Response of Six Cultivars of Tuna Fruits To Cold Storage

Joel Corrales-García, Julia Andrade-Rodríguez,
Eusebio Bernabé-Cruz
Programas Nopal y Alimentos
CIESTAAM-DIA
Universidad Autónoma Chapingo
Chapingo Edo. de México CP 56230
e-mail: joelcg@taurus1.chapingo.mx

INTRODUCTION

Prickly pears, called tunas, are nonclimacteric fruits. That is, their respiration declines with time and is not different for fruits harvested at different stages of ripeness (Lakshminarayana et al., 1979). Nonclimacteric fruits are also characterized by a lack of starch as a carbohydrate reserve. Therefore, there is no significant increase in sugar content of nonclimacteric fruits after harvest (Tucker, 1993; cited by Cantwell, 1995). According to Cantwell (1991), the ethylene production rate in tuna fruits is also very low, so their physiological activity is low. Therefore, the perishability of tunas lies not in their physiology, but mainly in physical damage to the peel and stem end during harvest and postharvest handling.

Tuna fruits are highly perishable and begin to show spotting and rotting nine days after harvest. Twenty days after being harvested, there is usually a 70% to 80% loss, due mainly to mechanical injury during postharvest handling. Injured fruits are easily infected by microorganisms causing stem-end rot. Common postharvest pathogens found on cactus fruits include *Fusarium* spp., *Alternaria* spp., *Chlamydomyces* spp., and *Penicillium* spp. (Guzman, 1982; Chessa, 1993; cited by Cantwell, 1995).

Another serious problem during postharvest handling of tuna fruits is weight and water loss because it decreases saleable weight and appearance. Techniques to reduce weight and water loss include the use of wax and polyethylene liners. Storage at lower temperatures (5°C) reduces water loss by reducing the vapor pressure deficit (Cantwell, 1986; Chessa and Barbera, 1984; cited by Cantwell, 1991). However, tunas are sensitive to chilling. Storage at 5°C to 7.5°C (41°F to 45°F) is generally recommended for a storage life of about three weeks, although Chavez-Franco and Saucedo-Veloz (1985) have reported chilling injury to Tuna Blanca types stored below 10°C. Chilling injury in tuna fruits is manifested as small dark surface discolorations and bronzing of the fruit peel (Cantwell, 1995).

Rodriguez-Felix et al. (1992) studied the effects of some postharvest treatments on the quality of tuna fruits during storage and concluded that the removal of glochids (spines) did not increase decay. Late season fruits developed chilling injury after storage at 5°C for 15 days and were more susceptible to chilling injury than early season fruits. Weight losses on fruits were less than 7.7% and did not affect fruit appearance. Candelilla wax (CONAZA C-9 formula) reduced weight loss, although it did not reduce decay or chilling injury.

However, other researchers report that tuna fruit is more tolerant of chilling injury. Berger et al. (1978; cited by Cantwell 1995), stored fruits of O. *ficus-indica* for up to two months at 0°C and concluded that they are relatively tolerant to low-temperature storage. According to Cantwell (1995), variations in susceptibility to chilling injury among cultivars and according to the season of harvest may be expected and should be further investigated. The author recommended the evaluation of storage conditions for different cultivars.

The objective of this work was to evaluate and to compare the responses of six commercial cultivars of tuna fruits to different periods of cold-storage in terms of physiological and quality parameters.

MATERIALS AND METHODS

This study was carried out with tuna fruits of six cultivars from different commercial plantations: cvs. Burrona, Cristalina, and Amarillo Montesa were harvested in Pinos, Zacatecas, on August 20, 1994; cvs. Picochulo, Copena-Torreoja, and Copena T-5 were obtained from Ojuelos, Jalisco, on August 21, 1994.

Fruits were harvested manually and carefully, then transported immediately by land to the postharvest laboratory of Agroindustrial Engineering Department, Autonomous University of Chapingo in the State of México. Afterward, fruits from each cultivar were sorted for size uniformity and for absence of defects. Selected fruits (180 per cultivar) were grouped into 9 lots and put into cardboard boxes similar to those used for the export market (9 experimental units with 20 fruits each, for three treatments with three replications). A randomized complete design with 18 treatments was originally proposed. Treatments were arranged into a factorial structure with two factors:

- Cultivar (Amarillo Montesa, Burrona, Copena, Cristalina, Picochulo, and Torreoja)
- Storage period (at 9°C for one, two, and three months)

However, many fruits of two cultivars were heavily damaged during the first month. Following storage at 9°C, the fruits were transferred to room-temperature conditions (20°C and 65% to 75% RH, approximately) for four or six days in order to evaluate firmness of pulp, total soluble solids (TSS), external color, weight loss, respiratory behavior, and chilling injury.

Firmness of pulp, TSS, and external color determinations were carried out immediately after harvest and at the end of each storage period. Firmness of pulp was measured with a handheld penetrometer (Effegi, R. Lusa) using the 0.5 cm tip. The registers were reported as kg•f (kg). Total soluble solids (TSS) were determined with a handheld refractometer (National, trademark). The results were expressed as degrees Brix (°Bx). External color of fruits was measured with a Hunter Lab colorimeter. L, a, and b values were used to calculate a color index (CI) according to Dominguez (1992):

CI = ab/L for colored fruits

CI = -1 (ab)/L for white fruits

Weight loss was calculated using the equation:

WL (%) = 100 (Wi S Wf)/Wi

Where:

WL = Weight loss

Wi = Initial fruit weight in grams (g)

Wf = Final fruit weight at the end of the indicated storage period in grams (g)

Respiratory activity of fruits was determined immediately upon removal from each cold-storage period and then at two-day intervals (method of Claypool and Keefer, 1942).

Chilling injury incidence was estimated visually using 10 fruits per lot; the results were expressed in percent.

RESULTS AND DISCUSSION

All cvs showed a reduction of pulp firmness with time of storage according to Cantwell (1986), who found that the firmness of cactus fruits decreased slowly during storage at 20°C for one month. The cultivars Cristalina, Picochulo, and Amarillo Montesa registered initial values of firmness higher than the other cultivars. After three months of cold-storage cv Cristalina showed the highest firmness value of the group (Figure 1).

In general, TSS declined with time of cold storage. In this sense, Alvarado-Sosa (1978) reported a slight decline in soluble solids and sugars of fruits after two weeks of storage at 20°C. At the beginning, cv Amarillo Montesa registered the highest level of this variable; however, at the end (after three months of cold storage), cv Cristalina showed the highest values (Figure 2). Chávez-Franco and Saucedo-Veloz (1985) found that the stored fruits of O. amyclaea had higher sweetness scores than the fruits of O. ficus-indica, although soluble solids and sugar content were similar between fruits. Sensory evaluation has been included in few studies on cactus pears, and Kuti (1992) emphasized the need to conduct such studies to determine consumer preferences for different cultivars and stages of ripeness.

The highest percentage of change in the color index (after two months of cold storage) was registered by cv Picochulo, whereas cv Cristalina showed the lowest percentage change in the color index (Table 1). Figure 3 shows the tendencies of external color changes of each cultivar.

Table 1. External Color Change of Different Cultivars of Tuna Fruits after Two Months of Cold Storage at 9°C and 95% RH plus Five Days at Room Temperature and 65% to 75% RH

Parameter of Color	Cultivars							
	A. Montesa		Burrona		Cristalina		Picoculo	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
L	42.36	46.86	48.73	54.26	51.26	60.53	41.86	47.8
a	7.3	5.96	-10.5	-9.4	-9.73	-8	7.56	4.03
b	19.63	20.66	21.16	16.86	23	28.2	19.26	21.46
Cl	3.38	2.63	4.57	2.9	4.36	3.73	3.48	1.81
Change of Cl (%)		23		36.5		14.4		48

Cl = Color index

Weight losses (at the end of first month) of cvs Copena-Torreoja, Amarillo Montesa, and Copena T-5 were higher than cvs Cristalina, Picochulo, and Burrona. The cv Copena-Torreoja

had more than 10% weight loss when exposed four days at room temperature conditions after one month of cold storage. In contrast, cvs Cristalina, Picochulo, and Burrona did not show a significant increase in weight loss when fruits were transferred to room temperature conditions (Figure 4). For cactus fruits, a weight loss of about 8% was necessary to affect visual appearance (Rodríguez-Félix et al., 1992).

Respiratory behavior of all cultivars after the first month of cold storage did not show important increases, confirming the nonclimacteric pattern of these fruits, as reported before. The cvs Copena-Torreoja and Copena T-5 had the highest respiratory rates, whereas the cvs Burrona and Cristalina showed the lowest rates (Figure 5). After two months of cold storage, cvs Amarillo Montesa, Picochulo, Burrona, and Cristalina showed almost the same respiratory rates and patterns registered after the first month of cold-storage (Figure 6).

The cv Copena-Torreoja fruits had 100% injury from chilling after the first month of cold storage, cv Copena reached this level of damage after the second month, and cvs Picochulo and Amarillo Montesa had 100% injury from chilling after three months of cold storage. In general, cvs Burrona and Cristalina had the lowest levels of chilling injury.

CONCLUSIONS

These results show that:

- Cultivars Copena-Torreoja and Copena T-5 are chilling-injury sensitive
- The cultivars Burrona and Cristalina had the lowest loss of pulp firmness, weight loss, respiratory rates, and chilling injury levels and were, therefore, the best varieties under long-term storage conditions.

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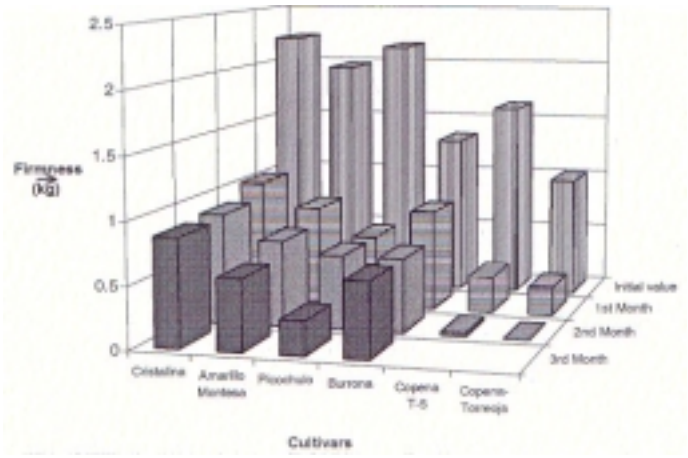

Figure 1. Firmness of Pulp in Tuna Fruits of Different Cultivars after Three Periods of Cold Storage at 9°C and 95% RH

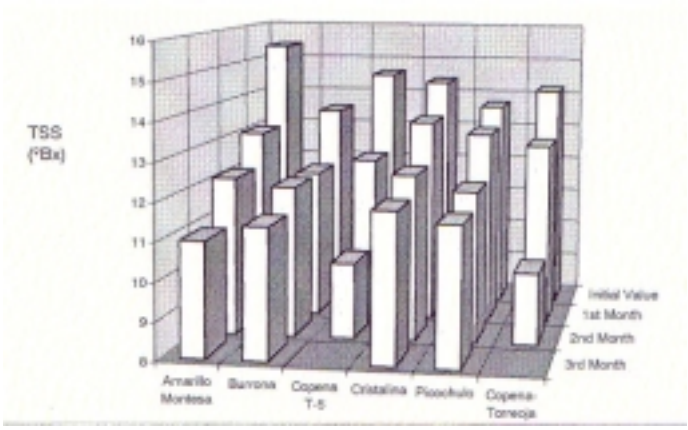

Figure 2. TSS (°Brix) in Tuna Fruits of Different Cultivars after Three Periods of Cold Storage at 9°C and 95% RH plus Four Days at Room Temperature and 65% to 75% RH

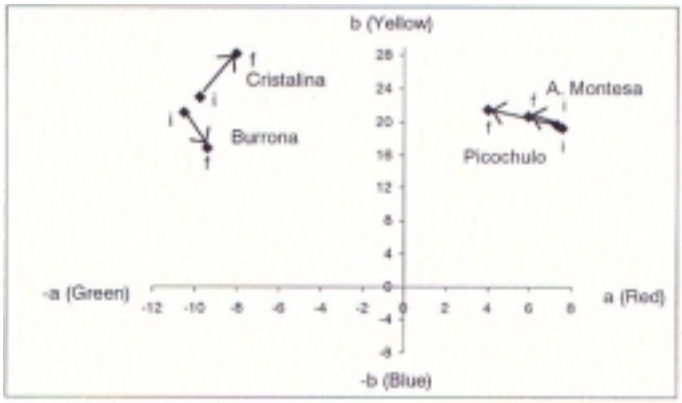

Figure 3. Color Map Showing External Color Change in Different Cultivars of Tuna Fruit after Two Months of Cold Storage at 9°C and 95% RH plus Five Days at Room Temperature

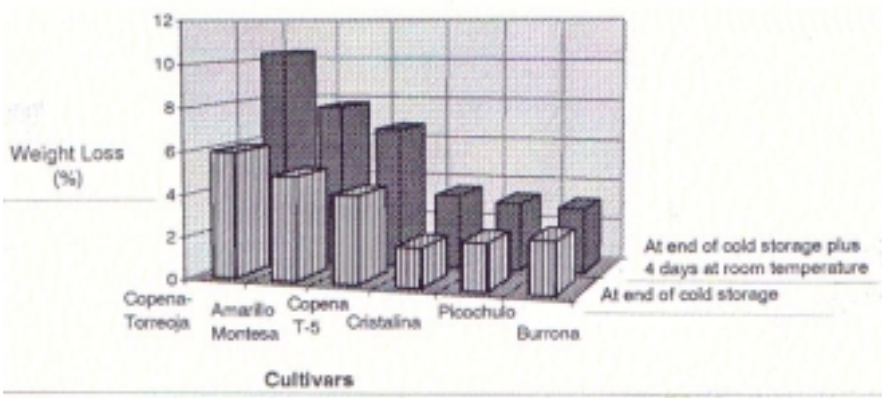

Figure 4. Weight Loss in Tuna Fruits of Different Cultivars After One Month of Storage at 9°C and 95% RH

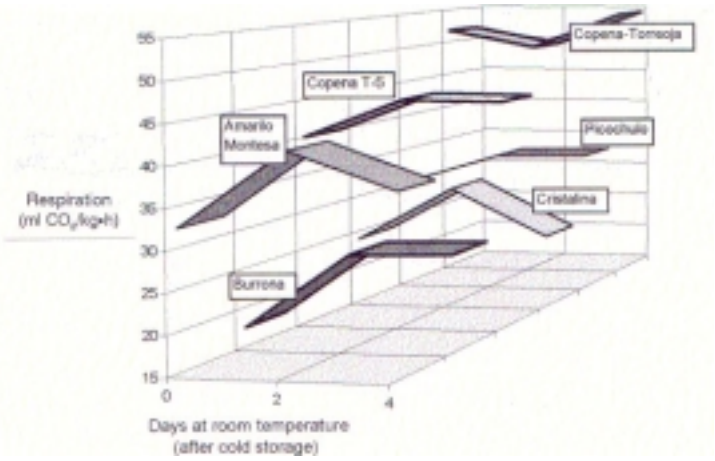

Figure 5. Respiratory Behavior of Prickly Pears of Different Varieties at Room Temperature after One Month of Cold Storage at 9°C and 95% RH

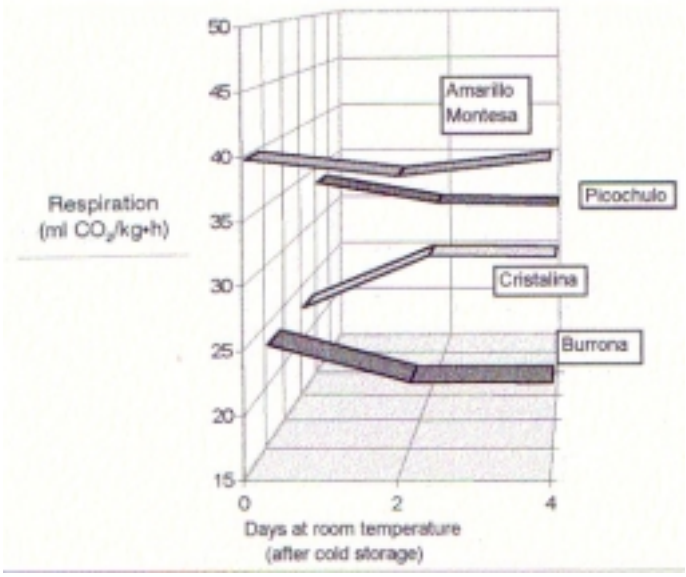

Figure 6. Respiratory Behavior of Prickly Pears of Different Varieties at Room Temperature after Two Months of Cold Storage at 9°C and 95% RH

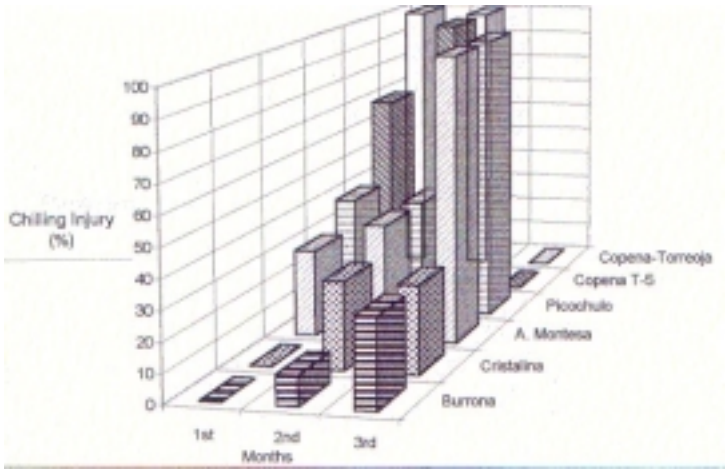

Figure 7. Chilling Injury in Tuna Fruits of Different Cultivars after One, Two, or Three Months of Cold Storage at 9°C and 95% RH plus Six Days at Room Temperature and 65% to 75% RH