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Wrapping in Polyvinyl Chloride Film Slows Quality Loss of Yellow Passion Fruit

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Abstract. **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 and 40 mg·ml^{-1} 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.**

Passion fruit stored at 5C 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 10C 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 7.2C 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). The objective of these experiments was to study the effects of PVC film wraps on the quality of stored yellow passion fruit.

Materials and Methods

Vine-ripened yellow passion fruit provided by J.R. Brooks and Son, Homestead, Fla., 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 a 0.5% sodium hypochloride solution on arrival, i.e., the day after harvest. Four-fruit samples were placed in a 15 × 15 × 2.5-cm-deep polystyrene tray and overwrapped with a plasticized PVC film (VF-60; Borden Chemical Division, Andover, Mass.). The experiment was a 2 × 2 factorial with wrapped and nonwrapped fruit stored at 10C for 15 or 30 days at 85% RH. 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. The experiment was conducted twice, starting 15 July and 8 Aug. 1989.

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 (1.0 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 chromatography fitted with a thermoconductivity detector and a column temperature of 75C.

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 × 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 was no treatment × experiment interactions for any of the characteristics measured, after analysis, data were pooled over experiments for comparisons of means.

Results and Discussion

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 1). Fruit stored for 15 days also had a better appearance than fruit stored for 30 days. After 15 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 (1977), who found that 80% of the mature passion fruit stored in plastic bags for 14 days at 23C 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 7.2C and 85% to 90% RH.

Initial sucrose and fructose levels in

Table 1. 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[z] appearance	Fruit wt loss (%)	Juice pH	SSC	Fruit wt (g)	Pulp (%)
Initial[y]	3 d[x]	---	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

[z]Expressed as percentage of fruit surface shriveled.
[y]Fruit analyzed immediately on arrival.
[x]Means followed by the same letter within a column do not differ by LSD at $P \leq 0.05$.

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Table 2. Effect of plastic film and storage time on sugar concentration of yellow passion fruit.

Treatment and days stored	Sugar concn ($mg \cdot ml^{-1}$)		
	Sucrose	Fructose	Glucose
Initial[z]	32 a[y]	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	31 c	37 b
LSD	14	6	6

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

wrapped fruit stored for 15 days declined 62% and 15%, respectively (Table 2). Sucrose content, after an initial drop, remained between 11 and 14 $mg \cdot ml^{-1}$ 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 or 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 2).

In these experiments, wrapping fruit with plasticized film minimized fruit weight loss and maintained the external appearance of 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.

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