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PRECOOLING OF PEACH FRUITS INFLUENCES HISTOLOGICAL CHARACTERISTICS AND FRUIT QUALITY DURING STORAGE

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ABSTRACT

Forced air precooled peach fruits cv. Swilling had significant higher flesh firmness and maintained its SSC low during storage period compared with room cooled ones. There was no significant effect of precooling treatments on malic acid content of the fruits, but generally, the precooled fruits had higher contents of malic acid during storage period. There was a highly significant effect of precooling treatments on reducing weight loss percentages of peach fruits especially when the fruits were washed before precooling, where they had a significant lower loss in both seasons. Precooled fruits had higher moisture content when compared with room cooled ones. Forced air precooled fruits after washing has the most turgid cells compared with the forced air precooled or room cooled ones.

INTRODUCTION

Cooling of fruits to maintain their freshness and their quality between harvest and consumption greatly influence their value As soon as mature fruits are harvested, they begin a slow process of dying, and the period of their good appearance and value is influenced by how fast they use up their stored energy in continuing life, so fast cooling of fruits immediately after harvest are require to remove field heat and to decrease the consumption rate of fruit to itself (Mitchell, 1978; Genma, 1985 and Oosthuyse *et al.*, 1995).

The three widely employed methods of precooling fruits are vacuum cooling, forced-air cooling and hydrocooling. Each method has certain distinctive characteristics which help to determine the method that should be used for a specific application (Zerbini and Testoni, 1983; Ilangantileke and Salokhe, 1989 and Tonini and Caccioni, 1991).The factors influencing the rate of forced-air cooling for different fruits are temperature, air pressure differential across the container, volume of air per kilogram of fruits which passes through containers and around the fruits, size of fruit, specific area per volume unit, arrangement of the fruits and the thermal properties of the fruit (O' Brien and Gentry, 1967; Hunter, 1972 and Cristina *et al.,* 2000), and as a result of the above factors the half-cooling time will differ for different fruits (Ito and Sato, 1987;Chadwich and Hellickson, 1989 and Tonini *et al.*, 1990).

Precooling has many effects on the commodity such as the decrease in respiration rate (Polderdijk and Schaik, 1988) and significant effect on maintaining fruit firmness and on decreasing weight loss (Ito and Sato, 1987;

Scandella et al., 1990; Tonini et al., 1990; Monzini and Gorini, 1979; El-Saedy, 1994; Brackmann *et al.,* 1996 and Celikel and Karacali, 1998) and the use of moist forced air significantly increased those effects (Ben-Arie *et al.*, 1984 and Macleod-Smith *et al.*, 1994). As a result precooling help to store fruits for long times without loss in quality (Shcherbatko, 1989; Ilangantileke and Salokhe, 1989; El-Saedy, 1994; Kapse and Katrodia, 1997 and Hohn *et al.*, 1998).

Histological characteristics of peach fruits are affect by cultivar, pre- and post-harvest treatments and storage conditions. Florda Prince peach fruits had higher density of trichomes than Almoge or T. Snow cvs., but T. Snow cv. had less and shorter trichomes, while Almoge cv. had longer ones. Large mesocarp cells were located underneath the exodermis and no clear differences among the tissue and cell anatomy from freshly harvested fruits, while cell size varied considerably in the same tissue (Mohamed, 1999). The thinner cuticle and the lower density of trichomes in fruits from the excess irrigation treatment reduced boundary layer resistance and thus increased the rate of water loss (Crisosto *et al.*, 1994). The cuticle thickness of nectarine fruits decreased as N fertilization levels increased. These differences in cuticle thickness might explain the difference in water loss. The cuticle acts as a barrier to water movement, so when it is thinner water loss occurs at a faster rate (Daane *et al.*, 1995).

The objectives of the present investigation are to: 1- Precool the peach fruits soon after harvest, using the forced-air cooling method with or without washing as well as the fruits investigate the effect of precooling on the general postharvest keeping quality of fruits. 2- Determine the cooling curve and the half-cooling time of peach fruits with or without washing at different air flow rates. 3- Study the effects of precooling and the following storage temperature on the physical (weight loss, moisture content and fruit firmness) and the chemical (soluble solids content and titratable acidity). 4- Study the storage potential of the peach fruits in response to the different cooling rates and following storage temperatures. 5- Study some of the histological characteristics of the surface and the cells of peach fruits.

MATERIALS AND METHODS

The present study was carried out on Swilling peach fruits harvested at July in both seasons from a private orchard in Behera Governorate when the fruit quality reached as shown from Table (1).

Table (1): Initial Quality at Harvest of Swilling Peach Fruits in 2003 and 2004 Seasons.

Parameters	2003 Season	2004 Season
Fruit Weight (g)	75.60	80.77
Fruit Size (cm):		
Length	3.30	3.41
Diameter	3.40	3.52
Firmness (lb/in2)	10.55	11.75
SSC	12.90	13.53
Acidity %	0.32	0.36

To meet the above mentioned objectives, temperature controlled rooms were adjusted to the desired temperature (0°C) and relative humidity of 85-90 %. Sound selected peach fruits were divided to 4 groups each one received one of the following treatments: The first one was forced-air precooling (FAP) to or near to storage temperature (0°C). The second group was washing then forced-air precooling (FAP+W) to or near to storage temperature (0°C).The third group was room cooled (RC) at 0°C. The last one was storing at room temperature (RT).

Forced-air precooling of peach fruits was carried out by using a precooling unit (Al-Ansari, 1989) and tow computerized thermocouples were used to determine fruit temperature and the air humidity inside the unit (around the fruits) during precooling processes. Another two computerized thermocouples were used for the room cooled fruits and the last two computerized thermocouples were used for the fruits stored at RT. When temperature of the fruits under forced-air precooling reached at or near the desired storage temperature they were transported to the corresponding cold room for storage.

The initial physio-chemical properties of the fruits were determined and the changes in such properties were followed up after 2 days then every 4 days throughout the experimental working period as follows: Percent fruit weight loss was calculated for 15 labeled fruits in every treatment in relation to its original weight and the average weight loss percent was calculated for each treatment. Flesh firmness was determined for the peeled tow opposite sides of each given fruit in the sample by using the Effegi pressure tester with an eight mm plunger (Effegi, 48011 Alfonsine, Italy) in two types, the first one (1-30 lb/in^2) for the initial determination and follow ups and the second one (1-10 lb/in^2) for the latter stages of storage when the fruits became softer due to ripening. Soluble solids content (SSC) was determined by a hand refractometer (Chen and Mellenthin, 1981) in juice of two opposite segments from the rose to the stem and as deep as to the stone of the fruit. Titratable acidity was determined in the juice of another two segments according to Chen and Mellenthin, 1981 as g malic acid /100ml of fruit juice. Moisture content was determined by draying a recorded weight of fruit flesh and subsequent periodical weight determinations were carried out to obtain a constant dry weight then the percentage moisture was calculated in relation to the initial recoded weight.

Fruit histological studies: Preparation of peach fruits for scanning electron microscopic study was carried out as follows:1- Tissue samples consisting of small fragments of peach fruits were fixed in universal E.M.(Mc Dowell and Trump, 1976) and after dissection they were kept at 4°C till processing. 2- Rinsing twice in 0.1 M phosphate buffer for 10min. 3- Post fixation in 1%, 0.2 %M phosphate buffered osmium tetroxide for 1 hour at 4°C. 4- Rinsing with phosphate buffer for 8 min, then dehydration started in 50,70,95 then 100 % ethyl alcohol changed twice for 10,8,10 and 15 min, respectively with continuous shaking in every step.5- Drying to the critical point.6- A thin coating of gold was done under vacuum using Sputterer coater JEOL.JFC-1100E. 7- Examining with scanning electron microscop 5300 JEOL.

The termination of the experiment was done when fruits firmness reached the average of 3 lb/in^2. All obtained data were statistically analyzed according to Snedecor and Cochran, 1980. The individual comparisons were carried out by using the least significant difference (LSD) according to SAS Institute (1985). Simple regression coefficient between storage period and studied properties was calculated as referred by SAS Institute (1985).

RESULTS AND DISCUSSIONS

The temperature changes of precooled and room cooled peach fruits:

The initial core temperature of peach fruits were 24.5°C and 23.5°C for non washed and washed fruits, respectively (Table 2). Half- cooling time for forced- air cooled fruits was 45.0 min. however, the half- cooling time for forced- air cooled fruits after washing was 30.0 min. Those fruits reached to or near the desired temperature after 510 min. On the other hand, the half cooling time for room cooled fruits was 210 min.

Table (2): The Temperature Changes of Precooled and Room Cooled Swilling Peach Fruits.

Time (hours)	Coolant Temperatures (°C)		
	F A P	F A P + W	R C
0.0	24.5	23.5	24.5
0.5	14.9	12.5	20.2
1.0	9.5	9.2	17.4
1.5	8.4	8.2	14.9
2.0	7.7	7.3	13.5
2.5	6.2	6.2	12.8
3.0	5.8	5.8	12.4
3.5	5.4	5.4	12.0
4.0	5.0	5.0	11.7
4.5	4.5	4.4	11.0
5.0	4.1	4.0	10.6
5.5	3.6	3.5	10.2
6.0	3.0	3.0	9.9
6.5	2.5	2.4	9.5
7.0	2.0	2.0	9.1
7.5	1.4	1.6	8.4
8.0	0.8	1.0	8.0
8.5	0.4	0.5	7.7
9.0			7.3
9.5			6.5
10.0			6.2
10.5			5.8
11.0			5.4
11.5			5.0
12.0			4.5
12.5			4.0
13.0			3.5
13.5			3.0
14.0			2.5
14.5			2.0
15.0			1.6
15.5			1.2
16.0			0.8
16.5			0.5

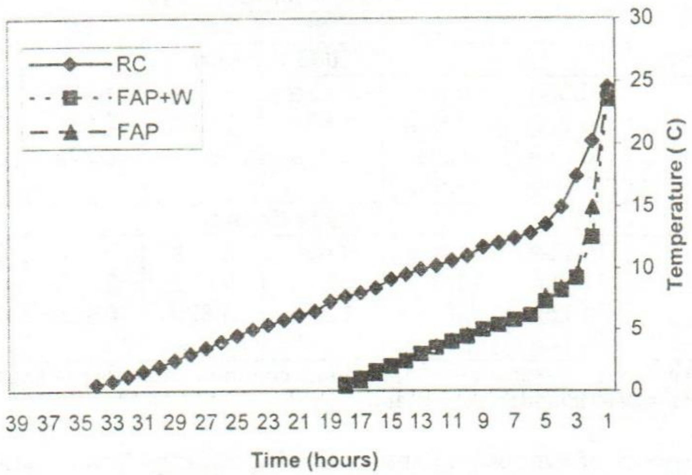


Fig (1): **Temperature changes of precooled and room cooled peach fruits.**

It was obvious from the obtained data that at the beginning of the cooling process, the cooling rate relatively higher than that towards the end of the cooling period. This finding can be explained by the fact that the bigger the difference between the commodity temperature and the coolant the faster cooling rate is expected.

It is obvious that when cooling is delayed after peach fruits are harvested where the fruits are expected to suffer shortened storage period and deterioration during storage (EL-Saedy, 1994 and Romero *et al.*, 2003).

Fruit flesh firmness: Forced air precooled fruits had significant higher flesh firmness than the room cooled ones during the storage period at 0°C in both seasons (Table 3). The best results in both seasons were obtained for the forced-air precooled fruits without washing yet, that is not significant.

The loss in flesh firmness when calculated of percent (Table 4) was the least for precooled fruits especially for non washed fruits where they had the lower percent of loss during the storage period.

Also, when the loss was calculated as a percent per day (Table 5) the non precooled fruits had the highest values during the storage period when compared by precooled ones. On the other hand, the loss of flesh firmness was higher by increasing storage temperature where the fruits stored at RT generally lost its flesh firmness after 2 days and they had the highest percent of loss per day when compared with the refrigerated fruits.

Table (3): Effects of Precooling and Following Storage Temperatures on Flesh Firmness (lb/in^2) of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)					
	0	2	6	10	14	r^2
	2003 Season					
F A P	10.55a	10.84a	9.29a	4.19a	1.81a	0.93**
F A P+W	10.55a	10.54a	6.83a	3.74a	2.03a	0.98**
R C	10.55a	9.24a	7.37a	3.61a	0.72a	0.99**
R T	10.55a	1.30a				
	2004 Season					
FAP	11.75a	11.44a	9.41a	4.48a	2.70a	0.96**
FAP+W	11.75a	10.07b	7.61a	4.49a	2.17a	0.99**
RC	11.75a	8.01c	4.84b	3.82a	0.92b	0.97**
RT	11.75a	1.05d				

Means within columns (in same season) having a common letter are not significantly different. r^2 =Determination coefficient.

Table (4): Effects of Precooling and Following Storage Temperatures on Loss Percentage in Flesh Firmness (%) of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)				
	0	2	6	10	14
	2003 Season				
F A P	0.00	2.75	11.94	60.28	82.84
F A P+W	0.00	0.10	35.26	64.55	80.76
R C	0.00	12.41	30.14	65.78	93.18
R T	0.00	87.68			
	2004 Season				
FAP	0.00	2.64	24.86	61.87	77.02
FAP+W	0.00	14.30	35.23	61.79	81.53
RC	0.00	31.83	58.81	67.49	92.17
RT	0.00	91.06			

The loss in fruit firmness with the increasing of storage temperature and with the progress of storage period is due to mainly to decomposition, enzymatic degradation of insoluble protopectins to more simple soluble pectins, solubilization of cell and cell wall contents as a result of the increasing in pectin esterase activity and subsequent development of juiciness and the loss in peel and pulp hardness. Such changes may slowed down by fast cooling. Such findings agree with those reported by Mozini and Gorini (1979) on apricots, Ben-Arie *et al.* (1984) on Perlette grapes, Scandella *et al.* (1990) and Kurnaz and Kaska (1993) on peaches.

Table (5): Effects of Precooling and Following Storage Temperatures on Loss Percentage / Day in Flesh Firmness of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)				
	0	2	6	10	14
	2003 Season				
F A P	0.00	1.38	1.99	6.03	5.92
F A P+W	0.00	0.05	5.88	6.46	5.77
R C	0.00	6.21	5.02	6.58	6.66
R T	0.00	43.84			
	2004 Season				
FAP	0.00	1.32	4.14	6.19	5.50
FAP+W	0.00	7.15	5.87	6.18	5.82
RC	0.00	15.92	9.80	6.75	6.58
RT	0.00	45.53			

Soluble solids content (SSC): There was a significant effect of precooling treatments on the changes of SSC (Table 6) where precooling treated fruits maintained its SSC low during storage period compared with room cooled fruits. Also, the increasing rate in SSC was lower for the precooled fruits during the storage period. There was a non significant increase of SSC percentages with the progress of storage period at both storage temperature.

Table (6): Effects of Precooling and Following Storage Temperatures on Flesh SSC of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)					
	0	2	6	10	14	r^2
	2003 Season					
F A P	12.90a	13.52c	13.67b	115.63a	15.47a	0.86*
F A P+W	12.90a	14.50b	13.44b	14.16b	14.12b	0.27
R C	12.90a	14.67b	15.01a	14.28b	15.84a	0.64
R T	12.90a	15.69a				
	2004 Season					
FAP	13.53a	13.65c	13.08c	14.46ab	14.17b	0.36
FAP+W	13.53a	14.39b	13.86b	14.17b	15.66a	0.61
RC	13.53a	14.94ab	15.62a	15.29a	14.99a	0.42
RT	13.53a	15.08a				

Means within columns (in same season) having a common letter are not significantly different. r^2 **=Determination coefficient.**

The gradual increase in the values of SSC with the increasing of storage temperature and storage period could be due to the degradation of complex insoluble compounds (pectins) to simple soluble ones (sugars) which are the major component of SSC in the fruits, and that changes increase with increasing storage temperature as a catalytic factor. Also, the changes increased with the progress of storage time where it allow the accumulation of SSC in the fruits. Precooling treatments slow such changes in the treated fruits. The above results and related discussions agree with those reported by Hussein (1996) on Florda Prince, Almoge and Tropical Snow peaches, Kamal *et al.* (1996) on Florda Sun, Early Grand, Desert Gold and Mit Ghamr peaches and Mohamed (1999) on Florda Prince, Almoge and Tropical Snow peaches.

Titratable acidity (%): There was no significant effect of precooling treatments on malic acid content of peach fruits (Table 7) except for the higher significant content of malic acid for the precooled fruits without washing after 6 days in the first season and after 6 and 10 days in the second season, but generally, the precooled fruits had higher contents of malic acid during the storage period. Malic acid content for all treatments decreased with increasing the storage period and with the progress of storage period.

Table (7): Effects of Precooling and Following Storage Temperatures on Titratable Acidity (%) of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)					
	0	2	6	10	14	r^2
	2003 Season					
F A P	0.32a	0.26a	0.23a	0.22a	0.20a	0.90*
F A P+W	0.32a	0.19b	0.26a	0.20a	0.22a	0.32
R C	0.32a	0.18b	0.23a	0.23a	0.20a	0.31
R T	0.32a	0.17b				
	2004 Season					
FAP	0.36a	0.22b	0.29a	0.22a	0.24a	0.40
FAP+W	0.36a	0.19c	0.24ab	0.20ab	0.22a	0.39
RC	0.36a	0.25a	0.22b	0.19b	0.22a	0.66
RT	0.36a	0.16d				

Means within columns (in same season) having a common letter are not significantly different. **r^2 =Determination coefficient.**

Precooling treatments retard the metabolic process respiration and as a result the treated fruits contained more malic acid as a respiratory substrate. The consumption of malic acid in respiration increase with increasing storage temperatures and with the progress of storage time (Wang *et al.*, 1993 on Babygold 5, Babygold 7 and Crethaven peaches; Hussein, 1996 on Florda Prince, Almoge and Tropical Snow peaches and Mohamed, 1999 on Florda Prince, Almoge and Tropical Snow peaches).

Weight loss and moisture content: There was a highly significant effect of precooling treatments on reducing weight loss percentages of peach fruits (Table 8) especially when the fruits were washed before precooling treatment where they had a significant lower loss in both seasons. Fruit weight loss of all treatment in both seasons increased significantly with the advancing storage period and the changes were most rapid in fruits stored at RT.

There was a significant effect of precooling on fruit moisture content (Table 9) in the first season and at the end of the second season where the precooled fruits had higher moisture content when compared with the room cooled ones.

The weight loss is mainly a result of water loss from the fruit tissues and partially of the respiration process. Precooling reduced the fruits weight loss (higher moisture content) because its effect in reducing physiological changes rate mainly respiration process rate. The higher storage temperature the higher the respiration rate and the higher the weight loss is and the lower moisture content is because of the high capacity of high temperature air to evaporate water, also the higher temperature of the fruit the greater is its tendency to lose moisture (Ben-Arie *et al.*, 1984; El-Saedy, 1994; Macleod, 1994; Hussein, 1996; Celikel and Karacali, 1998).

Table (8): Effects of Precooling and Following Storage Temperatures on Weight Loss (%) of Swilling Peach Fruits in 2003 and 2004 Seasons.

Treatments	Storage period (days)					
	0	2	6	10	14	r^2
	2003 Season					
F A P	0.00a	2.16c	6.45b	9.76b	12.98b	0.99**
F A P+W	0.00a	1.77d	4.94c	7.76c	11.32c	0.99**
R C	0.00a	3.82b	8.05a	12.67a	17.25a	0.99**
R T	0.00a	6.06a				
	2004 Season					
FAP	0.00a	2.35c	6.11a	9.69a	13.77a	0.99**
FAP+W	0.00a	2.08c	4.27b	7.69b	10.84b	0.99**
RC	0.00a	3.07b	6.71a	9.36a	13.49a	0.99**
RT	0.00a	5.46a				

Table (9): Effects of Precooling and Following Storage Temperatures on Moisture Content (%) of Swilling Peach Fruits in 2003 and 2004 seasons.

Treatments	Storage period (days)					
	0	2	6	10	14	r^2
	2003 Season					
F A P	83.33a	84.33a	85.33ab	83.67a	83.67b	0.01
F A P+W	83.33a	84.00ab	86.33a	85.00a	85.67a	0.55
R C	83.33a	83.33b	83.67b	85.33a	83.00b	0.05
R T	83.33a	83.33b				
	2004 Season					
FAP	83.67a	84.67a	85.67a	84.67a	85.33a	0.47
FAP+W	83.67a	85.00a	84.33a	84.67a	85.67a	0.61
RC	83.67a	84.67a	83.67a	83.67a	84.00b	0.02
RT	83.67a	85.33a				

Means within columns (in same season) having a common letter are not significantly different. r^2 =Determination coefficient.

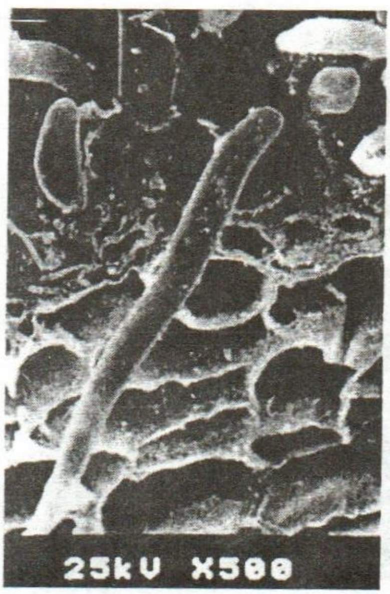
Fruit histological studies:

The initial electron microscope scanning (EMS) for Swilling peach fruits showed the trichomes density, shape and heights on the fruit surface (Fig. 2, A). On the other hand, it showed the initial cell appearance of the mesocarp (Fig. 2, B). It was noticed that large mesocarp cells located underneath the exodermes and the cell size varied considerably in the same tissue (Mohamed, 1999) also, those turgid paranchymatous cells were with thin primary walls and distinct intercellular spaces (Luza *et al.*, 1992).

After 2 days of storage at room temperature (Fig. 3, A), EMS revealed microbial growth on the trichomes and the opening and collapsing of the stomatum (Mohamed, 1999). Also, Fig. (3, B) showed the disarray of flesh cells that reflected the loss in fruit firmness and the high loss in fruit water content. After the same period at 0°C, the forced air precooled fruits after washing has the most turgid cells compared with the forced air precooled or the room cooled ones (Figs. 4B, 5B and 6B, respectively).

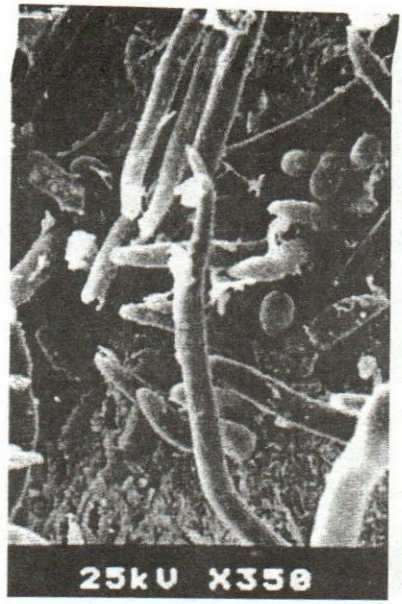
At the end of the storage period, trichomes withered due to water loss (Mohamed, 1999), and its density was lower in all treatments compared with that at the beginning of the storage period (Figs. 7A, 8A and 9A). There was no significant difference between forced air precooled fruits and forced air ones after washing in the appearance of fruit cells, but, they were better than the appearance of room cooled fruits where the cells were more turgid (Figs. 7B, 8B and 9B, respectively).

A

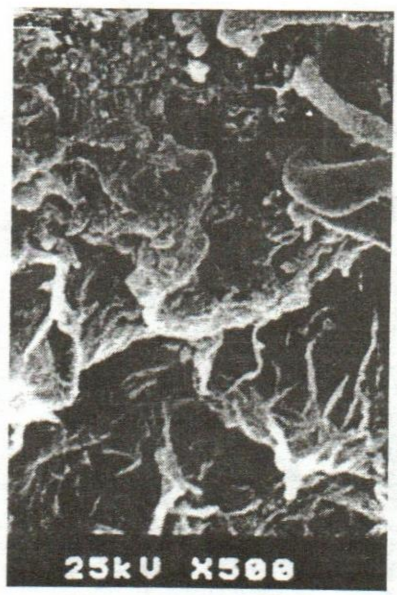


B

Fig (2): Initial EMS of peach fruits.
A- Surface B- Cells

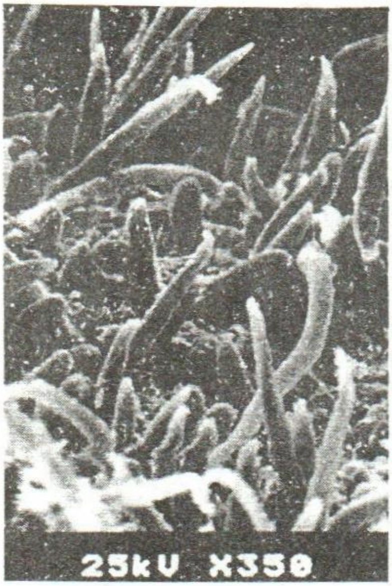


A

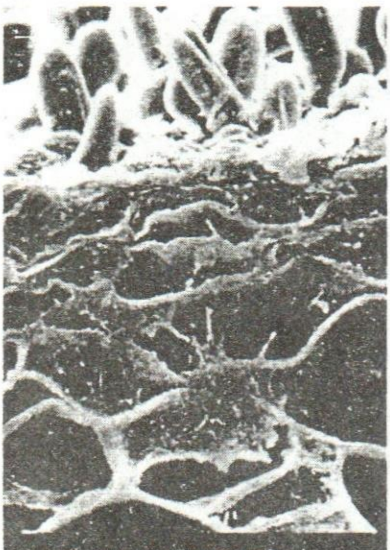


B

Fig (3): EMS of peach fruits after 2 days at RT.
A- Surface B- Cells



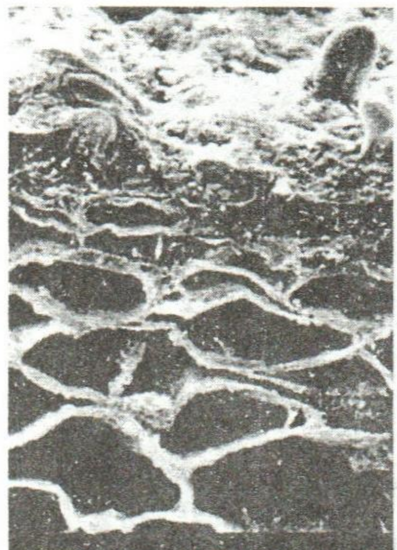
A



B

Fig (4): EMS of FAP peach fruits after 2 days at 0°C.
A- Surface B- Cells

A



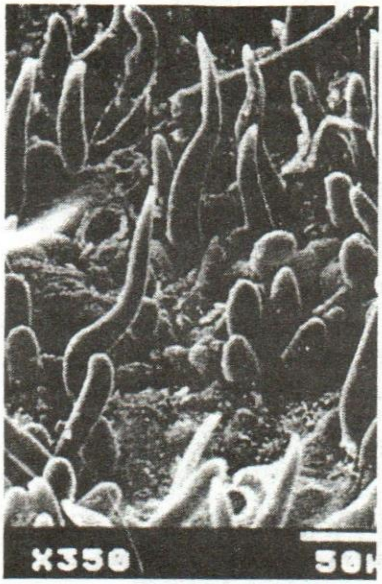
B

Fig (5): EMS of FAP + W peach fruits after 2 days at 0°C.
A- Surface B- Cells

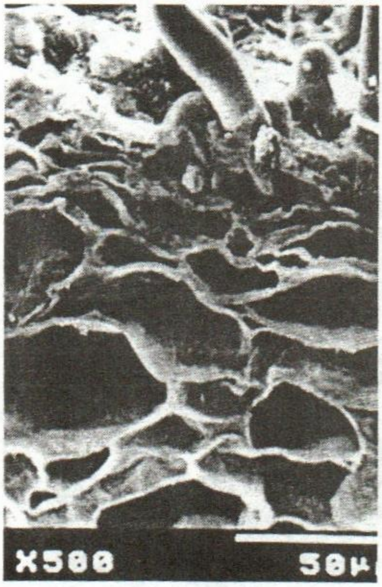
A

B

Fig (6): EMS of RC peach fruits
after 2 days at 0°C.
A- Surface B- Cells

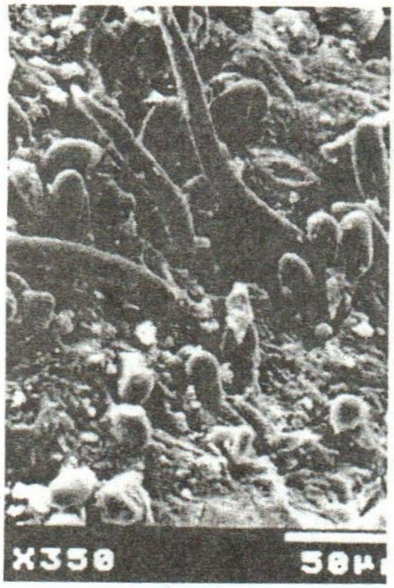


A

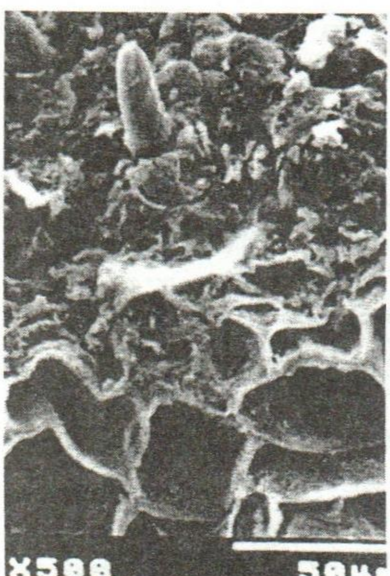


B

Fig (7): EMS of FAP peach fruits
after 14 days at 0°C.
A- Surface B- Cells

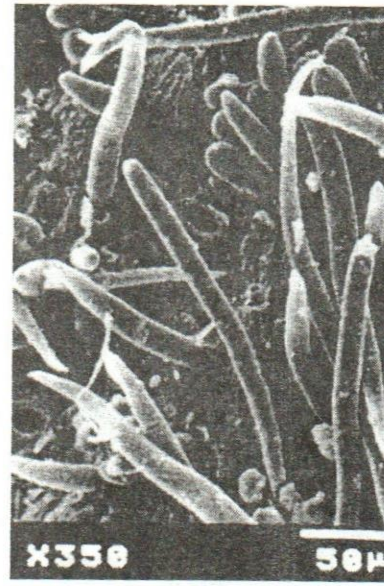


A

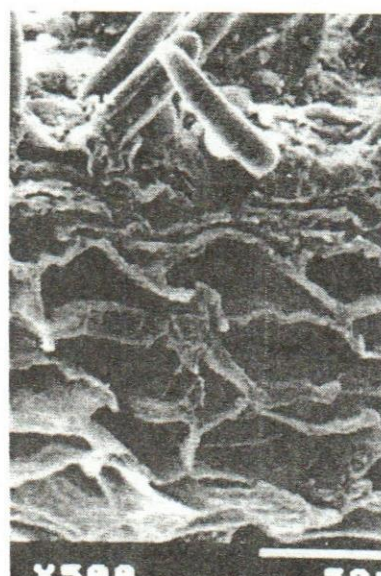


B

Fig (8): EMS of FAP+W peach fruits after 14 days at 0°C.
A- Surface B- Cells



A



B

Fig (9): EMS of RC peach fruits after 14 days at 0°C.
A- Surface B- Cells

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REFERENCES

Al-Ansary, A. A. (1989). Forced-air precooling of mango in boxes. M. Sc. Thesis, Alexandria Univ., Alexandria, Egypt.

Ben-Arie, R.; A. Hass; Z. Shoshani;; E. Ben-Lev; M. Zeidman and Y. Zutkhi (1984). The effect of precooling Perlette table grapes wrapped in various plastic films on their keeping quality during air and sea export. Hassadeh, 64(7): 1380-1387. (C. F. Agr. Eng. Abst. 9: 4145).

Brackmann, A.; M. Mazaro and R.Cecchini (1996). Precooling and postharvest chemical treatment of Gold Delicious and Fuji apples. Ciencia Rural, 26(2): 185-189).(C. F. Hort. Abst. 67: 3769).

Çelikel, F. G. and I. KaraÇali (1998). Effects of harvest maturity and precooling on fruit quality and longevity of Bursa Siyahi figs (*Ficus carica* L.). Acta Horticulturae No. 480: 283- 288 ISBN 90- 6605- 751-3. (C. F. Hort. Abst. 69: 5704).

Chadwick, J. M. and M. L. Hellickson (1989). Cooling rates of packaged pears. Amer. Soci. Agr. Eng. 89: 6560.

Chen, P. M. and W. M. Mellenthin (1981). Effects of harvest date on ripening capacity and postharvest life of d,Anjou pears. J. Amer. Soc. Hort. Sci. 106(1): 38-42.

Crisosto, C. H.; R. S. Juvenal; G. Luza and G. M. Crisosto (1994). Irrigation regimes affect fruit soluble solids concentration and rate of water loss of O'Henry peaches. HortScience 29(10): 1169-1171.

Cristina, A.; N. Cesar; P. Virseda and I. Juancorena (2000). Determination of the convective heat transfer coefficient during hydrocooling process. IIR Conference October, Murica, Spain.

Daane, K. M.; R. S. Johnson; T. J. Michailides; C. H. Crisosto; J. W. Dlott; H. T. Rammirez; G. Y. Yokota and D. P. Morgan (1995). Excess nitrogen raises nectarine susceptibility to disease and insects. California Agriculture, July- August, p13-18.

El-Saedy, R. M.(1994). Physiological studies on cooling and refrigerated storage of fresh Le Conte pears. M. Sc. Thesis, Alexandria Univ., Egypt.

Genma, H.(1985). Refrigeration of fruits. The characteristics of stone fruits. Refrigeration, 60(696): 1062-1067. (C. F. Hort. Abst. 57:4079).

HÖhn, E.; D. Dätwyler and M. Jampen (1998). Cherry cooling: cool cherries are fresh cherries. Obst-und Weinbau, 134(13): 330-333.(C. F. Hort. Abst. 68: 8286).

Hunter, D. L. (1972). Test show forced air cooling offers major advantages to shippers of fresh cherries and other soft fruits. Good Fruit Grower, 22(7): 10.

Hussein, A. M. (1996). Development of harvest maturity indices and postharvest handling procedures for newly introduced peach cultivars in North West Region (NWR) of Egypt. ATUT Final Report, Ministry of Agriculture and Land Reclamation, Egypt.

Ilangantileke, S. and V. Salokhe (1989). Low pressure atmosphere storage of Thai mango. Proceedings of the Fifth International Controlled Atmosphere Research Conference, Wenatchee, Washington, USA, 14-16 June vol.2: 103-117.(C. F. Hort. Abst. 63: 822).

Ito, H. and E. Sato (1987). Studies on the transport of figs. 5- The quality of the fruit after vacuum precooling. Research Bulletin of the Aichiken Agricultural Research Center, Japan.No. 19: 296-302. (C.F. Hort. Abst. 59: 5364).

Kamal, H. M.; M. T. Kabeel and S. M. El-Etreby (1996). Physiological studies on fruits of some old and new peach varieties. Bull. Fac. Agric., Cairo Univ., 47: 611- 628.

Kapse, B. M. and J. S. Katrodia (1997). Studies on hydrocooling in Kesar mango (*Mangifera indica* L.). Acta Hort. No.455:707-717 ISBN 90-6605-849-8. (c. F. Hort. Abst. 68: 7233).

Kurnaz, S. and N. Kaşka (1993). Investigations on the postharvest physiology of some peach vaieties grown in Adana. Doga, TÜrk Tarim Ve Ormancilik Dergisi, 17(1): 39-51. (C. F. Hort. Abst. 65: 1885).

Luza, J. G., R. Van Gorsel; V. S. Polito and A. A. Kader (1992). Chilling injury in peaches: A cytochemical and ultrastructural cell wall study. J. Amer. Soc. Hort. Sci. 117(1): 114-118.

Macleod-Smith, R. I.; J. Van Espen; G. Mager (1994). Modern practices in wet air cooling for precooling and storage of fresh produce. Proceedings of the Institute of Refrigeration, 90, 85-92 ISBN 1-872719-06-6. (C. F. Hort. Abst. 65: 10394).

Mc Dowell, E. M. and B. F. Trump (1976). Histologic fixative suitable for diagnostic light and electron microscopy. Arch. Pathol. Lab. Vol. 100:405-413.

Mitchel, F. G. (1978). Temperature management studies. Vital need to observe requirements of each fruit kind and cultivar. Apricot, Pear and Peach Growers Association Annual. Paarl, South Africa No. 12:42-45. (C. F. Hort. Abst. 49: 409).

Mohamed, Kh.S. (1999). Postharvest studies on newly introduced peach varieties in the north west region of Egypt. M.Sc. Thesis, Fac. Agric. (Saba Basha), Alexandria Univ., Egypt.

Monzini, A. and F. Gorini (1979). Prospects of a new cold storage system for winter fruits. Frutticoltura, 41(2): 5-9. (C. F. Hort. Abst. 50: 5006).

O' Brien, M. and J. P. Gentry (1967). Effect of cooling methods on cooling rates and accompanying desiccation of fruits. Trans of the ASAE, 10(5): 603-606.

Oosthuyse, S. A.; M. E., Mabila; B. Van, Straten and A. J., Winter (1995). Effect of hydro-cooling on field heat removal of mangoes, and differing water temperatures on fruit quality after four weeks of cool storage. Year book. South AfricanMango Growers´Association, 14: 54-57.

Polderdijk, A. and Schaik, A.C.R. Van (1988). Hollow and brown conference, the remedy is known, the deeper cause is not. Fruitteelt 78(34): 12-13. (C. F. Hort. Abst. 59: 5583).

Romero, D. M.; S. Castillo and D. Valero (2003). Forced air cooling applied before fruit handling to prevent mechanical damage of plums (*Prunus salicina* Lindl.). Postharvest Biology and Technology 28: 135-142.

SAS Institute (1985). SAS user` guide statistics for personal computers version 5th ed. SAS Inst. Cary NCO.

Scandella, D.; P.Moras; S. Venien; M. Jost and Al. Delcout (1990). The quality line: the identification of temperature treatments for maintaining the quality of peaches during distribution. Neuvieme Colloque Sur les Recherches Fruitieres. La Maitrise de la Qualite des Fruits Frais, Avignon 4-5-6 Decembre. (C. F. Hort. Abst. 62: 5565).

Shcherbatko, D. M. (1989). Study of the keeping quality of pear fruits. Nauchno-Tekhnicheskii Byulleten, Vsesoyuznogo Ordena Lenina I Ordena Druzhby Narodov Nauchno- Issledovate l`Skogo Institula Rastenievodstva Imeni N. I. Vavilova, No 196: 50-52. (C. F. Hort. Abst.61: 4691).

Snedecor, G. W. and W. G. Cochran (1980). Statistical methods. 7th Ed., Fourth Printing, the Iowa State Univ. Press Ames., Iowa U. S. A.

Tonini, G. and D. Caccioni (1991). Precooling of apricot: influence on rot, ripening and weight loss. Acta Horticulturae, 293:701-704.

Tonini, G.; S. Brigati and D. Caccioni (1990). Air precooling of plums: Technical and biological aspects. Rivista di Frulticottura e di Ortofloricoltura, 52(6): 71-74. (C. F. Hort. Abst. 62: 3730).

Wang, T.; A. R. Gonzalez; E. E. Gbur and J. M. Aselage (1993). Organic acid changes during ripening of processing peaches. J. Fd. Sc. 58 (3): 631-632.

Zerbini, P. E.; A. Sozzi and A. Testoni (1980). The effect of hydrocooling and delayed storage on keeping quality of Kaiser pears stored in controlled atmosphere. Rivista della Ortoflorofrutticoltura Itaian 64(6): 611-621. (C. F. Fd. Sci. Tech. Abst. 14: 1148).

تأثر الصفات التشريحية ومواصفات الجودة أثناء تخزين ثمار الخوخ بالتبريد السريع

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كانت صلابة ثمار الخوخ صنف سويلنج المبردة سريعا بدفع الهواء مرتفعة بينما كان محتواها من المواد الصلبه الذائبة اقل اثناء فترة التخزين مقارنة بالثمار المبردة بدون دفع الهواء. لم تؤثر معاملات التبريدالسريع معنويا علي محتوي ثمار الخوخ من حمض الماليك ولكن بصورة عامة كان محتوي حمض الماليك أعلي في الثمار المبردة سريعا أثناء فترة التخزين. وقد انخفضت نسبة الفقد في الوزن بصورة معنوية في الثمار المعاملة بالتبريد السريع خاصة اذا غسلت الثمار قبل إجراء التبريد السريع عليها والتي أعطت أقل فرق معنوى في كلا اتموسمين. وقد وجد أن الثمار المبردة سريعا كانت الأعلى فى محتواها الرطوبي بالمقارنة بالثمار غير المبردة سريعا. وكان امتلاء الخلايا في الثمار المبردة سريعا بدفع الهواء بعد الغسيل أعلى مقارنة بالثمار المبردة سريعابدفع الهواء فقط او المبردة بدون دفع الهواء.