

An Optical Reflectance Nondestructive Method for Studying Apricot Fruit Color

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*Fruit colour is a major quality attribute of apricots affecting perception of consumer of their maturity and eating quality and is a main factor of good price of fruits. The aim of this study is the objective estimation of fruit colour by the use of colorimetric tristimulus system CIE L*a*b*, CIE L*C*h. To this goal, fresh fruits from apricot varieties were analyzed by spectral measurement in reflectance. The color parameters (L*, a*, b*) of the fruits were evaluated by using a colorimeter Hunter Lab Mini Scan XE Plus with a special software that allowed the recording of the data and their processing. Spectral recordings in the visible wavelength range using reflectance mode were tested to obtain information on the fruit pigment content which is related to the ground colour of fruit. To establish fruit quality the measurement of soluble solids content and titratable acidity was made. Comparing the results obtained it was found that colorimetric method could achieve characterization of fruit color, fruit quality control, and objective selection of high performance hybrid relying on maturity period with a view to optimal valorization. Likewise, this method is highly advantageous, as it nondestructive, it is not toxic and does not pollute environment and is very quickly.*

Keywords: CIELAB, apricot, color, nondestructive method

Fruit colour represents a characteristic for quality evaluation and for determination of maturity stage at harvest.

The color of fruits as a component of quality, is important to farmers and to the processors as it affects product appearance and consumer acceptance.

To obtain high crops of superior quality, in the new orchards, new cultivars and perspective selections, that correspond to the market demands, have to be introduced.

Many methods have been used to analyze colour and change of colour in horticultural products nevertheless most of most of them being destructive and less practicable outside the laboratory.

The study of the variability of apricot colour is important for quality control, and for selection of the best variety intended to be accounted.

The color parameters of apricot fruits were evaluated by CIE L*a*b* system, that measures the color objectively, fast and nondestructively using chromatic parameters red-green (a*) and yellow-blue (b*) reproducing those seen by the human eye [1].

This method has been applied abroad with conclusive results to study many fruits [2, 3], but also *Prunus* fruits [4-6].

In Romania the method using the colour parameters has been sporadically applied for characterization of some industrial paint, food product, wine quality [7]. Also in our country using this nondestructive technique for horticultural products color determination especially for fruits is seldomly [8, 9].

The objective of this study was to characterize apricot fruit colour and to determine the difference between chromatic characteristics of apricot hybrids and the check to cultivar with an optical reflectance method.

Experimental part

Materials and methods

Apricot genotypes Excelsior (used as check) and 10 perspective hybrids with medium maturation during

validation have been studied. The apricot fruits were obtained from RDSP Baneasa orchard. Fruits were harvested by hand, from five trees taken in study from all three levels of tree canopy being a sample average.

In order to determine the colour parameters, work was performed on samples containing 20 fruits for every hybrid, each fruit being analyzed on two sides (the more coloured and the lesser coloured sides) in the equatorial zone of fruit.

Chromatic characteristics of fruits has been measured in CIE L*a*b* system where a value of L* describes lightness (L*=0 for black, L* =100 for white), a* describes colour intensity in red (a*> 0) or in green (a*< 0), b* describes colour intensity in yellow (b*> 0) or in blue (b*< 0). The coordinates a* and b* were used to compute the hue angle $h^{\circ} = \tan^{-1} \frac{b^*}{a^*}$ and chromaticity $C^* = \sqrt{a^{*2} + b^{*2}}$

The measurements were performed with tristimulus spectrophotometer HunterLab MiniScan XE Plus under D65 illuminant conditions.

To determine the chemical components, the fruits were peeled, sliced and homogenized; the obtained mixture was centrifuged and the supernatant used for analyses.

Content of carotenoidic pigments was determined by spectrophotometric analyze at $\lambda = 450$ nm, in acetone extract [12]. Results were expressed as mg total carotenoids / 100 g fresh weight.

Refractometric determination of soluble solids content (SSC) has been made with a Atago refractometer with temperature correction. Results were reported as °Brix.

The titratable acidity (TA) was obtained through titration with 0.1N NaOH until reaching an end point of pH=8.2. The results were expressed as percentage of malic acid which is the predominant acid in this species (mg malic acid / 100 g fresh weight). Ratio soluble solids content / titratable acidity, reflecting eating fruit quality.

To establish possible relation between color parameters and carotenoids content, as well quality attributes, the

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correlation coefficient between these attributes was determined by using polynomial regression.

Results and discussions

Spectral reflectance curves in visible range 400-700nm obtained for check and perspective hybrids are plotted in figure 1.

Spectra of ripe apricot for all hybrids present the maximum at 640nm and the minim at 670nm. Also, it can be noted that shape of spectra is similar to that of check (Excelsior) but some exception exist: 85.5.100 BIV, 82.28.62 BIV, 82.32.29 BIV, 82.28.62 BIV that present another maximum at 600nm (fig. 1).

The spectral shapes relates to the pigmentation present and give an indication of the appearance of the apricot fruit.

An emphasized variety of colour parameters between genitor and hybrids has been recorded.

Figure 2 shows the representative points of fruits hybrids and check in the colour space CIELAB, making evident the colouring difference between samples.

As for the lightness (L^*), it is noted that hybrids 82.12.91 BIV, 82.28.62 BIV, 82.32.29 BIV, 85.11.85 BIII a have a colour more light than the check. These hybrids are the same presenting an additional maxim at 600nm, which means that fruits are in preclimacteric stage (half-ripe). Also, we can observe that lightness values for 85.11.95 BIII, 85.2.89 BIII hybrids are low so their colour is more dark than check meaning that, the fruits are in overripe stage.

The a^* value for Excelsior was higher than the a^* value of all hybrids implying that the fruit of check was redder than fruits of hybrids. However is noted that hybrids 82.32.29 BIV and 85.4.95 BIII, have values of parameters a^* very close to check (Excelsior).

Also 82.12.91BIV and 85.5.100BIII are remarked by increased values of b^* parameter very close to check Excelsior, this denoting a higher content of yellow than of red.

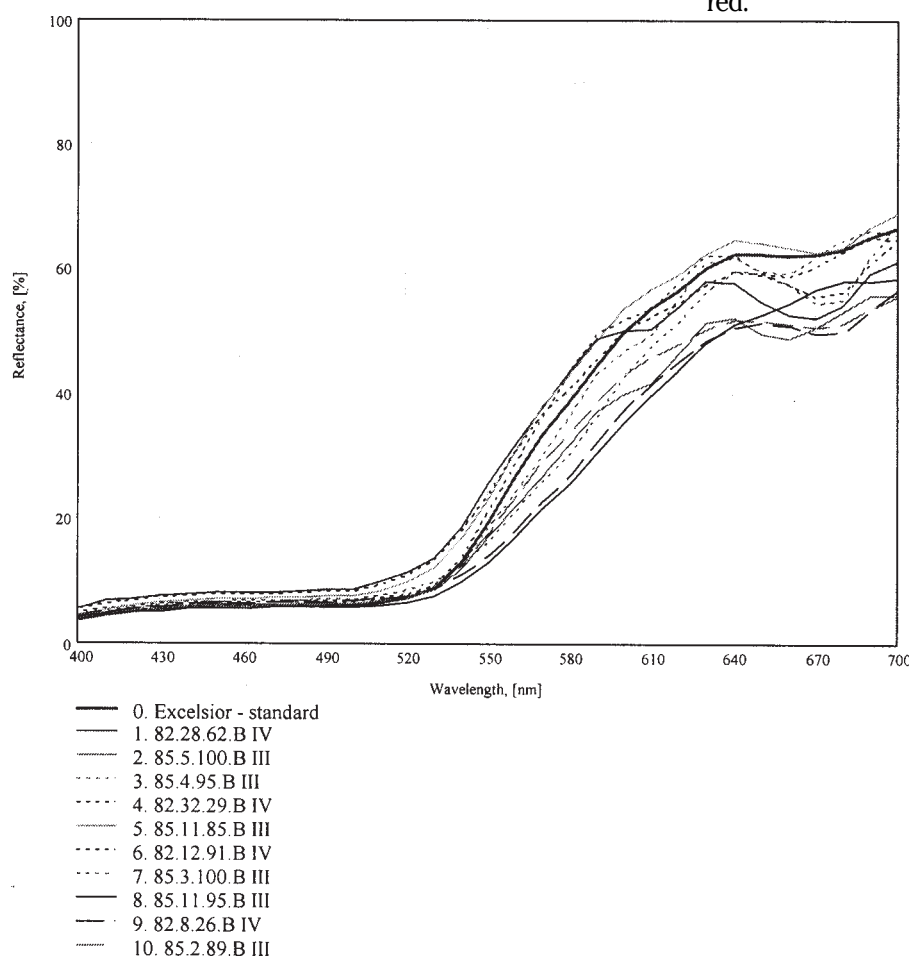


Fig. 1. Genitor's hybrids' spectra

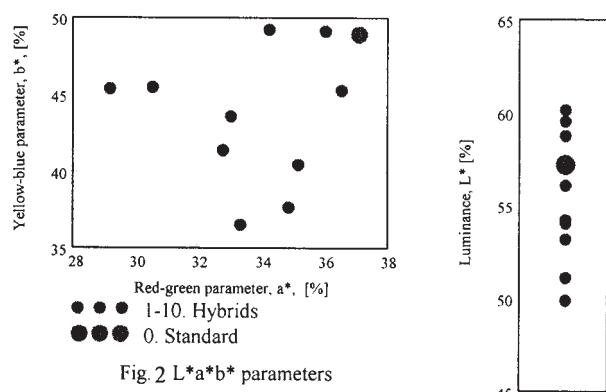


Fig. 2. $L^*a^*b^*$ parameters

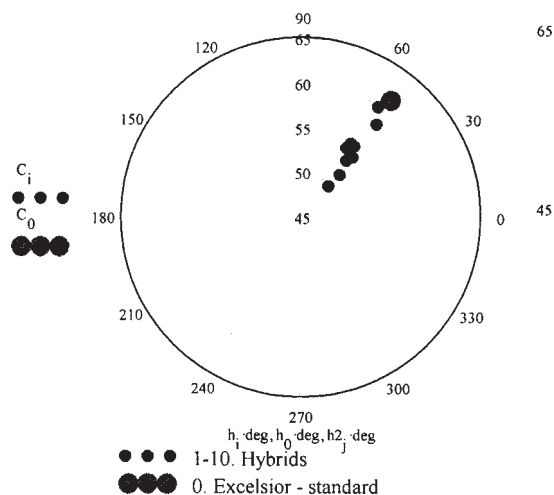


Fig. 3. C*h parameters

Table 1
CHEMICAL ATTRIBUTES FOR PERSPECTIVE APRICOT HYBRIDS
AND CHECK WITH MEDIUM MATURATION

Sample	Total carotenoids mg %	Titrateable acidity malic acid %	Soluble solids °Brix	Soluble solids/acidity
Excelsior – check	4.22	1.35	18.5	13.7
82.28.62.B IV	4.88	1.79	15.6	8.71
85.5.100.B III	5.02	2.25	16	7.11
85.4.95.B III	5.38	1.59	19.8	12.45
82.32.29.B IV	4.87	1.32	19	14.39
85.11.85.B III	3.85	1.67	17.2	10.65
82.12.91.B IV	5.06	1.63	16.4	10.06
85.3.100.B III	3.85	1.43	15.23	10.65
85.11.95.B III	5.66	1.23	21.5	17.48
82.8.26.B IV	5.26	1.66	19.5	11.74
85.2.89.B III	4.77	1.11	20.5	18.31

Table 2
CORRELATION COEFFICIENTS BETWEEN QUALITY ATTRIBUTES AND CHROMATIC COORDINATES
OF APRICOT FRUIT WITH MEDIUM MATURATION

	L*	a*	b*	C*	h°
Total carotenoids	0.5653	0.8755	0.7698	0.7585	0.9424
Titrateable acidity	0.0161	0.187	0.057	0.0648	0.0477
Soluble solids contents	0.2415	0.2488	0.1845	0.161	0.2368
SSC/TA	0.1218	0.2127	0.0633	0.0477	0.1352

It is observed that all hybrids studied have a lower chroma (C*) value which reflect darker fruit colours (fruit color more intense) for hybrids to light fruit colours for check (fig.3).

As it can be seen in table 1 the total carotenoids content varied from 3.85 to 5.66mg/100g f.w in all samples studied. Likewise it is remarked that by the carotenoid pigments content eight of the ten hybrids containing between 4.77 mg % (85.2.89 BIII) and 5.66 mg % (85.11.95 BIII) over the check (Excelsior) with a 4.22 mg % content (table1).

This high carotenoids content is supported and values of hue angle are contained between 47 and 57 corresponding to an orange colour.

Juice acidity is an important parameter in fruit quality definition. In fact, fruit taste is a balance between acids and sugars. It has been described previously that for

optimal taste, apricot should show a ripening index (SSC/TA) higher than 8 and lower than 15 [10]. Values above 15 are achieved in 85.11.95BIII and 85.2.89BIII hybrids that are overripe. The other hybrids studied had values of SSC/TA between 8.71 and 14.39 what denoting a balanced taste.

Table 2 gives the coefficients of the correlation between quality attributes and the colour parameters of apricot fruit. The correlation between total carotenoids and h° is good, due to the better correlations of both coordinates considered separately with total carotenoids but is weak for L* parameter.

In addition the carotenoids content show good correlation with chroma (C*) since this attribute is directly related with coordinates a* and b*.

The obtained correlation allows a very quick and easy estimate for the carotenoid content from values of the chromatic coordinates a* and b*, which are easy to obtain

experimentally. The correlation of color parameters L^* , a^* , b^* , C^* , h° with soluble solids and titratable acidity was very weak and contradictory.

According to [11], hue angle and chroma give more information, about spatial distribution of colours, and indeed a better correlation is obtained between pigment concentration with these parameters than direct values from the colorimeter.

The correlation obtained from this study may be used for the determination of the colour quality in relation to pigment content in the quality control of fresh fruits.

Conclusions

The study points out that in hybrids of apricot with medium maturation: 82.32.29 BIV, 85.4.95 BIII, 82.12.91 BIV were relevant over the check (Excelsior), as regarding the colour parameters.

It can be noticed that for all hybrids studied was recorded the same minimum and maximum of reflectance spectra comparative to the check, excepting: 85.5.100 BIV, 82.28.62 BIV, 82.32.29 BIV, 82.28.62 BIV that present another maximum at 600nm.

The optical reflectance method used allows rapid fruit analyses, a fact of major significance in the breeding programs allowing both tests of genitor and hybrids.

This method can achieve color characterization, fruits quality control and objective selection of the most performing hybrids, as depending on maturation period, in correlation to organoleptic qualities.

Eight from ten hybrids studied had values of SSC/TA between 8.71 and 14.39 denoting a balanced taste of fruit. Values above 15 are achieved in 85.11.95BIII and 85.2.89BIII hybrids that are overripe.

We obtained a good correlation between a^* parameter and carotenoid content ($R^2=0.87$), h° parameter and carotenoid content ($R^2=0.94$) and satisfactory correlation between b^* and carotenoids. But, correlation between L^* and carotenoids contents at these cultivars is weak. The correlation of color parameters L^* , a^* , b^* , C^* , h° with soluble solids and titratable acidity was very weak and contradictory.

Results obtained in this study and data obtained later have as final target to establish the limits for color parameters for apricot species in general and for different cultivars especially and which of these parameters can be used for color characterization and for differentiation between stage of maturity.

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