

Taste Ratings of New Apple Cultivars

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Abstract

Panels of volunteers tasted apple cultivars on 16 dates in 1988, 1989, and 1990. Fruit were from trees on either M.26 or M.7 rootstocks planted in 1985-1987 and trained to the central axis method in a research plot at Corvallis, Oregon. Three or four samples of 10 fruit per cultivar were harvested at weekly intervals and kept in cold storage at about 1°C until two days before tastings. Only fruit from the best-tasting samples were rated. Mean taste ratings for 'Fuji,' 'Braeburn,' 'Melrose,' 'Elstar,' 'Gala,' 'Liberty,' 'Spartan,' 'Empire,' and some others were significantly higher than for 'Delicious' on most dates. Ratings for 'Jonagold,' 'Brock,' 'Mutsu,' 'Golden Supreme,' 'Elstar,' and some others were only occasionally higher than ratings for 'Golden Delicious.'

Introduction

Successful marketing of 'Granny Smith,' 'Gala,' and 'Braeburn' in the U.S. has stimulated grower interest in new cultivars. It is difficult to imagine an apple more beautiful than the high-colored strains of 'Delicious'; yet, these new cultivars are selling at substantially higher prices than 'Delicious.' One must conclude that they are succeeding on the merits of their flavor rather than on looks.

Since the taste evaluations of Janson (6) in 1972, little has been published in North America on taste ratings of apples. Few modern cultivars were included in his long list, which were divided into six groupings according to flavor. Although no details of the rating procedure were given, it appears that they may have been the product of but a single taster. A recent comparison of taste, by panels of 24 to 32 individuals, between 'Gala' and 'McIntosh' apples showed a clear preference for 'Gala' (2). Numerous reports have indicated that many new apple cultivars have high dessert qualities.

According to sensory evaluation by 271 participants using a 9-point hedonic scale (1), among strains of 'Delicious,' 'Starking,' 'Topred,' 'Oregon Spur,' 'Nured Royal,' and 'Silver Spur' were reported to have greater overall quality and acceptance than 'Ace,' 'Starkspur Supreme,' 'Starkrimson,' and 'Starkspur Ultrared.' Taste panels have been used frequently to evaluate apple cultivars in Holland and Germany (3, 4, 5, 8, 9). Taste panels have been found to detect quality deterioration connected with defective handling, harvesting, and storage (9) as well as the relative acceptability of cultivars (8). The purpose of this study was to determine differences between apple cultivars in overall acceptability by taste panels.

Materials and Methods

Fruit, used for evaluations of taste, was produced in a cultivar collection at Corvallis, Oregon in 1988 and 1989. Most of the trees were planted in 1985, and were cropping heavily in 1988, and less heavily in 1989. In most cases, fruit from trees on both M.26 and M.7 were used. Although the trees were thinned by hand within 45 days of full bloom, some cropped too heavily in 1988 and failed to bloom in 1989. All trees were trained to the central axis system (7), with minimal pruning. About 56 kg per hectare of nitrogen was applied, and trees received daily trickle irrigation. Glyphosate and simazine were used for weed control.

Commercial cultivars such as 'Ace Delicious,' 'New Spur Red Delicious,' 'Golden Delicious,' 'Newtown,' and 'Gravenstein' were grown in the plot as controls. In 1989, 'Starking Deli-

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cious' fruits from 35-year-old trees on M.9 roots were substituted as controls due to alternate bearing of 'Ace' and 'New Spur Red Delicious' trees in the plot.

In 1988, July, August, and September were unusually warm months. The highest temperatures exceeded 32°C on 19 days and 38°C on 5 days. Many exposed fruit were sunburned. In 1989, June and Sept. were warmer than usual, but July and Aug. temperatures were cool. Fruit coloration was noticeably poorer as a result of September temperatures which were the 7th warmest in 100 years. There was less sunburn than in 1988. In 1989, the warm June weather seemed to have advanced maturity of the early cultivars by about one week, but those which matured after mid-September appeared to be only slightly ahead of 1987 and 1988.

Two fruit samples, which consisted of 10 fruits taken from various parts of the trees on M.26 and M.7 rootstocks, were harvested on each of three or more sampling dates one week apart. They were placed in perforated plastic bags. One sample was tested immediately for soluble solids, starch-iodine rating, and organoleptic ratings of flavor and texture. The other was placed in cold storage at about 1°C. A small room which afforded only poor temperature control (2°C ± 1°) was used in 1988. A larger room with more constant temperature control (1°C) was used for the 1989 crop. Samples were removed from storage about 48 hours before taste ratings were begun and kept at 20°C.

The same three tasters, A. Duncan, D. Duncan, and O. C. Compton, selected the best and second best-tasting samples from the various picking dates and rootstocks, and used only these samples for the panel ratings. Samples were assigned random code numbers and arranged on a table in random order in a dimly-lit hallway.

Participants for the taste panels were recruited for each date from the students, professors, staff, and others in the large building which houses Horticulture as well as other departments.

Panelists were given a ballot with 8 to 11 code numbers and asked to rate fresh slices of the apples on a 9-point hedonic scale with 1 = dislike extremely to 9 = like extremely, similar to the method used by Crassweller et al. (1). One panel was conducted in Yakima, Washington, on 3 Dec. 1988, at a meeting of fruit variety testers.

In 1989, data were subject to analysis of variance, using ballots as replications, and the mean separation was by the Waller Duncan k-ratio t-test, k-ratio = 100.

Results and Discussion

Sunburn ratings for those cultivars which had large amounts of sunburn in 1988 are shown in Table 1. In addition to sunburn, fruits of 'King' and 'Cox's Orange Pippin' had watercore

Table 1. Percent of apples with sunburn, 1988.

Cultivar	Rootstock	Sunburn rating ²		Percent of crop
		Slight	Severe	
Akane	M-26	14	3	18
Akane	M-7	4	2	6
Jonee	M-7	4	3	7
Royal Gala	M-7	9	5	13
King	M-26	22	17	39
Gala	M-26	9	9	17
Jonagold	M-26	21	6	27
Cox's	M-26	27	20	47
Cox's	M-7	27	9	36
Cortland	M-7	19	1	21
Cortland	M-26	23	9	32
Golden Delicious	M-7	23	1	24
Ozark Gold	M-7	31	4	35
NW Greening	M-7	16	6	22

²—Slight = faded, yellowed spot but not brown.

Severe = brown spot on side exposed to sun.

at harvest and subsequent storage breakdown. The hot weather may also have adversely affected the storage quality of other cultivars which did not show as much sunburn. Many of the cultivars tested might receive higher ratings when grown in a cooler climate.

Among the summer apples, there was no significant difference in ratings between the best-tasting 7 cultivars, but 'State Fair,' 'Red Melba,' and 'Viking' were rated lower than the best 6 cultivars (Table 2a). Since our control cultivar, 'Gravenstein,' has a reputation as a high-quality summer apple in Oregon, it is surprising that so many early cultivars equaled it. Because the tartness of 'Gravenstein' is not matched by any of the others, it seems likely that texture influenced ratings more than did a perception of tartness or sweetness. 'Summerred' was also ranked high in the taste tests and in similar tests in Holland (4).

In a group of cultivars which share 'Golden Delicious' as a parent (Table 2b), only 'Mutsu' was rated higher than the 'Golden Delicious' control. Differences between the group of cultivars from 'Golden Supreme' to 'Jonagold' were slight. 'Starking Delicious' was rated below all the others.

'Belle de Boskoop' and 'Esopus Spitzenberg' ranked highest in a group of "rustic" cultivars evaluated on 29 Nov. 1989 (Table 2c). However, when stored until 14 Jan., 'Boskoop' from the 1988 crop was ranked higher than 'Golden Delicious,' but lower than 'Elstar' (data not shown). 'Belle de Boskoop' had a high soluble solids content, 15.8%, in 1988 (data not shown), but tasted quite tart at harvest.

Among the scab-immune cultivars, selection number OSU 31-19 ranked highest, with PRW11 T28 second highest (Table 2d).

On 13 Dec., 'Marshall McIntosh,' 'Jonamac,' and 'Morspur McIntosh' ranked lower than 'Redgold,' 'Macoun,'

'Spartan,' 'Liberty,' 'Keepsake,' 'Empire,' and 'Cortland' (Table 2e). There was no difference between 'Liberty' and 'Empire.' 'Morespur McIntosh' ranked higher on 7 Feb. 1989 and 11 Jan. 1990 than it did on 13 Dec. 1989 (Table 3). On 9 Jan., 'Golden Supreme' and 'Golden Delicious' were ranked well below 'Jonagold' (Table 2f). As seen in Table 3, relative ratings for 'Jonagold,' 'Brock,' 'Mutsu,' 'Golden Supreme,' and 'Golden Delicious' tended to change from one testing date to another. The high score for 'Mutsu' (Table 2b) was unusual in our tests.

Another group of cultivars, many with 'Golden Delicious' parentage, was rated on 9 Jan. 1990 (Table 2f). The best-tasting group included 'Coromandel Red,' 'Jonagold,' and 'Spigold.' These plus 'Arlet,' 'Golden Supreme,' and 'Newgold' were rated higher than 'Golden Delicious,' while 'Elstar' ranked equal to 'Golden Delicious.' Of the six dates on which 'Golden Delicious' was rated, the rating on 9 Jan. 1990 was lowest (Table 3). Early ratings for 'Golden Delicious' are usually much higher than later ones. Interestingly, the 9 Jan. rating was the highest rating 'Jonagold' received.

Six numbered selections from breeding programs and four named cultivars were compared on 11 Jan. 1990 (Table 2g). The best-tasting group included NJ55, #29, NJ100, 'Red Fuji,' and NY 428. The lowest rated group included NJ56, 'Jonamac,' and 'Marshall McIntosh' ranked nearly the same as on 13 Dec. 1989 (Table 2e).

A group of late-maturing cultivars was rated on 21 Feb. 1990 (Table 2h). 'Fuji' ranked higher than the rest, followed by 'Toko,' 'Mutsu,' 'Braeburn,' 'Melrose,' and 'Starking Delicious.' 'Shamrock' and 'Idared' were ranked lowest. The rating of 5.4 was the highest recorded for a strain of 'Delicious,' agreeing with the results of Crassweller et al. (1). 'Toko' had a mean rating of 6.9 in 1988 (data not shown).

Table 2a. Ratings of summer apples on 23 Aug. 1989.

Cultivar	Score ^a	Date Picked	
		Best	Second
Summerred	a		
Gravenstein	a		
Stark Summer Treat	a		
Paulared	a		
Redfree	a		
Earligold	a		
Jerseymac	ab		
State Fair	bc		
Red Melba	c	8-9	
Viking	c	8-9	

Table 2b. Ratings on 15 Nov. 1989.

Mutsu	7.6 a	9-25	10-2
Golden Supreme	6.0 b	9-25	
Elstar	5.9 bc	9-4	
Red Jonagold	5.8 bcd	9-4	
Golden Delicious	5.7 bcd	9-25	10-9
Stark Gala	5.6 bcd	9-11	9-4
Nicobel Jonagold	5.4 cd	9-18	9-11
Royal Gala	5.2 d	9-11	9-4
Brock	5.2 d	9-25	10-2
Jonagold	5.2 d	9-4	9-18
Starking Delicious	4.1 e	10-9	10-2

Table 2c. Ratings on 29 Nov. 1989.

Belle de Boskoop	6.6 a	9-25	10-2
E. Spitzenberg	6.0 ab	9-25	10-2
Kent	5.7 bc	9-18	9-25
Holstein	5.5 bcd	9-18	9-11
Suntan	5.1 cd		
Jonee	5.0 d	9-25	
Lord Lambourne	4.8 e	9-11	9-4
Cox's O.P.	4.5 e	9-4	9-11
Watts	4.4 e		
Stearns	4.2 e	9-11	9-18

Table 2d. Ratings on 6 Dec. 1989.

OSU 31-19	7.3 a	9-25	9-11
PRW11 T28	6.0 a	9-4/26	9-4/7
Sir Prize	5.1 b	9-18/26	9-18/7
Liberty	5.0 bc	9-18	9-25
McShay	4.8 bcd	9-4	9-11
Jonafree	4.8 bcd	9-18	9-11
Nova Easy Gro	4.6 bcd	9-11/7	9-11/26
PAR12 T101	4.5 cd	9-4	9-25
Freedom	4.3 de	9-25	9-18
Priscilla	4.1 e	9-11/26	9-11/7

Table 2e. Ratings on 13 Dec. 1989.

Cultivar	Score ^z	Date Picked	
		Best	Second
Redgold	6.2 a		
Macoun	6.0 ab		
Spartan	5.8 abc		
Liberty	5.7 abcd		
Keepsake	5.6 bcd		
Empire	5.5 cd		10-2
Cortland	5.2 d		9-4
Marshall McIntosh	4.6 e		9-4
Jonamac	4.4 ef		9-11
Morspur McIntosh	4.0 f		9-12

Table 2f. Ratings on 9 Jan. 1990.

Coromandel Red	6.8 a	9-25	9-18
Jonagold	6.5 a	9-4	9-18
Spigold	6.5 a	9-18	
Arlet	5.4 b	9-25	
Golden Supreme	5.3 b	9-18	9-25
Newgold	5.2 bc	9-11	9-18
Parkdale Beauty	4.7 cd	9-18	9-25
Criterion	4.6 d	9-25	9-18
Golden Delicious	4.5 d	10-9	10-2
Elstar	4.3 e	9-18	9-25
Hawaii	3.9 e	9-25	9-18

Table 2g. Ratings on 11 Jan. 1990.

NJ 55	6.3 a	9-18	9-11
# 29	6.2 ab	9-11	9-4
NJ 100	5.9 ab	9-4	
Red Fuji	5.9 ab	10-2	9-25
NY 428	5.8 b	9-11	9-4
MS McIntosh	5.2 c	8-28	9-11
NY 543	5.1 c	9-11	
NJ 56	4.4 d	9-11	9-4
Jonamac	4.0 de	9-4	8-28
Marshall McIntosh	3.9 e	9-4	9-18

Table 2h. Ratings on 21 Feb. 1990.

Fuji	7.2 a	10-2	10-9
Toko	6.2 b	9-25	9-18
Mutsu	6.1 bc	9-18	
Braeburn	6.0 bc	10-2	9-25
Melrose	5.7 cd	9-25	9-18
Starking	5.4 d	10-9	
# 34	4.8 e	9-18	9-11
Sekaiichi	4.8 e	9-25	10-2
Shamrock	4.0 f	9-18	9-18
Idared	3.9 f	9-18	9-25

Table 2i. Ratings on 28 Feb. 1990.

Cultivar	Score ^z	Date Picked	
		Best	Second
Braeburn	a	.2	
Red Fuji	ab	.23	10-9
Newtown	bc	.2	10-9
Idared	bc	.2	9-25
Granny Smith	c	.16	10-23
Earlee Grannee	c	.23	10-9
Granspur	c	.16	10-2
Shamrock	d	.1	9-11

^zMeans separation by Waller Duncan k-ratio t-test, k-ratio = 100.

Five green cultivars were rated with four late red cultivars on 28 Feb. 1990 (Table 2i). 'Braeburn' ranked higher than all others except 'Fuji.' 'Shamrock' rated lower than the others.

'Jonagold' was rated equal to or lower than 'Golden Delicious' by three of four taste panels (Table 3). The picking date for 'Jonagold' for the 9 Jan. 1990 panel, 4 Sept. 1989, was three weeks to a month before the normal picking time in Holland and Belgium. A sample picked on 18 Sept. 1989, which is closer to the normal commercial harvest time, was rated second by the three tasters who selected the samples for the panels. Commercial orchardists normally apply three or more calcium sprays to 'Jonagold' to increase storage life. These sprays may delay maturity. It seems likely that our 'Jonagolds' would be rated higher than 'Golden Delicious' if they were sprayed with calcium and picked on a later date, after they had more red color and higher sugar content.

Taste panel ratings for 'Brock,' 'Golden Supreme,' and 'Mutsu' declined between early and late removal from storage (Table 3). All three did surpass 'Golden Delicious' in one taste panel. In the fall marketing period these cultivars may equal 'Fuji' and 'Braeburn' in taste, and surpass 'Golden Delicious.'

Among the named scab-immune cultivars, 'Liberty' was rated with 'Empire,' and higher than 'Delicious' (Tables 2d and 3). The ratings received by

OSU 31-19 and PRW11 T28 also were high (Tables 2d and 3).

The relatively low rating of 'McIntosh' strains agrees with the findings of Autio and Greene (2). Some cultivars with 'McIntosh' parentage, 'Macoun,' 'Spartan,' 'Liberty,' and 'Empire' were rated higher than 'McIntosh,' (Tables 2e, 3). In general, 'McIntosh' was rated about as low as 'Delicious,' (Table 3). It has been said that high quality 'McIntosh' can only be grown in a cool climate. Probably most summers in the Willamette Valley of Oregon are too hot for 'McIntosh.'

The highest rated cultivars, 'Braeburn' and 'Fuji,' consistently received ratings between 6.0 and 7.2 (Table 3). Many cultivars received ratings similar to 'Melrose,' which were higher than 'Delicious' and 'McIntosh,' but lower than 'Braeburn' and 'Fuji' (Table 3). This result suggests that a "high control," which would be the normally highest-rated cultivars, should be included in future taste panels. Being rated superior to 'Delicious' and 'McIntosh' should not be enough reason to recommend a cultivar unless it is also at least sometimes equal to the highest rated cultivars.

The low rating of 'Shamrock' in taste panels conducted in February are not completely fair to this cultivar because it was introduced as one to be sold before 'Granny Smith' (Table 3). The consistent ratings for the three strains of 'Granny Smith' and 'Newtown' are encouraging because they

Table 3. Taste ratings for cultivars on various dates for the 1988 crop and 1989 crop, respectively.

Cultivar	Date of Test					
	1988				1989	
	9 Nov	3 Dec	24 Jan	8 Feb	15 Nov	9 Jan
Jonagold						
Brock	6.8					
Mutsu				4.8		
Golden Supreme				6.2		5.3
Golden Delicious	6.1	6.1	4.7	5.2		4.5
	1 Dec	26 Jan	7 Feb		13 Dec	11 Jan
Liberty		5.3				
Spartan	5.9			4.7		
Empire	4.6					
Cortland				5.0		
Morspur McIntosh				5.0		5.2
Ace or N.S.R. Delicious	5.0	3.4	3.8			
	9 Nov	3 Dec	26 Jan		21 Feb	28 Feb
Fuji						
Braeburn						
Melrose	5.6					
Delicious	3.8**	5.0**				
	1 Dec		4 Feb		21 Feb	28 Feb
Newtown						
Granny Smith						
Earlee Grannee						
Granspur						
Idared		4.5			3.9	
Shamrock			3.5		4.0	

*This sample was probably immature.

**Ace or N.S.R. Delicious.

***Starking Delicious.

illustrate the consistency of taste panels when given cultivars which are nearly the same.

We have conducted taste panels on 16 dates in two seasons. For the 1989 crop, 491 individual ballots were completed with 4,938 individual tastes. The sources of variability, i.e. between fruits, between tasters, between samples from the same trees, and crop loading effects, are serious. Nevertheless, it appears that the use of large numbers of tasters and repeated evaluations has generated a pattern which is, for the most part, reasonably con-

sistent. The use of a single location, clonal roots, and a consistent production system has helped to reduce variability. Variability from fruit to fruit on the same trees can be reduced by picking them from a more prescribed location on the trees. Larger future crops should permit this. More tasters evaluating more fruits of a given kind could further reduce the effect of fruit-fruit variability.

Thus far, we have removed about 26 cultivars from the trial, but added more so that it now contains about 150. All cultivars which rank low in

three or more taste panels, such as 'Shamrock,' will be removed, unless, like 'Delicious,' they are needed as controls. Cultivars which consistently rank high, such as 'Fuji' and 'Braeburn,' will be recommended to growers. More testing is needed to reach conclusions about the large number of cultivars which only occasionally rank high. It is important to learn the conditions under which these cultivars perform well.

Apple taste tests in Germany (8) showed that preference for each cultivar varied between seasons. Also, in some seasons cultivars were rated higher in the autumn, but in other seasons the same cultivars were preferred in the spring. We have seen this result most notably with 'Jonagold,' 'Brock,' and 'Mutsu' (Table 3). In Holland (3), well-colored fruits of 'Jonagold' tasted better than poorly-colored fruits, with differential effect of picking and assessment dates being slight. It seems likely that temperatures in 1988 and possibly also in 1989 were

too high for development of good quality 'Jonagold' at Corvallis. Fruits in our samples had little red color.

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"Enie, Menie, Miney, Moe"

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In 1947, the Agriculture Canada research station in Ottawa had several pear selections that looked promising. The decision about which clone to name was apparently quite daunting, and so a children's game was employed to decide between the four finalists. In the end, researchers either must not have remembered, or (as is often the case with the youngsters in my family) could not agree on the last verse of the poem, and so all four clones were named. The four cultivars are enumerated in the title of this short essay.

'Menie' was derived from the cross

'Kurskaya' x 'Flemish Beauty,' and the other three have the pedigree 'Zuckerbirne' x 'Clapp Favorite.' These cultivars were released for home garden use in eastern Ontario and Quebec and in general were cold hardy and reasonably resistant to fireblight. 'Menie' and 'Moe' are represented in the USDA National Clonal Germplasm Repository pear collection. The repository is looking for scions of 'Enie' and 'Miney' to complete this quartet.

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