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OBSERVATIONS OF EARLY SEASON GRAPEFRUIT IMPORTED INTO ROTTERDAM

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Abstract. **Fruit size, rind thickness, fruit weight, juice volume, total soluble solids and total acids of newly arrived grapefruit (*Citrus paradisi* Macf.) imported into Rotterdam from Florida, Mexico, Cuba, and Honduras during the period of Oct. through mid Nov. 1984 and 1985 were measured and compared at weekly intervals. Florida fruit had the highest solids/acids ratio during these sampling periods. The juice content (volume/weight) ratio was higher for Florida fruit than for fruit from Cuba. The mean juice volume per size 56 fruit was the highest for fruit from Mexico and Honduras, however, within a specific diameter range, juice volume per fruit for Florida fruit was comparable with that for Mexican fruit. Fruit from Cuba and Florida of selected size categories was smaller in diameter than fruit from Mexico and Honduras. Grapefruit from Florida and Mexico had the thinnest rinds.**

Palatability of grapefruit depends on the sweetness and a high ratio of total soluble solids to total acids (4). Solids and acid homographs are used to determine palatability (1,2). Other research showed that the solids/acids ratio was a good standard for grapefruit, although it was noted that the relationship of palatability to solids/acids ratio was not as close as it should be (5). Besides the solids/acids ratio, the volume of juice is used as a basis for determining maturity and palatability (1,2).

A survey on the variation of three physical and three chemical characteristics of the quality of fresh grapefruit originating from 13 countries, and imported into Western Europe, indicated that 'Marsh' seedless grapefruit (*C. paradisi*) from Florida had a higher juice/fruit weight ratio, and a higher solids/acids ratio than fruit from most other countries (3). However, these findings were based on year-round averages.

Seasonal changes of the internal quality of grapefruit have been reported (6). Early season grapefruit is known to have a low juice content (2,5). Also, the solids/acids ratio increases as the season advances (2,4).

Due to reduced supplies of U.S. grapefruit entering Western Europe over the last few years, other grapefruit exporting countries, such as Cuba, Honduras and Mexico, have increased their volume to the European market. Therefore, because of the rapidly changing quality parameters on early grapefruit, this study was undertaken to investigate the extent of the variation of some physical and chemical characteristics of early season grapefruit from Florida compared to simultaneously marketed fruit originating from competing production areas.

Materials and Methods

From 8 Oct. through 12 Nov. 1984, and 22 Oct. through 12 Nov. 1985, grapefruit samples were collected weekly from the lots displayed at the Rotterdam Citrus Auction. Each lot was sampled only once, when placed on the auction. Each standard sample (7) contained five fruit out of one box, with fruit never larger than size 48. Samples were collected from four points of origin: Florida, Mexico, Cuba and Honduras.

To determine the solids/acids ratio and the juice/fruit weight ratio (ml/100 g) for each fruit sample the following characteristics were measured:

Total soluble solids. Total soluble solids were determined with an Atago refractometer, model ATC-1, with a range of 0 to 32%.

Total acid. Total acid was measured by titrating a 25-ml juice sample with a sodium hydroxide solution (0.4063 N) to the phenolphthalein end point. The concentration was expressed as percent of anhydrous citric acid.

Juice volume. The five-fruit samples were juiced with a type 7 Sunkist juice extractor. The juice was strained

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through a 1.2-mm mesh strainer to separate the seed and pulp from the juice. The strained juice was measured in a graduated cylinder to obtain the juice volume of five fruits to the nearest 5 ml.

Fruit weight. The total weight of each five-fruit sample was determined to the nearest gram.

Fruit size. The diameter of each fruit was measured to the nearest millimeter at the equator, and averaged over five fruit.

Rind thickness. The thickness of the rind was measured to the nearest millimeter at two spots between section membranes cut transversely at the equator of the fruit, and averaged over five fruit.

Results and Discussion

A total of 101 samples were collected from Florida, Mexico, Cuba and Honduras. The majority of these samples, ca. 53%, originated from Florida. Newly arrived Florida grapefruit was present during each sampling period, whereas, fruit from the other points of origin were less frequently available on the Rotterdam auction. Seventy-three percent of all fruit collected was size 56, mostly 'Ruby Red'.

Total soluble solids. All fruit samples collected, from Florida as well as from other countries, had a total soluble solids (TSS) level of more than 7.6%. When averaged over both the 1984 and 1985 seasons, Cuban fruit had the lowest level of TSS, 8.5% with a range of 7.8 to 9.2%. Mexican and Honduras fruit both had a mean TSS of 9.4% with a range of 8.8 to 10.6% and 8.4 to 10.6%, respectively. The mean TSS for Florida fruit was 8.9% and the minimum and maximum levels were 7.6 and 10.4% respectively (data not shown).

Total acid. Mexican fruit, with 1.6%, had the highest total acid level, ranging from 1.3 to 1.8%, followed by Cuba and Honduras, both with 1.4% mean total acids, ranging from 1.2 to 1.5% and 1.8%, respectively. Fruit from Florida had the lowest mean total acids level with 1.2%, ranging from 0.9 to 1.6% (data not shown).

Solids/acids ratio. The high acid levels of fruit from Mexico, Cuba and Honduras resulted in lower mean solids/acids ratios than those of Florida fruit (Table 1). The mean solids/acids ratio of Florida fruit gradually increased from 6.0 in the beginning of October, to 7.3 in mid November. Solids/acids ratios of fruit from Mexico, Cuba, and Honduras also generally increased as the season progressed. The ratio for Mexican fruit never exceeded that of Florida and only two samples, one each of Cuban and Honduras fruit collected in early and mid October, had a higher solids/acids ratio compared to Florida fruit collected during that same week.

Table 1. The mean solids/acids ratio for early season grapefruit collected at the Rotterdam Citrus Auction in 1984 and 1985, by origin and sampling period.

	Date					
Origin	10/8	10/15	10/22	10/29	11/5	11/12
Florida	6.0	6.9	7.3	7.1	7.4	7.3
Mexico	5.6	5.9	6.4	6.4	6.8	–
Cuba	5.5	5.6	7.6	–	6.5	–
Honduras	6.2	–	7.0	6.4	6.7	6.7

Juice volume. Juice volume depends on the time of the year and fruit size. The mean juice volume per fruit of size 56 fruit from all points of origin generally increased as the season advanced (Table 2) (Data only shown for size 56; 73% of all fruits from all sources was size 56). Florida fruit increased from 119 ml per fruit at the beginning of October to 156 ml in November. In weekly comparisons, Cuban fruit contained less juice per fruit that Florida fruit, except during the weeks of October 8 and 15. Mexican and Honduras fruit samples contained more juice per size 56 fruit than Florida and Cuban samples. When juice volume per fruit was correlated to the actual size of the fruit, it was noted that larger fruit contained more juice (Table 3), except for Cuban fruit. Honduras fruit generally had the highest juice content for each range in size, shown in Table 3, closely followed by Florida and Mexican fruit. Fruit from Cuba had the lowest juice volume per fruit for each size range.

Juice/fruit weight ratio. The mean juice/fruit weight ratio for Florida fruit increased as the season advanced from 43.5 in the beginning of October, to 51.2 in November (Table 4). Cuban fruit had a lower juice/fruit weight ratio than Florida fruit collected during the entire sampling period, whereas Mexican and Honduras fruit generally had a higher juice/fruit weight ratio than Florida fruit.

Fruit size. The mean diameters of the size 56 and 64 fruit originating from Florida as well as Cuba, were 8.9 and 8.5 cm, respectively, and were smaller than fruit from

Table 2. The mean juice volume per fruit, size 56, for early season grapefruit collected at the Rotterdam Citrus Auction in 1984 and 1985, by origin and sampling period.

	Date					
Origin	10/8	10/15	10/22	10/29	11/5	11/12
	ml	ml	ml	ml	ml	ml
Florida	119	133	149	159	154	156
Mexico	155	166	164	174	–	–
Cuba	121	147	132	–	132	–
Honduras	151	–	182	–	180	–

Table 3. Juice volume per fruit for early season grapefruit collected at the Rotterdam Citrus Auction during October and November 1984 and 1985, by diameter range and origin.

	Diam range in cm			
Origin	8.4-8.7	8.8-9.0	9.1-9.3	9.4-9.7
	ml	ml	ml	ml
Florida	146	152	167	175
Mexico	144	157	172	172
Cuba	122	137	137	–
Honduras	155	159	161	199

Table 4. The mean juice/fruit weight ratio for early season grapefruit collected at the Rotterdam Citrus Auction in 1984 and 1985, by origin and sampling period.

	Date					
Origin	10/8	10/15	10/22	10/29	11/5	11/12
Florida	43.5	47.2	49.6	51.3	50.8	51.2
Mexico	46.8	50.4	52.1	54.6	51.2	–
Cuba	43.7	46.4	48.8	–	50.2	–
Honduras	48.4	–	53.7	50.7	55.3	52.8

Table 5. Fruit diameter for early season grapefruit collected at the Rotterdam Citrus Auction during October and November 1984 and 1985, by origin and marketing size.

Origin size	Mean diam	Size range	
		min diam	max diam
	cm	cm	cm
Florida			
64	8.5	8.4	8.7
56	8.9	8.5	9.6
48	9.3	9.1	9.6
Mexico			
64	9.0	8.7	9.4
56	9.2	8.9	9.2
48	9.3	9.3	9.3
Cuba			
64	8.5	8.4	8.6
56	8.9	8.7	9.1
48	9.3	9.1	9.4
Honduras			
64	8.8	8.6	9.0
56	9.1	8.9	9.2
48	9.6	9.6	9.6

Mexico or Honduras, which had fruit diameters of 9.2 and 9.0 cm and 9.1 and 8.8 cm, respectively (Table 5). The minimum fruit diameter per marketing size was generally larger for fruit from Mexico and Honduras, compared to fruit from Florida and Cuba. For marketing size 48, Honduras had the largest fruit.

Rind thickness. The mean rind thickness of fruit did not vary during the marketing season. However, there was a noticeable difference between countries of origin. Fruit from Florida and Mexico had the thinnest rinds, with a mean of 5.3 mm, followed by fruit from Honduras and Cuba with rind thickness of 5.8 and 6.3 mm, respectively (data not shown).

Results of this investigation indicate the comparative position of early season Florida grapefruit to fruit originating from other sources of supply. Florida fruit had the highest solids/acids ratios and comparative juice volumes per fruit when correlated to a specific diameter range, although juice volume per size 56 fruit was lower than that for fruit from Mexico and Honduras due to smaller fruit sizes. Because these other citrus-producing countries may strengthen their position on the European market and because additional grapefruit exporting countries may penetrate this early market, it is of great importance to regularly observe the quality of early season Florida grapefruit compared to fruit from competing countries.

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OVERSEAS TESTS OF WRAPPED GRAPEFRUIT IN NONREFRIGERATED VAN CONTAINERS

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Abstract. **Five test shipments of Florida grapefruit were made at about 6-week intervals from Nov. 1984 to Apr. 1985 from Jacksonville, Florida, to Rotterdam, The Netherlands, in nonrefrigerated van containers. Fruit condition was determined on arrival and after storage for 3 weeks. Individually film-wrapped fruit were compared to nonwrapped fruit. Also several fungicide treatments were evaluated for decay control. No chilling injury developed even though the fruit was exposed to low temperatures during transit. Film wrapping improved fruit shelf life by decreasing weight loss. Imazalil spray reduced mold rots and thiabendazole and imazalil sprays reduced stem-end rots. Imazalil-coated film had no advantage over spray applications of fungicides directly on the fruit to prevent decay in these grapefruit.**

The merits of wrapping individual citrus fruit in heat-shrinkable films (i.e., reduced moisture loss, less fruit deformation, extended shelf life, improved appearance, brand identification, preventing cross decay infections to healthy fruit, etc.) are well documented (1, 2, 3, 4, 5, 6, 8, 9, 10, 12). No information is available, however, concerning the feasibility of shipping wrapped fruit to European markets in nonrefrigerated van containers. Hinds (11) in 1970 and Biales et al., (7) in 1973, exported unwrapped grapefruit in insulated dry freight van containers modified with vent doors only or special ventilation systems and reported favorable results. Biales stated that shipping selected perishable products that require less critical temperature management in dry-freight van containers may reduce export transport costs. There are no published ocean freight rates for shipping fresh grapfruit in dry freight van containers. However, we conservatively estimated that total savings for shippers, ocean carriers, and

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