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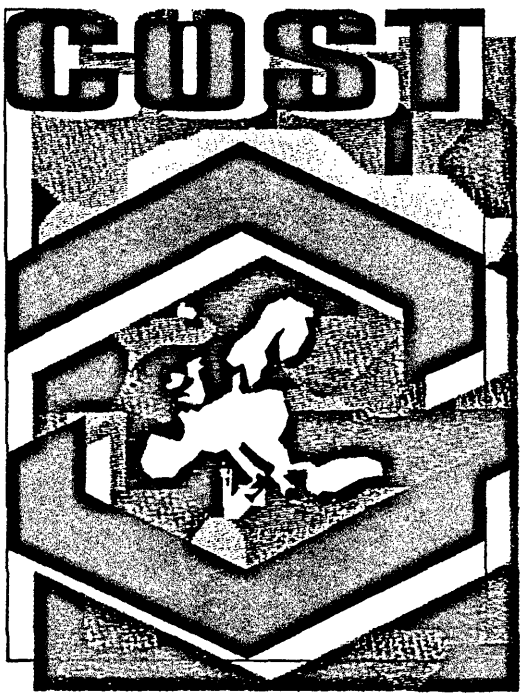

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RESPONSE OF CACTUS PEAR FRUIT TO HIGH TEMPERATURE CONDITIONING AND FILM WRAPPING

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Summary
First crop cactus pear cv "Gialla" fruits harvested the 15th of September were wrapped with a 19 mm thick film or left unwrapped and then divided into two lots, of whom one was immediately stored at 17°C and 60% relative humidity (RH) for 2 or 4 weeks, while the other one before being stored at the same conditions, was conditioned at 36°C and 90% RH for 36 hours. At each inspection time fruit were checked for incidence of decay, overall appearance and presence of dermatosis. High temperature conditioning, although not detrimental, had a negative effect on overall appearance and dermatosis. Dermatosis appeared in the form of brown spots on the peel, similar to the symptoms of chilling injury previously described by other authors. The incidence of decay was higher in conditioned fruits than in nonconditioned ones. Plastic film had a positive effect in reducing ageing and dermatosis, while promoted microorganism development. Neither the plastic film nor the curing treatment had important influence on chemical parameters, while significant was the effect of the storage period on pH, which changed from 5.95 of harvest to 6.3 after 4 week's storage, and titratable acidity (% citric acid), which decreased from 0.077% of harvest to 0.045 % at the end of the storage period. In conclusion, the results show a very positive contribution of the plastic film in maintaining the initial quality of the fruits, in fact at the end of the trial the wrapped fruit appeared as fresh as at harvest, while no positive influence was exerted by the curing treatment.

Key word: Chemical parameters, decay, dermatosis, *Opuntis ficus-indica* Mill., overall appearance.

Introduction

Cactus pear is a very high perishable tropical fruit, whose postharvest life, if stored at the optimal temperature, is of about 2-4 weeks [17;18]. In fact, at temperatures of refrigeration close to 0°C, which should be suitable to slow down ageing and to delay micro-organisms development, fruits manifest evident symptoms of chilling injury in the form of dermatosis, alteration of the normal physiological activity, and progressive weakening and lesions of the tissue. Consequently, after the removal from the chilling temperatures to shelf-life conditions the fruit show an increased susceptibility to decay and a reduction of postharvest life. Although the use of high temperature conditioning has been mainly developed to disinfest fruit from insects (i. g. Caribbean fruit fly) and to control fungal disease [13], studies on physiological aspect of heat treatments have shown some positive effects on postharvest physiology of fruit.
Superficial scald, a physiological disorder of apples that occurs during storage, was inhibited in heated apples [14]. Softening of the flesh, increase in sugar/acid ratio,

enhanced colour development, and augmentation in respiratory activity and ethylene production, which are the most striking aspects of the ripening process in climacteric fruits, are often attenuated by exposure to high temperatures [3;7;8;9;11] thus allowing the fruits to maintain their quality longer during the shelf-life at 20°C [10]. In citrus fruit combining high temperature conditioning with film plastic has helped to reduce the incidence of decay and to slow down ageing and physiological deterioration even for several weeks at shelf-life conditions, without refrigeration [1;6].
Objective of our experiment was to evaluate if the combination of the treatments of high temperature conditioning with film wrapping was suitable to maintain the overall quality of cactus pear fruits over a period of time sufficient to let the fruit be commercialised.

Materials and Methods

Fruit of cactus pear *(Opuntia ficus-indica* Mill.) of the cultivar "Gialla" were harvested the 15th of September in the experimental station of the CNR in Oristano.
From July to until 20 days before harvesting the plantation was treated three times with Dimethoate (100 g/100 l) and cupric oxychloride (300 g /100 l) to prevent Mediterranean fruit fly infestation and protect the plants from bacterial and fungi infections.
After harvesting, half of the fruit were sealed with a 19 μm thick heat shrinkable film (Cryovac), while the remaining half was left unwrapped. Soon after half of the unwrapped fruit and half of the unwrapped ones were put in storage at 17°C and 60% relative humidity (RH) for 2 or 4 weeks, while the remaining half of each group before storage were exposed at 36°C and 90% RH for 36 hours.
At each inspection time the fruits were checked for overall appearance, alteration of the peel (dermatosis), and the presence of decay, expressed as percentage of rotten fruits. In particular, overall appearance was evaluated on the basis of a scale ranging from 5 to 1, were 5 = fruit very fresh as at harvest; 3 = fruit still sufficiently fresh to be commercialised, and 1 = fruit very aged. In relation to the intensity of dermatosis, which appeared in the form of brown staining of the rind as previously described by Chessa and Barbera [4], fruit were classified into 4 categories, with 1 = fruit free of any defect; 2 = presence of few brown spots less than 1 mm in diameter; 3 = presence of several brown spots spread out all over the surface of the fruit and often coalescing to form larger depressed areas. In addition the chemical analysis (pH, titratable acidity and TSS, as °Brix), in the juice extracted from the flesh, were carried out either at harvest or after 2 or 4 weeks of storage.
Data were analysed by analysis of variance, and the means were separated by the LSD test.

Results

The amount of rotten fruit increased during the time in storage, changing from 2.75 after 2 weeks of storage to 5.5 % after 4 weeks (data not shown). The symptoms showed by most of the rotten fruits appeared as a watersoaked area, starting from the stem end and spreading downwards, with the affected zones assuming a slight brown colour. No characteristic structure of fungi microorganism appeared on the surface of the affected areas, and only sporadically some mould was detected, probably due to secondary infections. In previous experiments other researchers have reported a rich miscellaneous of species of microorganism affecting cactus pear fruit after harvest [2;4;5]; maybe the treatment with cupric oxychloride gave a positive contribution in reducing the incidence of decay. The conditioned fruit reported a higher incidence of decay than the control one, either after 2 weeks of storage or 4 weeks (Fig.1). Our results are in contrast with those reported by Schirra *et al.* [15], who relieved a significant reduction of decay development in fruit conditioned at 38°C for 24 hours. The plastic film also had a promoting effect on

decay development, and the highest losses were recorded in the group, which received the combination of the wrapping-heating treatments.The overall appearance of heated fruit worsened at a faster rate than the control (Fig.2). On the other hand the results related to the influence of the plastic film were very positive, confirming those previously found by Piga *et al.*[14], but the wrapped fruit which were conditioned after 4 weeks of storage appeared less fresh than those which received only the wrapping treatment.
Dermatosis, in the form of brown depressed areas varying in size from little pits to larger spots, similar to those indicated by other investigators [4;5;14;15;16] as chilling injury symptoms, appeared since the 2nd week of storage, and interested an increasing number of fruits after 4 weeks. The conditioned fruit reported always a higher incidence of these symptoms than the control (Fig. 3), even if these differences were not significant. In wrapped fruit, on the other hand, this alteration of the rind appeared in a slighter form than in nonwrapped ones. Moreover, while in nonwrapped fruit the affected areas proceeding with the refrigeration increased in size and assumed a dark-brown coloration, the wrapped fruit manifested little pits, which never became depressed and remained slight in colour.
The treatments had no substantial effect on the evolution of the chemical parameters (Tab. 1). Regarding the influence of the storage period, TSS and vitamin C underwent few changes during the 4 weeks of the trial, while the most important variations interested the pH and the titratable acidity, which, respectively, increased from 5.95 to about 6.4 and decreased from 0.077% to 0.040% respectively at harvest and after 4 week of storage.

Discussion and Conclusions

The objective of our experiment was to verify if the combination of film wrapping and high temperature conditioning was able to reduce both microbiological and physiological deterioration of "agostani" cactus pear fruits, thus allowing to store the fruit at shelf-life conditions for a period of 2 or 4 weeks without refrigeration. The results obtained are positive only for the treatment with the plastic film. The curing at high temperature conditioning gave no positive contribution in reducing decay and ageing of the fruit. On the contrary, although not detrimental and not always significant, the effect of high temperature conditioning was negative either in nonwrapped fruit or in wrapped one. Since the fruit ripen continually from the first week of August to until December, during different climatic conditions, it is possible that the exposure to heat gives different responses in relation to the harvesting period. Heating, on the other hand, might have different physiological influences on fruit tissue, and the stress of heating might result beneficial, in the case of cactus pear only when fruit are stored at low temperatures. We believe that the influence of high temperature conditioning on cactus pear need further investigations. Before concluding, we want to emphasize the unexpected development of dermatosis, which resembles the chilling injury symptoms previously described by other authors [4;5;14;15;16]. We did not expect something like that in fruit stored at 17°C. What can be speculated from these results is that the little, invisible wounds caused by the tiny, almost invisible spines, underwent a high transpiration rate and, consequently, desiccating, evolved towards a symptom similar to chilling injury. The question arises if what so far has been classified as a chilling injury symptom is a really consequence of low temperatures or a physiological alteration caused by other factors differing from chilling temperatures, whose appearance, in some way is helped by exposure at low temperatures.

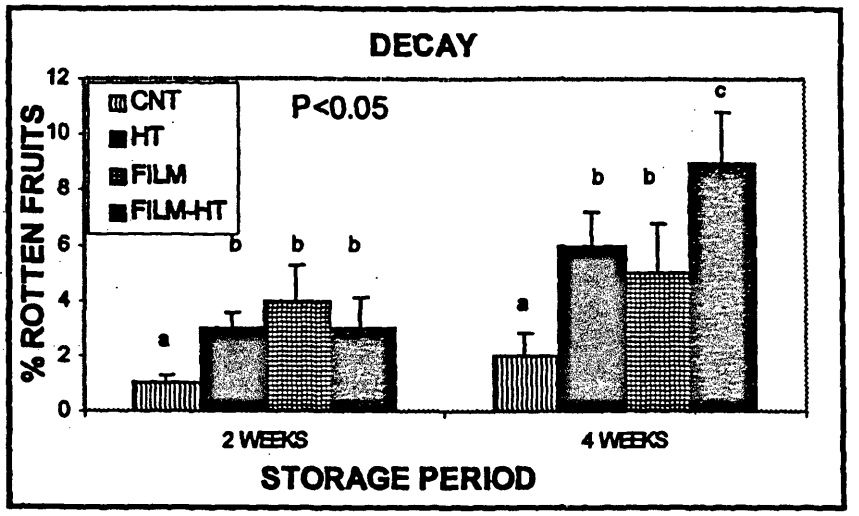

Figure 1 - Effect of treatments on incidence of decay after 2 or 4 weeks of storage at 17°C and 60% relative humidity. Vertical bars indicate SE (n = 100).

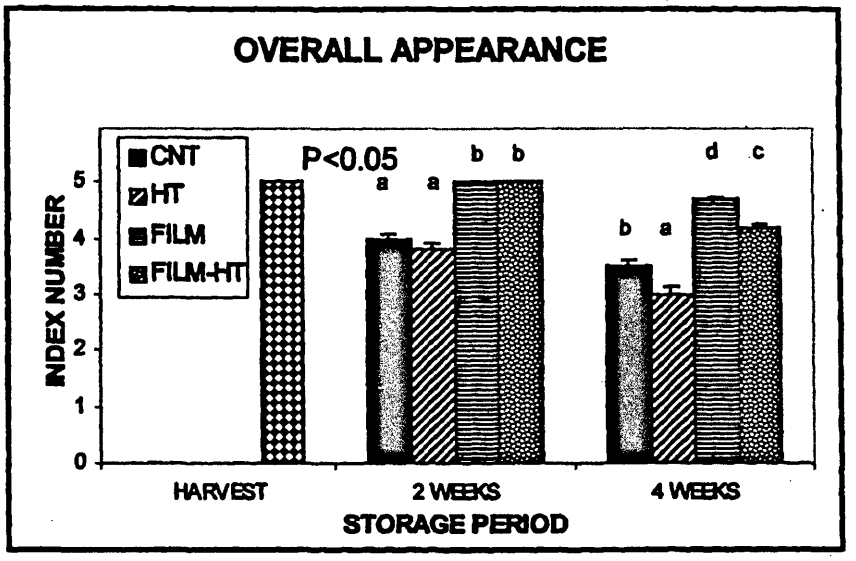

Figure 2 - Overall appearance as affected by the treatments after 2 or 4 weeks of storage at 17°C and 60% relative humidity. Vertical bars indicate SE (90< n<100).

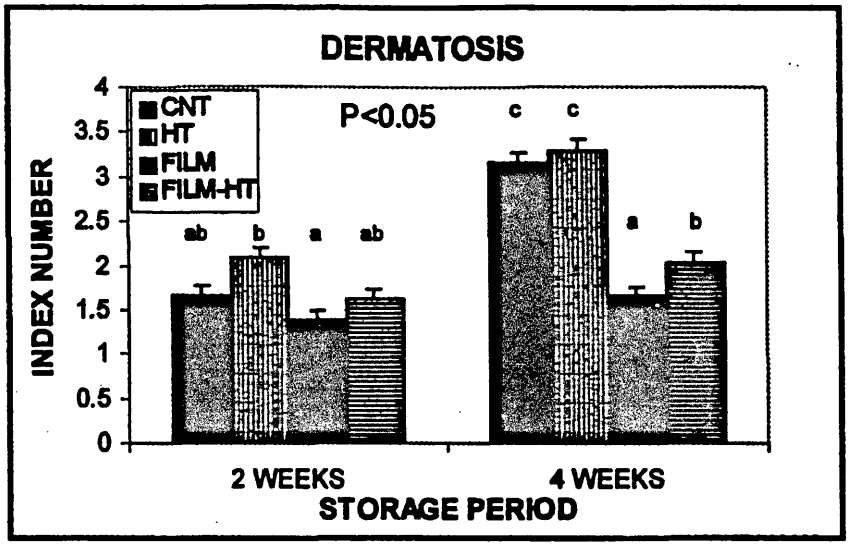

Fig. 3 - Effect of the treatments on alteration of the peel (dermatosis) after 2 or 4 weeks of storage at 17°C and 60% relative humidity. Vertical bars represent SE (90< n <100)

Tab. 1 - Effect of treatments on chemical parameters after 2 or 4 weeks of storage at 17°C and 60 % relative humidity.

STORAGE PERIOD	pH	TITRATABLE ACIDITY (% citric acid)	TSS (°Brix)	VITAMIN C (mg/100 g)
Harvest	5.95	0.077	14.2	31.75
2 Weeks Storage				
Control	6.03a*	0.063a	13.6a	31.43a
HT	6.12a	0.062a	13.4a	30.06a
Film	5.99a	0.063a	13.3a	29.90a
Film-HT	6.20b	0.060a	13.3a	29.13a
4 Weeks Storage				
Control	6.24a	0.043a	13.1a	30.43a
HT	6.31ab	0.041a	12.9a	30.07a
Film	6.39b	0.040a	12.9a	29.44a
Film-HT	6.41b	0.039a	13.2a	29.23a

* *Means separation in columns for each storage period by the LSD test at the 5% level.*

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