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

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## 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 standards), during the second harvest picking at the firm-ripe stage (as determined by ground color change). Care was exercised to collect fruit uniformly

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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

**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 |

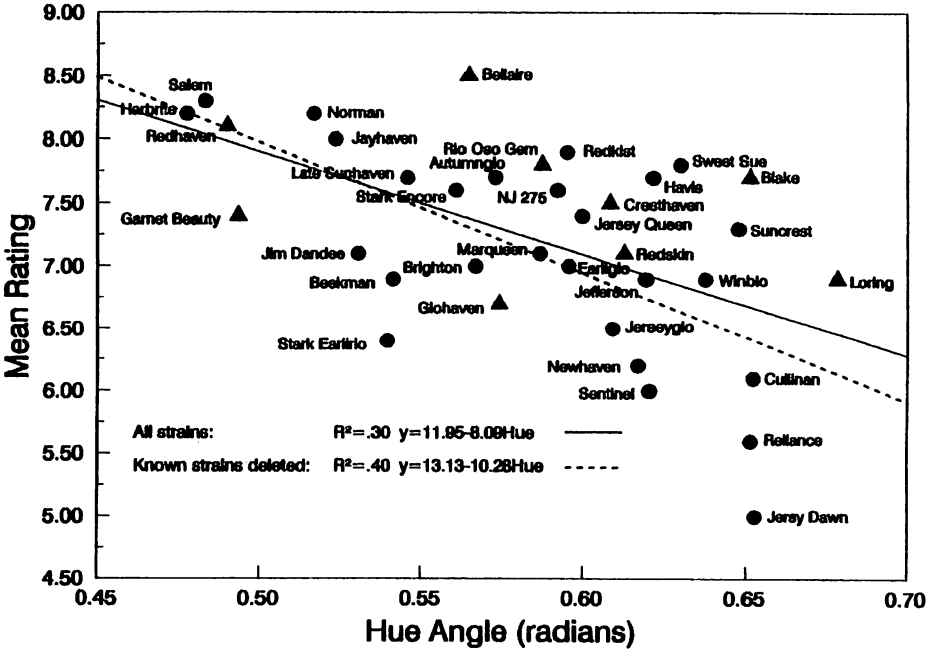
[z]Cultivars visually rated on a 1-10 scale (where 10 = highly attractive overall color).
[y]Commercial standards.
[x]Winter hardiness standard.

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,' 'Redhaven' 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.

## Literature Cited

1. Bible, B. B. and S. Singha. 1993. Canopy position influences CIELAB coordinates of peach color. Hortscience 28(10):992-993.
2. Clydesdale, F. M. 1978. Colorimetry methodology and applications. Critical Rev. in Food Sci. and Nutr. 10:243-301.
3. Crassweller, R. M., H. L. Braun, T. A. Baugher, G. M. Greene II and R. A. Hollendar. 1991. Color evaluations of 'Delicious' strains. Fruit Varieties Journal 45(2):114-120.
4. Delwiche, M. J. 1987. Grader performance using a peach ground color maturity chart. Hortscience 22(1):87-89.
5. Delwiche, M. J. and R. A. Baumgardner. 1985. Ground color as a peach maturity index. J. Amer. Soc. Hort. Sci. 110(1):53-57.
6. Delwiche, M. J. and R. A. Baumgardner. 1983. Ground color measurements of peach. J. Amer. Soc. Hort. Sci. 108:1012-1016.
7. Francis, F. J. 1980. Color quality evaluation of horticultural crops. Hortscience 15(1): 14-15.
8. Hunter, R. S. 1975. The measurement of appearance. Wiley-Interscience, New York, New York.
9. Lockshin, L. S. and W. T. Rhodus. 1991. Consumer perceptions of quality: key issues for horticultural research. Hortscience 26(7): 823-825.

10. McGuire, R. G. 1992. Reporting of objective color measurements. Hortscience 27(12): 1254-1255.
11. Meredith, F. I., J. A. Robertson and R. J. Horvat. 1989. J. Agric. Food Chem. 37:1210-1214.
12. Robertson, J. A., R. J. Horvat, B. G. Lyon, F. I. Meredith, S. D. Senter and W. R. Okie. 1990. Comparison of quality characteristics of selected yellow- and white-fleshed peach cultivars. J. Food Sci. 55(5):1308-1311.
13. Singha, S., T. A. Baugher, E. C. Townsend and M. C. D'Souza. 1991. Anthocyanin distribution in 'Delicious' apples and the relationship between anthocyanin concentration and chromaticity values. J. Amer. Soc. Hort. 116(3):497-499.
14. Singha, S., E. C. Townsend and T. A. Baugher. 1991. Relationship between visual rating and chromaticity values in 'Delicious' apple strains. Fruit Varieties Journal 45(1):33-36.

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# Southern Highbush Blueberry Clones Differ in Postharvest Fruit Quality

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## Abstract

Fruit from genotypes of southern highbush blueberries (*Vaccinium* spp.), and 'Sierra' were compared for postharvest quality. Commercially important rabbiteye (cv. Climax) and northern highbush (cv. Bluecrop) were included as standards. 'Gulfcoast,' 'Cooper' and 'Cape Fear' fruit retained 10-20% of pedicels after harvest ('stemming') while very few pedicels were retained on other cultivars. Fruit from the selection G616 were greatest in weight (2.8g) and 'Cooper' the smallest (1.7g). A109 fruit had the smallest stem scar and MS108 the largest. 'Sierra' and 'Climax' fruit had the least decay among all clones. G616 fruit were the least firm of all clones after storage. Soluble solid concentration/titratable acidity ratios were between 10 and 19 for all clones. Anthocyanin content was highest in 'Cape Fear' and lowest in MS108. Of the new southern highbush clones, 'O'Neal,' G616 and A109 cultivars were equal to or better than 'Bluecrop' or 'Climax' in postharvest quality and shelf life.

The storage life of rabbiteye (*Vaccinium ashei* Reade) and northern highbush (*Vaccinium corymbosum* L.) blueberries has been studied extensively (1, 2, 3, 5, 9, 10, 11, 17). The southern highbush blueberry (*Vaccinium* spp.) is a hybrid derived largely from *V. corymbosum* and *V. darrowi* Camp. parentage and has a low chilling requirement and earlier ripening date than rabbiteye cultivars (8). Acreage planted in southern highbush blueberries is predicted to expand greatly by the year 2000 (13).

The storage life of rabbiteye blueberry fruit is reported to be superior to that of northern highbush fruit due to less fungal decay (10). However, only a few southern highbush blueberry cultivars have been studied for fruit quality. Miller et al. (12) found that southern highbush 'Sharpblue' fruit softened more rapidly than 'Climax' rabbiteye fruit during storage. Lang and Tao (7) reported that stored southern highbush fruit from 'Gulfcoast' was of lower quality than 'Sharpblue.' Although 'Sharpblue' acreage is currently the largest in the world, this cultivar has stem scar tearing, and corolla and pedicel adhesion, making

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