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EFFECT OF SOME POST –HARVEST TREATMENTS ON STORABILITY OF MANFALOTY POMEGRANATES

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ABSTRACT

The present study was carried out during the two successive seasons of 2006 and 2007 on Manfaloty pomegranates "*Punica granatum*." to evaluate the influence of various post-harvest treatments on the storability of pomegranate fruits. The fruits were stored at 5 or 8 or 10±1° C and 90% relative humidity (RH) after using some post harvest treatments (Hot water, wax or control treatments) then packing the fruits in carton boxes / 6 Kg. capacity. The results showed that fruits treated with wax gave the best value of all the considered fruit characteristics. Concerning the effect of storage temperatures, no significant differences were detected between them but fruits stored at 8 or 10±1° C gave better results at the end of storage durations than the other one (5 °C).

Key words: pomegranates, post harvest treatments, hot water treatments, wax treatments, storage temperatures.

INTRODUCTION

In Egypt, pomegranate trees are widely planted especially in Assiut, Beheira, El-Sharkia, around Alexandria and in newly reclaimed lands. This tree is extremely drought tolerant and thrives on a wide range of soils (Badizadigan, 1975 and Ravi, 1999). Manfaloty is the most important pomegranate cultivar in Upper Egypt. It is believed that antioxidants in pomegranate juice have anti – cancer prostate, also pomegranate juice may help reduce the risk of heart disease (Allan and Pantuck, 2005).

Heat treatments have been used for many years to control fungal diseases and infestation of fruits. Heat may be applied to fruits and vegetables in several ways. Heat treatments have the advantage of effective insecticide and fungicidal action, ease of application, and absence of chemical residue (Couey, 1989).

Possible objectives which can be achieved by pre storage heat treatments are: 1. Slowing the ripening of climacteric fruits to obtain longer shelf life; 2. reducing the sensitivity of subtropical fruits to low temperature which cause chilling injury; 3. reducing post harvest rots by either inactivation of pathogens or enhancement of host resistance and 4. Controlling insect pests as a quarantine treatment (Klein and Lurie, 1991).

Waskar *et al.* (1999) reported that Ganesh pomegranate fruits treated by wax could be kept for up to 48 days in the cool chamber as against 30 days at room temperature.

Talaie *et al.* (2004) found that Malas- Torsh pomegranate fruits treated with hot water (50 ° C) for 1-2 minutes showed significant improvement in the quality. and reduced fungi infection in the fruits.

The aim of this work, to preserve the fruit quality for the longest period possible.

MATERIALS AND METHODS

Mature pomegranate fruits cv. Manfaloty were used in the present study during two successive seasons of 2006 and 2007. Fruits were obtained from the private orchard, El- Beheira Governorate, Egypt. Pomegranate trees six years old, were spaced at 3 x 5 m. All trees had received adequate irrigation, fertilization and other cultural practices recommended for pomegranate trees by Ministry of Agriculture.

Fruits harvested at maturity stage which was identified by both size and skin color, at September 7th in the first season while at the 16th September in the second one. Fruits were picked using small clippers and packed in storage boxes (carton boxes / 6 Kg each and measures 43× 33× 9 cm.), unsuitable fruits were rejected. Fruits were transported and taken directly to the post-harvest laboratory in Horticultural Research Institute at Giza and kept in cold rooms in the fruit handling department till subjected to the following treatments:-

- 1-Dipping in hot water at 50° C for two minutes.
- 2- Waxing the surface of fruits *.
- 3- Control (without any treatment).

* Citrosol-A: watery emulsion (polyethylene, wax & rosin 18% w/v)

Thus each treatment was replicated thrice and each replicate was packed in 3 carton boxes / 6 Kg. Then, pomegranate boxes were stored at 5 or 8 or 10±1° C and 90% relative humidity for 5 month.

The each treatment was ended when the discarded fruit percentage exceeded 50% of the stored fruits in each package.

Physical and chemical properties were evaluated every 4 weeks (monthly) from the beginning to the end of storage period (5 month) and determined as follows:-

Physical properties:-

1-Fruit discarded percentage (FDP): -

The number of discarded fruits due to fungus or any micro organism infection, chilling injury or unmarketable fruits were recorded and calculated as a percentage from the total number of fruits using the following equation :-

$$\text{FDP} = \frac{\text{number of discarded fruits}}{\text{Total fruit number}} \times 100$$

2- Fruit weight loss Percentage (FWL %): -

The fruits were weighed before cold storage to get the initial weight, and then weighed at each sampling date. Fruits weight was recorded, then percentages of weight loss were calculated according to the following equation: -

$$\text{FWL}\% = \frac{W_i - W_s}{W_i} \times 100$$

Where, W_i = fruit weight at initial period.

W_s = fruit weight at sampling period.

3- Shelf life period (in weeks):-

At the beginning of cold storage, and after one month periodically a fruit sample from each replicate was taken out and left

at marketing conditions ($18 \pm 1^\circ\text{C}$ and 90% RH) till bad appearance or rotting occurs. Then, the number of days was recorded and considered as shelf life.

Chemical properties:-

1- Soluble Solids content (SSC %):-

Abbe refractometer was used to determine the percentage of total soluble solids in fruit juice.

2-Total sugars percentage:-

Total sugars percentage was determined by using the phenol sulphuric methods, Smith *et al.* (1956) and the concentration was calculated from a standard curve of glucose as gm. per / 100 gm. fresh weight.

3- Titratable Acidity %:-

Titrate acidity % was determined by titrating the juice against 0.1 N sodium hydroxide using phenolphthalein as an indicator. Results were expressed as percentage of malic acid in fresh pulp weight. A.O.A.C. (1990).

4-SSC/ acid ratio %

By dividing the value of SSC over the value of titrate acidity for each sample.

5- Anthocyanins pigment percentage:-

Total anthocyanins percentage in fruit juice was determined as described by Wettstein,(1957)

Statistical analysis:-

The treatments were arranged as a factorial experiment in a randomized complete block design. All data were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran (1982) and means were compared by Duncan's Multiple range test at the 5 % level of probability in the two seasons of experimentation.

RESULTS AND DISCUSSION

Fruit discarded percentage:-

Data in Table (1) show the effect of some post harvest treatments on discarded percentage of Manfaloty pomegranates stored at $5\pm 1^{\circ}\text{C}$ or $8\pm 1^{\circ}\text{C}$ or $10\pm 1^{\circ}\text{C}$ and 90 % RH, during 2006 and 2007 seasons.

As for the effect of post harvest treatments regardless of storage temperature degree, all the used treatments did not give any discarded fruits before 12 weeks of storage. On the contrary, after 20 weeks of cold storage, the untreated fruits (control treatment) exhibited the highest value of discarded percentage (52.5, 45.8 %) in the two seasons, respectively. The least discarded fruit percentage (38.3, 28.3%) were recorded by wax treatment in both seasons, respectively.

Considering the effect of storage temperature regardless of postharvest treatments, significant differences were detected between the three studied storage temperatures. After 16 weeks of cold storage, fruits at $8\pm 1^{\circ}\text{C}$ recorded the least discarded fruit percentage (26.78, 25.60 %), while the highest percentage was recorded by fruits stored at $5\pm 1^{\circ}\text{C}$ (50.0, 50.0%) in the two seasons, respectively.

Also, these results are in agreement with the findings of Chun *et al.*(1988) and Shahbake(1994) who reported that, waxing fruits significantly reduced chilling injury incidence within fruits stored at low temperature.

As for the interaction between the two studied factors. One can notice that fruits treated by wax and stored at 8 or 10 °C for 20 weeks achieved the lowest discarded fruits % in both seasons contrary to the control ones.

In this respect, Talaie *et al.* (2004) found that pomegranate cv. Malas- Torsh fruits were treated with hot water (50 °C) showed significant improvement in the quality.

Table (1): Effect of some post-harvest treatments on discarded fruit % of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks											
	12				16				20			
	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006												
Hot water (50°C).	25.0 b	16.6 c	8.3 d	16.6B	50.0 a	25.0 d	26.7 d	33.9 B	-	43.3 c	45.0 c	44.2 B
Wax	16.7 c	8.3 d	8.6 d	11.2C	50.0 a	18.3 e	16.3 f	28.2 C	-	38.3 d	38.3 d	38.3 C
Control	33.3 a	26.7 b	26.7 b	28.9 A	50.0 a	37.0 c	45.0 b	44.0 A	-	55.0 a	50.0 b	52.5 A
Mean	24.9 A-	17.2B-	14.5 C-		50.0 A-	26.78 C-	29.32 B-		-	45.6 A-	44.4 B-	
2007												
Hot water (50°C).	26.0 b	16.6 c	8.3 d	16.9 B	50.0 b	25.0 e	26.7 e	33.9 B	-	33.3 d	45.0 b	39.2 B
Wax	8.3 d	0.01e	0.01e	2.8 C	41.67 c	18.3 f	18.4 f	26.1 C	-	28.3 e	28.3 e	28.3 C
Control	25.0 b	25.0 b	33.3 a	27.7 A	58.3 a	33.3 d	41.6 c	44.4 A	-	41.7 c	50.0 a	45.8 A
Mean	19.8 A-	13.9 B-	13.9 B-		50.0 A-	25.6 C-	28.9 B-		-	34.4 B-	41.1 A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Weight loss percentage:-

Table (2) show the effect of some post-harvest treatments on weight loss percentage of Manfaloty pomegranates stored at 5 or 8 or $10\pm 1^{\circ}\text{C}$ and 90 % RH, during 2006 and 2007 seasons.

A gradual increase in weight loss was shown towards the end of the storage period (20 weeks), regardless of storage temperature degree, significant differences between the all treatments were noticed. However, the least weight loss percentage was recorded by wax treatment (10.75, 17.17) in the first and second seasons, respectively. On the other hand, hot water treatment at 50°C exhibited the highest weight loss value (13.99, 22.11) in both season, respectively.

In this regard, Ahmed Amen (1987) reported that weight loss percentage significantly increased with the progress of storage periods. These results could be attributed to water loss resulted from transpiration.

As for the effect of storage temperature regardless of post harvest treatments, fruits stored at low temperature ($5\pm 1^{\circ}\text{C}$) recorded less weight loss percentage than those stored at higher temperature ($8\pm 1^{\circ}\text{C}$) or ($10\pm 1^{\circ}\text{C}$). Significant differences between the two storage temperatures appeared during storage periods in the first season, while there were no significant differences between the two storage temperatures in the second one, except after 8 and 20 weeks of storage.

Ryall and Pentzer (1982) noted that respiration, ethylene production and water loss were held to a minimum, and ripening and senescence were delayed by low temperatures.

Interaction between post harvest treatments and storage temperatures appeared in significant differences in most cases. After 20 weeks of storage, the least values of weight loss (9.11 and 16.99%) were obtained by fruits treated with wax and stored at $8\pm 1^{\circ}\text{C}$ and $10\pm 1^{\circ}\text{C}$ in the first and second seasons, respectively. However, the highest percentage of weight loss (14.59 and 22.80 %) were obtained by hot water and control fruits treatments and storage at $10\pm 1^{\circ}\text{C}$, in both seasons, respectively.

These results are also in accordance with those obtained by Chun *et al.*, (1988) and Aworh *et al.* (1991) they mentioned that, waxing reduced weight loss of Citrus fruits during storage.

Table (2): Effect of some post-harvest treatments on weight loss % of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks																			
	4				8				12				16				20			
	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																				
Hot water (50°C).	3.58ab	4.38ab	4.41ab	4.12A	5.87ab	7.85a	7.87a	7.20A	7.43c	10.31ab	10.37ab	9.37A	8.82b	12.66a	12.78a	11.42A	-	13.38ab	14.59a	13.99A
Wax	2.58b	2.81b	3.48ab	2.89B	4.47b	4.74b	6.10ab	5.10B	5.96c	6.35c	6.10bc	6.80B	7.37b	7.98b	10.12ab	8.40B	-	9.11c	12.38ab	10.75B
Control	3.78ab	3.98ab	4.79a	4.10A	6.05ab	6.23ab	6.19a	6.62A	7.90c	8.02bc	10.92a	8.95A	9.72ab	9.89ab	13.36a	10.99A	-	11.35b	14.55a	12.95A
Mean	3.32A	3.66A	4.23A		5.46B	6.27AB	7.39A		7.10B	8.23B	9.90A		8.64B	10.18B	12.09A		-	11.28B	13.84A	
2007																				
Hot water (50°C).	6.46ab	7.31a	6.11abc	6.63A	12.36ab	12.28ab	12.34ab	12.33A	16.80ab	16.10ab	14.34bc	15.75A	20.22a	18.25a	17.56ab	18.66A	-	21.99c	22.22b	22.11A
Wax	3.04d	3.98bcd	4.41a-d	3.81B	6.83c	7.58c	7.96c	7.45C	10.00d	10.50d	10.46d	10.32B	11.93c	12.33c	14.11bc	12.78B	-	17.35e	16.99f	17.17C
Control	3.17cd	5.42a-d	6.09abc	4.89B	6.76c	9.42bc	13.04a	9.74B	12.17cd	14.58bc	18.24a	15.00A	16.44ab	19.23a	20.44a	18.70A	-	19.88d	22.80a	21.34B
Mean	4.22A	5.57A	5.54A		8.65B	9.75AB	11.11A		12.99A	13.73A	14.35A		16.20A	16.60A	17.36A		-	19.74B	20.67A	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Shelf life period:-

Data tabulated in Table (3) showed the effect of some post harvest treatments on shelf life of Manfaloty pomegranates stored at 5 or 8 or 10±1°C and 90 % RH, during 2006 and 2007 seasons.

There were slight differences occurred between all used treatments regardless of storage temperature degree. The longest shelf life was recorded by wax treatment in the two seasons, respectively, whereas, the shortest shelf life was noticed with the control treatment during the two studied seasons, respectively.

Concerning the effect of storage temperature, regardless of post harvest treatments on shelf life, there were no significant differences occurred between the three storage temperatures. Wherever, fruits stored at 10±1°C recorded the highest value of shelf life compared with fruits stored at 5±1°C or 8±1°C, in both seasons.

As for the interaction between post-harvest treatments and storage temperature, significant differences appeared in most cases. After 20 weeks of storage, the highest significant values (3.0 and 3.0 weeks) were noticed with fruits treated with wax and stored at 8±1° or 10±1°C followed by fruits treated with hot water and control with slight differences between them.

Soluble Solids Content percentage (SSC %): -

Table (4) show the effect of some post harvest treatments on SSC% of Manfaloty pomegranates stored at 5 or 8 or 10± 1°C and 90% RH, during 2006 and 2007 seasons.

Concerning the effect of hot water, wax and control treatments, regardless of storage temperature degree on fruits, SSC% increased with the advance in cold storage. The highest percentages of SSC were obtained by wax treatment (16.15, 16.60%) in the two seasons, respectively. On the other hand, control fruits treatment exhibited the least values of SSC (14.25, 15.60 %),

As for the effect of storage temperature regardless of postharvest treatments, it is clear that fruits stored at the high temperature (10±1°) showed the highest values of SSC, compared to those stored at low temperatures (5±1°) or (8±1°) .

No significant differences between the storage temperatures were obtained during storage periods in the two seasons.

Interaction between the two studied factors was significant in most cases in the first season. But, no significant differences were

Table (3): Effect of some post-harvest treatments on shelf life (weeks) of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp	Storage periods in weeks.																				
	0	4				8				12				16				20			
		5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																					
Hot water (50°C).	5.0AB	4.0b	4.0b	4.5ab	4.17B	4.0ab	4.0ab	4.0ab	4.0 AB	3.0a	4.0a	4.0a	3.67 A	2.5bc	3.5a	3.0ab	3.0 A	-	2.0ab	2.0ab	2.0 AB
Wax	7.0A	5.0ab	6.0a	5.0ab	5.33A	5.0ab	5.5a	4.5ab	5.0 A	3.0 a	4.0 a	4.0 a	3.67 A	3.0 ab	3.5 a	3.5 a	3.33 A	-	3.0 a	3.0 a	3.0 A
Control	4.0B	4.0b	4.0b	3.5b	3.83 B	3.0b	3.5ab	3.5ab	3.33 B	3.0 a	3.0 a	3.0 a	3.0 A	2.0 c	2.5 bc	2.5 bc	2.33 B	-	1.0 b	2.0 ab	1.5 B
Mean	5.3	4.3 A-	4.7 A-	4.3 A-		4.0 A-	4.3 A-	4.0 A-		3.0 A	3.67 A-	3.67 A-		2.5 B-	3.2 A-	3.0 A-		-	2.0 A-	2.3 A-	
2007																					
Hot water (50°C).	5.0AB	4.0 b	4.0 b	4.5 ab	4.2 B	4.0 abc	4.0 abc	4.0 abc	4.0 B	3.0 a	4.0 a	4.0 a	3.7 AB	2.5 ab	3.5 a	3.0 ab	3.0 A	-	2.0 a	2.0 a	2.0 A
Wax	7.0A	6.0 a	6.0 a	6.0 a	6.0 A	5.0 ab	5.5 a	5.0 ab	5.2 A	4.5 a	4.0 a	4.5 a	4.3 A	3.0 ab	3.5 a	3.5 a	3.3 A	-	3.0 a	3.0 a	3.0 A
Control	4.0B	4.0 b	4.0 b	3.5 b	3.8 B	3.0 c	3.5 bc	3.5 bc	3.33 B	3.0 a	3.0 a	3.0 a	3.0 B	2.0 b	2.5 ab	2.5 ab	2.3 B	-	2.0 a	2.0 a	2.0 A
Mean	5.3	4.7 A-	4.7 A-	4.7 A-		4.0 A	4.3 A-	4.2 A-		3.5 A-	3.7 A-	3.8 A-		2.5 B-	3.2 A-	3.0 AB-		-	2.3 A-	2.3 A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Table (4): Effect of some post-harvest treatments on SSC% in fruit juice of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp	Storage periods in weeks.																				
	0	4				8				12				16				20			
		5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																					
Hot water (50°C).	15.60A	16.20abc	16.50ab	16.70a	16.47A	16.50a	16.50a	16.50a	16.50A	15.70a	16.20a	16.30a	16.07A	15.10abc	15.60abc	15.50abc	15.40B	-	15.00ab	16.00ab	15.00B
Wax	15.60A	15.60c	16.60c	15.60c	15.60B	15.80a	15.80a	15.80a	15.80A	15.90a	16.00a	16.00a	15.87A	15.90ab	16.10a	16.10a	16.03A	-	16.10a	16.20a	16.15A
Control	15.60A	15.70bc	15.80bc	15.90bc	15.80B	15.80a	16.00a	16.40a	16.07A	16.00a	15.90a	15.60a	15.83A	15.20abc	14.90bc	14.70c	14.83B	-	14.40b	14.10b	14.25B
Mean	15.60	15.83A-	15.97A-	16.07A-		16.03A-	16.10A-	16.23A-		15.87A-	16.03A-	15.97A-		15.40A-	15.53A-	15.43A-		-	15.17A-	15.10A-	
2007																					
Hot water (50°C).	16.10A	16.20a	16.40a	16.50a	16.37A	16.50a	16.80a	16.90a	16.73A	16.10a	16.30a	16.40a	16.27A	15.70a	16.00a	16.10a	15.93A	-	15.50b	16.80ab	15.85B
Wax	16.10A	16.10a	16.10a	16.20a	16.13A	16.30a	16.20a	16.30a	16.27A	16.40a	16.30a	16.40a	16.37A	16.50a	16.60a	16.60a	16.53A	-	16.60a	16.50a	16.60A
Control	16.10A	16.40a	16.30a	16.40a	16.37A	16.60a	16.80a	16.90a	16.77A	16.20a	16.60a	16.70a	16.50A	16.80a	16.30a	16.50a	16.20A	-	15.50 b	15.70ab	15.60B
Mean	16.10	16.23A-	16.27A-	16.37A-		16.47A-	16.60A-	16.70A-		16.23A-	16.40A-	16.50A-		16.00A-	16.27A-	16.40A-		-	16.07A-	16.27A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

noticed in all cases in the second one. After 20 weeks of storage, the highest value of SSC were recorded by wax treated fruits (16.20 %) and stored at ($10 \pm 1^\circ \text{C}$) in the first season, and (16.60 and 16.60 %) and stored at ($8 \pm 1^\circ \text{C}$) and ($10 \pm 1^\circ \text{C}$), respectively in the second season. However, the least value of SSC (14.10, 15.50%) was recorded by control fruits and stored at ($10 \pm 1^\circ \text{C}$) and at ($8 \pm 1^\circ \text{C}$) in the two seasons, respectively.

Total sugars%:-

Data in Table (5) show the effect of some post harvest treatments on total sugars% of Manfaloty pomegranates stored at 5 or 8 or $10 \pm 1^\circ \text{C}$ and 90% RH, during 2006 and 2007 seasons.

Total sugars% increased gradually with the advance in cold storage period regardless of storage temperature degree. After 16 weeks of storage, the highest total sugars (13.63 and 14.05%) were obtained by wax treatment while the least values (12.69%) in the first season were recorded by control fruits while hot water treated fruits recorded the least values (13.54%) in the second season. No significant differences between the used treatments were detected.

As for the effect of storage temperature regardless of post harvest treatment, it is clear that fruits stored at the higher temperature ($10 \pm 1^\circ \text{C}$) recorded the highest values of total sugars than those stored at low temperature ($8 \pm 1^\circ \text{C}$) or ($5 \pm 1^\circ \text{C}$). No significant differences between the storage temperatures were noticed during storage durations.

The interaction between the tested factors (treatments & temperatures) showed no significant differences in total sugar contents in most cases in the two seasons. After 16 weeks of storage, the highest values of total sugars (13.69, 14.11%) were obtained by fruits treated with wax and stored at $10 \pm 1^\circ \text{C}$ in both seasons, respectively. Meanwhile, the least value of total sugars (12.50 %) was showed in control fruits stored at $10 \pm 1^\circ \text{C}$ in the first season, and hot water treated fruits (13.35%) stored at $5 \pm 1^\circ \text{C}$ in second season.

Titrateable acidity percentage in juice:-

Data tabulated in Table (6) indicated the effect of some post harvest treatments on titrateable acidity% of Manfaloty pomegranate fruits stored at 5 or 8 or $10 \pm 1^\circ \text{C}$ and 90% RH, during 2006 and 2007 seasons.

Table (5): Effect of some post-harvest treatments on total sugars% in fruit Juice of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks.																				
	0	4				8				12				16				20			
		5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
Treatments																					
2006																					
Hot water (50°C).	13.26A	13.77a	14.03a	14.20a	14.00A	14.03a	14.03a	14.03a	14.03A	13.35a	13.77a	13.86a	13.86A	12.84a	13.26a	13.16a	13.09A	-	12.75a	12.75a	12.75A
Wax	13.26A	13.26a	13.26a	13.26a	13.26A	13.43a	13.43a	13.43a	13.43A	13.52a	13.60a	13.60a	13.57A	13.52a	13.69a	13.69a	13.63A	-	13.69a	13.77a	13.73A
Control	13.26A	13.35a	13.43a	13.52a	13.43A	13.43a	13.80a	13.94a	13.66A	13.60a	13.52a	13.26a	13.46A	12.92a	12.67a	12.50a	12.69A	-	12.24a	11.99a	12.11A
Mean	13.26	13.46A-	13.57A-	13.66A-		13.63A-	13.69A-	13.80A-		13.49A-	13.63A-	13.57A-		13.09A-	13.20A-	13.12A-		-	12.89A-	12.84A-	
2007																					
Hot water (50°C).	13.69A	13.77a	13.94a	14.03a	13.91A	14.03a	14.28a	14.37a	14.22A	13.69a	13.88a	13.94a	13.89A	13.35a	13.60a	13.69a	13.64A	-	13.16a	13.43a	13.30A
Wax	13.69A	13.69a	13.69a	13.77a	13.71A	13.86a	13.77a	13.86a	13.93A	13.94a	13.86a	13.94a	13.91A	14.03a	14.03a	14.11a	14.05A	-	14.11a	14.11a	14.11A
Control	13.69A	13.94a	13.86a	13.94a	13.91A	14.11a	14.28a	14.37a	14.25A	13.77a	14.11a	14.20a	14.03A	13.43a	13.86a	14.03a	13.77A	-	13.69a	13.64a	13.61A
Mean	13.69	13.80A-	13.83A-	13.91A-		14.00A-	14.11A-	14.20A-		13.80A-	13.94A-	14.03A-		13.60A-	13.83A-	13.94A-		-	13.65A-	13.83A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Table (6): Effect of some post-harvest treatments on titratable acidity% in fruit juice of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks.																				
	0	4				8				12				16				20			
		5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																					
Hot water (50°C).	0.758A	0.842abc	0.812bc	0.872abc	0.842B	0.712bc	0.828abc	0.894a	0.811A	0.890abc	0.912abc	0.915abc	0.896A	0.988ab	0.960abc	0.928a-d	0.959A	-	0.784c	0.840bc	0.812B
Wax	0.768A	0.704ab	0.784a	0.768ab	0.752A	0.772abc	0.708bc	0.858ab	0.779A	0.828c	0.815c	0.948ab	0.854A	0.902ab	0.828cd	0.800d	0.873B	-	0.844bc	0.904abc	0.874B
Control	0.768A	0.518c	0.851abc	0.535c	0.507B	0.872c	0.808abc	0.784abc	0.765A	0.892abc	0.848bc	0.955a	0.898A	1.056a	0.956abc	0.908bcd	0.973A	-	0.940ab	0.992a	0.966A
Mean	0.768	0.821A-	0.882A-	0.555A-		0.719B-	0.781AB-	0.845A-		0.860B-	0.859B-	0.940A-		1.012A-	0.915B-	0.879B-		-	0.856A-	0.912A-	
2007																					
Hot water (50°C).	0.747A	0.821B-c	0.591cds	0.851abc	0.821B	0.691bc	0.807ab	0.873a	0.790A	0.839abc	0.861abc	0.855abc	0.875A	0.987ab	0.939ab	0.907b	0.938A	-	0.763b	0.819ab	0.791B
Wax	0.747A	0.683abc	0.763a	0.747ab	0.731A	0.751abc	0.687bc	0.837ab	0.758A	0.807bc	0.795c	0.927ab	0.843A	0.971ab	0.807cd	0.779d	0.852B	-	0.823ab	0.863ab	0.853AB
Control	0.747A	0.495a	0.830a-d	0.514de	0.546C	0.651c	0.787abc	0.763abc	0.734A	0.871abc	0.827abc	0.934a	0.877A	1.035#	0.935ab	0.887bc	0.852A	-	0.919a	0.971a	0.945A
Mean	0.747	0.800A-	0.581A-	0.837A-		0.698B-	0.760AB-	0.824A-		0.839A-	0.838B-	0.919A-		0.991A-	0.894B-	0.858B-		-	0.835A-	0.891A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Data revealed that titratable acidity % increased with the progress in storage period up to 16 weeks, then decreased regardless of storage temperature.

After 16 weeks, the highest values (0.973, 0.952 %) were recorded by control fruits in both seasons, respectively. After 20 weeks, the highest values were recorded by control fruits. While the least percentage of acidity were noticed by fruits treated with 50°C hot water in the two seasons.

The obtained results agreed partially with those reported by Siddiqui *et al.* (1991), who noted that acidity increased progressively according to the length of storage period in all postures of guava fruits.

Concerning the effect of storage temperature regardless of post harvest treatments, it is clear that fruits stored at the high temperature ($10\pm 1^\circ\text{C}$) recorded higher titratable acidity values than those stored at low temperature ($5\pm 1^\circ\text{C}$) or ($8\pm 1^\circ\text{C}$). Significant differences between the storage temperatures were noticed during storage periods.

In this regard, Reberto *et al.* (1990) found that no statistical differences in titratable acidity among guava fruits held at different temperatures.

Interaction between the two studied variables was significant in most cases. After 20 weeks of storage, the highest percentage of titratable acidity (0.992 and 0.971 %) was recorded by control fruit and storage at $10\pm 1^\circ\text{C}$ in the two seasons, respectively. On the contrary, the least value of total acidity (0.784 and 0.763 %) was obtained by hot water treatment stored at $8\pm 1^\circ\text{C}$ in both seasons, respectively.

In this regard, Klein and Lurie (1991) found that titratable acidity of heat treated apple fruit were markedly lower than non treated fruit. They added that the decrease in acidity might be due to leakiness of tonoplast membranes at high temperature, this in turn would allow vacuolar malic acid into the cytoplasm, where it would come in contact with cytoplasmic malic acid decarboxylase.

SSC/acid ratio

Table (7) show the effect of some post harvest treatments on SSC/ acid ratio of Manfaloty pomegranates stored at 5 or 8 or $10\pm 1^\circ\text{C}$ and 90% RH , during 2006 and 2007 seasons .

Table (7): Effect of some post-harvest treatments on SSC/ acid ratio in fruit juice of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks.																				
	0	4				8				12				16				20			
	Treatments	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																					
Hot water (50°C).	20.31A	26.23b	26.96b	24.56bc	26.66B	23.17ab	19.93cd	18.46d	20.34A	18.26abc	17.78abc	17.79abc	17.93A	16.28b	16.26b	16.70b	16.66B	-	19.13a	17.56a	18.47A
Wax	20.31A	22.16cd	19.90d	20.31d	20.74C	20.47bcd	22.32abc	18.41d	20.27A	19.20ab	19.61a	16.88bc	16.48A	16.03b	19.44a	20.13a	18.38A	-	19.02a	17.92a	18.48A
Control	20.31A	30.42a	34.27bc	29.72a	27.86A	23.61a	19.80cd	20.92a-d	21.29A	17.84abc	18.78abc	18.34c	17.93A	14.39b	15.69b	16.19b	16.34B	-	16.32b	14.21b	14.76B
Mean	20.31	25.61A-	23.40B-	24.41AB-		22.31A-	20.61B-	18.20B-		18.45A-	18.87A-	16.98B-		15.22B-	16.86A-	17.66A-		-	17.72A-	16.66A-	
2007																					
Hot water (50°C).	21.64A	23.67cd	21.10d	21.69d	22.12C	21.70bcd	23.66ab	19.47d	21.69B	20.32a	20.60a	17.69c	19.61A	16.99cde	20.46ab	21.31a	19.62A	-	20.17a	18.80a	19.48A
Wax	21.66A	33.13a	26.87bc	31.91a	30.30A	26.50a	21.36bcd	22.16bc	23.06A	18.60abc	20.07ab	17.88bc	18.66A	16.27a	17.43cde	18.90a-d	17.10B	-	17.62a	16.89a	17.20A
Control	21.66A	27.07b	24.60bc	26.68bc	26.78B	23.60ab	21.63bc	20.26cd	21.90AB	19.36abc	19.58abc	17.96bc	18.96A	16.16de	18.20bcd	19.12abc	17.62B	-	18.24a	18.26a	18.73A
Mean	21.65	27.92A-	23.66B-	26.42A-		23.60A-	22.25B-	20.63C-		19.42A-	20.05A-	17.84B-		16.13B-	18.69A-	19.68A-		-	18.98A-	17.96A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

Concerning the effect of treatments regardless of storage temperature degree on fruits. SSC/acid ratio decreased with the advance in cold storage. After 20 weeks of storage, the highest percentages of SSC/acid ratio were obtained by wax and hot water treatments (18.48, 19.48) in the two seasons, respectively. On the other hand, control and waxed fruits treatments exhibited the least value of SSC/acid ratio (14.75, 17.20) in both seasons, respectively. With significant differences between the treatments in the most cases in both seasons.

As for the effect of storage temperature regardless of post harvest treatments, significant differences between the storage temperatures were obtained during storage periods in the two seasons.

Interaction between the two studied factors was significant in most cases. After 20 weeks of storage, the highest value of SSC/ acid ratio were recorded by hot water treated fruits (19.13, 20.17) and stored at ($8 \pm 1^\circ \text{C}$) in the first and second seasons. However, the least value of SSC/ acid ratio (14.21) was recorded by control fruits stored at ($10 \pm 1^\circ \text{C}$) in the first season and (16.89) by wax treatment stored at ($10 \pm 1^\circ \text{C}$) in the second season.

Total anthocyanin%:-

Data tabulated in Table (8) declared the effect of some post-harvest treatments on total anthocyanin % of Manfaloty pomegranates stored at 5 or 8 or $10 \pm 1^\circ \text{C}$ and 90 % RH , during 2006 and 2007 seasons.

It is clear that, all used treatments regardless of storage temperature degree increased total anthocyanin % than the control fruits. However, total anthocyanin % increased with the advance in cold storage period. Data showed also that wax treatment gave higher anthocyanin values. On the other hand, control -treated fruits exhibited the least value in most cases.

As for storage temperature effect regardless of post harvest treatments, it is clear that fruits stored at low temperature ($5 \pm 1^\circ \text{C}$) recorded lower values of total anthocyanin than those stored at higher temperature ($8 \pm 1^\circ \text{C}$) or ($10 \pm 1^\circ \text{C}$). Significant differences between the storage temperatures were observed during storage periods.

Interactions between the two studied factors (treatments & temperatures) were significant in most cases. After 20 weeks of storage, the highest percentages of total anthocyanin (0.984 and 0.955

Table (8): Effect of some post-harvest treatments on anthocyanin% in fruit juice of Manfaloty pomegranate fruits stored at 5°, 8° and 10±1°C and 90%RH, during 2006 and 2007 seasons.

Storage period and storage temp.	Storage periods in weeks.																				
	0	4				8				12				16				20			
		5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C	8°C	10°C	Mean	5°C*	8°C	10°C	Mean
2006																					
Hot water (50°C).	0.291A	0.325a	0.329a	0.397a	0.350A	0.385b	0.406b	0.467ab	0.426B	0.467b	0.678a	0.723a	0.623B	0.498c	0.778ab	0.887a	0.721B	-	0.884a	0.917a	0.951A
Wax	0.291A	0.358a	0.405a	0.495a	0.419A	0.509ab	0.536ab	0.632a	0.560A	0.681a	0.786a	0.755a	0.735A	0.896a	0.913a	0.810ab	0.873A	-	0.939a	0.970a	0.955A
Control	0.291A	0.366a	0.394a	0.315a	0.358A	0.376b	0.442ab	0.385b	0.395B	0.467b	0.506b	0.434b	0.489C	0.484c	0.677b	0.438c	0.532C	-	0.682b	0.567b	0.625B
Mean	0.291	0.346A-	0.376A-	0.403A-		0.424A-	0.462A-	0.495A-		0.538B-	0.651A-	0.637A-		0.628B-	0.789A-	0.711AB-		-	0.868A-	0.818A-	
2007																					
Hot water (50°C).	0.215A	0.310bc	0.339bc	0.547a	0.369AB	0.417cd	0.456cd	0.569abc	0.488B	0.471bc	0.628ab	0.658ab	0.586B	0.567c	0.659abc	0.772ab	0.866A	-	0.727b	0.844ab	0.788AB
Wax	0.215A	0.407abc	0.478ab	0.527a	0.471A	0.511bc	0.850ab	0.692a	0.616A	0.525bc	0.781a	0.799a	0.668A	0.614bc	0.806a	0.823a	0.746A	-	0.832ab	0.955a	0.854A
Control	0.215A	0.299bc	0.280c	0.315bc	0.291B	0.315d	0.493cd	0.353d	0.387C	0.380c	0.628bc	0.434c	0.480C	0.491c	0.566a	0.617bc	0.556B	-	0.844b	0.866b	0.558B
Mean	0.215	0.338AB-	0.356b-	0.463A-		0.414B-	0.534A-	0.545A-		0.482B-	0.645A-	0.627A-		0.567B-	0.677A-	0.735A-		-	0.738A-	0.822A-	

Values followed by the same letter (s) in each period are not significantly different at 5 % level.

* Storage period at 5°C stopped after 16 weeks where percentage of discarded fruits reached 50%

%) were obtained by hot water and wax treated fruits and stored at $8\pm 1^{\circ}\text{C}$ and $10\pm 1^{\circ}\text{C}$ in the two seasons, respectively. However, the least values of total anthocyanin (0.567, 0.648 %) were recorded with control treatment stored at $10\pm 1^{\circ}\text{C}$ and $8\pm 1^{\circ}\text{C}$ in first and second seasons, respectively.

REFERENCES

- Ahmed Amen., K.I. (1987). Effect of post – harvest calcium treatments on the storage life of guava fruits. *Assiut Journal of Agri. Sci.* (18): 4 (127- 137). Egypt.
- Allan, J. and P. Pantuck (2005): pomegranate juice helps prostate cancer. Study from Uni., California at Los Anglos.
- A.O.A.C. (1990). Official Methods of analysis 15th Edition. Association of Official Analytical Chemists. Washington D.C., USA. vol. 2. p. 918 (942015).
- Aworh, O. C.; C. F. Nwankwo and A. O. Olorunda (1991): Control of post harvest losses in citrus fruits under tropical conditions: Effects of wax and fungicide. *Tropical Science*. 31 (2) : 177 – 182.
- Badizadigan, M.(1975) : Growth of pomegranate (*punica granatum* L.) as affected by soil moisture tension. *J. Hort. Sci.* 50 (3) p. 227 – 232.
- Chun, D.; W. R. Miller and L. A. Risse (1988): Grapefruit storage decay and fruit quality after high- temperature pre- storage conditioning at high or low humidity. *J. Amer. Soc. Hort. Sci.* ; 113(6) : 873 – 876.
- Couey, H.M. (1989). Heat treatment for control of post harvest disease and insect pests of fruits. *HortScience*, 24(2), 198- 202.
- Klein, J.D. and S. Lurie. (1991). Post harvest heat treatment and fruit quality. *Post harvest News and Inf.* 2: 15 19.
- Ravi, K. (1999): A note of physio- chemical characters of the wild pomegranate (*punica granatum* L.) . *Anal. of Biol. (Ludhiana)*, 15(2): 231 – 232.
- Reberto I. ; O.Vazquez and T. Maria. (1990). Changes in Guavas of three maturity stages in response to temperature and relative humidity. *Hort. Science* 1990, 25 (1): 86-87.
- Ryall, A.L. and W.T. Pentzer. (1982). Handling. Transportation and storage of fruits and vegetables. Second edition, volume 2, fruits and tree nuts. The AVA publishing West port, Connecticut.

- Shahbake, M. A. (1994): Response of citrus fruit to high and low temperature treatments on the control of fruit flies and postharvest diseases (*Penicillium* spp.). *Seed and plant* (1994); 10 (3-4): 48-56.
- Siddiqui,S.; R.K. Sharma and O.P. Gupta.(1991). Physiological and quality response of Guava fruits to posture during storage. *Hort. Sci.* 26(10): 1295- 1297.
- Smith, F.; A. Gilles; J.K.Hamitn and A.P. Gedeas. (1956). Colourimetric methods for determination of sugar and related substances. *Anal. Chem.* 28, 350.
- Snedecor, C.W. and W.G. Cochran. (1982). *Statistical Methods*. 7th Ed. The Lowe state Univ. Press. Ames. Iowa, USA.
- Talaie , A; M.A.A. Sarcheshmeh;F. Bahadoran and D. Sherafatian (2004). The effects of hot water treatment and in polyethylene bag packaging on the storage life and quality of pomegranate (cv. Malas-Saveh). *Iranian – J. - Agric.Sci.* 2004; 35 (2): 369 – 377.
- Waskar, D.P.; R.M.Khedkar and V.K. Garande, (1999): Effect of post – harvest treatments on shelf – life and quality of pomegranate in evaporative cool chamber and ambient conditions. *J. Food Sci. Technology – Mysore.* (1999), 36 (2): 114 – 117.
- Wettstein, D.,(1957) : Chlorophyll., letal und der submikros – vopische frommech sell der plastiden. *Exptl . cell . Res.* 12, 427-433.

تأثير بعض معاملات ما بعد الحصاد على القدرة التخزينية لثمار الرمان المنفلوطى

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أجريت هذه الدراسة خلال موسمي 2006 ، 2007 على ثمار الرمان المنفلوطى لتقييم تأثير بعض معاملات ما بعد الجمع (الماء الساخن والتشميع) على القدرة التخزينية للثمار المخزنة على درجة حرارة 5 أو 8 أو 10 ± 1 ° م ورطوبة نسبية 90 % .
و أظهرت النتائج إن المعاملة بالشمع أعطت أفضل القيم فى صفات الجودة المقدره بينما لم يلاحظ اختلاف معنوى بين درجات حرارة التخزين على تلك الصفات وعموما كان التخزين على درجة 8 و 10 ° م أفضل من التخزين على الدرجة الاكثر برودة(5 ° م).