

trees is dependent on a number of factors, but particularly the balance of plant growth regulators for callus initiation and shoot induction. The season during which the young leaves are selected could be critical, since this experiment could not be successfully repeated during winter months (unpublished data). The BA preconditioning spray also appears to play a significant role. In a separate experiment, stock plants which were not treated with a BA spray did not successfully regenerate any organized structures in vitro (unpublished data). Some form of cytokinin preconditioning or rejuvenation was also necessary for successful in vitro regeneration of pomegranate, mulberry, guava and mangosteen.

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STORAGE CHARACTERISTICS OF 'FUYU' PERSIMMONS

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Additional index words. *Diospyros kaki* L., postharvest, chilling injury.

Abstract. Non-astringent persimmons (*Diospyros kaki* cv. Fuyu), grown in Gainesville, Florida, were harvested on 2 Nov. and 9 Nov. 1992. Fruit were firm and uniformly yellow at harvest. Fruit were stored at 32, 41, 50, or 68F (0, 5, 10, or 20C) for two weeks, followed by one week at 68F (20C). After storage, nearly all fruit originally at 41F (5C) showed chilling injury and were unmarketable. These developed a yellow-brown color and water-soaked appearance, and were very soft. Those persimmons from the first harvest, which were initially stored at 32, 50, or 68F (0, 10, or 20C), developed

good color after 1 week at 68F (20C), and most were marketable. Of fruit harvested on 9 Nov. those stored at 32 or 68F (0 or 20C) were marketable, while 80% of the 41F (5C) and 60% of the 50F (10C) treatment fruit were not. There were no significant differences between pH or soluble solids of the pulp among storage treatments, and no decay developed during storage. Based on these results, recommended storage temperatures for Florida-grown 'Fuyu' persimmons are 68F (20C) if rapid ripening is desired, or 32F (0 C) for longer storage.

The oriental persimmon, *Diospyros kaki* L., has been grown in Florida for many years. In the early 1900s there were commercial plantings of astringent Kaki persimmons numbering about 22,750 trees (Miller and Crocker, 1992). This industry did not successfully establish because of marketing difficulties. Plantings of non-astringent Kaki persimmons are increasing in the U.S. with about 600 ha now in production. California leads in production with a return to grower between \$.28 and 1.12 per kg of fruit (Collins et al., 1993). With more acreage being planted to persim-

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mon in Florida there has been increased interest in extending the shelf-life of persimmons to extend the market.

Non-astringent Kaki persimmons grown in Japan can be stored for 3 mo at 0C, but in New Zealand cold injury occurred at (4C), and storage life was reduced to 4 weeks (MacRae, 1987). Therefore it was decided that locally grown persimmons should be evaluated at various temperatures and times for the best storage conditions.

Materials and Methods

Non-astringent 'Fuyu' persimmon grown in Gainesville, Florida, were harvested on 2 Nov. and 9 Nov. 1992. Fruit were selected for uniformity of size and color, with those having even yellow coloration of 3.5 to 4 on the color scale developed in Japan for 'Fuyu' (Yamazeki et al., 1981). Preliminary studies in 1989 (unpublished data, Sargent) revealed the variability in ripening at other color stages. For this reason, all fruit were harvested at the yellow color stage. The fruit had not begun to soften at harvest. Fruit were stored in styrofoam trays covered with plastic bags left slightly open at one end to maintain a high relative humidity while allowing some air movement. Fruit were stored at either 32, 41, 50, or 68F (0, 5, 10, or 20C) for 2 weeks and at 68F (20C) for 1 week to simulate retail market conditions. There were 36 fruit per storage temperature from the first harvest and 40 fruit per storage temperature from the second harvest. The persimmons were checked periodically during storage for softening or decay. Fruit were removed from storage when soft over two-thirds of the surface, the point considered to be too soft for commercial shipping.

After the 7 days of storage at 68F (20C), five firm and five soft fruit of those remaining in each treatment were evaluated for color using the color scale developed in Japan for 'Fuyu' persimmons (Yamazeki et al., 1981), and rated for surface blemishes, decay, and marketability. Firmness was measured using an IFAS Firmness Tester, which consisted of a 0.59 in. (15 mm) convex probe placed on the fruit surface to which a static load of 2.205 lb-f (9.8 N) was applied for five sec., at which time deformation in 0.01 inch (0.25 mm) increments was measured. Three non-de-

structive deformations were made around the equator of each intact fruit. Fruits were selected for analysis based on similarity of firmness measurements (0.02-0.05 inches, 0.51-1.27 mm, for firm fruit and 0.13-0.25 inches, 3.30-6.35 mm, deformation for soft fruit) and similarity of color. After the storage period plus one week at 68F (20C), seeds and peel were removed from five soft and five firm fruits for each treatment, and fruit pulp was analyzed for pH and soluble solids using a Corning model 140 pH meter and Abbe Mark II digital refractometer.

Results and Discussion

Storage of 'Fuyu' fruit from the first harvest for 2 weeks at 32, 50, or 68F (0, 10, or 20C) followed by 1 week at 68F (20C) resulted in good quality, marketable fruit (Table 1). From the second harvest (Table 1), those fruit stored initially at 32F (0C) or 68F (20C) were marketable, while 60% of the fruit stored initially at 50F (10C) were not marketable due to symptoms of chilling injury. Fruit considered marketable showed satisfactory color development and normal flesh appearance, with a good aroma and flavor. They were still firm when at the orange color stage, which is a desirable characteristic because the non-astringent 'Fuyu' is normally eaten crisp, as are apples. Those fruit initially stored at 41F (5C), and some of those stored at 50F (10C), (Table 1) showed marked symptoms of chilling injury, including poor color development (a brownish-yellow), rapid softening, and a dark, water-soaked surface appearance. The pulp was unattractive and did not develop an acceptable aroma.

Marketability was evaluated subjectively as marketable or unmarketable, with those fruit with water-soaking, an unattractive color, or more than moderate blemishes being considered unmarketable. From the first harvest, only those fruit stored at 41F (5C) were unmarketable after one week at 68F (20C) (Table 1). For the second harvest, all of the 41F (5C) -stored fruit and 60% of the 50F (10C) -stored fruit were unmarketable, primarily due to chilling injury. If the fruit had been observed for more than a 2-week period, the 50F (10C) fruit from the first harvest may have developed chilling symptoms.

Table 1. Storage temperature effects on quality of 'Fuyu' persimmons harvested on 2 Nov.

Two week Storage Temp. (°C) ^z	Firmness at 3 weeks	Deformation (Firmness) (inches) ^y	Color Stage ^x	Surface Blemish Rating ^w	Marketable (%)
0	Firm	0.027 (0.010) ^y	5.5 (0.447) ^y	2.8 (0.980) ^y	100
0	Soft	0.252 (0.099)	6.0 (0.316)	3.2 (0.748)	80.0
5	Firm	----- none -----			
5	Soft	0.178 (0.053)	6.3 (0.600)	3.6 (0.490)	20
10	Firm	0.030 (0.006)	6.0 (0.894)	2.4 (0.800)	100
10	Soft	0.137 (0.028)	5.9 (0.583)	3.4 (0.490)	80
20	Firm	0.039 (0.006)	5.8 (0.510)	2.4 (0.490)	100
20	Soft	0.150 (0.061)	7.0 (0.632)	2.6 (0.800)	100

^zFruit harvested 2 Nov. and 9 Nov. 1992. Stored at 0, 5, 10, or 20C for 2 weeks, followed by 1 week at 20C. After 3 weeks storage, five firm and five soft fruit selected.

^yFirmness of fruit measured at three points around equator of fruit. Deformation in 0.01" increments. Mean taken of three measurements/fruit. Overall mean is of five fruit.

^xColor stage determined from Japanese color scale created for 'Fuyu' persimmons where 3.5-4 = yellow stage at harvest, 8 = deep orange of fully ripe fruit.

^wSurface blemish rating: 0 = none, 1 = very slight, 2 = slight, 3 = moderate, 4 = severe, 5 = extreme.

^yData are means of five fruit. (Sd).

Two week Storage Temp. (°C) ^z	Firmness at 3 weeks	Deformation (Firmness) (inches) ^y	Color Stage ^x	Surface Blemish Rating ^w	Marketable (%)
0	Firm	0.033 (0.004) ^v	5.8 (0.400) ^v	2.6 (0.800) ^v	100
0	Soft	0.183 (0.088)	6.4 (0.490)	2.8 (0.748)	80
5	Firm	----- none -----			
5	Soft	0.181 (0.032)	6.8 (0.400)	2.6 (1.020)	20
10	Firm	0.049 (0.010)	6.2 (0.245)	2.0 (0.894)	100
10	Soft	0.165 (0.010)	7.4 (0.490)	4.6 (0.490)	40
20	Firm	0.032 (0.006)	6.0 (0.548)	2.6 (0.490)	100
20	Soft	0.241 (0.124)	7.1 (0.917)	2.8 (0.400)	80

^zFruit harvested 2 Nov. and 9 Nov. 1992. Stored at 0, 5, 10, or 20C for 2 weeks, followed by 1 week at 20C. After 3 weeks storage, five firm and five soft fruit selected.

^yFirmness of fruit measured at three points around equator of fruit. Deformation in 0.01" increments. Mean taken of three measurements/fruit. Overall mean is of five fruit.

^xColor stage determined from Japanese color scale created for 'Fuyu' persimmons where 3.5-4 = yellow stage at harvest, 8 = deep orange of fully ripe fruit.

^wSurface blemish rating: 0 = none, 1 = very slight, 2 = slight, 3 = moderate, 4 = severe, 5 = extreme.

^vData are means of five fruit. (Sd).

Persimmons initially stored at 32F (0C) were slowest to soften (Fig. 1) yet were satisfactory upon reaching the eating stage. Only 44% from the first harvest and 3% from the second harvest were soft after 3 weeks. Fruit stored at 41F (5C) softened rapidly after being transferred to 68F (20C) and did not ripen normally. After two weeks at 41F (5C) and one week at 68F (20C), 97% from the first harvest and 100% from the second harvest were unacceptably soft. The fruit surface exhibited a severe water-soaked appearance and an unattractive, yellow-brown color. Internal appearance was also water-soaked. These symptoms have been previously reported for persimmons to be due to chilling injury (MacRae, 1987).

Those persimmons initially stored at 50F (10C) softened more rapidly than those at 68F (20C), but most from the first harvest appeared acceptable at the 3-week evaluation. For the first harvest, 67% of the fruit stored initially at 50F (10C) were soft after 3 weeks, while 50% of those stored constantly at 68F (20C) were soft (Fig. 1). For the second harvest, 63% of those fruit stored at 50F (10C) plus 1 week at 68F (20C) were soft, while only 23% of those held at 68F (20C) for 3 weeks were soft.

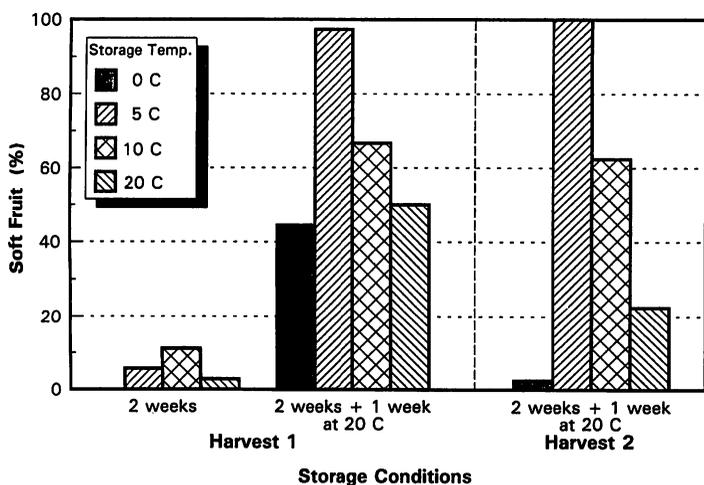


Figure 1. Storage temperature effects on % soft fruit of 'Fuyu' persimmons.

Fruit were evaluated for color, surface blemishes, decay, and marketability after the 68F (20C) holding period. The Japanese color scale assigned a value of 3.5 to 4 for the yellow color stage at harvest, and a value of 8 for the deep orange color of a fully-ripe persimmon (Yamazeki et al., 1981). For harvest one, color values for firm fruit after three weeks total storage ranged from 5.5 for the 32F + 68F (0C + 20C) treatment to 6.0 for the 50F + 68F (10C + 20C) treatment, and for soft fruit from 5.9 for the 50F + 68F (10C + 68C) treatment to 7.0 for those fruit stored constantly at 68F (20C) (Table 1). There was a great deal of variation between fruit, thus differences were not significant. Fruit from harvest two developed slightly more color after the same storage period.

Surface blemishes (Table 1) were rated on a scale of 0 to 5, with 0 corresponding to none and 5 being severe. Fruit from both harvests developed surface blemishes, mainly anthracnose spots, but were not severely infected. The soft fruit initially stored at 32, 41, or 50F (0, 5, or 10C) in harvest one were slightly more blemished than those stored constantly at 68F (20C), but the difference was not significant. In harvest two, the soft fruit from the 50F (10C) treatment were more blemished than those from the other storage temperatures. There was no other decay on any of the fruit from either harvest.

After the 3-week total storage period, there were no significant differences in pH nor soluble solids in soft versus firm fruit [there were no firm fruit remaining from the 41F (5C) treatment]. There were also no significant differences in pH or soluble solids among the storage temperature treatments (Table 2).

This research supports the contention that the high quality 'Fuyu' persimmons grown in Florida have the potential for shipment to distant markets; however, several considerations must be addressed. The ripening rate of fruits is quite variable. Harvest at the firm, full yellow color stage should aid in reducing this variability during subsequent handling. For the local market, fruit should be stored at 68F (20C) and 90% relative humidity to promote rapid ripening, while for more distant markets fruit should be stored for at least 2 weeks at 32F (0C) and the same humidity. Persimmons should not be stored at 41-50F (5-10C) to avoid development of chilling injury. Further studies

Table 2. Storage temperature effects on pH and percent soluble solids of 'Fuya' persimmons.

Two week Storage Temp (C) ^z	Firmness at 3 Weeks	2 Nov.		9 Nov.	
		pH	Soluble Solids (%)	pH	Soluble Solids (%)
Initial (At harvest)	Firm	5.86 (0.142) ^y	14.6 (1.203) ^y	5.77 (0.144) ^y	13.9 ^y (1.300)
0	Firm	5.74 (0.158)	16.2 (2.869)	5.64 (0.179)	14.1 (1.024)
0	Soft	5.29 (0.046)	13.8 (0.824)	5.43 (0.162)	13.6 (0.716)
5	Firm	----- none -----		----- none -----	
5	Soft	5.54 (0.263)	14.6 (0.824)	5.42 (0.086)	14.2 (1.530)
10	Firm	5.78 (0.134)	13.9 (0.640)	5.32 (0.089)	13.4 (0.824)
10	Soft	5.41 (0.055)	13.1 (0.531)	5.43 (0.153)	13.3 (1.275)
20	Firm	5.96 (0.074)	15.2 (0.839)	5.83 (0.117)	13.5 (0.768)
20	Soft	5.74 (0.107)	15.0 (1.176)	5.40 (0.071)	13.6 (0.839)

^zFruit harvested 2 Nov. and 9 Nov. 1992. Stored at 0, 5, 10 or 20C for 2 weeks, followed by 1 week at 20C. After 3 weeks storage, five firm and five soft fruit selected.

^yData are means of five fruit. (Sd).

should be performed to determine practical postharvest treatments to enhance uniform ripening and to develop appropriate methods for handling and packaging.

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FEIJOA HISTORY AND IMPROVEMENT

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fulness, and newer germplasm are problems for improvement of this interesting fruit and ornamental plant.

Additional index words. Varieties, propagation, climatic adaptation, pollination.

Abstract. Horticultural development of *Feijoa sellowiana* Berg. as a fruiting plant is discussed with notes on its origin, history, climatic adaptation, cultural requirements, and cultivar description and performance in Florida. Propagation, self-fruit-

Many hundreds of plants of Feijoa are in ornamental hedges and a few in foundation plantings on the University of Florida campus. Because of its hardiness and other qualities, it is recommended by Watkins and Sheehan (1969) in their popular book on landscape plants for Florida. In 1990, we began to survey the local plantings for possibility of a dual fruiting and landscaping plant. Feijoa flowers in late April and May and fruit ripen in September and October, so there are no frost hazards to fruiting. The plant withstands winter cold to -10C (14F) or lower without injury and is hardy throughout Florida (Mowry et al., 1958) as well as most of the Gulf Coast of the United States.

Why has it not also become of interest for its fruit in Florida, as it has in California, New Zealand, Uruguay, France, Russia, and other parts of the world? This paper may answer some questions and suggest solutions.

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