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Sensory Evaluation of Several Scab-Resistant Apple Genotypes[1]

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Abstract

Six scab-resistant and two scab-susceptible apples (*Malus domestica* Borkh.) stored in air at 2°C for 2-3 months were evaluated by descriptive analysis for taste and texture qualities. 'Liberty' was less aromatic but juicier and more acidic than the other genotypes. Crispness was best in 'Liberty,' 'Trent,' and CBR4T29. CBR4T29 and 'Liberty' were judged firmer than others. Mealiness was less obvious in 'Liberty.' FAR-54A48 was the sweetest apple. Electron microscopy studies on the cortical tissue of the soft and firm flesh genotypes did not reveal any differences in cell structure. The eight genotypes could be classified into three groups by similarity coefficients, A) 'Liberty,' 'Trent,' FAR-54A48 and CBR4T29, B) 74-50-13, 'MacSpur McIntosh' and 'Spartan,' C) 75-03-06.

Introduction

Scab is a serious problem in many apple-growing areas and the recent release of several scab-resistant genotypes (2) offers an alternative to the grower. Whether any of these genotypes become commercially acceptable will ultimately depend upon consumer acceptance and grower return. They also partially meet a current awareness for residue-free fruit (1, 13) because they require fewer sprays of fungicides. Insect control, however, is not different from that for scab-susceptible varieties. The purpose of this study was to determine how aroma, flavor and texture in several scab-resistant genotypes compared to those in scab-susceptible varieties. Favorable results would be the first step towards commercial introduction of the scab-resistant genotypes.

Materials and Methods

Apple genotypes. As only the mother tree was available for the St-Jean crosses, it was decided that single trees be used for the other-scab-resistant genotypes and scab-susceptible cultivars. All trees were into their 7th to 9th leaf and considered full bearing. Harvest dates were Sept. 6 for FAR54A48, Sept. 12 for 'McIntosh' and 'Spartan,' Sept. 19 for 75-03-06 and 74-50-13, Sept. 20 'Liberty,' Sept. 28 for CBR4T29, and Oct. 2 for 'Trent.' Maturity for the scab-resistant genotypes was determined by the starch and firmness values for 'McIntosh.'

Genotype description.

74-50-13, a 'McIntosh' x Co-op-11 cross is a late season scab-resistant apple, resembles 'Cortland' in appearance and taste, and has a storage period comparable to 'Cortland' (6). 75-03-06 was developed at Agriculture Canada,

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St-Jean-sur-Richelieu from a cross of 'McIntosh' x 'Trent.' Maturation and eating quality are comparable to 'McIntosh.' It is resistant to scab and stores as well as 'McIntosh' (6). FAR54A48, a St-Jean scab-resistant selection of 'Ott-525' x 'Blair,' has a dominant red color. Eating quality and firmness at harvest and after storage are similar to 'McIntosh' (6). CBR4T29, an Indiana selection of 'Graham' x '597NJ1,' is an attractive red apple, slightly oblate in shape and harvested shortly after 'McIntosh.' It stores longer than 'McIntosh' and overall eating quality improves with storage (6).

'Liberty,' a New York scab resistant cultivar of 'Macoun' x 'PRI54-12' is an attractive red apple of medium size. It is picked later and stores longer than 'McIntosh' (7).

'Trent,' an Ontario scab-resistant cultivar of 'MacSpur McIntosh' x 'R18T40' ['Jonathan'(x 'Rome Beauty' x *M. Floribunda* 821 sib.)], is a good eating apple, and is harvested about two weeks later than 'McIntosh.' Storage potential is good and fruit size is comparable to 'McIntosh.'

'MacSpur McIntosh' is picked between the 12th and 18th of September, the harvest period for 'McIntosh' in Quebec. It is a good quality red apple, highly susceptible to apple scab and keeps fairly well in cold storage (9).

'Spartan' is picked during 'McIntosh' season in Quebec. It is a good quality solid red apple at harvest, stores as well as 'McIntosh' but is susceptible to apple scab (5).

Resistance to *V. inaequalis* is believed to have originated from *M. floribunda* as it is a parent in all of the above scab-resistant genotypes.

Apple sampling and preparation. Samples of 50 fruits were picked for each genotype or cultivar and stored for 60 to 80 days (determined by harvest date) in air at 2°C and 85% relative humidity. Specific gravity was determined on the fruit in each sample and only those within 10% of the mean value were selected for the sensory evaluation. The selected fruit was then conditioned for 24 h at 20°C. Three to six cylindrical samples of flesh were taken from each apple with a 15 mm cork borer as described by Lapsley (10). These were immersed for 30 seconds in a 1% NaCl solution to prevent oxidative browning, rinsed and then distributed to the taste panel.

Sensory evaluation procedure. The taste panel consisted of 19 judges; 10 apple growers, two wine tasters, two pomologists and five food technologists. All had attended a training session in which aroma, sweetness, acidity, astringency, bitterness, firmness, juiciness, crispness and mealiness were identified and quantitated. The seven point scale flavor profile technique of Caul *et al.* (3) has 7 as the highest possible score and 1 as the lowest score for the sensory attributes. Panelists judged all samples on three occasions, Nov. 27, Nov. 30 and Dec. 4, 1989. A new set of apples was selected for each sampling date and panelists evaluated all genotypes and cultivars on each occasion. Samples were coded and randomized on each date.

Electron microscopy. Scanning electron microscopy (SEM) was done on parenchyma tissue (3 to 5 mm cubes) from the equatorial region of the flesh outside the core line for each of the 8 genotypes. Samples were fixed in 4% gluterraldehyde solution, dehydrated in ethanol, sputter coated (69 nm gold) and viewed in a Manolab LE 2100.

Data processing and analysis. Data were analyzed by the Statistical Analysis System (12). A one-way analysis of variance by rank was used to test the consistency of each panelist before genotype and cultivar evaluation. A similarity coefficient (SC) program was used for genotype categorization and data summaries. The Friedman test, a two-way analysis of variance by rank, was employed to test the 8 genotypes for identical population medians taking into account panel vari-

ability. The multiple comparison of total ranks was done using $\alpha = 0.15$ as the experiment wise error rate as a conservative approach.

Results and Discussion

Sensory evaluation by the panel was fairly consistent except for four judges who were differed in their responses (Figure 1A). Even though training was provided, a product x preference interaction was present and considered in the statistical evaluation of the data. Similarity coefficients (SC) were calculated for overall characteristics for each genotype. The sum of the similarity coefficient overall characteristics was plotted against genotypes and the eight genotypes could be classified into three groups of similarity: 'Liberty,' 'Trent,' FAR54A48 and CBR4T29; 74-50-13, 'MacSpur McIntosh' and 'Spartan'; 75-03-06 (Figure 1B). A similar procedure identified outlying judges

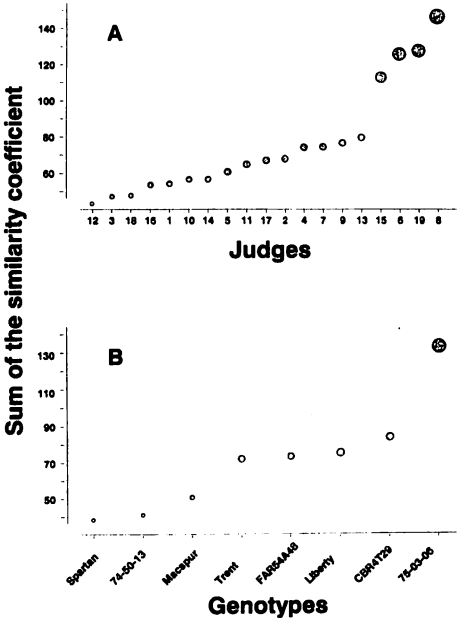

Figure 1. Classification of judges (A) and apple genotypes (B) based on the sum of similarity coefficient, size of the circles is relative to the sum of similarity coefficient.

(Figure 1A) and these were considered before running the Freidman test.

Aroma was best in 'Liberty,' CBR4T29 and 75-03-06 and lowest 'Trent' (Table 1). Sweetness was highest in FAR54A48. Acidity was more pronounced in 'Trent' and less pronounced in CBR4T29 and 75-03-06 than in the other genotypes. Astringency and bitterness were more evident in 74-50-13, 'Trent' and 'Liberty' than in the other genotypes. Firmness was high in CBR4T29 and low in 75-03-06. Juiciness was excellent in 'Trent' and poor in 75-03-06. CBR4T29, 'Liberty' and 'Trent' rated high for crispness and 75-03-06 was soft and mealy.

Rapillard (11) rated 'Liberty' better for flavour and texture than 'Priam' and 'Florina,' two scab resistant genotypes from France. Lamb (18) ranked 'Liberty' above 'Florina' and 'McIntosh,' but slightly below 'Empire.' Berkett and Cooley (2), however, ranked 'Liberty' above 'Empire.' 'Liberty' also received favorable scores in a study by Couley *et al.* (4).

An attempt to generate overall acceptability scores (OAS) for the genotypes was achieved by the following equation:

OAS = (Aroma + Sweetness + Acidity + Firmness + Juiciness + Crispness) - (Astringency + Bitterness + Mealiness)

Attributes that contributed to quality were placed in the first group and attributes considered detrimental to quality were placed in the second group. The difference between these 2 groups from values found in Table 1 constituted the OAS value score for each genotype. 'Liberty' and CBR4T29 received the highest values and 75-03-06 received the lowest value. All genotypes except 75-03-06 compared favorably to either 'McIntosh' or 'Spartan' (Table 1), cultivars grown commercially in Quebec.

There were no obvious differences (Figure 2) in the parenchyma cells of

Table 1. Cumulative scores for flavor and texture attributes of six scab-resistant and two scab-susceptible apple genotypes.[z]

	Flavor attributes					Texture attributes				
Genotype	Aroma	Sweetness	Acidity	Astringency	Bitterness	Firmness	Juiciness	Crispness	Mealiness	Diff.[y]
'Liberty'	100	70	138	107	111	114	131	127	57	404
'CBR4T29'	115	82	40	99	82	142	88	134	57	363
'Trent'	49	77	105	116	105	127	71	127	56	280
FAR54A48	79	119	68	65	67	41	93	43	110	200
74-50-13	77	65	108	112	105	101	74	87	102	192
75-03-06	107	82	43	43	55	22	46	26	138	90
'Spartan'	84	96	92	79	92	86	83	88	68	288
'MacSpur McIntosh'	76	94	92	64	69	54	99	55	98	237
Chi-square	27°°	18°	69°°	43°°	27°°	115°°	37°°	106°°	58°°	
Critical Range[x]	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	

[z]Each value is the total rank of at least 40 determinations.
[y]Calculated using Eq. 1.
[x]Critical range for multiple comparison within columns following the Friedman's analysis of variance by ranks at $\alpha = 0.15$ experiment wise error rate.
°, °°, ns, significant at $p = 0.05$ and $P = 0.01$ or not significant, respectively.

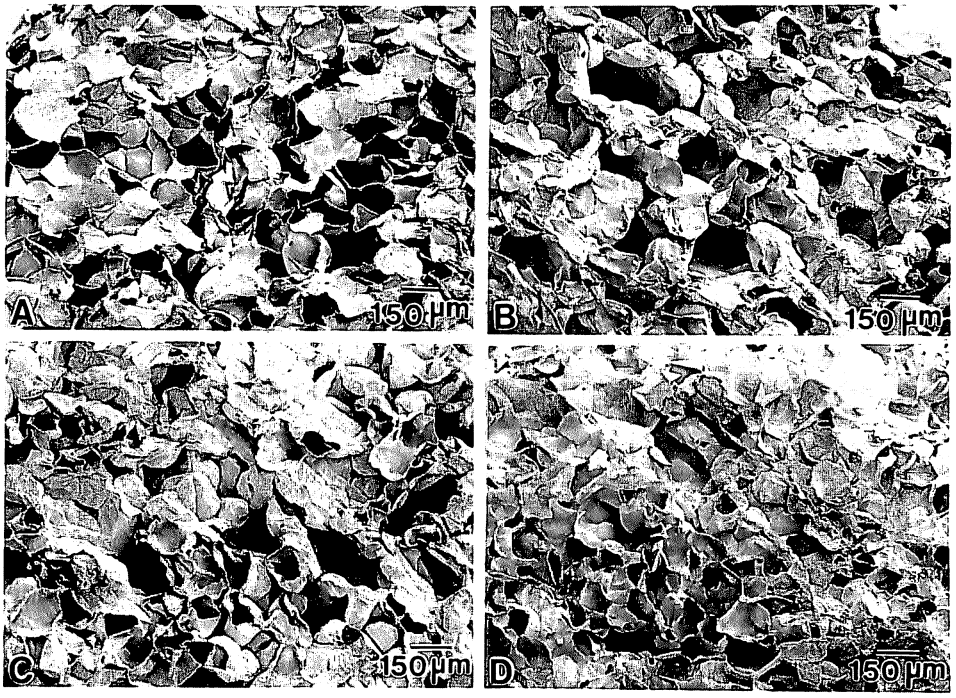

Figure 2. Scanning electron microscopic micrographs of (A) 'Liberty,' (B) CBR4T29, (C) 'MacSpur McIntosh' and (D) 75-03-06.

'Liberty' and CBR4T29 (firm apples) and that of 'MacSpur McIntosh' or 75-03-06 (soft apples). 'Liberty' was deemed coarse by Lamb *et al.* (11) but this was not evident in the present study (Figure 2).

In summary 'Liberty' and CBR4T29, two scab-resistant apples, were rated higher for overall quality than the two scab-susceptible varieties, 'MacSpur McIntosh' and 'Spartan.' 'Trent' and FAR54A48 also rated well with the 2 commercial cultivars (Table 1).

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Evaluation of Selected Almond [*Prunus dulcis* (Miller) D. A. Webb] Germplasm for Several Shell and Kernel Characteristics

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Abstract

Nine almond selections from a previous breeding program were compared with 'Nonpareil' for their potential usefulness. In-shell kernel weights, kernel percentage, percent doubles, amount of worm damage and kernel color were measured. All nine selections had significantly less worm damaged kernels than 'Nonpareil.' Variability was also present for in-shell and kernel weights, kernel percentage and kernel color. Other production characteristics including cross compatibility with 'Nonpareil' are also discussed.

Introduction

California almond growers have produced a majority of the world almond supply each year since 1979 (1). Over 170,000 H are currently planted in California with 1990 gross sales receipts totaling over $650 million. More than 40 cultivars are planted, but only a few predominate the total acreage. 'Nonpareil' is the cultivar of choice for growers, processors and

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