Temperature and Storage Time Affect Quality of Yellow Passion Fruit

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Abstract. Vine-ripened yellow passion fruit (*Passiflora edulis* f. *flavicarpa* Deg.) packed and shipped from Homestead, Fla., were stored for 15, 30, or 45 days at 5, 10, or 15C. Fruit analyzed immediately on arrival had the best external appearance and highest fruit weight. Fruit weight loss increased with storage time at all temperatures and the response was linear. Fruit external appearance deteriorated rapidly at 5 and 15C. Pulp percentage at 5C increased linearly with storage duration and did not change at 10C. Pulp percentage at 15C changed quadratically with storage time, increasing up to 30 days and then decreasing by 45 days. Soluble solids concentration did not change at 5 or 10C, but decreased linearly at 15C. Sucrose content decreased quadratically at 5C, linearly at 15C, but increased linearly at 10C. Fructose and glucose content decreased quadratically with storage time at 15C. Glucose content increased linearly at 5 and 10C and fructose content did not change at these temperatures.

Produce sensitive to chilling injury (CI) requires storage temperatures above 12C (Wills et al., 1982). Passion fruit is a tropical climacteric fruit (Biale, 1975; Wills, et al., 1982) subject to chilling injury when stored below 6.5C (Pruthi, 1963). Recommended storage temperatures are 3 to 5C (Wills et al., 1982), 7 to 10C (McGregor, 1987), and 5 to 7C (Pruthi, 1963). Yellow passion fruit stored longer than 7 to 10 days under ambient conditions is susceptible to shrivel, pulp fermentation, and fungal attack (Pruthi, 1963). However, 80% of the fruit was judged to be marketable after storage in plastic bags for 14 days at 23C (Salazar and Torres, 1977).

We discuss the effect of temperature and storage time on quality of yellow passion fruit.

Vine-ripened yellow passion fruit, packed in commercial cardboard boxes with 36 individual cell packs and shipped over night via express courier from Homestead, Fla., were randomly grouped in open plastic trays and subjected to one of nine treatments, i.e., storage for 15, 30, or 45 days at 5, 10, or 15C and 85% relative humidity (RH). The respective vapor pressure differences were $\approx$ 140, 180, and 260 Pa, respectively. Each experimental unit consisted of three fruit per treatment and treatments were replicated four times. The experiment was conducted three times using shipping dates as a blocking factor (Petersen, 1985; Steel and Torrie, 1980). Treatments were arranged in a split-plot de-

sign with temperature of storage rooms as whole-plots and three storage periods as sub-plots. Fruit were received at monthly intervals starting in Aug. 1988.

Data analysis based on three fruit per treatment and four replications were taken for the following characteristics: external appearance; fresh fruit weight; percentage of pulp; soluble solids concentration (SSC); and fructose, glucose, and sucrose concentrations. For sugar analysis, one sample per replication (three fruit per replicate) was tested in each experiment. Control fruit were analyzed immediately on arrival. Analysis of variance was performed on all variables and linear and quadratic contrasts were determined for the response of the variables to days in storage.

External fruit appearance was visually determined and expressed as percentage of fruit surface shrivelled. Pulp percentage was ex-

pressed as (pulp weight $\div$ by total fruit weight) $\times$ 100. We measured SSC with a Bausch and Lomb optical refractometer and expressed in $^{\circ}$ Brix. Fructose, glucose, and sucrose concentration of the juice was determined by means of high-performance liquid chromatography (HPLC) using a carbohydrate analysis column (part number 84038) from Water Associates (Milford, Mass.) as previously described by Arjona et al. (1991).

Fruit external appearance declined linearly with storage time at each storage temperature (Table 1). However, shrivelling was less at 10C. CI, as previously reported for purple passion fruit (Pruthi, 1963), at 5C and water loss at 15C may have contributed to the higher rates of fruit deterioration at these temperatures. Storage at 10C was recommended for passion fruit by McGregor (1987).

Fruit weight loss percentage consistently increased with storage time at all temperatures and the response was linear. The largest and about equal loss occurred at 10 and 15C during 45 days of storage. Fruit weight loss percentages in this experiment were similar to those reported by Pruthi (1963) in which weight loss of purple passion fruit increased with increasing temperatures and storage durations.

SSC of fruit stored at 5C did not differ from the control and was not affected by storage time (Table 1). Fruit stored at 10C had a lower SSC than the control, but storage had no effect. Fruit stored at 15C showed a linear decrease in SSC with storage time. SSC included reducing and nonreducing sugars, organic acids, and other soluble metabolites (Salisbury and Ross, 1985). A greater reduction in SSC would be expected at 15C because of the higher respiration rate.

Pulp percentage increased linearly with storage time at 5C, did not change at 10C, and changed quadratically at 15C with storage time (Table 1). Pruthi and Lal (1955) reported the yield of pulp from purple passion fruit to vary from 46% to 54%. Pulp

Table 1. External appearance percentage, fruit weight loss, soluble solids content (SSC), and fruit pulp percentage of yellow passion fruit as influenced by storage duration at 5, 10, and 15C.

Storage condition		External appearance ^z	Fruit wt loss (%)	SSC ($^{\circ}$ Brix)	Fruit pulp (%)
Temp ($^{\circ}$ C)	Duration (days)				
Control ^y		12	---	15.3	44.9
5	15	84	18	14.5	55.9
	30	86	39	15.7	63.9
	45	93	48	15.8	67.4
Significance ^x 10	15	L ^y	L*	NS	L*
	30	40	16	13.0	50.6
	45	65	26	13.0	50.8
		65	65	13.0	51.4
Significance ^x 15	15	L*	L*	NS	NS
	30	50	21	12.5	51.7
	45	80	37	10.4	56.4
		82	62	4.6	50.9
Significance ^x		L*	L*	L*	Q*

^zExpressed as percentage of surface shrivelled.

^yFruit analyzed immediately upon arrival.

*L = linear, Q = quadratic.

NS,*Nonsignificant or significant at $P = 0.05$.

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Table 2. Sugar content of yellow passion fruit as influenced by storage duration at 5, 10, and 15C.

Storage condition		Sucrose	Fructose	Glucose
Temp (°C)	Duration (days)			
Control ^z		3.1	4.7	4.9
5	15	3.0	4.5	4.2
	30	2.0	5.1	4.9
	45	2.2	5.5	5.5
Significance ^y		L*Q*	NS	L*
10	15	2.2	4.8	4.6
	30	2.3	5.1	5.4
	45	2.7	5.4	6.0
Significance ^y		L*	NS	L*
15	15	1.9	4.4	4.4
	30	1.5	4.4	4.4
	45	1.2	1.5	1.1
Significance ^y		L*	Q*	Q*

*Fruit analyzed immediately upon arrival.

^yL = linear, Q = quadratic.^{NS}.*Nonsignificant or significant at $P = 0.05$.

percentage has also been reported to vary with species (Pruthi, 1963).

Sucrose content decreased quadratically at 5C, linearly at 15C, but increased linearly at 10C (Table 2). These results agree with those obtained by Campbell et al. (1989), who found that carambola fruit stored at 10C were of better quality than those held at 15 or 20C. They also found that fruit kept at 5C had higher levels of soluble sugars (glucose, fructose, and sucrose) than did fruit stored at higher temperatures.

Fructose and glucose content decreased quadratically with storage time at 15C (no change at 30 days and a dramatic drop at 45 days). Glucose content increased linearly at 5 and 10C, but fructose content did not change at these temperatures (Table 2). Cleavage of

sucrose may be responsible for the increase in glucose content in fruit stored at 5C. The consumption of fructose and glucose during respiration may explain the lower fructose and glucose content of fruit stored at 15C relative to storage at 5 or 10C. Fruit senescence may explain the pronounced drop in sugars at 45 days in 15C air.

Results from this study indicate a rapid deterioration of external appearance and/or high weight loss at 5 and 15C for stored yellow passion fruit. Fruit stored for 15 days at 10C had the least surface shrivel and weight loss. Also, soluble sugars were maintained at a higher level at 5 and 10C than at 15C. Sugar loss was notable at 15C. Storage at 10C for 15 days appears feasible for maintaining quality in yellow passion fruit. Fur-

ther work should involve temperatures between 8 and 14C to provide a more specific data base for commercial use.

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