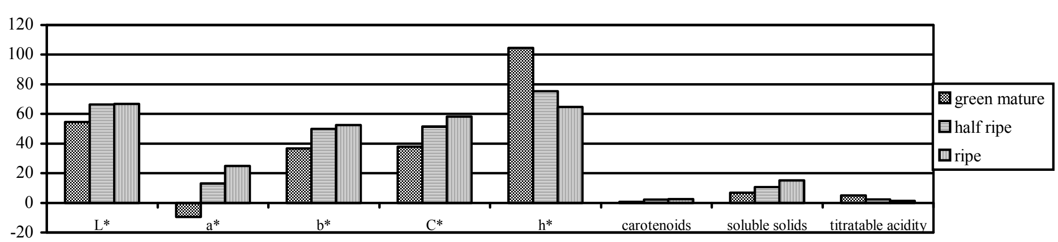

Fig. 1. Color and composition change in relation with fruit maturity stage at Rares cultivar

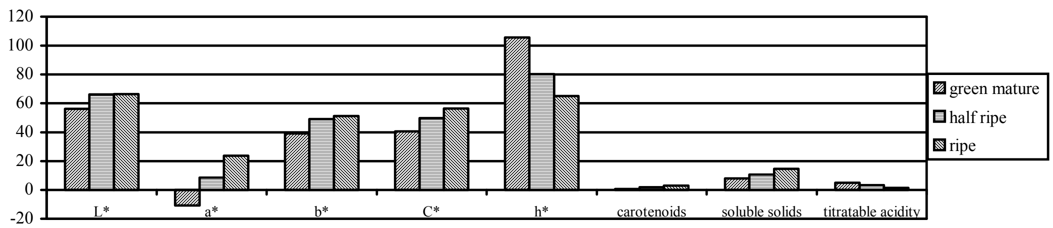

Fig. 2. Color and composition change in relation with fruit maturity stage at Valeria cultivar

Lightness (L*) increased with the maturation of apricot fruit. The a* parameter increased during maturation from the negative value (green color) to the positive value 24.9 (orange color) – fig.1 and fig.2. Also b* parameter increased from 36.68 to 52.57, denoting loss of chlorophyll and accumulation of carotenoids.

For both the cultivars studied, the hue angle decreased from the value of 105.55-104.46 – corresponding to the green color – to 75.32-80.17 for the half-ripe stage of the fruit – with yellow-orange color – reaching the value of 64.65-65.07 – evidenced by orange or orange-red color.

Soluble solids increased during maturation for these cultivars until value between 14.6-15.2 % in ripe stage. Also, acidity of fruits decreased during maturation reached value of 1.41-1.46 mg ac. malic %.

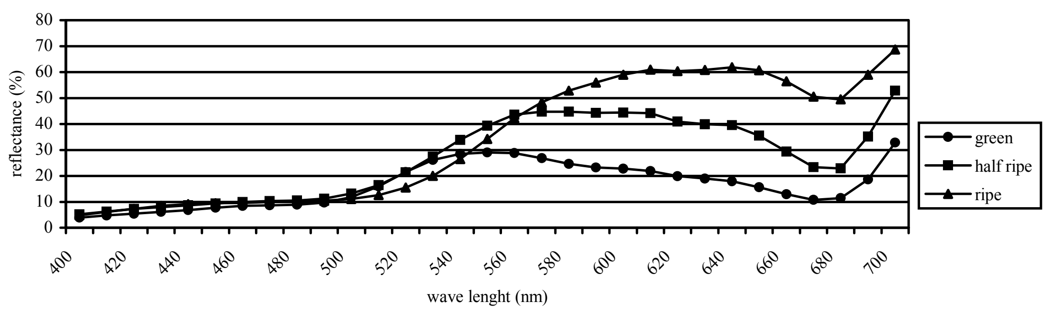

Fig. 3. Reflectance spectras of Rares cultivar in three stage of maturation

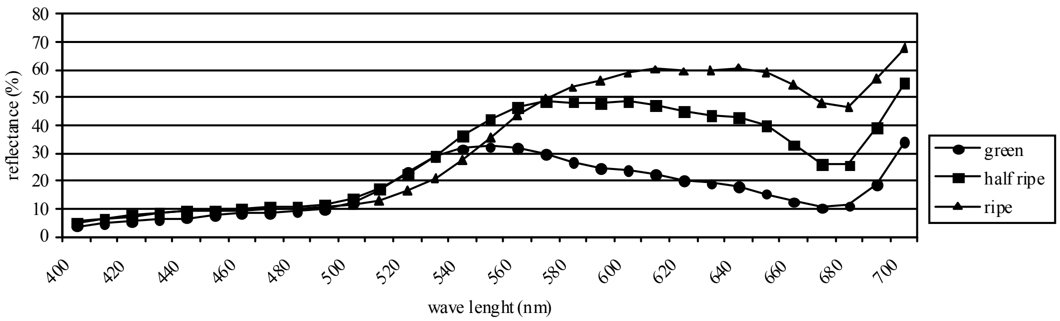

Fig. 4. Reflectance spectras of Valeria cultivar in three stage of maturation

Statistic results showed high correlation coefficients between the color parameters (a*, h, C*) and the carotenoids content (R.0.82), but the correlation of these color parameters with soluble solids and acidity showed very lower values.

4. Conclusions

Based on the presented results, one can conclude the following:

From CIELAB color characteristics, a* and h° values are those which have visible modifications during maturation, being feasible and objective indicators for fruit color quantification and for distinguishing the different maturity stages.

The spectral measurements have a promising potential to be added as an objective index in order to characterize fruit color, beside the chromatic parameters a*and h°.

High correlation coefficients obtained and regression equation claim that total carotenoids content can be estimated from the chromatic parameters.

The final conclusion is that color based on the determination of a*, h°, and a shift of spectra is a good and easily way of characterizing color and maturity at the harvest of the apricot cultivars studied. Moreover, this method used for examining fruit color is rapid, nondestructive, objective, easily to use and suitable for evaluating the fruit maturity.

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