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QUALITY OF PITAYA FRUIT (*Hylocereus undatus*) AS INFLUENCED BY STORAGE TEMPERATURE AND PACKAGING

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INTRODUCTION

Pitaya (*Hylocereus undatus*) is a non-climacteric fruit that reaches its best eating quality when harvested ripe, decreasing thereafter during storage (CHIEN et al., 2007). As a new crop, there have been limited studies focused on extending the postharvest quality of pitaya fruit. The main postharvest problems of pitaya fruit are mechanical injury, chilling injury, decay, and water loss (NERD et al., 1999; CHANDRAN, 2010). Mechanical injury leads to development of sunken areas from increased water loss. Chilling injury is characterized by translucency and browning of the outer portion of the flesh, darkening of the scales, as well as fruit softening, shriveling, and poor flavor after exposure to low storage temperatures on the range between 5 ºC and 10 ºC (NERD et al., 1999).

Packing the pitaya fruit in a perforated plastic bag is a potential approach to reduce water loss and rapid shriveling, which combined with low storage temperatures can extend the postharvest quality of the fruit. Our objectives were to determine the best combination of storage temperature and use of perforated plastic bags to decrease water loss and maintain the postharvest quality of pitaya fruit produced in California.

MATERIALS AND METHODS

Pitaya fruit were harvested 45 days after flowering from a commercial orchard in Escondido, CA, USA. After harvest, fruit were washed in water and allowed to dry at 20 ºC for 24 hours. Fruit were individually wrapped with shredded paper, packed in six fruit corrugated cardboard boxes and shipped overnight to the Postharvest Laboratory at the University of California, Davis, CA. Fruit were randomized into treatment groups and stored at 5, 7, or 10 ºC with and without a perforated plastic bag. The bags were perforated with 1 cm (diameter) holes, with 30 holes m^{-2}. Fruit were stored for 20 days at each temperature and then transferred to shelf-life conditions at 20 ºC for 5 days. During shelf-life, all fruit were held without a perforated bag. The

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relative humidity during storage and shelf-life was 80%. Each treatment was comprised of four replications with four fruit per replication. Fruit were analyzed for decay incidence, decay severity (number of decay spots per fruit), weight loss, chilling injury, firmness, total soluble solids content, and titratable acidity (malic acid equivalents). The analysis of variance (ANOVA) for a completely randomized design was performed for each variable. The mean values of four replicate samples were compared using Tukey's test (P = 0.05).

RESULTS AND DISCUSSION

Pitaya fruit stored at 5 ºC without a perforated plastic bag showed no decay incidence after storage and shelf-life conditions while there was 10% decay in fruit stored at 5 ºC in a bag (Figure 1). The use of perforated plastic bags also increased the percentage of fruit showing decay incidence during storage at 7 ºC and 10 ºC, as well as decay severity at 10 ºC (Figures 1A and 1B). Transferring pitaya fruit to 20 ºC after storage resulted in about 80% decay incidence in fruit stored at 5 ºC with a perforated plastic bag, while fruit stored at 5 ºC without a perforated bag had no decay. Fruit stored at 7 ºC and 10 ºC with and without a perforated plastic bag had 100% decay incidence after 5 days at 20 ºC (Figures 1B). Storing pitaya fruit in perforated plastic bags resulted in increased decay severity during shelf-life at 20 ºC even though the bag had been removed upon transfer (Fig. 1A).

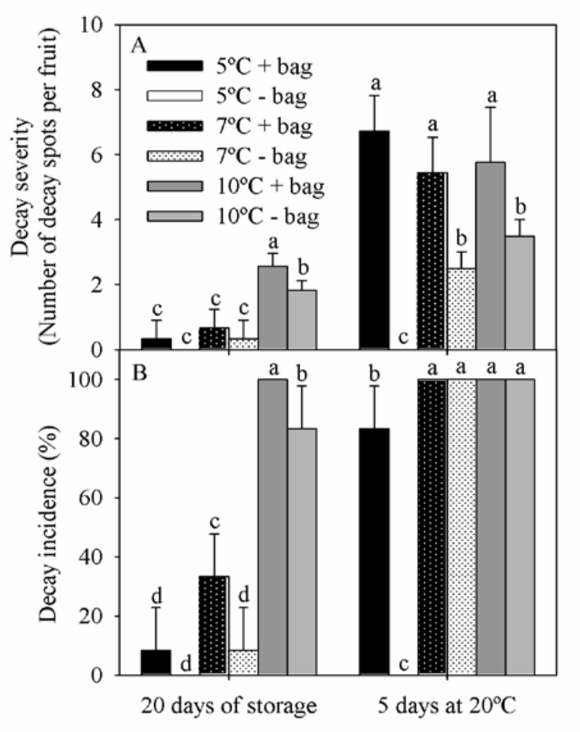

Figure 1 - Decay severity (A) and decay incidence (B) in pitaya fruit after 20 days of storage at 5, 7, or 10 ºC with and without perforated plastic bags and after five days of shelf-life at 20 ºC without bags. Data shown, means ± standard deviation.

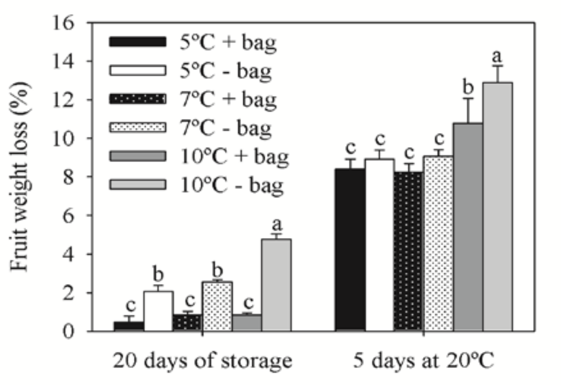

Figure 2 - Weight loss of pitaya fruit after 20 days storage at 5, 7, or 10 ºC with and without perforated plastic bags and after five days of shelf-life at 20 ºC without bags. Data shown, means ± standard deviation.

For fruit stored without perforated plastic bags, weight loss was higher at 10 ºC than at 7 or 5 ºC (Fig. 2). At all storage temperatures, fruit stored with perforated plastic bags had lower weight loss after 20 days of storage. After shelf-life conditions, the highest weight loss was observed in fruit previously stored at 10 ºC, with the highest values observed in fruit stored at 10 ºC without a perforated plastic bag. The weight loss was greater during 5 days of shelf-life at 20 ºC than during 20 days of storage at 5, 7, or 10 ºC. Although the use of perforated plastic bags effectively reduced pitaya fruit weight loss during storage, it also increased the percentage of fruit with decay symptoms during storage at 7 and 10 ºC, as well as during shelf-life at 20 ºC of fruit previously stored at 5 ºC. In addition, the use of perforated bags during storage resulted in greater decay severity after shelf-life. The higher levels of decay observed in fruit stored in perforated plastic bags is likely due to an elevated relative humidity that favored growth and development of pathogens in the fruit, especially with high storage temperatures. In this context, the use of perforated plastic bags could be beneficial if used in conjunction with decay control measures to maintain the postharvest quality of pitaya fruit.

Storage of pitaya fruit at 5 ºC resulted in a low level of chilling injury characterized by a thin layer of outer flesh tissue under the peel showing water-soaked symptoms, which was not influenced by the use of a perforated plastic bag (Fig. 3). Other studies have also shown that storage of pitaya fruit at 5ºC may result in chilling injury symptoms (NERD et al., 1999).

Figure 3 - Middle section of pitaya fruit after storage for 20 days at 5 °C (left column), 7 °C (middle column), or 10 ºC (right column) with (top line) and without (bottom line) perforated plastic bags plus five days of shelf-live at 20 ºC without bags.

Fruit firmness and titratable acidity decreased in all treatments during storage plus shelf-life (Table 1). The decrease in fruit firmness and titratable acidity was delayed by storage at 5 ºC, compared with higher storage temperatures. Storage at low temperatures is well known to reduce fruit metabolism and delay senescence. Similarly, low storage temperatures have been reported to delay softening and loss of acidity during storage of pitaya fruit (PUNITHA et al., 2010). The highest flesh firmness was observed in fruit stored at 5 ºC, which was statistically similar to the flesh firmness of fruit stored at 7 ºC. There was no change in total soluble solids content during storage plus shelf-life (Table 1). The highest acidity values after storage and shelf-life were in fruit stored at 5 ºC and the lowest in fruit stored at 10 ºC. The use of perforated plastic bags had no effect on fruit firmness, total soluble solids, or titratable acidity (Table 1).

Table 1. Flesh firmness, total soluble solids (TSS), and titratable acidity of pitaya fruit at harvest and after 20 days of storage at 5, 7, or 10 ºC with and without perforated plastic bags plus 5 days of shelf-life at 20 ºC without bags.

Temperature (ºC)	Bag	Firmness (N)	TSS (%)	Acidity (%)
At harvest		11.6 a*	10.0 a	0.361 a
5	+	9.1 b	10.1 a	0.129 b
	-	9.3 b	10.2 a	0.163 b
7	+	8.5 bc	10.3 a	0.112 c
	-	8.7 bc	10.1 a	0.090 c
10	+	8.1 c	10.7 a	0.076 d
	-	8.2 c	10.0 a	0.074 d
CV (%)		8.5	5.7	20.5

* Mean values with similar letters are not significantly different according to Tukey’s test (P = 0.05).

CONCLUSIONS

Our results suggest that 5 ºC is the best storage temperature for pitaya fruit, maintaining higher firmness and higher titratable acidity. Storage at 5 ºC also reduced decay incidence and severity, and weight loss. The use of perforated plastic bags may be a potential approach to reduce weight loss if combined with effective decay control strategies during storage and shelf-life of pitaya fruit.

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