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EVALUATION OF INDICES FOR FLORIDA AVOCADO MATURITY

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Maturity standards for the shipment of Florida avocados are based on minimum fruit weights and diameters, and earliest picking dates for each variety. Members of the Florida avocado industry are interested in evaluating other maturity indices for the purpose of refining present standards; such evaluation was the objective of this investigation.

The study included the evaluation of specific gravity and flesh color of the fruit, days required for fruit to soften and loss of weight during the softening period. Observations were also made on corking of the lenticels and seed-coat color.

MATERIALS AND METHODS

During the 1958-59 season, Pollock, Waldin, Booth 8, Lula, Taylor and Booth 1 varieties were studied. All fruit was from Dade County except the Taylor variety which was from Dade, Palm Beach and Highlands Counties.

The first samples of each variety were picked 4 weeks before the earliest picking date listed in the avocado shipping dates for the 1958-59 season (1). Samples were picked and analyzed biweekly until the date that size restrictions were removed. The testing period was 12 weeks for all varieties except Taylor, for which the period was 10 weeks. Samples were picked from 3 trees in each of 3 groves at each sampling date. Fruits were picked from the same trees throughout the sampling period. Fruits ranging from smallest to the largest size were selected in order to determine expected fruit size at each sampling; such sampling was also useful in relating fruit size to palatability and to other maturity indices. Hard fruits were used for specific gravity and flesh-color studies, while comparable fruits were allowed to soften at 70°F. to determine weight loss, days required to soften, and palatability.

Palatability was rated on the basis of characteristics described by Harding (2) and subsequently used by Hatton, *et al.*, (4) and on the merits of each variety without comparison with other varieties. Specific gravity was determined gravimetrically using whole fruits. Flesh color was determined by comparing the color in the center of the pericarp with comparable colors on the Nickerson color fan (5).

A different sampling procedure was used for studies of lenticel corking and seed-coat

color. The Tonnage variety was selected because it shows more conspicuous corking than most varieties. A sample of 9 fruits was selected biweekly from 3 trees. Because the source of fruit was limited, only one grove in the Dade County area was sampled. Sampling began 4 weeks before the earliest picking date listed in the avocado shipping dates for the 1958-59 season (1) and continued until the date when size restrictions were removed. The extent of corkiness was judged by the number of fruits affected as well as by the percentage of surface affected on individual hard fruits.

Seed-coat color observations were made on more than 2500 avocados at a packinghouse in Dade County during the 1957-58 season. Data and observations are included only for the Pollock variety.

Table 1 gives the official picking schedule for the varieties studied throughout the investigations.

RESULTS AND DISCUSSION

Specific gravity: — In general there was a downward trend in specific gravity as the season progressed (fig. 1). Pollock and Booth had lower specific gravities than the other varieties. Since seeds of Pollock and Booth fruits are loose in the seed cavity, it is possible that such cavity space accounts for the low specific gravities. Conversely, fruits of varieties with higher values had seeds contained tightly in the seed cavity. Stahl (7) found that specific gravity decreased as the season progressed. Harkness (3) found a decrease from about 1.02 on a very immature avocado to as low as 0.90 on some varieties when mature. His attempts to tabulate whole-fruit specific gravities gave erratic results.

Specific gravity of whole fruit may be used as a general index of maturity; however, its use as an accurate index is not practical because of fluctuation in the downward trend. The variation in specific gravity among individual fruits at the same picking date also limits use of this criterion of maturity. For example, in figure 1, the average specific gravity of Lula fruits on the official beginning picking date was 0.989; however, on this same date individual fruits ranged from 0.942 to 1.009. Determinations on fruits of the same size resulted in different specific gravity values. For example, a sample of Taylor fruits which all measured $3 \frac{4}{16}$ inches in diameter on the official beginning picking date had specific gravities ranging from 0.959 to 0.998.

Loss in weight and days required to soften: — In general, percent loss in weight and number of days required to soften decreased with successive picking dates (table 2). The downward trend in the softening period was not evident until after the fruit was mature as judged by palatability and was too gradual to be used as an accurate maturity index. For example, fruit of the Waldin variety picked on August 4 required 7 days to soften but was not palatable. Fruit picked two weeks later, on August 18, also required 7 days to soften but was palatable. Fruit picked 4 weeks after August 18 still required 7 days to soften and was also palatable.

Soule and Harding (6) found that percent loss in fruit weight and numbers of days required for softening, individually or in combination, were poorly related to palatability.

The reason for the variation in percent loss in weight during the softening process

cannot be explained. Variations in water content of the fruit, influenced by weather before picking, might affect weight loss during softening. Considerable range in the weight loss and in days required to soften was found on any specific picking date; neither index is an accurate measurement of maturity. For example, on October 13, Lula avocados passed the palatability test with an average rating of 71. This was also the beginning official picking date. At this same date, 6 days was the average length of time required for Lula fruits to soften; however, the range was from 5 to 8 days among individual fruits. Also, Lula fruits picked on this same date lost an average of 5.7 percent in weight; however, the range was from 4.3 to 8.2 percent among individual fruits. An additional objection to the use of the actual time required for fruit to soften and weight loss as maturity indices is the length of time required for these determinations.

Table 1.--Avocado Administrative Committee's Florida Avocado Shipping Schedule, 1958-59 season^{1/}

Variety	Date ^{2/}	Min. wt.	Min. diam.	Date ^{3/}	Min. wt.	Min. diam.	Date	Min. wt.	Min. diam.	Date	Min. wt.	Min. diam.
		oz.	inch.		oz.	inch.		oz.	inch.		oz.	inch.
Pollock	7-14	18	3 11/16	8-4	16	3 8/16	8-18	14	3 5/16	9-8		
Waldin	8-18	16	3 9/16	9-1	14	3 6/16	9-15	11	3 2/16	10-13		
Tonnage	9-8	15	3 6/16	9-15	13	3 3/16	9-22	11	3 0/16	9-29		
(Booth 8	9-22	16	3 7/16	10-6	14	3 5/16	10-13	12	3 2/16			
XBooth 8	-----	--	-----	-----	--	-----	10-27	10	2 15/16	11-10		
(Lula	10-13	18	3 10/16	10-20	16	3 7/16	11-3	14	3 4/16			
(Lula	-----	--	-----	-----	--	-----	11-17	11	2 15/16	12-1		
Booth 1	11-17	16	3 11/16	12-1	14	3 8/16	12-15	11	3 3/16	1-5		
Taylor	11-17	14	3 4/16	12-1	12	3 2/16	12-15	9	2 13/16	1-5		

^{1/} Where a minimum weight and minimum diameter are given, fruit which meets either standard may be shipped.

^{2/} No fruit may be shipped before this date.

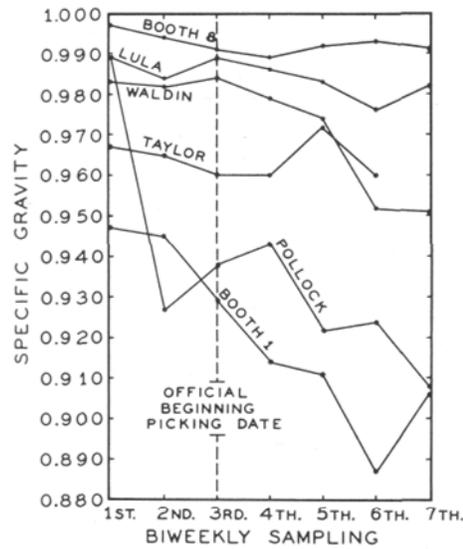
^{3/} No restrictions on size or weight on or after this date.

Table 2.—Loss in weight, softening period, palatability¹ and flesh color of avocados in relation to picking date, 1958-59.

Variety and picking dates	Loss in weight ^{2/}	Softening period (70° F.) ^{2/}	Palatability ^{2/}	Flesh color ^{2/}
	%	days		
Pollock:				
June 16	7.3	6	50	brilliant greenish yellow (7.5Y 9/0)
30	9.0	6	60	"
July 14	5.1	6	70	"
28	7.6	6	75	"
Aug. 11	5.4	4	80	"
25	3.6	4	83	"
Sept. 8	4.4	4	85	"
Waldin:				
July 21	10.4	10	50	vivid yellow (5Y 8/12) and brilliant
Aug. 4	8.4	7	60	yellow (5Y 9/9)
18	6.6	7	70	"
Sept. 2	6.8	7	71	"
15	6.2	7	76	"
29	7.9	6	81	"
Oct. 13	4.0	4	85	"
Booth 8:				
Aug. 25	6.7	8	52	brilliant greenish yellow (7.5Y 9/8)
Sept. 8	6.4	7	69	"
22	7.5	7	71	"
Oct. 7	4.0	7	75	"
20	4.4	7	75	"
Nov. 3	5.2	6	78	"
17	4.7	6	78	"
Lula:				
Sept. 16	7.1	8	65	brilliant greenish yellow (10Y 9/9)
29	8.3	7	69	brilliant greenish yellow (7.5Y 9/8)
Oct. 13	5.7	6	71	"
27	4.2	5	78	"
Nov. 10	6.1	5	81	"
24	4.9	7	82	"
Dec. 8	5.1	5	86	"
Taylor:				
Oct. 21	4.9	7	74	brilliant greenish yellow (10Y 9/9)
Nov. 3	8.4	6	76	brilliant greenish yellow (7.5Y 9/8)
17	5.8	5	80	"
Dec. 3	5.9	4	80	"
15	6.0	5	81	"
29	4.3	5	85	"
Booth 1:				
Oct. 21	6.5	8	56	brilliant greenish yellow (10Y 9/9)
Nov. 3	7.5	8	65	brilliant greenish yellow (7.5Y 9/8)
17	4.9	6	67	"
Dec. 3	3.4	5	73	"
15	4.9	5	74	"
29	4.0	4	78	"
Jan. 12	4.5	5	84	"

1. Palatability ratings were determined as follows: 90-100, very good to excellent; 80-89, good to very good; 70-79, fair to good; 50-69, immature.
 2. Each value represents the average of a minimum of 9 individual fruits; flesh color observations included a minimum of 27 individual fruits.

FIGURE 1.- AVERAGE¹ SPECIFIC GRAVITY OF WHOLE AVOCADO FRUITS



¹ EACH POINT REPRESENTS THE AVERAGE SPECIFIC GRAVITY DETERMINATION OF 36 INDIVIDUAL FRUITS.

Flesh color. — Since flesh color did not change during the maturation period, it has no value as a maturity index (table 2). In some cases more than one flesh color typified a variety; however, the same color or colors persisted throughout the sampling period. For example, the flesh of Waldin avocados was vivid yellow (5Y 8/12) and brilliant yellow (5Y 9/9) on July 21 when the fruits were immature and had a palatability rating of 50. On October 13, when fruits of this variety were in a state of advanced maturity and the palatability rating was 85, flesh colors remained the same.

Corking of lenticels. — As the season progressed, visible corking of lenticels generally became more prevalent. One month prior to the beginning official picking date for Tonnage variety, the only corking detected was slight on one third of the fruits. Two weeks later moderate corking was observed on two thirds of the fruits and none on the remainder. But on September 8, the beginning shipping date, moderate corking was observed on only one third of the fruits and the remainder exhibited only slight corking. By September 29 all fruits in the sample showed moderate corking, except one which had no corking. From the limited samples and the general observations made of fruits still on the trees it was concluded that changes in the extent of corking were so gradual and varied that, although it was a general index, corking of lenticels had little value as an accurate index of maturity. No relationship existed between fruit size and the extent of corking. Palatability tests showed no difference between fruits with corking of lenticels and those without it.

Seed-coat color. — As the seed matures inside an avocado, the seed-coat turns brown and often separates from the seed. This change has been used for a long time by Florida avocado growers as one of the best indices of when to pick. It is currently the official maturity index for seedling or unlisted varieties of Florida avocados which are green in color when soft. One of the difficulties encountered is the lack of uniformity of

seed-coat color.

During the 1957-58 studies it was found that the transition from white to brown was gradual, and at any one time considerable variation existed. For example, in 250 hard Pollock avocados randomly selected from a packinghouse and tested on August 2, 1957, 70 percent had brown, dry seed coats and the remainder had white, fleshy seed coats. Four days later in a similar sampling, only 8 percent had brown, dry seed coats, and the remainder had white, fleshy ones. Ten days later in a third similar sampling, 78 percent had brown, dry seed coats, and the remainder had white, fleshy seed coats. This variation in seed-coat color from one sampling date to the next was possibly due to the change in source of packinghouse fruits.

The use of seed-coat color as a precise measurement of maturity is limited because of variation and the gradual change of color. Brown seed coats were not seen early in the season when fruits were decidedly immature. Later in the maturation period, but before fruit was acceptable in palatability, numerous brown seed coats were seen in all varieties. After all fruits had become acceptable in palatability, brown seed coats were observed in all varieties showing that seed-coat color has some merit as a general index of maturity. Since the number and diversification of seedling and unlisted varieties make it almost impossible to list them in the official picking schedule on a weight and date basis, seed coat color appears to be the only practical and inclusive index of maturity for these types. The exception is seedlings and unlisted varieties that have purple skin when mature.

Palatability: — Fruits of all varieties passed the palatability test on the beginning official picking date with minimum acceptability except for Booth 1 and Taylor varieties; fruits of the Taylor variety had higher than minimum acceptability and those of the Booth 1 variety were not acceptable (table 2).

Considering all of the indices evaluated, determination of maturity on the basis of minimum fruit weights and diameters, in conjunction with earliest picking dates, appears to be the most practical method at the present time. Present regulations are flexible and growing conditions and qualities of fruit are considered in setting minimum fruit size and earliest picking dates.

SUMMARY

Several indices for measuring the maturity of Florida avocados were evaluated. Specific gravity of whole fruit, days required for fruit to soften, loss in fruit weight during softening, corking of lenticels, and seed-coat color were found to have some value as general maturity indices. Their value as precise indices was questionable because of wide variation at any one picking date and because of the erratic values and gradual trends shown between one picking date and the next. Flesh color did not change and has no value as a maturity index.

The evaluations indicate that indices used for present maturity regulations are still the most satisfactory for Florida avocados.

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