Effects of intermittent warming and different packing materials on the quality and storability of 'Swelling' peach fruits

Tayel, Enas, A.E.[1]; Amira, A.E.El-Helaly[2]; M.E. Sobieh[3]
1,2-Hort. Res. Station Alex., Hort. Res. Ins., A.R.C., Giza, Egypt.
3- Hort. Res. Ins., A.R.C., Giza, Egypt

ABSTRACT

Peaches (cv. 'Swelling') were packed in heat-sealed low density (LD) polyethylene bags (23.5±2 µm thick); high density (HD) polyethylene bags (15.6±2 µm thick); polypropylene bags (33±2 µm thick) or unpacked (control). Thereafter, fruits were stored for 6 weeks, continuously at 0°C and 85-90% RH or at intermittent warming (IW) of 6 days at 0°C and one day at 20°C in cycle with 85-90% RH. Samples were taken at weekly intervals and analysed immediately. The termination of the experiment was done, when fruit firmness reached around 3 lb/inch^2. The results indicated that, fruits received IW treatment remained only 2 weeks when they were unpacked (control), packing those fruits in HD polyethylene bags gained them one week more (3 weeks in storage), using LD polyethylene bags maintained the fruit 5 weeks, whereas fruits in polypropylene bags retained 6 weeks. On the other side, all fruits stored continuously at 0°C (either packed or not), could be lasted 6 weeks of storage. As the storage period advanced, there was a significant reduction in fruit firmness besides a significant increment in weight loss (W.L). Also at the end of storage period, the initial values of soluble solids content (SSC); ascorbic acid (V.C) and water soluble pectin significantly increased, while fruit acidity (TA) significantly decreased. Concerning the effectiveness of packing on fruit quality, as an average of all storage periods, polypropylene bags gave the firmest fruits. The three kinds of packing materials almost had the same effects in reducing weight loss, < 0.3% compared with control > 10.6%. Both kinds of polyethylene bags maintained SSC and reduced TA and V.C values. Packing generally had no effect on water soluble pectin. On the other side, fruit quality (firmness; W.L; SSC; TA; V.C and water soluble pectin) were not greatly influenced by IW treatment.

Key words: peach fruits; packaging; intermittent warming and storage.

INTRODUCTION

Temperature has a direct effect on the respiration rate of fruits and on the activity of decay-caused by organisms. Storage temperatures of -0.6° to 0°C are recommended for stone fruits (Hardenburg, 1986). For maximum storage life, peaches should be held at 0°C (Anderson and Penny, 1975). At 0°C, the storage life of peach fruit of most cultivars is 2 to 3 weeks and when held for longer periods, chilling injury usually occurs. Fruits with chilling injury appear normal when removed form storage, but do not ripen satisfactory when moved to room temperature and develop a physiological or internal breakdown which is characterized by the development of dry and mealy or wooly flesh. In advanced stages, the flesh becomes badly discoloured and a watery translucent breakdown occurs around the endocarp (Anderson and Penny, 1975). One important complex cause of quality deterioration of peach fruits is the presence of flesh browning, flesh mealiness, darkened pit cavity, flesh translucence, red

pigment accumulation (bleeding) and loss of flavor (Mitchell and Kader, 1989 and Crisosto *et al.* 1995a and 1995b). These symptoms result from internal breakdown, which normally appears during prolonged cold storage and / or after ripening at room temperature following cold storage. These disorders are the main limitations to long-term storage and shipping to distant markets for susceptible cultivars. (Claypool; 1977 and Saenz, 1991).

Mealiness in stone fruit can be alleviated by intermittent warming, in which fruits are removed at regular intervals from storage at 0° or 1°C and warmed to temperatures in the range 10 to 25°C (Anderson 1979 and Lill, 1985). The mechanism by which mealiness is alleviated by intermittent warming is not clear. Buescher and Furmanski (1978) suggested that intermittent warming protected the capacity of fruit to produce adequate levels of pectinesterase and polygalcturonase during ripening. Ben-Aire and Sonego (1980) observed that polygalacturonase activity in fruit warmed intermittently reached levels similar to those in normally-ripened fruit. They suggested that transfer of fruit to the higher temperatures within a critical period, before the inactivation of polygalacturonase, enabled resumption of enzyme activity resulting in dissolution of accumulated substrate, and normal ripening ensued. Pectinesterase activity was lower in intermittently warmed fruit than in fruit continuously stored at chilling temperatures.

On the other side, loss of moisture can often be minimized with protective packaging to supplement the benefits of refrigeration and high humidity plastic materials, such as polyethylene film, which can be used for consumer size packaging or for box liners to protect stored commodities (Hardenburg, 1986; Kader *et al.*, 1989 and Pretel *et al.*, 1994). Moreover, packaging with plastic filme provide a degree of modified atmosphere benefit (Wills *et al.*, 1989). Besides, many studies reported that the advantage of film wrapping reduced weight loss; maintained firmness; reduced chilling injury; delayed ripening and colour development (Geeson, 1989; El-Zyat *et al.*, 1997 and Mohamed, 1999).

Few studies have been done on determination of the additive effects of intermittent warming treatment and packing materials on the quality and storability of stone fruits. Therefore, this research was carried out, to study the effects of some packing materials (two kinds of polyethylene bags low and high density and polypropylene ones) during continuous storage at 0°C or intermittent warming (6 day at 0°C + 1 day at 20°C in cycle), on the quality and storability of 'Swelling' peach fruits.

MATERIALS AND METHODS

The present study was performed during two successive seasons (2005 and 2006). "Swelling" peach fruits were picked from a private orchard in El-Noubaria, Behera Governorate. The soil is sandy and drip irrigation is practiced in the orchard. Trees were subjected to normal cultural practices used in this area.

In the third week of June, in both experimental seasons, 735 mature fruits were carefully picked at random. The fruits were almost the same size and were free from obvious defects or mechanical damage. Fruits were washed with tap water and air dried. Fifteen fruits were used as an initial sample for physical and chemical analysis. The remaining fruits (720) were divided into 4 equal groups, i.e. each group was represented by 180 fruits. One group was unpacked (control), the fruits were put in mesh bags. The other 3 groups were packed in low density polyethylene bags (23.5±2 µm thick), high density polyethylene bags (15.6±2 µm thick) or polypropylene bags (33±2 µm thick). The plastic bags were heat-sealed. Fruits were packed as 5 fruits (replicate) in each bag. In other words, every group was divided into small ones, 5 fruits each, i.e. every group represented by 36 bags. Half of them (18 bags) was stored continuously at 0°C. The second half was subjected to intermittent warming as fruits stored at 0°C for 6 days followed by one day at 20°C, then returned to storage at 0°C again in cycle. The relative humidity always was 85 – 90%.

So then, the experimental treatments were as follows:

T1: Fruits were packed in polypropylene bags, stored continuously at 0°C.
T2: Fruits were packed in low density polyethylene bags, stored continuously at 0°C.
T3: Fruits were packed in high density polyethylene bags, stored continuously at 0°C.
T4: Unpacked fruits, stored continuously at 0°C.
T5: Fruits were packed in polypropylene bags, stored at IW (6 days at 0°C then one day at 20°C in cycle).
T6: Fruits were packed in low density polyethylene bags, stored at IW (6 days at 0°C then one day at 20°C in cycle).
T7: Fruits were packed in high density polyethylene bags, stored at IW (6 days at 0°C and 1 day at 20°C in cycle).
T8: Unpacked fruits, stored at IW (6 days at °C and 1 day at 20°C in cycle).

Fruits of each treatment were evaluated at weekly-intervals throughout the storage period (6 weeks). A sample of 3 replicates (bags) 5 fruits each, was taken for each treatment. On that base, 'Swelling' peach fruits were represented by 8 treatments x 3 replicates x 5 fruits x 6 evaluating dates = 720 fruits.

The termination of the experiment was done in the two years of study, when fruit firmness reached around 3 lb/inch^2, except fruits packed in polypropylene bags and stored continuously at 0°C (T1), as the fruit began to deteriorate even though they were firm, after 6 weeks of storage.

The effect of variouts treatments on physical and chemical properties of 'Swelling' peach fruits, was determined.

1- Physical properties:

Fruit firmness (lb/inch^2)

Flesh firmness was determined in any given sample by peeling the two opposite sides of the fruit and the firmness of each side was determined by using the Effegi pressure tester with an eight mm. plunger (Effegi, 48011 Alfonsine, Italy). Two types of the same Effegi pressure tester were used, the first one ranged from 1-30 lb/inch^2 as full scale while the second one ranged form 1-10 lb/inch^2. The former one was used for initial firmness determination and follow up, while the later one was used at later stages of storage when the fruits became softer due to ripening. The average flesh firmness of each fruits sample was calculated from 10 readings. Fruit firmness was expressed as pounds/inch^2.

Weight loss, as a percentage from the initial weight.

2- Chemical properties:

Soluble solids contents (SSC%)

Two segments were taken longwise from two opposite sides of each fruit form the rose to the stem and as deep as to the stone of the fruit. Each segment was squeezed and the obtained juice was used to determine the percentage of SSC by the use of a hand refractometer according to Chen and Mellenthin (1981). Average percentage of SSC for each sample was then calculated.

Titratable acidity (TA)

Another two segments were taken as mentioned above and three samples of juice were obtained. Five ml. samples of the obtained juice were used to determine the tritratable acidity. For the titration, 0.1N sodium hydroxide was used in the presence of phenolphethalein as an indicator according to Chen and Mellenthin (1981). The titratable acidity was expressed as g malic acid/ 100 ml of fruit juice.

Ascorbic acid (V.C)

V.C was determined in filtered juice samples by titration against 2.6 dichlorophenol indophenol blue dye, according to the A.O.A.C. (1985), and expressed as mg/100 ml juce.

Water soluble pectin (%)

Water soluble pectin content was estimated in the fruit pulp as calcium pectate percentage according to Care and Haynes (1922). 50 gm of pulp segments were extracted by boiling in distilled water for one hour and the extraction filtered was then completed to 250 ml as total volume. 100 ml of the obtained extraction was used to precipitate the calcium salt by acetic acid 1.0 N and calcium chloride 1.0 M. After one hour, the extraction was boiled for 2 min. and then filtered. The precipitate was washed with boiled distilled water until becomes free from chloride ions. The precipitate was dried and then weighed as calcium pectate to calculate water soluble pectin percentage.

All data were statistically analyzed according to Snedecor and Cochran (1971). The design was completely randomized with two factors experiment, treatments and storage periods, (split in time). The L.S.D method at (0.05) was used to compare the average of treatments (T), storage periods (P) and their interaction (T X P). As all treatments didn't terminate at the same time, so the statistical analysis were done at 2, 3, 5 and 6 weeks of storage.

RESULTS AND DISCUSSION

Effect of various treatments on the storability of 'Swelling' peach fruits

As the termination of the experiment was done, when the fruit firmness reached nearly 3lb/inch^2, so the data recorded in Tables (1 and 2), indicated that, in both experimental seasons, fruits received IW treatment remained only 2 weeks of storage when they were unpacked (T8), packing those fruits in HD polyethylene bags (T7) remained them one week more, using LD polyethylene bags (T6) resulted to maintain the fruits 5 weeks, while in polypropylene bags (T5) fruits retained 6 weeks. On the other side, all fruits continuously stored at 0°C (T1,2,3 and 4) remained 6 weeks of storage. It could be concluded that, IW treatment reduced the storage period of 'Swelling' peach fruits, except ones packed in polypropylene bags (T5), compared with those stored continuously at 0°C (T1,2,3 and 4). The results were in agreement with those found by Tayel (2001) on 'Florda prince', 'Desert red' and 'Hermosa' peach fruits. She noticed that IW treatment reduced storagability for the three peach varieties under test as compared with the control (fruits stored at 0°C).

On the other side, the effectiveness of packing on the storability were clearly noticed when the fruits received IW treatment. Polypropylene was the best one followed by LD polyethylene. The results were in accordance with those found by Turk and Ozkurt (1994) on peaches (cv. J.H.Hale) and plums (cv. Stanley). Fruits were wrapped in polyethylene, polypropylene or polyvinylchloride. They noticed that, for 'Stanley' plum fruits, the best treatment was polypropylene which resulted in the lowest respiration rate, the firmest fruits and the best overall appearance after storage for 6-7 weeks.

Effect of various treatments on physical and chemical properties of fruits

1- Physical properties

Firmness

The data in Tables (1 and 2) showed that, in both experimental seasons fruit firmness gradually, decreased as the storage period advanced with significant differences, as an average of the treatments used. The reduction of fruit firmness with the progress of storage time, is supported on different cvs of peaches by Dundar (1997) on J.H. Hale;

Mohamed (1999) on 'Florda prince', 'Almoge' and 'Tropical snow'; El-Seidy (2000) on 'Florda prince', 'Desert red' and 'Swelling' and El-Helaly *et al.* (2007) on 'Desert red' peach fruits. They all noticed that fruit firmness continuously decreased during storage period.

Fruits stored continuously at 0°C (T1,2,3 and 4) were more firm than those treated with IW treatment (T5,6,7 and 8), as an average of weeks of storage. Except, in first season, the differences were not significant between T2 and T6, as an average of 2 or 3 weeks of storage. However, after 5 weeks of storage, those differences became significant. The results were in accordance with the data obtained by Dawson and Watkins (1995) on 'Fantasia 2' nectarines [(*Prunus Persica*, L.) Batsch var. nectarina (Ait) maxim] and Kluge *et al.* (1996) on semi-mature 'BR-6' peach fruits, they all mentioned that IW treatments resulted in significant softening during storage. In addition, Tayel (2001) reported that IW treatments reduced storagability of peach fruits in comparison with control.

The data also indicated that, in both years of study, at the end of storage period (6 weeks), the fruits packed in polypropylene bags were the firmest ones when they were stored continuously at 0°C (T1). While they had the least values of firmness, when they were treated with IW treatment (T5), as an average of all storage periods. No significant differences were found between firmness values of unpacked fruits (T4) and those of fruits packed in LD polyethylene bags (T2). The superiority of polypropylene bags as compared with polyethylene ones in maintenance fruit firmness, was previously reported by Turk and Ozkurt (1994).

Weight loss

The data recorded in Tables (3 and 4) showed that, in both experimental seasons, weight loss percentages of 'Swelling' fruits were gradually increased as the storage period advanced with significant differences among storage periods, as an average of the treatments used. The increment of weight loss with the progress of storage period, was previously reported on some peach varieties by Mohamed (1999); El-Seidy (2000); Tayel (2001) and El-Helaly *et al.* (2007).

Weight loss was considerably reduced by packing. After 2 weeks of storage, packed fruits showed weight loss of < 0.1% at 0°C (T1,2 and 3) and <0.3% at IW (T5,6 and 7), while unpacked ones lost up of 3.5% at 0°C (T4) and up of 5% at IW (T8). At the end of storage period (6 weeks), as an average of all storage periods, packed fruits at 0°C (T1, 2 and 3) showed weight loss of < 0.3%, while unpacked ones (T4) lost up of 10.6%. The data also indicated that, the 3 kinds of packing materials, polypropylene; LD polyethylene and HD polyethylene almost had the same influence in reducing weight loss, as no significant differences were existed among weight loss percentages of the fruits packed in them. The effectiveness of packaging in reducing weight loss was previously reported on peach fruits by Sharma *et al.* (1988) on "Florda sun"; Schlimme (1990) on "Suncerst";

Tavares *et al.* (1991) on "Delicia" and "Talisma"; El-Shiekh and Habiba (1996) on "Early grand"; Kim *et al.* (1998) on 7 peach and nectarine cultivars and Kenawy (2001) on "Florda prince", "Desert red" and "Swelling" peaches.

Concerning the effectiveness of IW treatment, the data indicated that, in both experimental seasons, at 2 weeks of storage, no significant differences were detected between weight loss percentages of packed fruits stored continuously at 0°C (T1,2 and 3) and those of fruits received IW treatment (T5,6 and 7). In the meantime, weight loss percentages of unpacked fruits stored continuously at 0°C (T4) were significantly lower than those of fruits received IW treatment (T8). However the results were in line with those found by Kluge *et al.* (1996) on peaches cv. BR-6. They found IW treatments increased weight loss (although not significantly).

Generally, it could be concluded that weight loss was not greatly influenced by IW treatment. The most effective factor in reducing weight loss is packing whatever the kind of material used polypropylene, LD polyethylene or HD polyethylene.

2- Chemical properties:

Soluble solids content (SSC)

The data in Tables (5 and 6) revealed that SSC percentages significantly increased at the end of storage period. However, in second season after 6 weeks of storage, the differences were insignificant. The increase in soluble solids content could be attributed to the degradation of complex insoluble compounds like starch to simple soluble ones, like sugars which are the major component of soluble solids content in the fruits (EL-Seidy, 1994). The above mentioned data and related discussion are confirmed with those obtained by Dundar (1997); Mohamed (1999); El-Seidy (2000) and El-Helaly *et al.* (2007) on different varieties of peach fruits. However, Kim *et al.* (1998) on peaches and nectarines, found that storage period had no effect on SSC. Also Tayel (2001) found no significant relation between storage period and soluble solids content of peach fruits of some postharvest treatments.

The data also declared that, at the end of storage (6 weeks), as an average of all storage periods, packing fruits resulted to diminish the percentages of SSC. However, in first season, the differences were insignificant between SSC of unpacked fruits (T4) and those of fruits packed in polypropylene bags (T1). The results were in line with those found by Sharma *et al.* (1988). They found that packing "Florda sun" peaches resulted to maintain SSC. Fruits packed in polyethylene bags either low or high density, (T2 or 3) almost had the same percentages of SSC, and these percentages were lower than those of fruits packed in polypropylene bags (T1). However, in second season, the differences were insignificant between T1 and T2.

Concerning the effectiveness of IW treatment generally it could be concluded that SSC percentages of "Swelling" fruits were not greatly influenced by IW treatment. This conclusion agree with Kluge *et al.* (1996) on peaches. They found that IW had no effect on SSC.

Titratable acidity (TA)

The changes in the tiratable acidity (TA) expressed as malic acid percentage, are recorded in Tables (7 and 8). The data revealed that the percentages of malic acid significantly decreased in both experimental seasons, as an average of the treatment used. Malic acid is a respiratory substrate and its consumption in respiration increases with the progress of storage time, as the malic acid could be used as an organic substrate in the respiration process (El-Seidy, 2000). The above results and associated discussion were in agreement with the findings of Han Tao *et al.* (1996) on 'Beijing' china peach cv. 'Luhu'; Kamal *et al.* (1996) on 'Florda sun', 'Early grand', 'Desert gold' and 'Mit ghamr' peaches; Kim *et al.* (1998) on peaches and nectarines; Mohamed (1999) on 'Florda prince', 'Almoge' and 'Tropical snow' peaches and El-Helaly *et al.* (2007). They all found a significant decrease in the percentage of malic acid during storage period.

The data also indicated that, at the end of storage (6 weeks), as an average of all storage periods, packing fruits in polyethylene bags (T2 and 3) resulted to significant reduction in fruit acidity. In addition, the low density bags (T2) were more effective in reducing acidity than the high density ones (T3). On the contrary, using polypropylene bags at 0°C (T1) didn't influence fruit acidity. On the other side, no significant differences were detected between malic acid in fruits packed in polypropylene bags either stored continuously at 0°C (T1), or received IW treatment (T5). The results were in agreement with those obtained by Kluge *et al.* (1996) on 'BR-6' peaches. They found that IW had no effect on total titratable acidity.

Generally it could be concluded that IW treatment as same as polypropylene bags didn't greatly affect fruit acidity.

Ascorbic acid (V.C)

The data nominated in Tables (9 and 10) declared that the initial values of V.C significantly increased at the end of storage period, as an average of the treatments used.

Again as in fruit acidity, the data indicated that at the end of storage (6 weeks), as an average of all storage periods, only polyethylene bags (T2 and 3) significantly reduced V.C values. Low and high density polyethylene bags almost had the same influence in reducing V.C values. On the other side, no significant differences were detected between V.C values of fruits packed in polypropylene bags, stored continuously at 0°C and those received IW treatment (T1 and 5).

Generally, it could be concluded that V.C was not greatly influenced by IW treatment and using polyethylene bags resulted to reduce it's value, especially at the last period of storage. However, Sharma *et al.* (1988)

reported that packing 'Florda sun' peach fruits resulted to maintain ascorbic acid.

Water soluble pectin

The data recorded in Tables (11 and 12) indicated that the percentages of water soluble pectin increased at the end of storage period (6 weeks), as an average of treatments 1, 2, 3, 4 and 5. However, in first season, the differences were insignificant. The increment in water soluble pectin with the advancing of storage period, is due to the decomposition and the enzymatic degradation of protopectin to soluble pectin. α-D-galacturonase (polygalacturonase) and cellulose are involved only in softening fruits in the later stages of ripening. In addition, cell wall polymers containing long thin pectin aggregates were destroyed, whereas cell wall polymers containing short thick pectin aggregates remained. The above mentioned results and related discussion are confirmed with the results obtained by Kim *et al.* (1992); Fishman *et al.* (1993); El-Seidy (2000); Tayel (2001) and El-Helaly *et al.* (2007) on peach cvs. They recorded that the initial water soluble pectin increased at the end of storage period.

As an average of all storage periods, no significant differences were existed among water soluble pectin of fruits remained to the end of storage (T1, 2, 3, 4 and 5). Except, in second season, water soluble pectin percentages in fruits of T2 were significantly lower than those of other treatments (T1, 3, 4 and 5).

Generally, it could be concluded that neither packing nor IW greatly influenced water soluble pectin.

Conclusion:

The effectiveness of packing materials on the storability of "Swelling" peach fruits was clearly noticed when the fruits received IW treatment. As those fruits remained only 2 weeks of storage when they were unpacked (control), packing the fruits in HD polyethylene bags gained them one week more (3 weeks in storage), using LD polyethylene bags maintained the fruits 5 weeks, while fruits in polypropylene bags retained 6 weeks of storage. On the other side, all fruits stored continuously at 0°C (either packed or not) remained 6 weeks of storage. Disagreement to IW treatment, packing influenced fruit quality, polypropylene gave the firmest fruits and the three kinds of packing materials almost had the same superiority effects on reducing weight loss. So the authors confirm of using the packaging in polyethylene (high or low density) or polypropylene bags, in commercial uses, as a simple, cheap and effective method for keeping quality of "Swelling" peach fruits stored at 0°C.

Table (1): Effect of various treatments on fruit firmness (1b/inch^2) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	10.130	10.130	10.130	10.130	10.130	10.130	10.130	10.130	10.130^{A}	10.130^{A}	10.130^{A}	10.130^{A}
2	9.660	9.063	9.900	9.440	8.330	8.813	6.380	2.933	8.065^{B}	8.798^{B}	9.201^{B}	9.278^{B}
Average*	9.895^{AB}	9.596^{ABC}	10.015^{A}	9.785^{AB}	9.230^{C}	9.471^{BC}	8.255^{D}	6.531^{E}				
3	8.800	9.000	9.170	8.213	7.750	8.683	2.300	-		7.702^{C}	8.602^{C}	8.586^{C}
Average**	9.530^{AB}	9.397^{AB}	9.733^{A}	9.261^{AB}	8.738^{C}	9.208^{BC}	6.270^{D}	-				
4	8.983	8.013	8.350	6.993	6.583	5.960	-	-			7.480^{D}	7.784^{D}
5	7.863	6.400	5.760	5.810	4.993	2.573	-	-			5.566^{E}	6.165^{E}
Average***	9.087^{A}	8.521^{B}	8.662^{B}	8.117^{C}	7.557^{D}	7.232^{D}	-	-				
6	7.010	3.073	4.840	3.400	3.693	-	-	-				4.403^{F}
Average****	8.741^{A}	7.613^{C}	8.025^{B}	7.331^{C}	6.913^{D}	-	-	-				

L.S.D	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
0.05	0.592	0.603	0.906	0.952

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (2): Effect of various treatments on fruit firmness (1b/inch^2) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	9.943	9.943	9.943	9.943	9.943	9.943	9.943	9.943	9.943^{A}	9.943^{A}	9.943^{A}	9.943^{A}
2	10.213	9.513	10.240	9.973	8.900	8.273	6.483	2.693	8.286^{B}	9.085^{B}	9.518^{B}	9.768^{A}
Average*	10.078^{A}	9.728^{AB}	10.091^{A}	9.958^{A}	9.421^{BC}	9.108^{C}	8.213^{D}	6.318^{E}				
3	9.030	9.103	9.003	8.593	8.180	8.430	1.913	-		7.750^{C}	8.723^{C}	8.782^{B}
Average**	9.728^{A}	9.520^{A}	9.728^{A}	9.503^{A}	9.007^{B}	8.882^{B}	6.113^{C}	-				
4	9.330	7.903	6.660	7.303	6.243	6.403	-	-			7.307^{D}	7.488^{C}
5	8.683	6.223	5.880	5.663	4.813	2.050	-	-			5.552^{E}	6.252^{D}
Average***	9.440^{A}	8.537^{B}	8.345^{B}	8.295^{B}	7.616^{C}	7.020^{D}	-	-				
6	6.500	3.373	4.673	3.250	3.570	-	-	-				4.273^{E}
Average****	8.950^{A}	7.678^{B}	7.733^{B}	7.454^{B}	6.941^{C}	-	-	-				

L.S.D	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
0.05	0.563	0.585	0.820	0.849

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (3): Effect of various treatments on weight loss (%) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	-	-	-	-	-	-	-	-	-	-	-	-
2	0.000^{D}	0.011^{D}	0.098^{CD}	3.560^{B}	0.148^{CD}	0.149^{CD}	0.290^{C}	5.103^{A}		0.607^{B}	0.660^{D}	0.763^{E}
3	0.090	0.050	0.158	7.633	0.557	0.519	0.813	-		1.374^{A}	1.501^{C}	1.697^{D}
Average**	0.045^{D}	0.030^{D}	0.128^{CD}	5.596^{A}	0.351^{BC}	0.334^{BC}	0.451^{B}	-				
4	0.187	0.130	0.225	11.133	0.789	0.617	-	-			2.180^{B}	2.493^{C}
5	0.260	0.189	0.395	13.810	1.193	0.920	-	-			2.794^{A}	3.169^{B}
Average***	0.134^{B}	0.095^{B}	0.219^{B}	9.034^{A}	0.671^{B}	0.551^{B}	-	-				
6	0.540	0.250	0.583	19.113	1.380	-	-	-				4.373^{A}
Average****	0.215^{B}	0.126^{B}	0.291^{B}	11.050^{A}	0.813^{B}	-	-	-				

L.S.D 0.05	**for 2 storage periods Interaction	***for 4 storage periods Interaction	****for all storage periods Interaction
	0.069	0.701	0.739

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (4): Effect of various treatments on weight loss (%) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	-	-	-	-	-	-	-	-	-	-	-	-
2	0.018^{C}	0.028^{C}	0.009^{C}	3.570^{B}	0.180^{C}	0.152^{C}	0.123^{C}	5.572^{A}		0.583^{B}	0.659^{D}	0.761^{E}
3	0.087	0.113	0.129	7.623	0.676	0.321	0.589	-		1.362^{A}	1.491^{C}	1.725^{D}
Average**	0.052^{C}	0.070^{C}	0.069^{C}	5.596^{A}	0.428^{B}	0.236^{BC}	0.356^{B}	-				
4	0.170	0.210	0.205	10.270	0.951	0.495	-	-			2.050^{B}	2.361^{C}
5	0.230	0.205	0.315	14.430	1.200	0.900	-	-			2.880^{A}	3.276^{B}
Average***	0.126^{C}	0.139^{C}	0.164^{C}	8.973^{A}	0.751^{B}	0.467^{BC}	-	-				
6	0.510	0.223	0.560	17.500	1.413	-	-	-				4.041^{A}
Average****	0.203^{C}	0.155^{C}	0.243^{C}	10.678^{A}	0.884^{B}	-	-	-				

L.S.D	**for 2 storage periods Interaction	***for 4 storage periods Interaction	****for all storage periods Interaction
0.05	0.065	0.221	0.363

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (5): Effect of various treatments on soluble solids content (SSC) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	11.386	11.386	11.386	11.386	11.386	11.386	11.386	11.386	11.386^{B}	11.386^{B}	11.386^{C}	11.386^{D}
2	11.850	11.680	11.803	12.020	11.933	12.380	12.690	12.450	12.100^{A}	12.051^{A}	11.944^{B}	11.857^{C}
Average*	11.618^{A}	11.533^{A}	11.595^{A}	11.703^{A}	11.660^{A}	11.883^{A}	12.038^{A}	11.918^{A}				
3	12.100	12.200	10.823	13.000	12.360	12.320	13.390	-		12.313^{A}	12.133^{AB}	12.096^{BC}
Average**	11.778^{B}	11.755^{B}	11.337^{C}	12.135^{AB}	11.893^{B}	12.028^{B}	12.488^{A}	-				
4	13.083	11.753	11.493	13.090	12.630	11.280	-	-			12.221^{A}	12.410^{AB}
5	13.130	11.700	11.560	13.450	11.600	12.510	-	-			12.325^{A}	12.288^{AB}
Average***	12.310^{A}	11.744^{B}	11.413^{C}	12.589^{A}	11.982^{B}	11.975^{B}	-	-				
6	12.840	11.900	11.900	12.850	11.850	-	-	-				12.268^{AB}
Average****	12.398^{A}	11.770^{BC}	11.494^{C}	12.632^{A}	11.960^{B}	-	-	-				

L.S.D 0.05	*for 2 storage periods Interaction NS	**for 3 storage periods Interaction 0.695	***for 5 storage periods Interaction 0.551	****for all storage periods Interaction 0.547

Average followed by the same letters are not significant at 0.05 level. N.S: Not significant

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (6): Effect of various treatments on soluble solids content (SSC) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	11.833	11.833	11.833	11.833	11.833	11.833	11.833	11.833	11.833^{B}	11.833^{C}	11.833^{D}	11.833^{C}
2	11.440	11.580	12.170	12.970	11.693	12.550	13.323	12.880	12.325^{A}	12.246^{B}	12.067^{BC}	11.970^{BC}
Average*	11.636^{D}	11.706^{CD}	12.001^{BCD}	12.401^{AB}	11.763^{CD}	12.191^{ABC}	12.578^{A}	12.356^{AB}				
3	12.150	12.500	11.060	13.090	12.140	12.623	13.983	-		12.506^{A}	12.260^{AB}	12.188^{AB}
Average**	11.807^{D}	11.971^{CD}	11.687^{D}	12.631^{AB}	11.888^{D}	12.335^{BC}	13.046^{A}	-				
4	12.350	11.970	11.340	13.110	11.803	11.530	-	-			12.017^{CD}	12.114^{B}
5	12.500	12.273	11.863	13.800	11.523	12.033	-	-			12.332^{A}	12.392^{A}
Average***	12.054^{B}	12.031^{B}	11.653^{C}	12.960^{A}	11.798^{BC}	12.114^{B}	-	-				
6	12.650	11.340	11.720	12.250	11.850	-	-	-				11.962^{BC}
Average****	12.153^{B}	11.916^{BC}	11.664^{C}	12.842^{A}	11.807^{BC}	-	-	-				

L.S.D 0.05	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
	0.653	0.643	0.542	0.521

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (7): Effect of various treatments on titratable acidity (malic acid %) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321^{A}	0.321^{A}	0.321^{A}	0.321^{A}
2	0.286	0.273	0.268	0.300	0.293	0.300	0.320	0.366	0.300^{B}	0.291^{B}	0.286^{C}	0.284^{C}
Average*	0.303^{BC}	0.297^{C}	0.294^{C}	0.310^{BC}	0.307^{BC}	0.310^{BC}	0.320^{B}	0.343^{A}				
3	0.300	0.266	0.245	0.320	0.313	0.273	0.293	-		0.287^{B}	0.286^{C}	0.288^{BC}
Average**	0.302^{AB}	0.286^{BC}	0.278^{C}	0.313^{A}	0.309^{A}	0.298^{AB}	0.311^{A}	-				
4	0.279	0.252	0.300	0.307	0.299	0.279	-	-			0.286^{C}	0.287^{BC}
5	0.314	0.286	0.292	0.300	0.279	0.307	-	-			0.296^{B}	0.294^{B}
Average***	0.300^{AB}	0.279^{D}	0.285^{CD}	0.309^{A}	0.301^{AB}	0.296^{BC}	-	-				
6	0.313	0.200	0.285	0.259	0.252	-	-	-				0.261^{D}
Average****	0.302^{A}	0.266^{C}	0.285^{B}	0.301^{A}	0.293^{AB}	-	-	-				

L.S.D 0.05	*for 2 storage periods Interaction 0.031	**for 3 storage periods Interaction 0.025	***for 5 storage periods Interaction 0.021	****for all storage periods Interaction 0.020

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (8): Effect of various treatments on titratable acidity (malic acid %) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321	0.321^{A}	0.321^{A}	0.321^{A}	0.321^{A}
2	0.294	0.279	0.277	0.320	0.300	0.313	0.320	0.372	0.309^{B}	0.300^{B}	0.297^{B}	0.294^{B}
Average*	0.307^{B}	0.300^{B}	0.299^{B}	0.320^{B}	0.310^{B}	0.317^{B}	0.320^{B}	0.346^{A}				
3	0.300	0.259	0.238	0.320	0.314	0.286	0.300	-		0.288^{C}	0.286^{C}	0.286^{BC}
Average**	0.305^{B}	0.286^{C}	0.278^{C}	0.320^{A}	0.311^{AB}	0.306^{AB}	0.313^{AB}	-				
4	0.272	0.252	0.313	0.293	0.286	0.286	-	-			0.283^{C}	0.283^{CD}
5	0.300	0.293	0.295	0.310	0.277	0.300	-	-			0.295^{B}	0.295^{B}
Average***	0.297^{BC}	0.280^{D}	0.288^{CD}	0.312^{A}	0.299^{BC}	0.301^{B}	-	-				
6	0.320	0.216	0.305	0.272	0.266	-	-	-				0.276^{D}
Average****	0.301^{AB}	0.270^{C}	0.291^{B}	0.306^{A}	0.294^{B}	-	-	-				

L.S.D	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
0.05	0.030	0.027	0.021	0.021

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (9): Effect of various treatments on vitamin C (mg/100ml juice) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	1.212	1.212	1.212	1.212	1.212	1.212	1.212	1.212	1.212^{B}	1.212^{C}	1.212^{D}	1.212^{F}
2	1.360	1.520	1.360	1.520	1.520	1.653	1.520	1.493	1.493^{A}	1.493^{A}	1.488^{B}	1.456^{D}
Average*	1.286^{A}	1.366^{A}	1.286^{A}	1.366^{A}	1.366^{A}	1.432^{A}	1.366^{A}	1.352^{A}				
3	1.380	1.463	1.380	1.380	1.140	1.380	1.543	-		1.380B	1.353C	1.348^{E}
Average**	1.317^{A}	1.398^{A}	1.317^{A}	1.370^{A}	1.290^{A}	1.415^{A}	1.425^{A}	-				
4	1.533	1.440	1.440	1.760	1.506	1.360	-	-			1.506^{B}	1.536^{C}
5	1.860	1.460	1.546	1.790	1.870	1.790	-	-			1.719^{A}	1.705^{B}
Average***	1.469^{A}	1.419^{A}	1.387^{A}	1.532^{A}	1.449^{A}	1.479^{A}	-	-				
6	2.000	1.920	2.000	2.036	2.340	-	-	-				2.059^{A}
Average****	1.557^{AB}	1.502^{B}	1.489^{B}	1.616^{A}	1.598^{A}	-	-	-				

L.S.D	*for 2 storage periods	**for 3 storage periods	***for 5 storage periods	****for all storage periods
	Interaction	Interaction	Interaction	Interaction
0.05	NS	NS	0.169	0.170

Average followed by the same letters are not significant at 0.05 level. N.S: Not significant

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (10): Effect of various treatments on vitamin C (mg/100ml juice) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.160	1.160^{B}	1.160^{C}	1.160^{D}	1.160^{F}
2	1.280	1.440	1.440	1.440	1.603	1.760	1.600	1.520	1.510^{A}	1.509^{A}	1.493^{B}	1.440^{D}
Average*	1.220^{D}	1.300^{C}	1.300^{C}	1.300^{C}	1.381^{B}	1.460^{A}	1.380^{B}	1.340^{BC}				
3	1.460	1.210	1.300	1.460	1.310	1.053	1.460	-		1.321^{B}	1.298^{C}	1.348^{E}
Average**	1.300^{CD}	1.270^{D}	1.300^{CD}	1.353^{B}	1.357^{B}	1.324^{BC}	1.406^{A}	-				
4	1.630	1.440	1.440	1.760	1.360	1.280	-	-			1.485^{B}	1.526^{C}
5	1.790	1.460	1.502	1.790	1.710	1.630	-	-			1.647^{A}	1.650^{B}
Average***	1.464^{B}	1.342^{E}	1.368^{DE}	1.522^{A}	1.428^{C}	1.376^{D}	-	-				
6	2.083	1.853	1.960	2.010	2.253	-	-	-				2.032^{A}
Average****	1.567^{A}	1.427^{B}	1.467^{B}	1.603^{A}	1.566^{A}	-	-	-				

L.S.D	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
0.05	0.077	0.075	0.073	0.088

Average followed by the same letters are not significant at 0.05 level.

Treatments:

1- Polypropylene at 0°C
2- LD polyethylene at 0°C
3- HD polyethylene at 0°C
4- Control at 0°C
5- Polypropylene at IW
6- LD polyethylene at IW
7- HD polyethylene at IW
8- Control at IW

Table (11): Effect of various treatments on water soluble pectin (%) of 'Swelling' peach fruits during cold storage in 2005.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	2.350	2.350	2.350	2.350	2.350	2.350	2.350	2.350	2.350^{A}	2.350^{A}	2.350^{A}	2.350^{AB}
2	2.425	1.690	1.810	2.181	1.985	1.937	2.035	2.013	2.009^{B}	2.009^{B}	2.004^{BC}	2.018^{C}
Average*	2.387^{A}	2.020^{A}	2.080^{A}	2.265^{A}	2.167^{A}	2.143^{A}	2.192^{A}	2.181^{A}				
3	1.200	1.465	2.081	1.225	2.407	2.325	2.377	-		1.868^{B}	1.784^{C}	1.675^{D}
Average**	1.991^{A}	1.835^{A}	2.080^{A}	1.918^{A}	2.247^{A}	2.204^{A}	2.254^{A}	-				
4	2.621	2.110	2.693	2.670	1.590	2.450	-	-			2.355^{A}	2.337^{AB}
5	2.205	1.981	2.031	2.500	1.807	1.940	-	-			2.077^{B}	2.105^{BC}
Average***	2.160^{A}	1.919^{A}	2.193^{A}	2.185^{A}	2.027^{A}	2.200^{A}	-	-				
6	2.450	2.131	3.035	2.253	2.763	-	-	-				2.526^{A}
Average****	2.208^{A}	1.954^{A}	2.333^{A}	2.196^{A}	2.150^{A}	-	-	-				

L.S.D	*for 2 storage periods interaction	**for 3 storage periods interaction	***for 5 storage periods interaction	****for all storage periods interaction
0.05	NS	NS	0.629	0.652

Average followed by the same letters are not significant at 0.05 level. NS: Not significant

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

Table (12): Effect of various treatments on water soluble pectin (%) of 'Swelling' peach fruits during cold storage in 2006.

Weeks in storage	Treatments								Average	Average of the first 7 Tr.	Average of the first 6 Tr.	Average of the first 5 Tr.
	1	2	3	4	5	6	7	8				
0	1.973	1.973	1.973	1.973	1.973	1.973	1.973	1.973	1.973^{B}	1.973^{A}	1.973^{C}	1.973^{B}
2	2.010	1.861	2.180	2.425	2.353	2.031	2.181	2.255	2.162^{A}	2.149^{A}	2.143^{B}	2.166^{A}
Average*	1.991^{A}	1.917^{A}	2.076^{A}	2.199^{A}	2.163^{A}	2.002^{A}	2.077^{A}	2.114^{A}				
3	1.681	1.372	2.475	1.265	2.523	3.083	2.305	-		2.100^{A}	2.066^{BC}	1.863^{B}
Average**	1.888^{B}	1.735^{B}	2.209^{A}	1.887^{B}	2.283^{A}	2.362^{A}	2.153^{A}	-				
4	2.353	2.060	2.265	2.695	1.933	2.790	-	-			2.349^{A}	2.261^{A}
5	2.523	1.593	1.840	2.155	1.751	1.790	-	-			1.942^{C}	1.972^{B}
Average***	2.108^{B}	1.772^{C}	2.146^{B}	2.102^{B}	2.107^{B}	2.333^{A}	-	-				
6	2.183	2.035	2.423	2.340	2.083	-	-	-				2.213^{A}
Average****	2.120^{A}	1.815^{B}	2.192^{A}	2.142^{A}	2.103^{A}	-	-	-				

L.S.D	*for 2 storage periods Interaction	**for 3 storage periods Interaction	***for 5 storage periods Interaction	****for all storage periods Interaction
0.05	NS	0.451	0.364	0.352

Average followed by the same letters are not significant at 0.05 level. N.S: Not significant

Treatments:

1- Polypropylene at 0°C 2- LD polyethylene at 0°C 3- HD polyethylene at 0°C 4- Control at 0°C

5- Polypropylene at IW 6- LD polyethylene at IW 7- HD polyethylene at IW 8- Control at IW

REFERENCES

A.O.A.C. (1985). Official Methods of Analysis. The Association of Official Agriculture Chemists, 14th ed. Washington D.C. USA.

Anderson, R.E. (1979). The influence of storage temperature and warming during storage on peach and nectarine fruit quality. J. Amer. Soc. Hort. Sci., 104: 459-461.

Anderson, R.E. and R.W. Penny (1975). Intermittent warming of peaches and nectarines stored in a controlled atmosphere or air. J. Am. Soc. Hort. Sci., 151.

Ben-Arie, R. and L. Sonego (1980). Pectolytic enzyme activity involved in wolly breakdown of sotred peaches. Phytochemistry, 19: 2553-2555.

Buescher, R.W. and R.J. Furmanski (1978). Role of pectinesterase and polygalacturonase in the formation of wooliness in peaches. J. Food Sci., 43: 264-266.

Care, M.H. and S.Haynes (1922). Estimation of pectic substances. Cited from Ranganna S. (1979). Mannual of Analysis of Fruit and Vegetables Products, New Delhi, Tate Mc Graw-Hill Publishing, Company, Chapter, 2: 29-33.

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

Claypool, L.L. (1977). Plant nutrition and deciduous fruit crop quality. Hort. Sci., 10: 45-47.

Crisosto, C.H., T. DeJong, K.R.Day, R.S. Jonhanson, S. Weinbaum, D. Garner, G.M. Crisosto and D. Morrison (1995a). Studies on stone fruit internal break down In: 1994 research reports for California peaches and nectarines California Tree fruit Agreement, Sacramento, Calif.

Crisosto, C.H., F.C. Mitchell and R.S.Johanson (1995b). Factors in fresh market stone fruit quality. Postharvest News and Information, 6(2): 17N-21N.

Dawson, D.M. and C.B. Watkins (1995). Intermittent warming affects cell wall composition of 'Fantasia' nectarines during ripening and storage. J. Amer. Soc. Hort. Sci., 120 (6): 1057-1062.

Dundar, O. (1997). Investigation on cold storage and postharvest physiology of J.H. Hale peach.Acta Hort., 441: 411-414.

El-Helaly, A.A.E., E.A.E. Tayel and M.A. Shobaky (2007). A compartive study of the effectiveness of three rootstocks on the quality and storability of 'Desert red' peach fruits. J. Adv. Agric. Res. (Fac. Agric. Saba Basha), Vol. 12 (4), 2007; in press.

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

El-Seidy, R.M.A. (2000). Postharvest-prestorage-calcium treatments in relation to quality changes and storagability of peaches. Ph.D. Thesis, Alex. Univ. Alex. Egypt.

El-Sheikh, A.F. and R.A. Habiba (1996). Effect of storage time on the quality of peach fruit held in cold storage in different types of packaging. Gartenbauwissenschaft, 61 (1): 7-10.

El-Zyat, H.A., H.A. Allam and F.Q. Ibrahim (1997). Treatments to prolong storage life of apricots. Menofiya J. Agric. Res., 22(4): 1155-1170.

Fishman, M.I., B. Levaj, D. Gillespie and R.Scorza (1993). Changes in the physico-chemical properties of peach fruit pectin during on-tree ripening and storage. J. Amer. Soc. Hort. Sci., 118(3): 343-349.

Geeson, J.D. (1989). Modified atmosphere packaging of fruits and vegetables. Acta Hort., 258.

Han Tao, Li Liping and Gexing (1996). Physiological effect of heat shock treatment on peach fruit stored at low temperature. Plant physiology Communications, 32(3): 184-186. (Hort. Abst. 67(7): 5686).

Hardenburg, R.E. (1986). The commercial storage of fruits, vegetables, and florist and nursery stocks. P19 United States Department of Agriculture.

Kader, A.A., D.Zagony and L.E.Kerbel (1989). Modified atmosphere packaging of fruits and vegetables, volume 28 Issue (1) p.p.33.

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., Univ. Cairo, 47: 611-628.

Kenawy, O.M.F. (2001). Determination of maturity and beginning of ripening and extending shipment period of some peach cultivars. M.Sc. Fac. Agric. Cairo Univ.

Kim, I.S., J.K., Byun, J.W. Cho, Y.D. Choo, S.Y. Kim an B.S. Choi (1998). Evaluation of storageability of peach cultivars by storage temperature and polyethylene film packing. RDAJ. Hort. Sci. (II), 40(2) 41-46.

Kim, M.H., S.R. Shin, M.A. Son and K.S. Kim (1992). Changes in the cell components of peach during maturation and storage. J. Korean Soc.Food and Nutrition, 21(4): 372-376.

Kluge, R.A., A.Hoffmann, J.C. Nachtigal, A.B. Bilhalva and J.C. Fachinello (1996). Intermittent warming of cold-stored peach cv. BR-6. Pesquisa Agropecturia Brasileira, 31 (8): 543-547. (Hort. Abst., 67 (10): 8284).

Lill, R.E. (1985). Alleviation of interal breakdown of nectarines during cold storage by intermittent warming. Scientia Hort., 25: 241-246.

Mitchell, F.G. and A.A. Kader (1989). Factors affecting deterioration rate, p.165-178. In: La Rue, J.H. and R.S.Johnson (eds). Peaches, plums and nectarines. Growing and handling for fresh market, publication 3331. Univ. of California Division of Agriculture and Natural Resources.

Mohamed, K.S. (1999). Postharvest studies on newly introduced peach varieties in the north west region of Egypt. M.Sc. Thesis, Alex. Univ., Alex., Egypt.

Pretel, M.T., M.M. Serrano, G. Marinenz. F. Riquelne, F.Romo Jaro (1994). Influence of films of different peremability on ethylene synthesis and ripening of MA. Packaged apricots. Le bensmilted wissenchaht, technologie, 26 (1) 8-13. (Hort. Abst. 64: 337).

Saenz, M.V. (1991). Effect of position in the canopy on the postharvest performance and quality of stone fruit. In report on research projects for California peaches and nectarines. California Tree fruit Agreement, Sacramento, Calif.

Schlimme, D. (1990). Manuscript for 'plastic over wraps for ripe fruit'. Pennsylvania Fruit News, 70 (4): 76-77.

Sharma, R.K., J. Kumar, R.Singh and B.P. Mishra (1988). Shelf life of peach as affected by different packing and cushioning materials. Research and Development Reporter, 5 (1-2): 71-75.

Snedecor, G.W. and W.G. Cochran (1971). Statistical methods, 6th ed. Iowa State Univ., Press, Ames., Iowa USA.

Tayel, E.A.A. (2001). Non-chemical postharvest treatments to maintain fruit quality and improve storagability of three peach cultivars grown in west coast region of Egypt. Ph.D. Thesis, Alex. Univ., Alex. Egypt.

Tavares, L.B.B., M.I.F., Chitarra and A.B. Chitarra (1991). Use of modified atmosphere for storage of two peach (*Prunus persica* (L.) Batsch) cultivars: 1.Storage potential and quality. Arquivos de Biologia e Tecnologia, 34 (3-4): 401-413. (Hort. Abst. 64 (6): 4303).

Turk, R., A.S. Ozkurt (1994). The storage of some stone fruits in modified atmosphere. Acta Hort., 368: 850-855.

Wills, R.B., W.B. Mcglasson, D.Grohan, T.H. lee and E.G. Hall (1989). Postharvest An introduction to the physiology and handling of fruit and vegetables. Published by van nostrand Rien hold New York.

الملخص العربي

تأثيرات التدفئة المتقطعة و عدة أنواع من المغلفات على جودة و قابلية ثمار خوخ صنف "سويلنج" للتخزين

إيناس عبد العزيز طايل[1]، أميرة عبد الحميد الهلالي[2]، محمود السيد صبيح[3]

١، ٢. محطة بحوث البساتين– الإسكندرية – معهد بحوث البساتين – الجيزة – جمهورية مصر العربية.

٣. معهد بحوث البساتين – الجيزة – جمهورية مصر العربية.

أجريت هذه الدراسة على ثمار خوخ صنف "سويلنج". تم تغليف الثمار في أكياس غلقت حراريـاً من بولي أيثيلين منخفض الكثافة (سمك ٢٣,٥ ± ٢ ميكرون)، أكيـاس بـولي إثيلـين عـالي الكثافـة

(سمك١٥,٦ ± ٢ ميكرون) أو أكياس بولى بروبالين (سمك ٣٣ ± ٢ ميكرون). هذا بالإضافة إلى ثمار المقارنة (ثمار لم تغلف) ثم خزنت الثمار لمدة ٦ أسابيع تخزين مستمر على درجة صفر°م أو في دورة من التدفئة المتقطعة (٦ أيام على درجة صفر°م ثم يوم واحد على درجة ٢٠°م ثم العودة ثانية للدرجة صفر°م وهكذا). وكانت الرطوبة النسبية ٨٥-٩٠%. وقد أخذت العينات أسبوعياً وتم التحليل الفزيائي والكيميائي على الفور. تم تحديد نهاية التجربة بإنخفاض صلابة الثمار إلى حوالي ٣ رطل/بوصة^2. بإستثناء الثمار المغلفة في أكياس بولي بروبالين والمخزنة على صفر°م حيث أنها برغم احتفاظها بصلابتها إلا أنه بدأت تظهر عليها أعراض التدهور بعد ٦ أسابيع من التخزين.

أشارت النتائج إلى أن:

- الثمار التي عوملت بالتدفئة المتقطعة استمرت في التخزين أسبوعين عندما كانت غير مغلفة (مقارنة) بينما أدى تغليف هذه الثمار في أكياس بولي إثيلين عالي الكثافة إلى زيادة مدة التخزين أسبوع لتصبح ٣ أسابيع. في حين استمرت الثمار المغلفة بأكياس بولي إثيلين منخفض الكثافة ٥ أسابيع وأدى استخدام أكياس بولى بروبالين إلى استمرار الثمار لنهاية فترة التخزين (٦ أسابيع). من الناحية الأخرى، جميع الثمار التي خزنت على درجة صفر°م (سواء كانت مغلفة أو غير مغلفة) استمرت ٦ أسابيع بالتخزين.
- بتقدم فترة التخزين كان هناك انخفاض معنوي في صلابة الثمار وزيادة معنوية في فقد الوزن. و عند نهاية فترة التخزين حدثت زيادة معنوية في قيم المواد الصلبة الذائبة وحامض الاسكوربيك والبكتين الذائب في الماء و كذلك حدث إنخفاض معنوي لحموضة الثمار.
- بخصوص تأثير التغليف، أوضحت النتائج أنه كمتوسط لكل فترات التخزين أن أكياس بولى بروبالين أعطت الثمار الأكثر صلابة. بالمقارنة بأكياس البولى إثيلين سواء منخفض أو عالى الكثافة. وكانت تأثيرات الأنواع الثلاثة من الأكياس شبه متماثلة في الخفض المعنوي لفقد الوزن (<٠,٣% بالمقارنة بالثمار الغير مغلفة <١٠,٦%). أدى استخدام أكياس البولي اثيلين إلى الاحتفاظ بالمواد الصلبة الذائبة و خفض الحموضة وفيتامين C. بينما لم تتأثر قيم البكتين الذائب في الماء بالتغليف.
- لم تتأثر كثيراً صفات جودة الثمار (الصلابة – فقد الوزن – المواد الصلبة الذائبة – الحموضة – فيتامين C – البكتين الذائب في الماء) بمعاملة التدفئة المتقطعة.

توصية: توصي الدراسة باستخدام التغليف في أكياس بولي إثيلين منخفض أو عالي الكثافة أو بروبالين بشكل تجاري نظراً لأنه طريقة بسيطة ورخيصة وفعالة في حفظ جودة ثمار خوخ صنف سويلنج المخزنة على درجة صفر°م.