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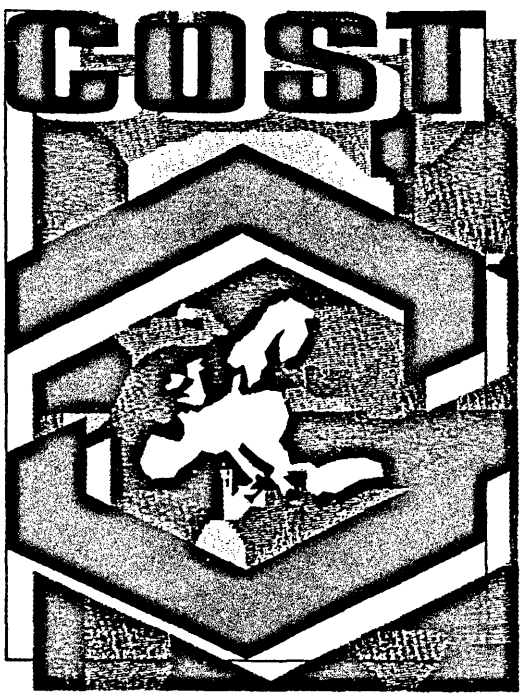

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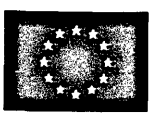

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PRESTORAGE ANAEROBIC TREATMENT OF "GIALLA" CACTUS PEAR

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Summary

"Gialla" first crop cactus pear fruits, harvested at the end of August, received a postharvest application of a low-O_2 atmosphere (1% O_2 + 99% N_2) for 1 hour within 250-liter containers, that were then ermetically sealed for 24 hours. After the treatment fruits were stored at 6°C and 90% of relative humidity (RH) for 3 or 6 weeks, plus 1 week of shelf-life conditions at 20°C and 70% RH following each storage period to simulate market conditions. Prestorage anaerobic application reduced, but not consistently, chilling injury (CI) simptoms both during storage and shelf-life, while overall appearance of treated fruits was quite similar to not exposed ones. Contrary to what expected, electrolite leakage was slightly higher in N_2-treated fruits. Anaerobic treatment permitted to reduce weight loss significantly, but only at the end of each cold storage period. Respiration rate was not influenced by the low-O_2 treatment as well as chemical parameters, with the exception of ascorbic acid content, always higher in exposed fruits if compared to those not treated. Taste of the fruit was not negatively affected by the N_2 exposition. Although the prestorage anaerobic treatment of this study was not as beneficial in reducing CI as in other fruit species, further attempts could permit to find the optimum combination N_2 concentration-exposure time.

Key words: Chilling injury, cold storage, decay, *Opuntia ficus indica* Mill..

Introduction

Cactus pear fruits (*Opuntia ficus indica* Mill.) are a perishable commodity having an high rate of ageing and being the pulp easily invaded by microorganism. Nevertheless, fruits are appreciated in distant markets, thus refrigeration is required to keep the quality of this fruit during transportation and subsequent marketing. However, like other tropical and subtropical fruits cactus pear undergoes CI manifestation when exposed to temperatures below 10°C and above the freezing point [2]. The main sympoms of CI are pits and dark spots on the peel, which often turn out in off-flavour and rot development, mainly when transferred to market conditions [17]. Storage at 6 to 8°C has been recommended for reducing both chilling injury and rot incidence for 3 to 4 weeks [2,3]. Several authors suggest the use of controlled atmosphere to extend the fruit storage life up to 6 weeks [19]. Other means to preserve quality and reduce CI susceptibility during cold storage include prestorage conditioning at 38°C and high humidity for 24 hours [18] and poliethylene film packaging [12, 13].

Prestorage treatments with low-O_2 atmospheres and high N_2 (>97%) or CO_2 (30 to 90%) for short periods have beneficial effects on different fruits and vegetables. Anaerobic conditions with CO_2 or N_2 removed astringency from persimmon fruits [9], inhibited ripening of tomatoes

[4] and delayed softening of peaches and nectarines [7]. Exposing second crop fig fruits to 1%O_2 + 99%N_2 drastically reduced loss for rots and extended the shelf-life [14].

The effectiveness of short pretreatments in alleviating CI has been also demonstrated in some fruit. Exposing lemons to an atmosphere containing 10 to 40% CO_2 lowered membranosis incidence during prolonged cold storage [1]. A 24 hours prestorage treatment with 97%N_2 + 3% O_2 significantly reduced CI symptoms in avocados after 3 weeks at 2°C [11].

In the present study are reported the effects of a short anaerobic treatment on quality parameters and CI development during cold storage and SL of "Gialla" cactus pear fruits.

Materials and Methods

First crop cactus pear fruits were harvested at the end of August at the peel colour breakage from the Institute's experimental orchard (southwest Sardinia). Fruits were sorted for homogenous size and maturity stage, weighed and divided into two lots (320 fruits a lot), that were placed in 250 l air-tight cabinets at 20°C. One of the cabinet was flushed with water-saturated nitrogen at a flow rate of 5 l/min until a desired atmosphere composition inside the cabinet of 99% N_2 + 1%O_2 was reached and then hermetically closed. Control fruits in the other cabinets were flushed with water saturated air alone. After 24 hours containers were opened and fruit transferred to storage at 6°C. Each lot was divided in four sublots corresponding to 3 or 6 weeks of cold storage plus one week of simulated shelf-life conditions (SL) at 20°C and 70% relative humidity. At the end of each cold storage and SL period fruits were inspected for weight loss and rot percentage, CI and overall appearance. Fruits were subjectively rated for CI with a scale ranging from 0=no injury, 1=slight 2=moderate and 3=severe injury and a CI index calculated with a weighted average. The external appearance of fruits was scored from 1 to 5 with 1=very aged, 3= fairly fresh (limit of marketability) and 5=very fresh. An informal panel test of five persons expressed its preference between one of the two groups. Chemical [pH, total soluble solids (TSS) as °Brix, vitamin C] and physiological (respiration rate) parameters were determined at harvest and after the above cited periods. Respiration rate of ten fruits taken at random was determined by gas-cromatography (TCD) as previously described [12]. Electrolyte leakage was determined on five fruits per treatment. Ten 10-mm-diameter disks were excised from the peel of each cactus pear and incubated in 20 ml sorbitol for 2 hours in a shaking water bath at 25°C. A conductivity meter was used to measure the elctrical conductivity at ambient temperature. After that samples were frozen at –20°C, thawed and total conductivity determined. Electrolite leakage was expressed as percent of the total conductivity. Data were analysed with a one-way ANOVA. Means were separated by the Duncan's Multiple Range Test at 0.05 level of significance.

Results and Discussion

Anaerobic conditions significantly decreased loss of weight, with respect to control fruit, but only at the end of each cold storage period, even if after the week of each SL weight loss of nitrogen exposed fruit kept remaining lower, but not statistically different than unexposed fruits (Fig. 1). The N_2 treatment may have slowed the general senescence of the cactus pear fruits, as previously reported for other fruit species [14, 20], while low temperature storage may have enhanced the beneficial effect of anerobic exposure.

Prestorage treatment reduced CI at the end of both cold storage and SL periods, but not significantly if compared to control fruits (Fig. 2). Among the hypotheses formulated to explain CI of the fruit, restriction of transpiration from the peel can account for reduction of CI symptoms. In fact, moisture loss due to transpiration may accelerate membrane collapse

occurring in fruits sensitive to CI when exposed to low temperatures, as detected by Purvis on grapefruit [16]. In a previous study we found that weight loss in cactus pear is mainly to be ascribed to peel moisture loss [13]. Thus, in our case the lower CI index in treated fruits, with respect to control, may be attributed to the above cited reduction of weight loss exerted by the N_2 treatment. Contrary to what expected electrolyte leakage was higher in treated fruits (Table 1). One of the qualitative indicator of CI is considered to be the ion leakage [5, 8], but, as long as results of the present study need further confirmation, our data are in contrast to what previously reported.

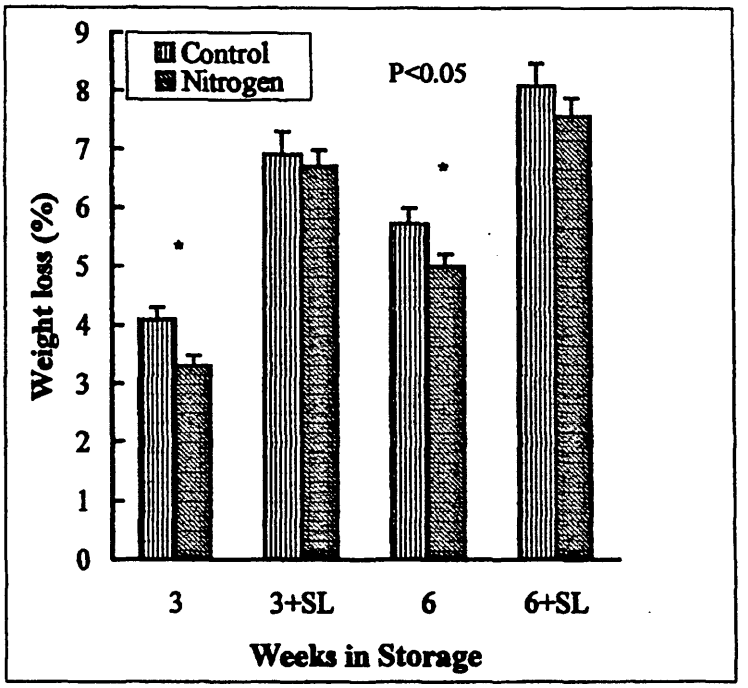

*Figure 1 - Effect of a N_2 prestorage treatment on weight loss of "Gialla " cactus pear stored at 6°C for 3 or 6 weeks and kept in simulated shelf-life conditions at 20°C for 1 week after each cold storage period. Data are the means of fifty measurements + SE. * Significant differences between treatments, P≤0.05.*

The external inspection of fruits revealed that nitrogen treatment have slight beneficial effects on maintaining the original freshness of the fruits. In fact, panellists gave similar scores both to control and treated fruits, with slight differences only at the end of each SL period (Fig. 3). As expected, the external appearance declined when fruit were transferred to SL conditions. Cactus fruit both treated and untreated maintained a good taste troughout the whole trial. Moreover, tasters did not detect any flavour difference between the two fruit groups (data not shown).

Rots occurred at every inspection time and reached at most 5% in N_2 treated fruit after 6 weeks of cold storage (data not shown). However, there were no significant differences between treated and control fruits. In treated fruits rot percentage was always slightly higher than control fruit, contrary to what otherwise indicated for other crops [6, 10]

Chemical parameters of the juice were not affected by the anaerobic treatment (Table 1), with the exception of Vitamin C content, that was always higher in treated fruit with respect to control as already reported in a previous work on mandarins [15].

Concerning respiration rate negligible differences were detected in the evolution of CO_2 between the two treatments (data not shown).

Based on the data for this study, a 24-h treatment with 1% O2 + 99% N2 resulted in some beneficial effects as delayed degradation of ascorbic acid, reduced weight loss at the end of cold storage and slight diminution of CI. Further studies are needed to ascertain if anaerobic conditions can enhance the positive effects on CI incidence with other more appropriate combination atmosphere composition-exposure time.

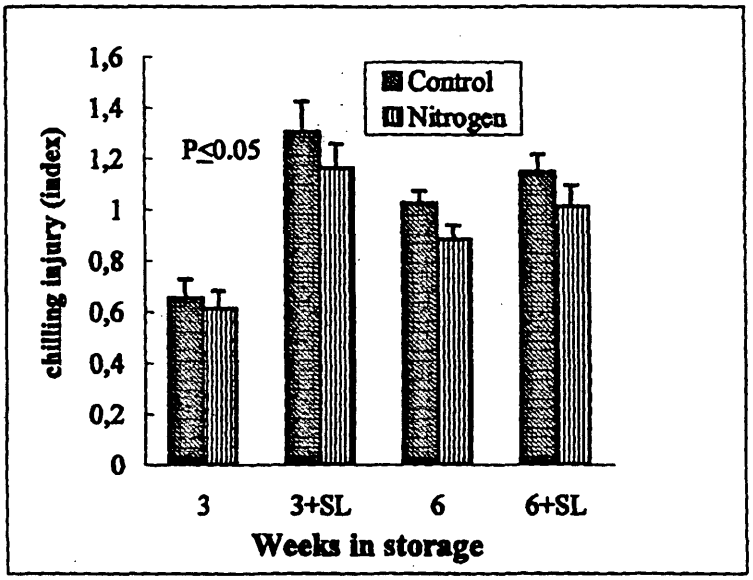

Figure 2 – Effect of a N_2 prestorage treatment on chilling injury of "Gialla " cactus pear stored at 6°C for 3 or 6 weeks and kept in simulated shelf-life conditions at 20°C for 1 week after each cold storage period. Vertical bars indicate SE.

Table 1: Effect of 24-h anaerobic treatment on chemical parameters and ion leakage in the peel of "Gialla" cactus pear during storage at 6°C and shelf-life.

Treatment	Storage period	pH	Acidity (% citric acid)	TSS (°Brix)	Vitamin C (mg/100ml)	Electrolyte Leakage (% of total)
	harvest	5.53	0.09	14.3	30.3	39.08
Control	3 weeks	6.05a*	0.08a	13.3a	22.37b	44.62a
Nitrogen		6.17a	0.08a	13.4a	28.28a	48.46a
Control	3 weeks+SL	6.24a	0.07a	12.4a	20.52b	45.60a
Nitrogen		6.29a	0.07a	12.6a	26.53a	55.94a
Control	6 weeks	6.72a	0.04a	12.5a	16.34b	53.89a
Nitrogen		6.63a	0.04a	13.7a	20.98a	53.75a
Control	6 weeks+SL	6.76a	0.04a	12.1a	14.25b	58.64a
Nitrogen		6.79a	0.04a	13.3a	19.54a	59.05a

*Mean separation in columns within each storage period by Duncan's multiple range test, 5% level.

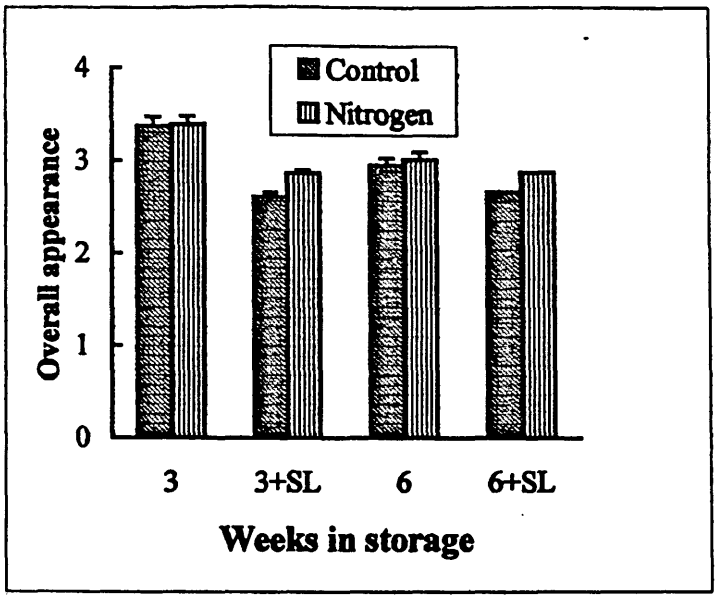

Figure 3 - Effect of a N_2 prestorage treatment on overall appearance of "Gialla " cactus pear stored at 6°C for 3 or 6 weeks and kept in simulated shelf-life conditions at 20°C for 1 week after each cold storage period. Vertical bars indicate SE.

Acknowledgements

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