For the 5 shipments, serious deformation was significantly lower for fruit packed in the deep cartons and averaged 12.1% as compared to 23.5 to 25.5% for fruit shipped in the other containers (Table 4). Thus, data from these commercial shipments agree with data from laboratory tests conducted by Hale in 1973 (2), in that the overall appearance of grapefruit was related to fruit-pack heights. The higher the fruit is bulged when packed, the more serious is the deformation at subsequent unloading.

Container types B and C maintained original size and shape slightly better than the other shipping containers (Table 5). However, the differences in the amounts of bottom sag, end bulge, and side bulge among the 5 types of containers were not statistically significant.

Table 4. Percentage of grapefruit seriously deformed in 5 types of shipping containers on arrival at Tokyo, 5 test shipments, 1977.

Carton identification letter	Seriously deformed[z]
Standard:	
A	24.5
Experimental:	
B	12.1[y]
C	25.5
D	23.5
E	24.0

[z]Seriously deformed fruit is defined as fruit with total aggregate flattened or indented surface area more than 2 inches in diameter.
[y]Statistically significant difference from all other treatments at the 1% level.

Table 5. Amount of physical damage to 5 types of shipping containers during 5 test shipments from Florida to Tokyo, 1977.

Carton identification letter	Type of carton damage		
	Bottom sag	Side bulge	End bulge
	Inches		
Standard:			
A	0.8	0.8	0.6
Experimental:			
B	0.7	0.7	0.5
C	0.7	0.8	0.4
D	0.8	0.9	0.6
E	0.9	0.8	0.7

Literature Cited

1. Florida Department of Citrus. 1976. Containers, packs, stamping and labeling of fresh fruit. Official Rules, Chap. 20-39:11.
2. Hale, P. W. 1973. Which grapefruit pack: bulge, flat, or slack? *Citrus and Vegetable Mag.* 36(12):8,11.
3. ————, and J. J. Smoot. 1973. Exporting Florida grapefruit to Japan. *Citrus and Vegetable Mag.* 37(3):20-23,45.
4. McCornack, A. A., G. E. Brown, and J. J. Smoot. 1977. Imazalil, an experimental postharvest citrus fungicide with activity against benzimidazole-resistant penicilliums. *Plant Dis. Rptr.* 61:788-791.
5. ————, W. F. Wardowski, and G. E. Brown. 1976. Postharvest decay control recommendations for Florida citrus fruit. *Fla. Coop. Ext. Serv. Cir.* 359A.
6. Smoot, John J. 1977. Factors affecting market diseases of Florida citrus fruits. *Proc. Int. Soc. Citriculture.* 1:250-254.

Proc. Fla. State Hort. Soc. 90:154-156. 1977.

INTERNAL FREEZE DAMAGE IN FLORIDA GRAPEFRUIT HELD IN FLORIDA AND SIMILAR FRUIT SHIPPED AND HELD IN JAPAN DURING LATE SPRING 1977

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Additional index words. drying, export.

Abstract. **Grapefruit from five USDA experimental shipments to Japan were cut and inspected to determine if internal drying increased after harvest and during transit to Japan. Off-grade fruit increased from 3% at packing to 30% on arrival due to internal freeze damage, based on the extent of damage to comparable fruit cut in Florida at time of packing. Granulation also contributed to the dryness of some of the lots of fruit. Commercial grapefruit, consisting of 168 cartons and 18 brands from 4 shipments that arrived in Japan during April and May 1977, were similarly tested. Fruit that went through frozen-fruit separators at the packinghouse averaged 32% U.S. No. 2 or below; and fruit not separated averaged 42%. Fruit classified as U.S. No. 2 and below, according to packinghouse lots, ranged from 0 to 71%. The larger the size of the fruit, the less was the internal freeze damage.**

Subfreezing temperatures on January 20 and 21, 1977, seriously damaged citrus groves throughout the State of Florida. Immediately after the freeze, a 10-day embargo was imposed to prevent the shipment of damaged or unwholesome fruit as prescribed by the Florida citrus code (1). During the embargo, much of the seriously frozen fruit dropped from the trees and some drying, particularly at the stem end, affected fruit that remained on the trees. The extent of freeze damage to these remaining fruit was difficult to assess without cutting the fruit. Dried fruit can be separated in the packinghouse by specific gravity or water flotation (4). The purposes of these investigations were to determine 1) if the level of internal freeze damage (drying) at picking increased during storage (simulated transit) or during actual transit to Japan, the largest importer of Florida grapefruit, and 2) to survey, after arrival in Japan, the extent of internal freeze damage in commercially shipped grapefruit.

Materials and Methods

All fruit were cut and examined by the official procedure prescribed to grade Florida citrus for internal dryness or freeze damage (3). The fruit were inspected and graded according to U.S. standards for Florida grapefruit (2). Tabulations were made of individual fruit that met one of these three categories: U.S. No. 1, U.S. No. 2, or below U.S. No. 2; however, fruit shipped to Japan must

meet requirements for U.S. No. 1 grade. A 10% tolerance is allowed.

Experimental shipments. "Indian River" grapefruit were obtained from commercial packinghouses and taken to the U.S. Horticultural Research Laboratory, Orlando, where they were externally graded, washed, waxed, and packed. One sample of about 50 fruit was cut and inspected for internal freeze damage or drying, a second sample was stored at 10°C (50°F) to simulate transit time to Japan, and a third sample was shipped with commercial fruit to Japan. The same procedure was followed for each of the 5 test shipments that were loaded at the port of Tampa and shipped at 10° to 11°C (50-52°F). Fruit stored in Orlando and similar fruit discharged in Tokyo were then held at 21°C (70°F) and 24°C (75°F), respectively, for 14 days, then were cut and inspected for internal freeze damage. Inspection dates of cut fruit are shown in Table 1. All shipments were delayed, so the simulated transit times in Orlando were shorter than the actual transit times.

Table 1. Inspection dates for the 5 experimental shipments for internal freeze damage in Florida grapefruit shipped to and held in Japan, and for similar fruit held in Orlando, 1977.

Experimental Shipment No.	Date		
	Packed	Held in Orlando[z]	Shipped to Tokyo[y]
1	March 23	April 25	May 6
2	March 25	May 12	May 25
3	April 4	May 17	May 27
4	April 12	May 23	June 10
5	April 21	June 6	June 10

[z]Stored at 10°C (50°F) then held at 21°C (70°F) for 14 days prior to cutting and inspecting.
[y]Shipped at 10-11°C (50-52°F) then held at 24°C (75°F) for 14 days.

Commercial shipments. After arrival in Japan, commercial fruit (18 different brands) from a total of 47 different packinghouse lots, representing 4 shipments, were cut and inspected for internal freeze damage. Three shipments arrived in April, and the fourth in May 1977. A total of 168 cartons of fruit were cut and inspected; this represented at least 1 carton of fruit for each size available in each lot. Only 2 packinghouses had used separators to eliminate some of the frozen fruit prior to packing.

Results and Discussion

Experimental shipments. That fruit shipped to Japan and that held at Orlando increased in internal drying after packing (Fig. 1). The extent of internal freeze damage or drying, based on off-grade with quality less than U.S. No. 1, averaged 3% when packed, 18% after holding in Orlando, and 30% after shipping and holding in Tokyo. Drying of fruit held in Orlando was not as severe as that in fruit shipped to Japan, because the time of holding in Orlando averaged 11 days less than the time for comparable fruit in Japan (Table 1), and the holding temp in Japan was slightly higher. Fruit tested in shipments 3, 4, and 5 had no drying, and fruit in shipments 1 and 2 had less than 10% drying, thus meeting U.S. No. 1 grade at time of packing; however, the increase in drying was substantial, especially in shipment 4 to Japan, where considerable granulation was observed in addition to the type of drying characteristic of freeze damage.

Commercial shipments. Although an extremely small number of commercial fruit were cut and graded in Tokyo compared to the total number arriving, those that were cut and inspected gave some perspective regarding the parameters involved.

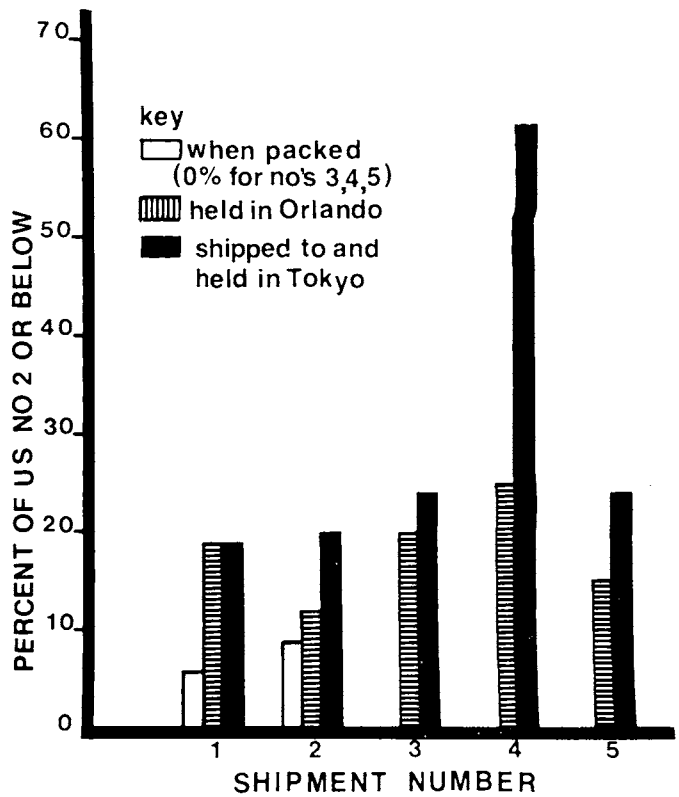

Fig. 1. Internal freeze damage (drying) in Florida experimental grapefruit, measured by U.S. Grade Standards, in shipments destined for Japan during April 1977.

Cutting and inspecting 36 packinghouse lots from 3 commercial shipments during April 1977, we found the overall average graded 40% U.S. No. 2 or below. Based on 6 of the above lots in which a frozen-fruit separator was used versus 30 in which no separator was used, the separators reduced the number of frozen or dried fruit (Fig. 2 and 3). Fruit that passed through a separator averaged 32% U.S. No. 2 or below, with lots ranging from 0 to 60% U.S. No. 2 or below; whereas those that

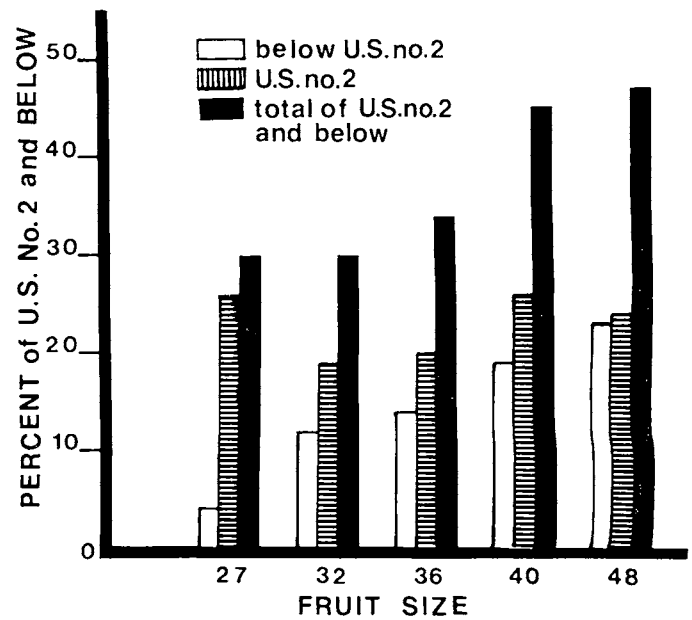

Fig. 2. Internal freeze damage (drying) in Florida commercial grapefruit, measured by U.S. Grade Standards, in four commercial shipments arriving in Japan during April 1977. No separator was used at packinghouses.

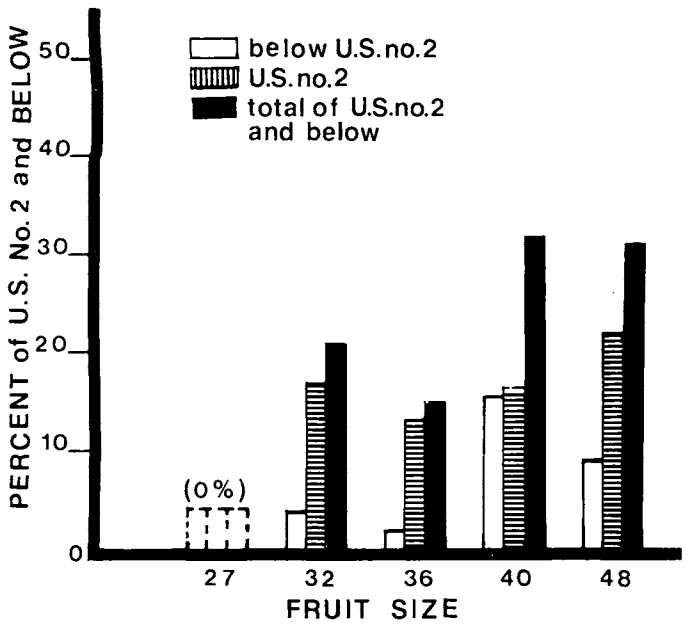

Fig. 3. Internal freeze damage (drying) in Florida commercial grapefruit, measured by U.S. Grade Standards, in four commercial shipments arriving in Japan during April 1977. Separators were used at packinghouses.

did not pass through a separator averaged 42% U.S. No. 2 or below, with lots ranging from 13 to 71% U.S. No. 2 or below. Generally, the larger the size of the fruit, the less was the internal freeze damage (Figs. 2 and 3).

Eleven lots of fruit were cut and inspected in a single commercial shipment that arrived in Tokyo during May 1977. Two lots graded 0% U.S. No. 2 or below and one lot graded 75% U.S. No. 2 or below; the average was 16% U.S. No. 2 or below.

Conclusions

Internal freeze damage (drying) progresses after grapefruit are picked and packed, during refrigerated storage or extended transit periods. Consideration should be given to setting more stringent standards for grapefruit that show freeze damage at packing, especially for those destined for export or storage. Consideration also should be given to the judicious use of frozen-fruit separators for grapefruit when freeze damage is present, even though separators do not eliminate, but only reduce the incidence of freeze-damaged fruit. Generally, the larger the size of the fruit, the less is the internal freeze damage.

Literature Cited

1. Florida Statutes. 1977. Chap. 601.90.
2. U.S. Department of Agriculture, AMS. United States standards for grades of Florida grapefruit. (Effective October 15, 1967, as amended February 13, 1968, and January 31, 1973) 11 pp.
3. U.S. Department of Agriculture official visual aids for Florida citrus. 1973. The John Henry Co., Lansing, Michigan. p. 39.
4. Winston, J. R. 1950. Harvesting and handling citrus fruits in the Gulf States. *U.S. Dept. Agr., Farmers' Bul. 1763*, 67 pp.

Proc. Fla. State Hort. Soc. 90:156-158. 1977.

CHARACTERISTICS OF WASTEWATER FROM CITRUS PACKINGHOUSES USING FROZEN FRUIT SEPARATORS[1]

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Additional index words. COD, BOD, pollution control.

Abstract. **Oil-emulsion and water frozen citrus fruit separators were used extensively in citrus packinghouses following the freeze of January 1977. Wastewater samples from 2 packinghouses, one with an oil-emulsion and the other with a water separator, were analyzed for COD, BOD, and settleable, total, volatile, and fixed solids. Phenolic residues, methylene blue active substances (MBAS), and turbidity were also determined. Wastewater from the packinghouse using the oil separator had high COD and BOD readings, while the wastewater from the packinghouse using a water separator *exhibited lower* values in the same tests. The presence of oil separator fluid in wastewater drastically changed its physical properties. Coagulated solids in oily wastewater tended to float to the top, while that in non-oily waste sank to the bottom.**

Following the January 1977 freeze, a 10-day embargo on the sale and transportation of fresh citrus fruit was instituted by the Florida Citrus Commission (5). The purpose of this ban was to protect the consuming public as well as the citrus industry against use of citrus fruit which may have been damaged by freezing. The order further stipulated that no fresh citrus fruit damaged by freezing shall be sold or offered for sale, except to processing plants for the purpose of conversion into processed citrus products or by-products. Therefore, fruit shipped in fresh fruit channels must meet rigorous standards for freeze damage.

Such restrictions necessitate the use of frozen fruit separators in citrus packinghouses to eliminate freeze-damaged fruit from reaching the consumer. There are 2 principal types of separators, namely water and oil (3, 7), both work on the principle of separation based on differences in specific gravity between freeze damaged and non-damaged fruit. Oil separators utilize an emulsion of purified mineral oil and water to separate sound fruit, which sink onto a roller conveyor, from freeze-damaged fruit which float and are removed from the emulsion on another conveyor. Water separators rely on the greater buoyancy of damaged fruit when either dropped into or released below a moving stream of water (7). Grierson and Hayward (3) published extensive evaluation of the 2 types of separators following the 1957 freeze in Florida.

Since the presence of oil-emulsion seemed to adversely affect the quality of packinghouse wastewater,

[1]Florida Agricultural Experiment Stations Journal Series No. 865.
[2]The authors express appreciation to Mr. Ben Wood and Mr. Perry Cooper for excellent technical assistance.