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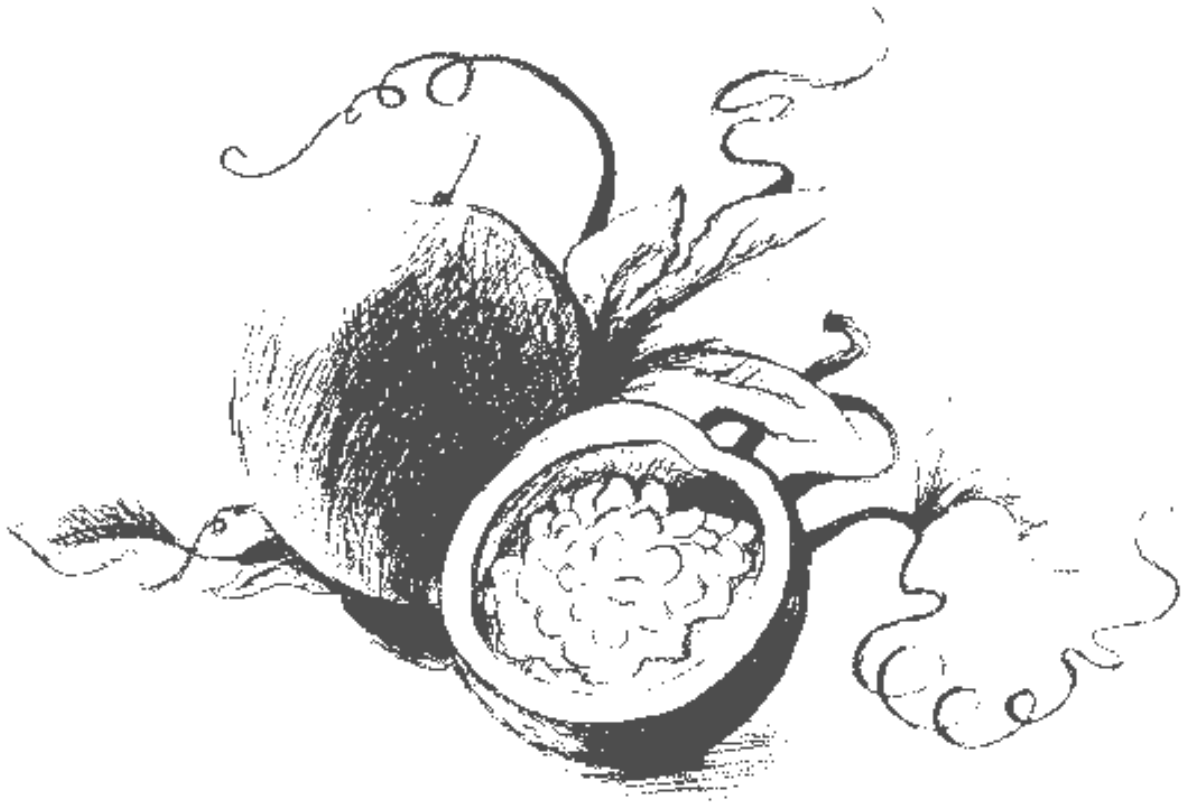
STUDIES ON

Postharvest Quality *of* Passion Fruit



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Studies on Postharvest Quality of Passion Fruit

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Studies on Postharvest Quality of Passion Fruit

INTRODUCTION

Passion fruit (*Passiflora edulis* Sims), a tropical fruit species produced in the United States, has become a popular addition to some diets (Campbell, 1986; Campbell and Knight, 1983; Knight and Sauls, 1983). Juice of the fruit is a good source of vitamins A and C, and its aroma and flavor make pleasant contributions to drinks and desserts (Campbell and Knight, 1983; Pruthi, 1963).

Commercially matured fruit are ground-harvested after natural drop. Fruit that abscise from the vine begin dehydrating immediately and are frequently contaminated with soil-borne pathogens. Passion fruit is climacteric, and the climacteric rise occurs while the fruit is still attached to the plant (Biale, 1975). Fruit picked from the vine have an unripened flavor (Campbell and Knight, 1983; Knight and Sauls, 1983). The storage life may be extended considerably if mature-green fruit could be harvested before the climacteric rise and induced ripened in storage at low temperatures (Biale, 1975). Ethylene-induced ripening of mature green bananas and tomatoes after harvest is a widely accepted commercial practice (Jeffery et al., 1984; Liu, 1976).

Passion fruit stored at 5° C and 85% relative humidity (RH) lost moisture rapidly; 80% of the fruit surface was shriveled after 3 days in storage (Arjona et al., 1992). While passion fruit juice remained wholesome for 7 days, fruit began shriveling soon after abscission (Knight and Sauls, 1983). The rind accounted for most of the dehydration in the first 15 days of storage (Arjona, 1990). Storing passion fruit in sealed polyethylene bags at 6° to 10° C can protect them from shriveling for 3 to 4 weeks (Campbell and Knight, 1983). Cereda et al. (1976) reported that passion fruit stored in polyethylene bags at 7.2° C and 85% to 90% RH remained marketable up to 30 days. However, moisture condenses on the fruit surface under consistently high RH, creating conditions favorable for pathogen growth (Zagory and Kader, 1988). For fresh-fruit use, water loss that results in wilting and shriveling must be minimized.

Recent studies on modified-atmosphere packaging of horticultural commodities show that highly permeable films such as polyvinyl chloride (PVC) overwraps can maintain postharvest quality by reducing transpiration and respiration (Kader, 1986).

Produce sensitive to chilling injury (CI) requires storage temperatures above 12° C (Wills et al., 1982). Passion fruit is a tropical climacteric fruit (Biale, 1975; Wills, et al., 1982) subject to chilling injury when stored below 6.5° C (Purthi, 1963). Recommended storage temperatures are 3° to 5° C (Wills et al., 1982), 7° to 10° C (McGregor, 1987), and 5° to 7° C (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 23° C (Salazar and Torres, 1977).

The objectives of this study were to (1) examine the effect of harvest time and ethylene treatment on postharvest quality of mature-green passion fruit, (2) study the effects of polyvinylchloride (PVC) film wraps on quality of stored yellow passion fruit, and (3) determine the effect of temperature and storage time on quality of yellow passion fruit.

METHODS

Experiment I

Purple passion fruit vines were grown at the Box Horticultural Greenhouse, Mississippi State University. Plants were produced from vegetative tip cuttings and grown in the greenhouse at 30 ± 2° C. Plants were irrigated as needed and fertilized with 13 N-5.7P-10.7K at 200 mg of N per liter every 2 weeks. Flowers were tagged at anthesis (late May and early June 1989), and fruit was harvested at three developmental stages: (1) mature-green, harvested 55 days after anthesis (DAA); (2) mature-green, harvested 60 DAA; and (3) fully ripe, harvested immediately after abscission (70 to 80 DAA). Immediately after harvest, fruits were surface-disinfected by holding them for 5 minutes in a 10% sodium hypochlorite (chlorine bleach) solution and stored to 10 days at 10° C for initial evaluations. For the fruit used for storage, the following four treatments were established: (1) mature-green, harvested 55 DAA, no ethylene; (2) mature-green, harvested 60 DAA, no ethylene; (3) same as treatment 1, but with ethylene; and (4) same as treatment 2, but with ethylene. Fruit were exposed to ethylene for 35 hours and held in air at 21° C for 48 hours. The experiment was conducted twice using a completely randomized design with three replications. Each replicate contained three fruits.

For initial evaluations, juice was extracted from the fruit immediately after harvest and analyzed for pH, soluble solids concentration (SSC), fructose, glucose, and sucrose. Sugars were determined by high-performance liquid chromatography (HPLC). Fruit were cut in half. The pulp was spooned out, and the juice and seeds were separated by squeezing the pulp in two-layers of cheesecloth. The juice was collected and then centrifuged at 1500 x *g* for 1 hour. The supernatant was collected and filtered through a sep-pack C-18 cartridge previously activated with 2 ml of methanol and rinsed with 10 ml of distilled water. The sample was filtered with a 0.45-μm-pore filter, collected, and injected into the HPLC system. Acetonitrile (80%) in water was used as a solvent. A 10-μl sample was manually injected for every determination. The pump (Waters Assoc., Milford, Massachusetts) was calibrated to deliver 2 ml per minute at 10,545 kPa. A carbohydrate analysis column (Waters Assoc.) was used. Chromatograms were plotted in a standard strip chart recorder. A series of 1%, 2.5%, 5%, and 10% solutions of each sugar was used to obtain a standard curve. Juice pH was measured with an Accumet pH meter 925 (Fisher Scientific, Pittsburgh). SSC was determined with a 5.5 Bausch and Lomb (Rochester, New York) optical refractometer.

The remaining fruits harvested 55 to 60 DAA were arranged in a 2x2 factorial with fruit age (55 or 60 DAA) and ethylene treatment (0 and 10 μl of ethylene per liter for 35 hours using a commercial ripening banana chamber maintained at 10° C and 80% RH. Fruit of different age were not in the chamber at the same time. Ethylene was applied with a catalytic generator (Catalytic Generators, Chesapeake, Virginia.) present to deliver the appropriate concentration. The remaining half of the fruit was maintained in a separate chamber, also at 10° C and 80% RH, without ethylene. After the ethylene treatment, the fruit were taken from the storage chambers and place at room temperature (21° C) and 30% RH for 48 hours for continued ripening. The percentage of fruit surface with purple pigmentation was determined visually. Analysis of variance was performed for all variables, as well as LSD, were used to compare treatments (P=0.05).

Experiment II

Vine-ripened yellow passion fruit provided by J.R. Brooks and Son of Homestead, Florida, were packed on the day of harvest in commercial cardboard boxes (36 individual cell packs) and shipped, via express courier, to our laboratory. Fruit were rinsed with tap water and treated with 0.05% sodium hypochloride solution on arrival (i.e., the day after harvest). Four-fruit samples were placed in a 15x15x2.5-cm-deep polystyrene tray and overwrapped with a plasticized PVC film (VF-60; Borden Chemical Division, Andover, Massachusetts). The experiment was a 2x2 factorial with wrapped and nonwrapped fruit (all combinations) stored at 10° C for 15 or 30 days at 85% RH in a commercial ripening banana chamber. The average fruit weight in each container was 198 ± 1 g. The treatments were replicated four times (four fruit per replication). Fruit was analyzed immediately on arrival and after treatment with sodium hypochloride as the control (initial).

The atmosphere within the packages and in the storage room was sampled 0, 5, 10, 15, 20, 25, and 30

days after storage. A 2-ml sample from wrapped trays was taken with a gas sampling syringe and needle through a neoprene septum (1 cm in diameter) previously attached to the film. All gas samples were analyzed for CO_2 and O_2 concentration by means of a gas chromatograph fitted with a thermo conductivity detector and a column temperature of 75° C.

Fruit were analyzed after 15 and 30 days of storage for the following characteristics: (1) external appearance (percentage of surface shriveled); (2) weight; (3) pulp percentage (weight of fleshy pericarp and seeds divided by fruit weight times 100); (4) juice pH; (5) total soluble solids concentration (SSC); and (6) juice fructose, glucose, and sucrose contents determined by high-performance liquid chromatography following the method of Arjona et al. (1992). Fruit weight loss was calculated by subtracting fruit weight at the end of the storage period from the initial weight. Analysis of variance was performed for all variables measured, and LSD tests were used to separate treatment means. Since there were no treatment-by-experiment interactions for any of the characteristics measured, after analysis, data were pooled over experiments for comparisons of means.

Experiment III

Vine-ripened yellow passion fruit, packed in commercial cardboard boxes with 36 individual cell packs and shipped overnight via express courier from Homestead, Florida, were randomly grouped in open plastic trays and subjected to one of nine treatments: storage for 15, 30, or 45 days at 5°, 10°, or 15° C and 85% relative humidity (RH). The respective vapor pressure differences were approximately 140, 180, and 260 Pa. 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 design with temperature of storage rooms as whole plots and three storage periods as subplots. Fruit were received at monthly intervals starting in August 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 within each temperature.

External fruit appearance was visually determined and expressed as percentage of fruit surface shriveled. Pulp percentage was expressed as pulp weight divided by total fruit weight times 100. We measured SSC with a Bausch and Lomb optical refractometer and expressed in °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, Massachusetts) as previously described by Arjona et al. (1991).

Results and Discussion

Experiment I

Juice pH (range 2.8-3.3) and SSC (range 10.8% to 12.5%) did not differ significantly among treatments. Fruit harvested at 55 and 60 DAA and analyzed immediately had an entirely green surface. Since consumers prefer purple pigment on at least 90% of the fruit surface, fruits harvested at 55 and 60 DAA with less than 10% purple (Table 1) were unacceptable for market. Fruit harvested at 55 and 60 DAA, stored for 10 days at 10° C, and not treated with ethylene develop the typical purple pigmentation of the ripe stage on approximately 30% of the fruit surface, particularly at the peduncle and in the blossom-end areas. The remaining 70% of the surface turned a yellowish-green. These fruit also would have been unmarketable. Fruit harvested at 55 or 60 DAA, stored, and treated with ethylene developed the characteristic purple surface of vine-ripened fruit on more than 80% of the surface, indicating that ethylene enhanced pigment development (Table 1). These results with ethylene are consistent with the literature, in which the role of ethylene in enhancement of fruit color has been well established (Moore, 1979).

Table 1. Effect of interval between anthesis and harvest (DAA) and ethylene treatment on color development of purple passion fruit.

Time of evaluation (DAA)	Ethylene[1]	Surface purple[2]
	µl/L	*%*
Initial		
Vine-ripened, 70 to 80	—	92a
Green, 55	—	3 c
Green, 30	—	5 c
After Storage		
Green, 55	10	88 a
Green, 60	10	92 a
Green, 55	0	34 b
Green, 60	0	42 b
LSD[2]		7

[1]Measured after the fruits were stored at 10° C for 10 days, followed by exposure to ethylene for 35 hours and holding in air at 21° C for 48 hours.
[2]The percentage of purple on the fruit surface was visually estimated. Values are the means for four fruit.

The sucrose content of fruit harvested at 55 or 60 DAA and stored for 10 days decreased during storage (Figure 1). Ethylene-treated fruit harvested 55 DAA has less sucrose than the same fruit without ethylene (Figure 1). Sucrose is metabolized during storage and yields fructose and glucose (Jeffery et al., 1984), thereby accounting for the reduction in sucrose and the increase in fructose and glucose after storage. Vine-ripened fruit (70 to 80 DAA) and fruit harvested at 55 DAA and treated with ethylene after storage contained less sucrose than fruit analyzed at harvest or fruit harvested 55 DAA and not treated with ethylene. Sucrose content was similar for vine-ripened fruit and fruit treated with ethylene. Thus, sucrose content remained the same whether fruit ripened on the vine or were induced to ripen with ethylene after harvest.

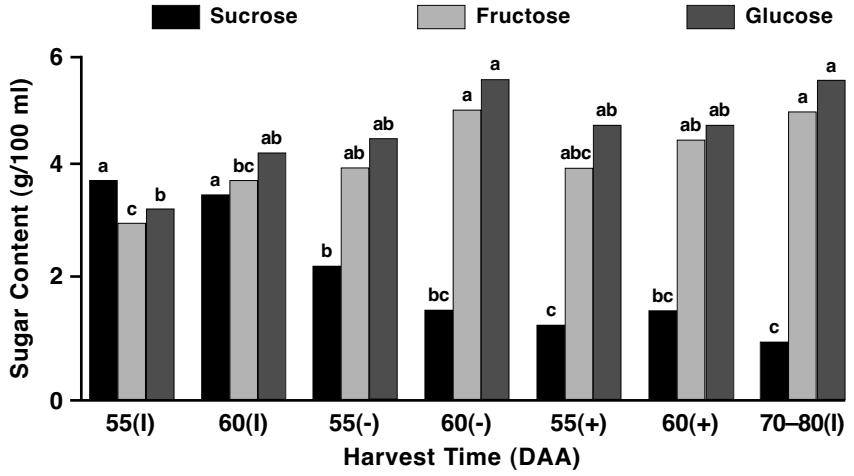

Figure 1. Sucrose, fructose, and glucose contents of passion fruit harvested 55, 60, or 70 to 80 days after anthesis (DAA). I, initial; -, no ethylene; +, ethylene (LSD test, P ≤ 0.05). Measurements were made at two points: (1) immediately after harvest for initial evaluations and (2) after the following sequence — storage at 10° C for 10 days, exposure to 0 µl or 10 µl of ethylene per liter for 35 hours, holding in air at 21° C for 48 hours.

In general, fructose concentration increased as fruit ripened and as sucrose content decreased (Figure 1). Fructose content of fruit harvested at 55 DAA and analyzed immediately was lower than that of most other samples harvested 55 DAA.

Glucose followed a similar pattern as fructose (Figure 1). The glucose content in fruit harvested at 55 DAA and analyzed immediately was significantly lower than that of vine-ripened fruit or that harvested at 60 DAA and not treated with ethylene. As in the case of fructose, glucose content increased as ripening proceeded.

Results from this study indicate that, regardless of ethylene treatment, mature-green fruit harvested 55 or 60 DAA, stored at 10° C for 10 days, and allowed to ripen for 48 hours develop the same SSC and juice pH as those allowed to ripen on the vine. Mature-green fruit (harvested 55 to 60 DAA) lost sucrose and gained fructose and glucose during storage. Sugar concentrations were not influenced by ethylene. It appears that mature-green fruit may be harvested from the vine and allowed to ripen to obtain postharvest quality similar to vine-ripened fruit. However, an ethylene treatment is required to enhance pigment development of fruit harvested at the mature-green stage to render them marketable. No effort was made to relate flavor to maturity indices of passion fruit. Tests to determine the influence of storage conditions and ethylene treatment on fruit flavor warrant investigation.

Experiment II

The CO_2 concentration within the package never exceeded 0.5% and that of O_2 never dropped below 13% throughout the 30 days of the experiment. In both experiments, superficial mold growth was observed following 30 days of storage, but the growth was minimal and no fruit were discarded.

Film-wrapped fruit had a better appearance, expressed as percentage of surface shriveled, than nonwrapped fruit (Table 2). Fruit stored for 15 days also had a better appearance than fruit stored for 30 days. Fruit stored for 25 days also had a better appearance than fruit stored for 30 days. After 25 days of storage, 50% of the surface of nonwrapped fruit shriveled; the percentage of surface shriveled increased to 100% in nonwrapped fruit stored for 30 days. Nonwrapped fruit had the highest weight loss, and weight loss increased with storage time. Because nonwrapped fruit lost more weight than wrapped fruit, nonwrapped fruit had a higher pulp percentage. Juice pH was unaffected by any of the treatments. Fruit lost SSC during storage, but there were no differences among treatments. These results agree with those reported by Salazar and Torres (1997), who found that 80% of the mature passion fruit stored in plastic bags for 14 days at 23° C remained marketable. Cereda et al. (1976) also obtained similar results. They found that the storage life of passion fruit could be extended up to 30 days if fruit were treated with paraffin wax or packed in polyethylene bags and stored at 7.2° C and 85% to 90% RH.

Initial sucrose and fructose levels in wrapped fruit stored for 15 days declined 62% and 15%, respectively (Table 3). Sucrose content, after an initial drop,

Table 2. Effect of plastic film and storage duration on external appearance, juice pH, soluble solids concentration (SSC), fruit weight, fruit weight loss, and pulp percentage of yellow passion fruit.

Treatment and days stored	External[1] appearance	Fruit weight loss	Juice pH	SSC	Fruit weight	Pulp
		%			*g*	%
Initial[2]	3 d[3]	—	3.2	15 a	49 a	45 b
Wrapped						
15	7 d	7 d	3.2	11 b	47 a	46 b
30	18 c	14 c	3.3	10 b	45 a	45 b
Nonwrapped						
15	50 b	32 b	3.3	11 b	33 b	68 a
30	100 a	51 a	3.4	12 b	25 c	70 a
LSD	8.2	6.4	NS	2.7	5.5	7.8

[1]Expressed as percentage of fruit surface shriveled.
[2]Fruit analyzed immediately on arrival.
[3]Means followed by the same letter within a column do not differ by LSD at P≤0.05.

remained between 11 mg and 14 mg per milliliter regardless of wrapping or days in storage. Fructose content, however, was higher in wrapped fruit stored for 15 days than in nonwrapped fruit stored for 15 to 30 days. The decrease in glucose in wrapped fruit stored for 15 days was nonsignificant. Glucose content of wrapped fruit decreased 18% from initial measurements after 30 days in storage. The glucose content of nonwrapped fruit stored for 15 or 30 days was similar (Table 3).

Table 3. Effect of plastic film and storage time on sugar concentration of yellow passion fruit.

Treatment and days stored	Sucrose	Sugar concentration	
		Fructose	Glucose
		mg/ml	*mg/ml*
Initial[1]	32 a[2]	47 a	49 a
Wrapped			
15	12 b	40 b	43 ab
30	11 b	35 bc	40 b
Nonwrapped			
15	14 b	33 c	40 b
30	10 b	21 c	37 b
LSD	14	6	6

[1]Fruit analyzed immediately on arrival.
[2]Means followed by the same letter within a column do not differ by LSD at $P \leq 0.05$.

In these experiments, wrapping fruit with plasticized film minimized fruit weight loss and maintained the external appearance stored fruit. RH under the wrapped treatments was not measured, but condensation, which may have contributed to the mold growth, formed in the packages after 25 days of storage. Considering the minor increase in CO_2 and moderate decrease in O_2 under the PVC film in these experiments, much of the beneficial effect of film wrap was from controlling weight loss. The utility of permeable plastic films that would result in higher CO_2 and lower O_2 levels than we achieved needs investigation in relation to storage of yellow passion fruit.

Experiment III

Fruit external appearance declined linearly with storage time at each storage temperature (Table 4). However, shriveling was less at 10° C. Chilling injury, as previously reported for purple passion fruit (Pruthi, 1963), at 5° C and water loss at 15° C may have contributed to the higher rates of fruit deterioration at these temperatures. Storage at 10° C was recommended for passion fruit by McGregor (1987).

Fruit weight loss percentage consistently increased with storage time at each storage temperature, and the response was linear. The largest and about equal loss occurred at 10° and 15° C 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.

Soluble solids concentrations (SSC) of fruit stored at 5° C did not differ from the control and was not affected by storage time (Table 4). Fruit stored at 10° C had a lower SSC than the control, but storage had no effect. Fruit stored at 15° C 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 15° C because of the higher respiration rate.

Pulp percentage increased linearly with storage time at 5° C, did not change at 10° C, and changed quadratically at 15° C with storage time (Table 4). Pruthi and Lal (1955) reported the yield of pulp from purple passion fruit to vary from 46% to 54%. Pulp percentage has also been reported to vary with species (Pruthi, 1963).

Sucrose content decreased quadratically at 5° C and linearly at 15° C, but it increased linearly at 10° C (Table 5). These results agree with those obtained by Campbell et al. (1989), who found that carambola fruit stored at 10° C were of better quality than those held at 15 or 20° C. They also found that fruit kept at 5° C 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 15° C (no change at 30 days and a dramatic drop at 45 days). Glucose content increased linearly at 5° to 10° C, but fructose content did not change at these temperatures (Table 5). Cleavage of sucrose may be responsible for the increase in glucose content in fruit stored at 5° C. The consumption of fructose and glucose during respiration may explain the lower fructose and glucose content of fruit stored at 15° C relative to storage at 5°

Table 4. 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 15° C.

Storage condition		External	Fruit	SSC	Fruit
Temperature	Duration	appearance[1]	weight loss		pulp
°C	*days*		*%*	*°Brix*	*%*
Control[2]	—	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[3]		L*[2]	L*	NS	L*
10	15	40	16	13.0	50.6
	30	65	26	13.0	50.8
	45	65	65	13.0	51.4
Significance[3]		L*	L*	NS	NS
15	15	50	21	12.5	51.7
	30	80	37	10.4	56.4
	45	82	62	4.6	50.9
Significance[3]		L*	L*	L*	Q*

[1]Expressed as percentage of surface shriveled.
[2]Fruit analyzed immediately upon arrival.
[3]L = linear, Q = quadratic, NS = Nonsignificant or significant at P = 0.05.

or 10° C. Fruit senescence may explain the pronounced drop in sugars at 45 days in 15° C air.

Results from this study indicate a rapid deterioration of external appearance and/or high weight loss at 5° and 15° C for stored yellow passion fruit. Fruit stored for 15 days at 10° C had the least surface shrivel and weight loss. Also, soluble sugars were maintained at a higher level at 5° and 10° C than at 15° C. Sugar loss was notable at 15° C. Storage at 10° C for 15 days appears feasible for maintaining quality in yellow passion fruit. Further work should involve temperature between 8° and 14° C to provide a more specific database for commercial use.

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

Storage condition		Sucrose	Fructose	Glucose
Temperature	Duration			
°C	*days*	*g/100 ml*	*g/100 ml*	*g/100 ml*
Control[1]		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[2]		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[2]		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		L*	Q*	Q*

[1]Fruit analyzed immediately upon arrival.
[2]L = linear, Q = quadratic, NS = Nonsignificant or significant at P = 0.05.

SUMMARY

Experiment I

Greenhouse-grown purple passion fruit (*Passiflora edulis* Sims) were harvested mature-green 55 or 60 days after anthesis (DAA) and stored for 10 days at 10° C. After storage, half the fruit were treated with 10 μl of ethylene per liter for 35 hours and then stored at 21° C for 48 hours. Juice of treated and nontreated fruit was analyzed for comparison with juice of vine-ripened fruit (harvested 70 to 80 DAA). Sucrose concentration decreased and fructose and glucose concentrations increased after storage, regardless of ethylene treatment. Fruit harvested 55 or 60 DAA, with or without ethylene, had the same sugar and soluble solids concentrations and pH as vine-ripened fruit. Ethylene treatment enhanced surface purple pigmentation of fruit harvested mature-green.

Experiment II

Vine-ripened yellow passion fruit (*Passiflora edulis f. flavicarpa* Deg.) were placed in Styrofoam trays and wrapped with VF-60 plastic film and stored for 15 and 30 days. Wrapping prevented fruit weight loss while maintaining external appearance. Storage time contributed to quality loss of external appearance. Wrapping maintained fruit glucose and fructose content at 43 mg and 40 mg per milliliter up to 15 days, respectively, and did not influence juice pH. Initial sucrose content of wrapped fruit declined 62% after 15 days in storage. Plastic film did not effectively modify O_2 or CO_2.

Experiment III

Vine-ripened yellow passion fruit (*Passiflora edulis* f. *flavicarpa* Deg.) packed and shipped from Homestead, Florida, were stored for 15, 30, or 45 days at 5°, 10°, or 15° C. 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 15° C. Pulp percentage at 5° C increased linearly with storage duration and did not change at 10° C. Pulp percentage at 15° C 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 10° C, but it decreased linearly at 15° C. Sucrose content decreased quadratically at 5° C and linearly at 15° C, but it increased linearly at 10° C. Fructose and glucose content decrease quadratically with storage time at 15° C. Glucose content increased linearly at 5° and 10° C and fructose content did not change at these temperatures.

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