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Relationship Between Chromaticity Measurements and Visual Ratings of Peach Cultivars[1]

TARA AUXT BAUGHER,[2] EDWIN C. TOWNSEND,[2] SUMAN SINGHA,[3]
DAVID W. LEACH[2] AND SANDRA P. WALTER[2]

Abstract

A study was conducted to determine the relationship between sensory color evaluations of peach [*Prunus persica* (L.) Batsch] cultivars and Commission Internationale d'Eclairage (CIE) L* a* b* color space coordinates and to compare the fruit color of 36 cultivars. Fruit color was visually rated on a 1-10 scale, with 10 representing highly attractive overall color. Fruit color also was measured with a portable tristimulus colorimeter at the mid-point between the stem and the stylar end on the blushed and on the nonblushed surfaces. Nonblushed surface measurements did not correlate with sensory panel evaluations. The hue angle of the blushed surface was linearly related to panel rating. The blushed surface hue angle indicated that the cultivars 'Harbrite,' 'Salem,' 'Redhaven' and 'Garnet Beauty' had the most intense red fruit coloration. Based on hue angle, a number of newer peach selections have color superior to the commercially planted midseason cultivar 'Loring.'

Introduction

An increasing concern voiced by Mid-Atlantic fruit packers and brokers is that color of currently grown peach cultivars is unacceptable in many markets. As researchers evaluate new cultivars for these markets, it will be important to relate measured improvements in fruit characteristics to market expectations of quality and appearance (9, 12).

Hunter (8), Clydesdale (2), Francis (7) and McGuire (10) have demonstrated that colorimetry offers an objective means of measuring fruit color differences. Research on peaches has shown that a tristimulus colorimeter is a useful tool for measuring changes in ground color to assess fruit maturity (4, 5, 6, 11). Delwiche (4, 5, 6) and Meredith et al. (11) reported that differences in ground color due to maturity were best reflected by differences in the "a" coordinate and in hue angle. Research conducted in West Virginia on apples has demonstrated that the Commission Internationale d'Eclairage (CIE) L* a* b* color space coordinates determined with a portable colorimeter are useful predictors of visual ratings (3, 13, 14). Singha et al. (13) and Crassweller et al. (3) reported that a*/b* ratio, hue angle and L* were correlated to sensory panel evaluations.

The objective of the present study was to determine the relationship between qualitative sensory color evaluations of peach cultivars and CIE L* a* b* color space coordinates measured with a portable tristimulus colorimeter. An additional purpose was to compare the fruit color of 36 peach cultivars.

Materials and Methods

Fruit for the study were collected in 1991 from a cultivar evaluation block established at the West Virginia University Experiment Farm in 1985. Five fruit were sampled from each of 5 replicate trees of each of 36 cultivars (27 newer cultivars and 9 commercial

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[2]West Virginia University, P.O. Box 609, Kearneysville, WV 25430-0609.
[3]The University of Connecticut, 1376 Storrs Rd., Storrs, CT 06269-4067.

standards), during the second harvest picking at the firm-ripe stage (as determined by ground color change). Care was exercised to collect fruit uniformly from the top third, outer periphery of the tree canopy. The fruit were randomly divided into 5 five-fruit subsamples (1 fruit per tree in each). Fruit color was measured with a Minolta CR-200b portable tristimulus colorimeter (Minolta, Ramsey, NJ) at the mid-point between the stem and the stylar end on the blushed and on the nonblushed surfaces of each of the twenty-five fruit. Calibration and measurement procedures have been previously reported (13). One set of fruit subsamples was delivered to each of 5 peach packers who had agreed to serve on a sensory color evaluation panel. The panelists rated fruit color on a 1-10 scale, with 10 representing highly attractive overall color (blushed and nonblushed surfaces; consideration given to blush and undercolor, shade, sheen, stripes and blotches). Regression analysis (SAS, 1993) was used to compare mean sensory color ratings to L^* (lightness—small values for dark colors and large for light colors), a^* (redness if positive and greenness if negative), b^* (yellowness if positive and blueness if negative), a^*/b^*, hue angle ($\tan^{-1} b^*/a^*$) and chroma ($\sqrt{a^{*2} + b^{*2}}$). Analysis of variance and least significant difference tests (SAS, 1993) were used to compare color quality among cultivars.

Results and Discussion

Relationship between chromaticity measurements and visual ratings

Nonblushed surface L^*, a^*, b^*, a^*/b^*, hue angle and chroma were not correlated to sensory panel evaluations. On the blushed side, only hue angle was linearly related to rating (Fig. 1). This contrasted a previously conducted study on 'Delicious' apple strains in which a^*/b^* ratio, L^*, hue angle and chroma were all correlated to sensory panel evaluations (14). Prediction equations for ratings for each packer were inconsistent (data not shown). With the exception of hue angle, the panelists used different criteria (e.g. percent red blush, uniformity of red blush) for judging peach quality. The R^2 comparing hue angle to mean panel rating was 0.30 ($p \leq 0.05$) if all 36 cultivars were considered and increased to 0.40 ($p \leq 0.05$) if the 9 standard commercial cultivars were deleted, most likely due to biases the panel may have had for known cultivars.

Comparisons of fruit color among cultivars

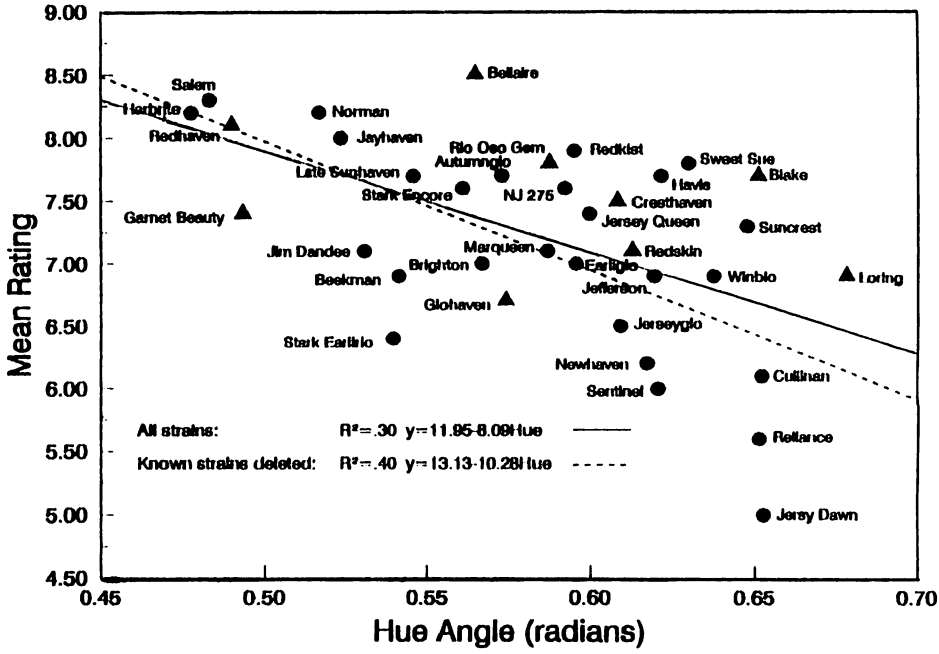
Mean qualitative color ratings ranged from a high of 8.5 for 'Bellaire' to a low of 5.0 for 'Jersey Dawn,' with the commercial standards 'Redhaven' and 'Loring' averaging 8.1 and 6.9, respectively (Table 1). Cultivars, in addition to 'Jersey Dawn,' with the lowest color ratings were 'Reliance,' 'Sentinel,' 'Cullinan,' 'Newhaven,' 'Stark Earlirio' and 'Jerseyglo.' Blushed surface L^* measurements indicated that 'Loring,' 'Reliance' and 'Jersey Dawn' were the lightest colored cultivars, and 'Salem,' 'Harbrite,' 'Stark Earlirio,' 'Garnet Beauty,' 'Beekman' and 'Redhaven' were the darkest cultivars (Table 1). Nonblushed surface L^* measurements indicated that 'Garnet Beauty,' 'Norman' and 'Brighton' had the darkest ground color measurements. All fruit had positive a^* readings, since harvest had been determined by a change in ground color, and a^* readings for both the blushed and nonblushed surfaces differed among cultivars (Table 1). In a previous study a^* was shown to be poorly related to anthocyanin concentration (13). CIE b^* readings also were positive, and blushed surface yellowness was highest on 'Jersey Dawn,' while nonblushed surface yellowness was highest on 'Blake' and 'Stark Earlirio' (Table 1). The blushed surface hue angle—the only color function correlated to sensory evaluations—indicated that the reddest (lowest readings) cultivars were 'Harbrite,' 'Salem,' 'Red-

Table 1. Chromaticity measurements and sensory color evaluation panel ratings of 36 peach cultivars at harvest, 1991.

Cultivar	Panel Rating[z]	Blushed Surface				Nonblushed Surface			
		L°	a°	b°	Hue Angle	L°	a°	b°	Hue Angle
Bellaire[y]	8.5	40.7	29.4	19.0	0.56	68.1	14.4	45.6	1.25
Salem	8.3	32.9	29.4	15.8	0.48	68.1	16.2	47.7	1.24
Harbrite	8.2	34.4	32.5	17.0	0.48	68.4	12.1	46.0	1.31
Norman	8.2	37.0	25.1	14.4	0.52	61.6	16.7	42.3	1.20
Redhaven	8.1	35.7	30.0	16.1	0.49	67.3	17.1	45.1	1.21
Jayhaven	8.0	39.8	28.7	16.7	0.52	64.6	17.4	41.0	1.17
Redkist	7.9	38.6	27.5	18.6	0.60	66.5	10.3	46.4	1.35
Rio Oso Gem	7.8	39.9	27.0	18.1	0.59	69.2	6.1	47.7	1.44
Sweet Sue	7.8	42.1	26.9	19.8	0.63	71.5	4.0	50.2	1.49
Autumnglo	7.7	37.8	25.9	17.0	0.57	64.9	3.3	46.3	1.50
Blake	7.7	42.6	29.3	22.8	0.65	70.3	4.2	53.7	1.49
Havis	7.7	42.1	26.1	18.7	0.62	69.6	9.4	44.4	1.36
Late Sunhaven	7.7	39.9	29.8	18.4	0.55	67.3	16.0	46.0	1.23
Stark Encore	7.6	39.1	29.4	18.7	0.56	69.5	1.9	49.5	1.53
Ernie's Choice	7.6	42.4	29.0	19.9	0.59	68.3	12.6	46.5	1.31
Cresthaven	7.5	42.3	28.0	19.7	0.61	70.5	5.6	49.5	1.45
Garnet Beauty	7.4	34.9	26.2	14.2	0.49	60.8	24.5	36.5	0.98
Jersey Queen	7.4	41.2	29.6	20.5	0.60	68.3	8.7	47.3	1.39
Suncrest	7.3	38.4	27.8	21.4	0.65	64.2	8.8	42.2	1.36
Jim Dandee	7.1	39.8	28.2	17.1	0.53	66.3	17.5	45.3	1.20
Marqueen	7.1	39.6	27.7	18.5	0.59	70.9	4.9	51.5	1.47
Redskin	7.1	39.9	28.2	20.0	0.61	68.1	8.0	48.2	1.41
Brighton	7.0	37.7	28.5	18.7	0.57	61.8	19.4	38.2	1.10
Stark Earliglo	7.0	41.9	32.5	22.7	0.60	64.1	22.7	37.7	1.03
Beekman	6.9	34.9	26.1	15.6	0.54	64.8	7.9	40.8	1.37
Jefferson	6.9	41.3	31.4	22.4	0.62	69.4	9.9	49.3	1.37
Loring	6.9	47.1	30.1	24.6	0.68	71.1	9.9	47.6	1.36
Winblo	6.9	42.3	31.6	23.8	0.64	71.2	9.3	47.2	1.37
Glohaven	6.7	40.1	26.7	17.9	0.57	69.8	8.5	49.8	1.40
Jerseyglo	6.5	40.6	25.9	18.3	0.61	71.6	3.9	51.6	1.50
Stark Earlirio	6.4	34.5	25.1	15.4	0.54	70.0	6.3	53.1	1.45
Newhaven	6.2	41.9	32.8	23.7	0.62	71.0	9.2	47.6	1.38
Cullinan	6.1	41.5	31.1	23.9	0.65	70.8	8.8	50.1	1.39
Sentinel	6.0	43.0	26.5	18.9	0.62	67.7	13.0	39.8	1.25
Reliance[x]	5.6	45.4	28.6	22.0	0.65	66.9	10.2	43.5	1.34
Jersey Dawn	5.0	44.9	32.8	25.4	0.65	69.1	10.1	44.1	1.34
LSD (0.05)	1.4	2.4	2.6	2.6	0.05	1.8	2.9	2.3	0.07

[z]Cultivars visually rated on a 1-10 scale (where 10 = highly attractive overall color).
[y]Commercial standards.
[x]Winter hardiness standard.

haven' and 'Garnet Beauty' and that 'Loring,' 'Cullinan,' 'Reliance,' and 'Jersey Dawn' had the least red color (Fig. 1). Based on hue angle, a number of newer peach selections have color superior to the midseason standard, 'Loring.'



Conclusions

McGuire (10) suggests that value (lightness, from black to white), chroma (saturation, from gray toward pure chromatic color) and hue (red, orange, yellow, etc.) are the aspects of color perceived by growers, buyers and consumers. In this study, many color parameters were involved in individual sensory ratings, but hue angle of the blushed fruit surface was the best single predictor of mean rating. The data are consistent with a report by Bible and Singha (1) which indicates that hue color changes during peach maturation are greater than changes in either L^* or chroma.

Based on hue angle, a number of newer cultivars had better red color than the widely grown 'Loring.' Factors in addition to color to consider in selecting cultivars for new plantings include productivity, fruit size, flavor, firmness and market window. As proposed by others (9, 10), the potential market success of a new cultivar will best be determined by multidisciplinary teams of food scientists, horticulturists and market economists.

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Influence Over a Ten-Year Period of Training System on Yield and Fruitfulness of Table Grape Cultivars

DWIGHT WOLFE[1] AND GERALD R. BROWN[2]

Abstract

Twenty Grape cultivars [*Vitis* species, (L.) Batch], planted Spring, 1983, were trained to the four-cane Kniffin (KN) and to the Geneva Double Curtain (GDC) system over a ten-year period. Yield per vine, pruning weight, number of nodes, cluster weight, berry number per cluster, berry weight, and percent fruit soluble solids were recorded annually through 1993. Across cultivars, vines trained to the GDC averaged 2 kg more yield per vine per year than vines trained to the KN. Yield per node and the number of clusters per vine also were greater for vines trained to the GDC system.

The four-cane Kniffin system is one of the most common systems for grape training in Kentucky (1). Growers use this system because cultivars with varying degrees of vigor are adapted to it. However, Shaulis *et al.* (6) reported 'Concord' vines, especially vigorous ones, trained to the GDC to be more productive than those trained to the umbrella Kniffin. An increase in vine yield using the GDC when compared to the bilateral cordon has also been reported for 'Concord' (3), and 'Niagara' (4). Shaulis and Oberle (5) have reported investigations using various training systems with 'Fredonia.' However, there are many commercial table grape cultivars for which training system studies have not been conducted. This paper reports on table grape performance and yield components in Kentucky using the KN and the GDC.

Materials and Methods

The GDC and the KN training systems, were assigned randomly to ten 60 m-long rows spaced 3.7 m apart with one training system per row. Each row was divided into four 15-m long plots with six vines per plot. Twenty table grape cultivars were assigned randomly to the twenty plots for each training system. Vines were planted 2.5 m apart within rows in June 1983. Beginning in 1986, vines were balanced pruned annually (30 buds left for the first pound of prunings plus 10 buds for each additional pound), and the weight of the prunings and the number of nodes left per vine recorded. These buds were distributed as five to six buds per fruiting spurs on vines trained

[1]Horticulture Research Specialist, [2]Extension Professor of Horticulture, Department of Horticulture, University of Kentucky, Research and Education Center, P.O. Box 469, Princeton, KY 42445.
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