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QUALITY PROFILE OF FRESH MARKET MELTING AND NONMELTING PEACH FRUIT

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Abstract. **A quality study of Florida-grown peaches (*Prunus persica* (L.) Batsch.) was conducted on fruit harvested at three maturity stages in the spring of 1994. Two cultivars of melting-flesh peaches (FL 90-20 and Tropic Beauty) and two of nonmelting-flesh peaches (Oro A and FL 86-28C) of comparable maturity dates were allowed to ripen and evaluated by a trained taste panel of 10 members. Panelists rated the fruit based on three textural aspects (hardness, rubberiness and juiciness) and six flavor aspects (sweetness, sourness, bitterness, and green, peachy and overripe character). Ripe fruit were also analyzed for soluble solids, pH and titratable acidity. A principal component analysis was conducted on the results from the sensory evaluation. When all sensory aspects were analyzed jointly, a clear distinction between the sensory nature of melting and nonmelting fruit was observed. However, when texture and flavor characters were analyzed separately, no such clear distinction was observed in regard to the flavor aspects. These results suggest that while textural aspects are critical in distinguishing melting and nonmelting fruit, the flavor profile is not distinctly demarked for both types of cultivars. Although soluble solids, pH and titratable acidity did differ among cultivars, no consistent grouping based on the melting/nonmelting nature of the fruit could be made.**

When melting-flesh peaches, which are usually grown for the fresh market, are left to ripen on the tree in order to achieve maximum quality, they show a propensity to bruising, have a short postharvest life, and develop various problems related to mechanical damage and decay when shipped (Robertson *et al.*, 1992a). Unlike melting-flesh peaches, nonmelting-flesh fruit are traditionally grown for canning purposes and remain firm during ripening, but lack the red coloration, acidity, and aroma of commonly grown dessert-type fruit. A breeding program to develop peaches with nonmelting flesh, but with fresh market organoleptic characteristics, is currently underway at the University of Florida. The goal is to develop fruit which are able to attain maximum flavor on the tree, yet maintain sufficient firmness to allow distribution under normal marketing channels (Sherman *et al.*, 1990).

The main distinction between melting and nonmelting-flesh fruit lies in the reduced capability of the latter to degrade its cell walls (Postlmayr *et al.*, 1956; Shewfelt, 1965). Water-soluble pectin, which has been shown to increase during normal ripening of melting-flesh peaches (Shewfelt *et al.*, 1971), remains low during ripening of nonmelting-flesh peaches (Shewfelt, 1965). This behavior is explained by the fact that while melting-flesh peaches have both endo- and exo-polygalacturonase, nonmelting-flesh types lack the endo-form of the enzyme (Pressey and Avants, 1978). Furthermore, it has been suggested that, while in nonmelting types transcription of the endo-polygalacturonase gene occurs normally, the small size of the RNA transcript may reflect a sequence aberration that affects translation and/or enzyme production (Lester *et al.*, 1994).

While sensory changes occurring during ripening of melting-flesh peaches have been thoroughly studied (Delwiche and Baumgardner, 1983; Chapman *et al.*, 1991; Robertson *et al.*, 1992b), nonmelting-flesh fruit intended for the fresh market have not received the same attention. In the present paper, we report the results of a study aimed to detect differences, if any, in sensory and physicochemical aspects of two peach cultivars of melting flesh (FL 90-20 and Tropic Beauty) and two of nonmelting flesh (Oro A and FL 86-28C) of comparable maturity dates.

Materials and Methods

The study was conducted on two cultivars of melting-flesh fruit (FL 90-20 and Tropic Beauty) and two of nonmelting-flesh (Oro A and FL 86-28C) obtained from the Teaching Orchard, Horticultural Sciences Dept., University of Florida, Gainesville, during the spring of 1994. In order to study a range of maturities, fruit were harvested on three dates at intervals of 10 days. On each date, only those fruit that were considered to be at a uniform maturity stage and representative of the average maturity based on their ground color were collected. For data analysis, results were averaged across the three stages of maturity for each cultivar.

After harvest, the fruit were stored at 0C for 14 days in order to simulate shipping/marketing conditions and subsequently allowed to ripen at 20C. During ripening, ethylene production was monitored, and when the ethylene peak was observed, the fruit were removed from storage and divided in two groups for sensory evaluation and chemical analysis. The group for chemical analysis consisted of 15 fruit that were stored at -20C until analyzed, when they were peeled, sliced, pitted and pureed in a Waring Blender for 1 minute. The slurry was centrifuged (20 minutes; 17,600xg; 6C) and the fluid fraction was used for the determination of soluble solids, pH, and titratable acidity. For sensory evaluation, the fruit were peeled and sliced and presented in duplicate to a panel of 10 members, with responses made on a descriptive 15-point scale. Before the actual tests, all panelists received training in two sessions, during which they became familiar with the different varieties and stages of maturity and agreed on the sensory notes and their intensities. Two types of attributes were assessed: textural aspects (hardness, rubberiness and juiciness) and flavor aspects (sweetness, sourness, bitterness, and green, peachy and overripe character).

While a consumer preference test would have easily revealed consumer preference for one type over the other, this type of evaluation requires a high number of panelists and can often render information of dubious quantitative significance. On the other hand, descriptive sensory evaluation is a

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very accurate approach, but due to the high number of variables measured (sensory notes), it requires some data manipulation in order to reduce them to a single meaningful variable that allows for comparisons between the two types of fruit (Morten *et al.*, 1991). This need is met by the multivariate procedure principal components analysis, which is able to transform a set of correlated variables into a substantially smaller set of uncorrelated variables (principal components) (Dunteman, 1989). Each principal component results from the linear combination of each one of the correlated variables affected by their loading factor. The loading factors denote the degree of correlation between each variable and a principal component. Ideally, the absolute magnitude of the loading factor should indicate the weight or importance that each variable (in our case, sensory note) had in defining the principal component; positive or negative values attached to the loading factors would in turn allow for the grouping of variables of the same nature. Since each principal component only explains part of the total variation, many principal components (actually, as many as variables in the set) can be extracted in order to explain 100% of the existing variation. However, it is usually the first few principal components that are used for data interpretation. Eigenvalues, which are indices that denote the portion of the total variance of a correlation matrix that is explained by a principal component, often provide an indication of how many principal components should be interpreted (Dunteman, 1989; Bryant and Yarnold, 1995).

Analyses of variance were conducted on the principal components and on the results of the chemical analyses.

Results and Discussion

When principal components analysis was applied to the sensory data, the first three principal components explained 64% of the total variation; the individual principal components PC1, PC2, and PC3 explained 28%, 22%, and 14% of the variation, respectively (Table 1). All three principal components had Eigenvalues greater than 1.0, which is a criteria used for their selection (Pino *et al.*, 1993).

The loading factors shown in Table 1 give an indication of the importance of each sensory note within each of the "overall" principal components. It is apparent that all of the "textural" notes, hardness, juiciness and rubberiness, had large impacts on the "overall" sensory assessment described by PC1. It is also evident that a contrast between negative and positive loading factors can be conceived, with sweetness, peach character, and overripe being opposed to the other sensory notes. It could be argued that a difference is being established between attributes associated with early stages of fruit development (hardness, sourness, green character, etc.) and those associated with more advanced phases of ripening (sweetness, peach character, and overripe).

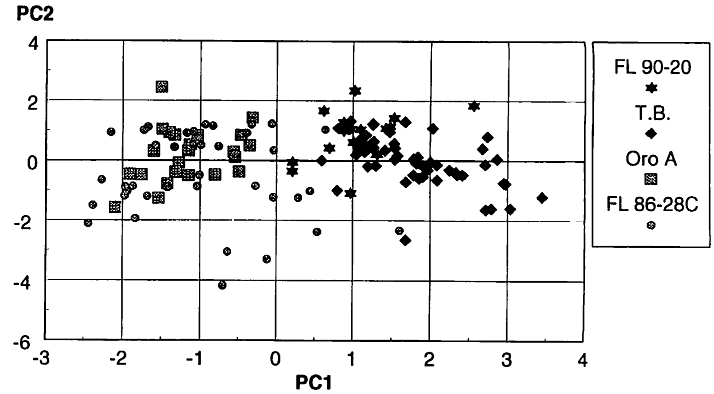

Figure 1. Plot of "Overall" PC1 vs. "Overall" PC2.

In order to obtain a graphic representation of the results, a two-dimensional scatter plot of PC1 vs. PC2 was constructed (Fig. 1). The data points are distributed in two bands along the PC1 axis, indicating that PC1 is effective at explaining total variation. The plot also reveals a clear distinction between the "overall" assessments for melting and nonmelting-flesh fruit. Similarly, mean separation for "overall" PC1 among the cultivars (Table 2) grouped the nonmelting-flesh fruit differently from the melting-flesh types. Based on the importance of the "textural" notes in PC1, separate principal components analyses were conducted for the "textural" and "flavor" notes.

In the case of the "textural" principal components, "textural" PC1 was the only principal component to show an Eigenvalue greater than 1.0, and on its own explained as much as 70% of the total variability. A plot of "textural" PC1 vs. "textural" PC2 also revealed a separation of melting and nonmelting-flesh fruit (Fig. 2).

In the case of the "flavor" principal components, the higher number of notes involved in its definition made it more difficult for a single principal component to explain the total variation; however, the cumulative proportion of the variation explained by "flavor" PC1 and "flavor" PC2, both with Eigenvalues greater than 1, was 58%. A striking aspect of the plot of "flavor" PC1 vs. "flavor" PC2 was that the results for melting and nonmelting-flesh fruit appeared intermingled in the scatter plot (Fig. 3). These results suggest that, even when panelists were able to make an overall distinction between the two types of fruit, it was the texture rather than the flavor attributes that accounted for this distinction.

Table 1. Loading factors for principal components (PC) analysis of "overall" sensory data.

Note	PC1	PC2	PC3
Hardness	0.521539	0.143715	−0.223348
Juiciness	0.482794	0.113131	−0.196886
Rubberiness	0.410792	0.017952	−0.283714
Sweetness	−0.046661	0.507920	0.186649
Sourness	0.169910	−0.076463	0.738783
Bitterness	0.133020	0.433222	0.319628
Green Char.	0.251560	0.358976	0.216818
Peach Char.	−0.204884	0.518440	−0.288902
Overripe	−0.414916	0.342156	−0.132604
% Cumulative Variance	28	50	64

Table 2. Least-squares means for sensory "overall", "textural", and "flavor" principal components 1 (PC1).

Cultivar	Overall PC1	Textural PC1	Flavor PC1
Melting flesh			
FL 90-20	0.396 b[z]	0.719 b	0.719 b
Tropic Beauty	1.924 a	1.705 a	−0.590 b
Nonmelting flesh			
Oro A	−1.147 c	−1.070 c	0.401 a
86-28 C	−0.942 c	−1.003 c	−0.211 b

[z]Mean separation in columns by pairwise t-tests at α=0.01.

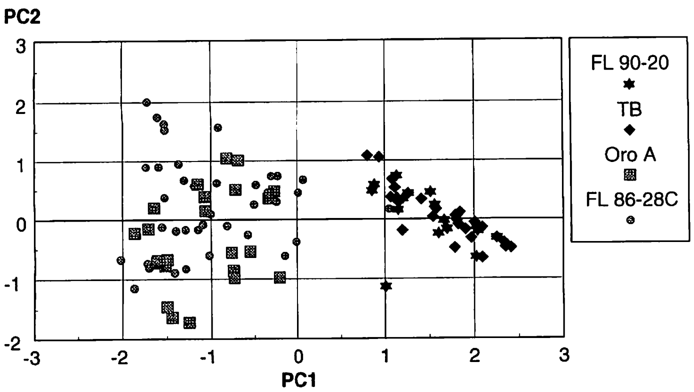

Figure 2. Plot of "Textural" PC1 vs. "Textural" PC2.

Differences in pH, titratable acidity, and soluble solids were detected in the four cultivars analyzed (Table 3), but no consistent grouping could be made based on the melting/nonmelting nature of the fruit. Although variations in the chemical attributes of the four cultivars are to be expected, it is apparent that in the "flavor" profile described by the principal components, no distinction could be made between melting and nonmelting-flesh cultivars. In actuality, the flavor is a composite of smell and taste and its characterization results from the interplay between the basic taste sensations (sweet, sour, bitter or salty) and an array of aroma volatiles (Lawless and Lee, 1993). Even within taste, a single chemical attribute is not always able to define it; for example, in many fruits it is the ratio of sugar:acids that explains the gustatory characteristics. Since the principal component is able to integrate the results of sensory evaluation, it is expected that its results will not parallel those of individual chemical properties.

Based on these results, it is concluded that the inclusion of the nonmelting-flesh trait did not compromise fruit flavor quality in the cultivars studied, thus validating the main breeding objective. The results also point to the need for conducting sensory evaluation whenever the final goal is to determine the fresh market suitability of a new species or cultivar. Finally, it was apparent that principal components analysis can be a valuable tool to integrate the results of descriptive sensory evaluation.

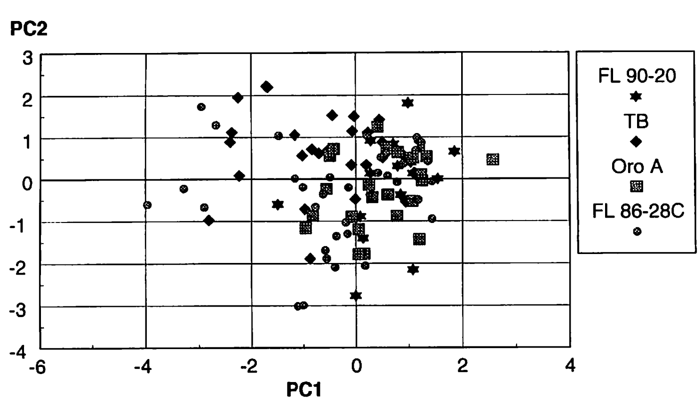

Figure 3. Plot of "Flavor" PC1 vs. "Flavor" PC2.

Table 3. Chemical attributes of ripe melting and nonmelting peaches.

Cultivar	pH	Titratable acidity (%)	Soluble solids (°Brix)
Melting flesh			
FL 90-20	3.93 ab[z]	1.50 bc	10.2 b
Tropic Beauty	3.86 ab	2.06 a	10.5 b
Nonmelting flesh			
Oro A	3.97 a	1.68 b	12.0 a
FL 86-28C	3.84 b	1.39 c	11.9 a

[z]Mean separation in columns by pairwise t-tests at α=0.01.

Literature Cited

Bryant, F. B. and P. R. Yarnold. 1995. Principal-components analysis and exploratory and confirmatory factor analysis. p. 99-137. *In:* Grimm, L. G. and P. R. Yarnold (eds.), Reading and Understanding Multivariate Statistics. American Psychological Association, Washington, D.C.

Chapman, G. W., R. J. Horvat, and W. R. Forbus, Jr. 1991. Physical and chemical changes during maturation of peaches (cv. Majestic). J. Agr. Food Chem. 39:867-870.

Delwiche, M. J. and R. A. Baumgardner. 1983. Ground color measurements of peach. J. Amer. Soc. Hort. Sci. 108:1012-1016.

Dunteman, G. H. 1989. Principal Components Analysis. Sage Publications, Newbury Park, CA. 96 pp.

Lawless, H. T. and C. B. Lee. 1993. Common chemical sense in food flavor. p. 23-57. *In:* Acree T. E. and R. Teranishi (eds.). Flavor Science: Sensible Principles and Techniques. American Chemical Society, Washington, D.C.

Lester, D. R., J. Speirs, G. Orr, and C. J. Brady. 1994. Peach (*Prunus persica*) endopolygalacturonase cDNA isolation and mRNA in melting and nonmelting peach cultivars. Pl. Physiol. 105:225-231.

Morten, M., G. V. Civille, and B. T. Carr. 1991. Sensory Evaluation Techniques. CRC Press, Inc., Boca Raton, FL. 354 pp.

Pino, J. A., R. Torricella, and L. Chang. 1993. Relationship between sensory and analytical determinations of canned single-strength grapefruit juice as determined by principal component analysis. J. Food. Qual. 17:1-8.

Postlmayr, H. L., B. S. Luh, and S. J. Leonard. 1956. Characterization of pectin changes in freestone and clingstone peaches during ripening and processing. Food Technol. 10:618-625.

Pressey, R. and J. K. Avants. 1978. Difference in polygalacturonase composition of clingstone and freestone peaches. J. Food Sci. 5:1415-1423.

Robertson, J. A., F. I. Meredith, B. G. Lyon, G. W. Chapman, and W. B. Sherman. 1992a. Ripening and cold storage changes in the quality characteristics of nonmelting clingstone peaches (FLA 90-20C). J. Food. Sci. 57:462-465.

Robertson, J. A., F. I. Meredith, W. R. Forbus, and B. G. Lyon. 1992b. Relationship of quality characteristics of peaches (cv. Loring) to maturity. J. Food Sci. 57:1401-1404.

Sherman, W. B., B. L. Topp, and P. M. Lyrene. 1990. Nonmelting flesh for fresh market peaches. Proc. Fla. State Hort. Soc. 103:293-294.

Shewfelt, R. L. 1965. Changes and variations in the pectic constitution of ripening peaches as related to product firmness. J. Food Sci. 30:573-576.

Shewfelt, R. L., V. A. Paynter, and J. J. Jen. 1971. Textural changes and molecular characteristics of pectic constituents in ripening peaches. J. Food Sci. 36:573-575.