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IMPACT OF SOME POST-HARVEST TREATMENTS ON STORABILITY OF MAAMOURA CV. GUAVAS.

M. Abou Rawash*, Rawheya Bedeir*, M. Sobieh, Fatma Korany****

**Horticultural Departments, Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Cairo, Egypt.*
***Horticultural Research Institute, Agricultural Research Center, Giza, Egypt.*

ABSTRACT

The present study was carried out during the two successive seasons of 2002 and 2003 on Maamoura guava fruits (*Psidium guajava* L.) to evaluate the influence of various post-harvest treatments on the storage ability of guava fruits.

Guava fruits were stored at 5± 1° C or at 8± 1° C and 90 % relative humidity (RH) after using some post harvest treatments (Hot water or fungicide or calcium chloride treatment) then packing the fruits in carton boxes of 3 Kg capacity

The results showed that fruits treated with $CaCl_2$ gave the highest values of all the considered fruit characteristics.

Concerning the storage temperatures, no significant differences were detected between 5± 1° C or 8± 1° C in their effect on the stored fruits during storage but fruits stored at 5°C gave better results after the end of storage than the other ones.

Key words: Guava, post-harvest treatments, Hot water treatment, $CaCl_2$ treatment, fungicide treatment, Storage temperature.

INTRODUCTION

Heat treatments have been used to control fungal diseases and infestation of fruits for many years. Heat may be applied to fruits and vegetables in several ways. Heat treatments have the advantage of effective insecticide and fungicidal action, case 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 caused 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).

To reduce infection by Guignardia Psidii rot, guava fruits were dipped in hot water at 50◦ C for 30 min. (Tozetto and Ribeiro. 1998).

Madhukar and Reddy (1990) noted that rotting of guava fruits decreased when fruits were dipped in hot water 50◦ C for 10, 20 or 30 minutes. Fruit rot decreased with increased duration of hot water treatment .Treatment for 30 minutes protected the fruits from fungal attack and preserved their storage quality.

Heat treated fruit had more insoluble pectin and calcium pectate and less soluble pectin than none treated apples even after ripening (Klein and Lurie, 1990).

Salmah –Yusof *et al*. (1992) noted that hot water dip and vapour heat treatment reduced fruit ascorbic acid contents in guava fruits.

Garica and Lakshminarayana (1989) found that immersion of Mango fruits in a calcium chloride solution (5%, 10 min.), reduced chilling injury, especially in Tommy Atkins cultivar stored at 3 º C for 7 days. Also they reported that soluble solids content increased in Manila cv., while no definite trend was observed in Tommy Atkins, as a Mango result of immersion in calcium chloride solution (5 %, 10 min.).

Nawar and Ezz (1994) noted that the $CaCl_2$ treatment reduced skin browning and poly phenol oxidase activity compared with controls. High incidence of fruit browning was generally associated with low TSS and ascorbic acid contents and low acidity.

Pathmanaban *et al.* (1995) reported that the $CaCl_2$ dip prolonged shelf life of fruit for 4 days. Moisture loss was high in untreated fruits during the period of storage, whereas only minimum water loss was observed in fruits treated with fused Ca salts. Treated fruits received significantly higher quality ratings than untreated fruits.

MATERIALS AND METHODS

Mature yellowish green guava fruits cv. Maamoura were used in the present study during two successive seasons of 2002 and 2003. Fruits were obtained from the Horticultural Experimental Station, El-Maamoura, Alex. Ministry of Agriculture.

Guava trees, twenty seven years old were spaced at 5 x 5 m .All trees received adequate irrigation, fertilizers and other cultural practices recommended for guava trees by Ministry of Agriculture. However fruits were harvested at proper maturity (yellowish green).Fruits were picked using small clippers and packed in plastic boxes. Before packing in storage boxes (carton boxes / 3 Kg each), unsuitable fruits were rejected. Fruits were stacked in a refrigeration car and taken directly to the post-harvest laboratory in Horticultural research institute and kept in cold rooms in the post- harvest department at Giza.

The post-harvest treatments were as follows:-

1-Dipping in hot water at 48º c for two minutes.
2-Dipping in hot water at 50º c for two minutes.
3-Dipping in promote* (biological control) at 1000ppm for two minutes.
4- Dipping in promote* at 2000ppm for two minutes.
5- Dipping in calcium chloride at 2 % concentration for four minutes.
6- Dipping in calcium chloride at 4% concentration for four minutes.
7-control (with out any treatment).

Promote* is a fungicidal material containing spores of *Trichoderma koningii* and *T. harzianum*.

Thus each treatment was divided into three replicates; each replicate was packed in 3 carton boxes / 3 Kg. Then, fruits were stored at 5±1º or 8±1º C and 90% relative humidity for 15 days.

The experiment was ended when the decay percentage exceeded 50% of the stored fruits in each package.

Physical and chemical properties and sensory evaluation were evaluated every 3 days from the beginning to the end of marketing period (15days) and determined as follows:

Physical properties:-

1- Percentage of fruit weight loss: -

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

$$FWL\% = \frac{Wi - Ws}{Wi} \times 100$$

Where, Wi = fruit weight at initial period.
Ws = fruit weight at sampling period.

2- Pulp Texture:-

Was recorded by lfra texture analyzer instrument , using a penetrating cylinder of 1 mm of diameter , to a constant distance 1 or 2 cm inside the pulp , and by a constant speed , 2 mm /sec , and the results were expressed as the resistance force to the penetrating tester ,in units of pressure (per gram) .

3-Fruit decay percentage (FDP): -

The number of decayed fruits due to fungus or any micro organism infection was recorded periodically and calculated as a percentage from the total number of fruits using the following equation : -

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

4- Shelf life period (in days):-

After 12 or 15 days of storage a fruit sample from each replicate was taken out of cold storage and left at room temperature 22 ± 2 °C and 55-60 % RH till bad appearance or rotting occurs. Then, the number of days was recorded and considered as shelf life.

Chemical properties:-

1- Total Soluble Solids %:-

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

2- Titratable 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).

3-Ascorbic acid content:-

Was determined by titration against 2,6 dichlorophenol endophenol, using 2% oxalic acid solution as substrate. Ascorbic acid was calculated as milligrams per 100 ml. of juice (Lucass, 1944).

Statistical analysis:-

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

Weight loss percentage:-

Tables (1, 2) show the effect of some post-harvest treatments on weight loss percentage of Maamoura guava fruits stored under 5±1ºC or 8±1ºC and 90 % RH , during 2002 and 2003 seasons.

A gradual weight loss was increased towards the end of the storage period (15 days). The least weight loss percentage was recorded by (2% or 4%) $CaCl_2$ treatments (6.94, 6.90) and (7.37, 6.77) in the first and second seasons respectively, without significant differences between them. On the other hand, hot water treatment at 50ºC exhibited the highest weight loss value (8.85, 10.46) 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.

Regarding the effect of storage temperature, fruits stored at low temperature (5±1ºC) recorded lower weight loss percentage than those stored at higher temperature (8±1ºC). Significant differences between the two storage temperatures appeared during storage period in the first season, while there were no significant differences between the two temperatures in the second season.

Table (1) Effect of some post-harvest treatments on Weight loss % of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002 season.

Storage Temp. / Treatments	Storage period in days														
	3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	1.56f	2.00b	1.78B	2.58de	3.40a	2.99A	4.14bcd	4.44abc	4.29B	6.76ab	6.76ab	6.76AB	7.48abc	8.75a	8.12AB
Hot water 50°C	1.66e	2.23a	1.95A	2.70d	3.34ab	3.02A	4.44abc	4.66a	4.55A	7.43a	7.26a	7.35A	8.63a	9.07a	8.85A
Promot 1000ppm.	1.20h	1.88d	1.54D	2.83d	2.76d	2.80AB	4.15bcd	4.48ab	4.32B	6.43abc	6.66ab	6.55B	7.31abc	7.74abc	7.53B
Promot 2000ppm.	1.33g	1.99bc	1.66C	2.19ef	2.91cd	2.55B	3.64e	4.36abc	4.00C	6.44abc	7.10a	6.77AB	7.83abc	8.27ab	8.05AB
$Cacl_2$ 2%	1.19h	1.70e	1.45E	2.05f	2.96bcd	2.51B	3.30f	4.39abc	3.85C	5.63bc	6.68ab	6.16B	6.45bc	7.42abc	6.94B
$Cacl_2$ 4%	1.15h	1.62ef	1.39E	2.52de	2.63d	2.58B	3.27f	4.35abc	3.81C	5.47c	6.57abc	6.02B	6.40c	7.40abc	6.90B
Control	1.90cd	1.90cd	1.90A	3.26abc	2.57de	2.92A	3.80de	4.07cd	3.94C	6.58abc	6.81a	6.70AB	7.45abc	7.99abc	7.72AB
Mean	1.43B*	1.90A*		2.59B*	2.94A*		3.82B*	4.39A*		6.39A*	6.83A*		7.36B*	8.09A*	

Values followed by the same letter (s) are not significantly different at 5 %

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Table (2) Effect of some post-harvest treatments on Weight loss % of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2003 season.

Storage Temp. / Treatments	Storage period in days														
	3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water48°C	3.24a	2.84ab	3.04A	4.00a-d	4.02a-d	4.01AB	5.77abc	5.97abc	5.87AB	6.35abc	7.31abc	6.83AB	8.10abc	8.27abc	8.19B
Hot water 50°C	3.30a	2.44a-d	2.87AB	5.00a	4.88ab	4.94A	7.07ab	7.44a	7.26A	8.18ab	8.54a	8.36A	10.38a	10.53a	10.46A
Promot1000ppm.	1.45d	2.66a-d	2.06CD	3.00bcd	3.72a-d	3.36BC	4.76bc	6.33abc	5.55B	5.62bc	6.52abc	6.07B	7.57bc	8.97ab	8.27B
Promot2000ppm.	1.62cd	2.74abc	2.18BCD	2.95bcd	3.61a-d	3.28BC	4.68bc	5.79abc	5.24B	5.50bc	6.73abc	6.12B	7.51bc	8.15abc	7.83B
$Cacl_2$ 2%	1.56cd	2.49a-d	2.02CD	2.65cd	3.25a-d	2.95BC	4.26c	5.30abc	4.78B	5.14c	6.04abc	5.59B	7.10bc	7.63bc	7.37B
$Cacl_2$ 4%	1.55cd	1.98bcd	1.77D	2.10d	3.07a-d	2.59C	4.15c	5.15abc	4.65B	5.06c	5.97abc	5.52B	6.11c	7.43bc	6.77B
Control	2.95ab	2.65a-d	2.80ABC	3.54a-d	4.10abc	3.82ABC	5.71abc	6.08abc	5.90AB	6.35abc	6.94abc	6.65AB	8.01abc	8.94ab	8.48B
Mean	2.24A	2.54A		3.32A	3.81A		5.20A	6.01A		6.03A	6.86A		7.83A	8.56A	

Values followed by the same letter (s) are not significantly different at 5 %

Interaction between post harvest treatments and storage temperature appeared significant differences in most cases.

After 15 days of storage, the least values of weight loss (6.40 and 6.11%) were obtained by fruits treated with 4%$CaCl_2$ and stored at 5±1ºC in the first and second seasons respectively. However the highest values of weight loss (9.07 and 10.53%) were obtained by hot water (50ºC) treatment followed by cold storage at 8±1ºC, in both seasons.

In this respect, Singh *et al*. (1981) stated that dipping guava fruits in calcium nitrate (0.5-2.0%) reduced weight loss and respiration rate.

It is also clear that all calcium chloride treatments clearly reduced weight loss percentages in guava fruit compared to untreated fruits. These data can be explained by the fact that $CaCl_2$ is hygroscopic (absorbs moisture), which is believed to be one of the reasons for its effectiveness in controlling weight losses. Water absorbed from the storage room helps to provide a continuous solution of $CaCl_2$ on the surface of the fruit throughout storage period. These observations are very close to those obtained by Singh *et al*. (1981), Ahmed Amen (1982), Kartar&Chauhan (1983), and Mehanna *et al.* (1984).

Fruit Texture:-

Data tabulated in Tables (3, 4) revealed the effect of some post-harvest treatments on the texture at 3mm depth of Maamoura guava fruits stored at 5±1ºC or 8±1ºC and 90 % RH , during 2002 and 2003 seasons.

Results indicated that texture values decreased with the advance of cold storage durations till 15 days.

However 2 or 4% $CaCl_2$ treatments showed the highest values with significant differences between them .On the other hand, the hot water at 50 ºC treatment and untreated fruits recorded the least values of the texture with no significant differences between them.

Concerning the effect of storage temperature, fruits stored at low temperature (5±1ºC) kept the less texture decrease values than those stored at high temperature (8±1ºC). Significant differences between the two storage temperatures appeared during storage periods.

Interactions between the two studied factors were significant in most cases.

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Table (3) Effect of some post-harvest treatments on fruit Texture at 3 mm depth (g / cm^2) of Maamoura guavas stored at 5 ± 1°C or 8 ± 1°Cand 90% RH during 2002 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water48°C	34.70a	34.70a	34.70A	27.00def	25.90efg	26.45C	21.50e	20.90e	21.20D	19.70de	16.90gh	18.30DE	18.80bc	14.50fg	16.65C	17.30bc	12.10g	14.70CD
Hot water50°C	34.70a	34.70a	34.70A	26.90def	23.70h	25.30C	20.40e	18.20f	19.30E	18.50efg	15.70h	17.10E	16.30de	13.40g	14.85D	15.90cde	11.80g	13.85D
Promot1000ppm	34.70a	34.70a	34.70A	27.60de	24.90gh	26.30C	20.90e	21.50e	21.20D	18.70efg	17.40fgh	18.05DE	17.50b-e	15.90ef	16.70C	15.40c-f	13.90f	14.65CD
Promot2000ppm	34.70a	34.70a	34.70A	29.70c	27.80d	28.75B	23.40cd	24.70c	24.05C	20.90d	19.90de	20.40C	19.20bc	16.50de	17.85BC	16.60bcd	14.20ef	15.40BC
$CaCl_2$ 2%	34.70a	34.70a	34.70A	31.90ab	30.30bc	31.10A	27.20b	26.90b	27.05B	24.50bc	22.80c	23.65B	18.90bc	17.90bcd	18.40B	17.90b	14.90def	16.40B
$CaCl_2$ 4%	34.70a	34.70a	34.70A	32.90a	31.50ab	32.20A	29.10a	27.80ab	28.45A	26.90a	25.00b	25.95A	22.80a	19.40b	21.10A	20.50a	16.80bcd	18.65A
Control	34.70a	34.70a	34.70A	26.40d-g	25.30fgh	25.85C	20.90e	22.10de	21.50D	18.90ef	18.20efg	18.55D	17.40cde	13.10g	15.25D	16.10b-e	11.90g	14.00D
Mean	34.70A'	34.70A'		28.93 A'	27.06B'		23.34A'	23.16A'		21.16 A'	19.41B'		18.70 A'	15.81B'		17.10 A'	13.66B'	

Values followed by the same letter (s) are not significantly different at 5 %

Table (4) Effect of some post-harvest treatments on fruit Texture at 3 mm depth (g / $cm^{2)}$ of Maamoura guavas stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2003 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	41.20a	41.20a	41.20A	37.40abc	36.20cd	36.80A	31.60de	29.50ef	30.55D	28.20cd	26.50def	27.35B	25.56bc	21.60de	23.58BC	23.60bc	18.70efg	21.15BC
Hot water 50°C	41.20a	41.20a	41.20A	35.40cde	34.30de	34.85B	29.20ef	27.90fg	28.55E	26.70de	23.40g	25.05C	23.40bcd	20.40e	21.90C	21.90cd	17.4g	19.65C
Promot1000ppm.	41.20a	41.20a	41.20A	34.70de	33.80e	34.25B	30.70de	28.10fg	29.40DE	27.20cde	25.20efg	26.20BC	23.10cde	20.93de	22.02C	21.40cd	18.20fg	19.80C
Promot2000ppm.	41.20a	41.20a	41.20A	37.40abc	35.90cde	36.65A	33.60bc	30.80de	32.20C	28.80cd	26.93de	27.87B	25.00bc	22.10de	23.55BC	22.50bcd	18.80efg	20.65C
$CaCl_2$ 2%	41.20a	41.20a	41.20A	38.80ab	36.40cd	37.60A	34.50b	32.50cd	33.50B	31.40ab	28.20cd	29.80A	25.90bc	23.40bcd	24.65B	24.80ab	20.70def	22.75B
$CaCl_2$ 4%	41.20a	41.20a	41.20A	39.10a	36.93bc	38.02A	36.90a	34.80b	35.75A	32.70a	29.80bc	31.25A	28.90a	26.20b	27.55A	26.60a	22.60bcd	24.60A
Control	41.20a	41.20a	41.20A	35.80cde	33.93e	34.87B	30.90e	27.20g	29.05E	28.50cd	24.10fg	26.30BC	25.20bc	21.93de	23.57BC	22.90bcd	18.40fg	20.65C
Mean	41.20A	41.20A		36.94A	35.35 B		32.49A	30.09B		29.07A	26.30 B		25.29A	22.37B		23.39A	19.26 B	

Values followed by the same letter (s) are not significantly different at 5 %

After 15 days of storage, the highest values of texture (20.50, 26.60) were shown by fruits treated with 4%$CaCl_2$ and stored at 5±1ºC in the first and second seasons respectively. However, the least values of texture (11.80, 17.40%) were obtained by fruits treated with hot water (50 ºC) and stored at 8ºC±1 in the two seasons respectively.

In this connection, Salmah Yusof *et al*. (1992) pointed out that hot water dip (HWD) and vapour heat treatment (VHT) resulted in much softer fruits than HWD. On the other hand, Bangerth *et al*. (1972) and Conway *et al*. (1989) showed that in apples, calcium chloride dipping treatment prior to storage, significantly increased firmness compared with the control.

Decay percentage:-

Data in Table (5, 6) illustrated that all used treatments did not give any discarded fruits (decay fruits) during 3, 6, 9 and 12 days of storage.

After 15 days of cold storage, untreated fruits (control treatment) exhibited the highest value of decay percentage (15%) followed by other treatments, without any significant differences between them.

Considering the effect of storage temperature, no significant differences between the two storage temperatures appeared till 12 days of cold storage. After 15 days of cold storage, fruits at 8±1◦ C recorded the highest decay percentage (10.00, 11.43); while the least decay percentage was recorded by fruit stored at 5±1◦ C (0.95, 0.95) in the two seasons respectively.

In this regard, Madhukar and Reddy (1990) noted that rotting of guava fruits (dipped in hot water 50ºC for 10, 20 or30 minutes) decreased with the increasing duration of hot water treatments. They also added that hot water treatment, 50ºC for 30min., protected fruits from fungal attack and preserved their storage quality.

Moreover, Majumdar and Pathak (1991) found that severity of rots significantly decreased when the fruits were treated with hot water at 50ºC.

Generally, the resistance of hot water treatment to fruit rotting may be due to the double effect of pre storage heat treatment on rotting and the possibility of storing fruits at low temperature, which also reduces rotting.

Table (5) Effect of some post-harvest treatments on Decay percentage of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002eason.

Storage Temp. / Treatments	Storage period in days														
	3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	6.67bc	3.33B
Hot water 50°C	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	6.67bc	3.33B
Promot 1000ppm.	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	10.00b	5.00B
Promot 2000ppm.	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	6.67bc	3.33B
$Cacl_2$ 2%	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	10.00b	5.00B
$Cacl_2$ 4%	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	0.00b	0.00A	0.00c	6.67bc	3.33B
Control	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00a	0.00a	0.00A	0.00b	3.33a	1.67A	6.67bc	23.33a	15.00A
Mean	0.00A	0.00A		0.00A	0.00A		0.00A	0.00A		0.00A	0.48 A		0.95B	10.00A	

Values followed by the same letter (s) are not significantly different at 5 %

The obtained results are in accordance with the findings of Couey (1982), as post harvest fungus diseases could be controlled by low temperature.

On the other hand, Sabry (1998) reported that promot (containing spores of *Trichoderma koningii* and *T. harzianum)* decreased decay percentage during storage. Similar results were confirmed by Dwivedi and Shukla (2002), who found that minimum infection (6%) was observed in pots when inoculated with *Trichoderma viride* compared to the control where the infection was 46% .

Concerning the effect of calcium chloride treatment, Conway *et al*. (1989) and Crisosto and Michailides (1991) pointed out that post harvest calcium application decreased decay incidence.

Shelf life:-

Data tabulated in table (7) showed that there were slight differences between fruits treated with hot water at 48 or 50ºC and $CaCl_2$ at 2 or 4%. However the longest shelf life (4.83 days) was recorded by hot water (50ºC) treatment. Whereas, the shortest shelf life (3.33 and 3.50 days) was noticed with the two promot treatments (1000 and 2000ppm) without significant differences between them.

Concerning the effect of storage temperature on shelf life, there were no significant differences between the two storage temperatures.

As for the interaction between post-harvest treatments and storage temperature, significant differences appeared in most cases. The highest significant values was noticed with fruits treated with hot water and stored at 5±1ºC followed by fruits treated with $CaCl_2$ and stored at 5±1ºC, with slight differences between them. On the other hand, fruits treated with promot (1000 and 2000ppm) and stored at 8±1ºC exhibited the shortest shelf life. The same trend was noticed in the second season.

In this respect, Pathmanaban *et al*. (1995) reported that the $CaCl_2$ dip prolonged shelf life.

Table (7) Effect of some post-harvest treatments on Shelf life of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002 and 2003 season.

Storage temp. / Treatments	2002			2003		
	5°c	8°c	M	5°c	8°c	M
Hot water48°C	5.33a	4.00bcd	4.67AB	5.00ab	4.33bc	4.67A
Hot water 50°C	5.33a	4.33abc	4.83A	5.00ab	4.67ab	4.83A
Promot1000ppm.	4.00bcd	3.00d	3.50C	3.67cd	2.67e	3.17C
Promot2000ppm.	3.67cd	3.00d	3.33C	3.33de	2.67e	3.00C
$CaCl_2$ 2%	5.00ab	4.33abc	4.67AB	5.33a	4.67ab	5.00A
$CaCl_2$ 4%	5.00ab	4.33abc	4.67AB	5.33a	5.00ab	5.17A
Control	4.33abc	3.33cd	3.83BC	4.33bc	3.67cd	4.00B
Mean	4.67A	3.76A		4.57 A	3.95 A	

Values followed by the same letter (s) are not significantly different at 5 %

Total Soluble Solids percentage (TSS %): -

Tables (8, 9) show the effect of some post harvest treatments on TSS % of Maamoura guava fruits stored at 5± 1º C or 8± 1º and 90% RH , during2002 and 2003 seasons .

Concerning the effect of hot water, calcium chloride and promot treatments, on guava fruits, TSS increased with the advance of cold storage till 15 days. The highest percentages of TSS were obtained by promot treatments (1000 or 2000ppm) (10.60, 10.40) and (12.25, 12.20) in the two seasons, respectively with significant differences between them. On the other hand, fruits treated with 4% $CaCl_2$ exhibited the least values of TSS (9.85, 10.25), while control , hot water 45º C and 50º C treatments exhibited moderate percentages of TSS (10.40, 10.20 and 9.90) and (11.70, 10.85 and 10.85) in the first and second seasons, respectively.

Regarding the effect of storage temperature, it is clear that fruits stored at the high temperature (8± 1ºC) showed the highest values of TSS compared to those stored at low temperature (5± 1ºC). No significant differences between the two storage temperatures were obtained during storage durations in the first season, but significant differences were found in the second one.

The interaction between the two studied factors was not significant in most cases in the first season. On the other hand, there were significant differences in most cases in the second season.

After 15 days of storage, the highest values of TSS were recorded by promot 2000ppm treated fruits (12.50 %) stored at (8± 1ºC) as well as control treatment. However, the least value of TSS (9.90%) was recorded by – fruits treated with $CaCl_2$ 4% and stored at (5± 1ºC).

The results obtained were similar to those mentioned by Aly and Ismail, (2000), who found that there guava fruits treated with $CaCl_2$ had lower TSS% compared to control.

Table (8) Effect of some post-harvest treatments on TSS% of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water48°C	8.60a	8.60a	8.60A	8.80c	8.90b	8.85C	9.00a	9.20a	9.10A	9.20a	9.40a	9.30A	9.50a	9.80a	9.65A	9.80a	10.00a	9.90A
Hot water50°C	8.60a	8.60a	8.60A	8.70d	8.80c	8.75F	9.20a	9.10a	9.15A	9.70a	9.50a	9.60A	10.00a	10.00a	10.00A	10.10a	10.30a	10.20A
Promot1000ppm	8.60a	8.60a	8.60A	8.80c	9.10a	8.95A	9.30a	9.60a	9.45A	9.70a	9.90a	9.80A	9.90a	10.50a	10.20A	10.50a	10.70a	10.60A
Promot2000ppm	8.60a	8.60a	8.60A	8.90b	8.90b	8.90B	9.10a	9.30a	9.20A	9.40a	9.70a	9.55A	9.80a	10.10a	9.95A	10.30a	10.50a	10.40A
$Cacl_2$ 2%	8.60a	8.60a	8.60A	8.70d	8.80c	8.75E	8.90a	9.40a	9.15A	9.40a	9.50a	9.45A	9.60a	9.70a	9.65A	9.90a	9.90a	9.90A
$Cacl_2$ 4%	8.60a	8.60a	8.60A	8.80c	8.70d	8.75E	9.00a	9.00a	9.00A	9.30a	9.30a	9.30A	9.50a	9.60a	9.55A	9.70a	10.00a	9.85A
Control	8.60a	8.60a	8.60A	8.70d	8.90b	8.80D	9.20a	9.30a	9.25A	9.60a	9.80a	9.70A	9.90a	10.20a	10.05A	10.20a	10.60a	10.40A
Mean	8.60A	8.60A		8.77B	8.87A		9.10A	9.27A		9.47A	9.59A		9.74A	9.99A		10.07A	10.29A	

Values followed by the same letter (s) are not significantly different at 5 %

Table (9) Effect of some post-harvest treatments on TSS% of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2003 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water48°C	9.10a	9.10a	9.10A	9.20f	9.50d	9.35F	9.50ab	10.00ab	9.75A	9.70i	10.50f	10.10E	9.80j	11.00e	10.40E	10.10k	11.60f	10.85E
Hot water50°C	9.10a	9.10a	9.10A	9.30e	9.70b	9.50D	9.40b	10.20ab	9.80A	9.60j	10.70e	10.15D	10.00h	11.20d	10.60D	10.30j	11.80e	11.05D
Promott1000ppm	9.10a	9.10a	9.10A	9.50d	9.90a	9.70A	9.70ab	10.80a	10.25A	10.90d	11.30b	11.10A	11.50b	11.90a	11.70A	12.10c	12.40b	12.25A
Promot2000ppm	9.10a	9.10a	9.10A	9.50d	9.60c	9.55C	10.30ab	10.40ab	10.35A	11.00c	11.00c	11.00B	11.40c	11.50b	11.45B	11.90d	12.50a	12.20B
$Cacl_2$ 2%	9.10a	9.10a	9.10A	9.30e	9.50d	9.40E	9.50ab	9.70ab	9.60A	9.70i	10.00g	9.85F	9.90i	10.50f	10.20F	10.00l	11.10g	10.55F
$Cacl_2$ 4%	9.10a	9.10a	9.10A	9.20f	9.30e	9.25G	9.40b	9.60ab	9.50A	9.60j	9.80h	9.70G	9.70k	10.20g	9.95G	9.90m	10.60i	10.25D
Control	9.10a	9.10a	9.10A	9.30e	9.90a	9.60B	9.50ab	10.80a	10.15A	9.70i	11.40a	10.55C	10.20g	11.90a	11.05C	10.90h	12.50a	11.70C
Mean	9.10A	9.10A		9.33A	9.63A		9.61 A	10.21A		10.03B	10.67A		10.36B	11.17A		10.74B	11.79A	

Values followed by the same letter (s) are not significantly different at 5 %

Juice total acidity percentage:-

Data illustrated in Tables (10, 11) revealed that total acidity of fruit juice increased with the progress of storage period till 9 days, then decreased.

There were no significant differences between all the used treatments. The highest values 0.261 % were recorded by fruits treated with 50ºC hot water in the first season and 0.309 % by 45 ºC hot water treatment in the second season .

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, it is clear that fruits stored at the high temperature (8± 1ºC) recorded higher total acidity values than those stored at low temperature (5± 1ºC). No significant differences between the two storage temperatures were noticed during storage period.

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

Interaction between the two studied variables was not significant in most cases.

After 15 days of storage, the highest percentage of total acidity (0.217) was recorded by 2% $CaCl_2$ followed by storage at 8± 1ºC in the first season and fruits treated with 4% $CaCl_2$ (0.245) stored at 5± 1ºC in the second season. On the contrary, the least value of total acidity (0.153%) was obtained by fruits stored at 5± 1ºC and treated with 2% $CaCl_2$ in the first season and also with fruits treated with promot at 2000ppm and stored at 5± 1ºC in the second season .

These results go in line with those reviewed by Nawar and Ezz (1994) and Nickhah *et al.* (1999) who found that treating fruits with $CaCl_2$ solutions increased acidity levels. Also Ahmed Amen (1987) and Aly & Ismail (2000) noted that guava fruits treated with $CaCl_2$ had higher acidity.

Table (10) Effect of some post-harvest treatments on Total Acidity % of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	0.160a	0.160a	0.160A	0.169a	0.169a	0.169A	0.208a	0.192a	0.200A	0.211a-d	0.256ab	0.234ABC	0.256a	0.179bc	0.218ABC	0.176ab	0.169ab	0,173A
Hot water 50°C	0.160a	0.160a	0.160A	0.170a	0.160a	0.165A	0.176a	0.201a	0.189A	0.256a	0.256ab	0.256A	0.201abc	0.179bc	0.190C	0.169ab	0.165ab	0.167A
Promot1000ppm.	0.160a	0.160a	0.160A	0.165a	0.176a	0.171A	0.170a	0.179a	0.175A	0.176d	0.256ab	0.216BCD	0.256a	0.211abc	0.234AB	0.160ab	0.169ab	0.165A
Promot2000ppm.	0.160a	0.160a	0.160A	0.163a	0.169a	0.179A	0.176a	0.179a	0.178A	0.185cd	0.192cd	0.189D	0.256a	0.256a	0.256A	0.179ab	0.192ab	0.186A
$Cacl_2$ 2%	0.160a	0.160a	0.160A	0.169a	0.169a	0.169A	0.195a	0.202a	0.199A	0.256ab	0.240abc	0.248ABC	0.160c	0.256a	0.208BC	0.153b	0.217a	0.185A
$Cacl_2$ 4%	0.160a	0.160a	0.160A	0.169a	0.169a	0.169A	0.192a	0.179a	0.186A	0.256ab	0.256ab	0.256AB	0.224ab	0.179bc	0.202BC	0.169ab	0.179ab	0.174A
Control	0.160a	0.160a	0.160A	0.160a	0.179a	0.170A	0.163a	0.185a	0.174A	0.195bcd	0.233a-d	0.214CD	0.256a	0.256a	0.256A	0.169ab	0.185ab	0.177A
Mean	0.160A`	0.160A`		0.166A`	0.174A`		0.174A`	0.188A`		0.219A`	0.241A`		0.230A`	0.217A`		0.168A`	0.182A`	

Values followed by the same letter (s) are not significantly different at 5 %

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Table (11) Effect of some post-harvest treatments on Total Acidity % of Maamoura guava fruits stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2003 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water43°C	0.160a	0.160a	0.160A	0.203a	0.203a	0.203A	0.213b	0.213b	0.213B	0.267ab	0.309a	0.288A	0.181e	0.192e	0.187C	0.171cd	0.192a-d	0.182A
Hot water50°C	0.160a	0.160a	0.160A	0.192a	0.171a	0.182A	0.192b	0.213b	0.203B	0.213b	0.256ab	0.235A	0.192e	0.267abc	0.230AB	0.171cd	0.192a-d	0.182A
Promot1000ppm	0.160a	0.160a	0.160A	0.192a	0.181a	0.187A	0.213b	0.224b	0.219AB	0.224b	0.224b	0.224A	0.213cde	0.235b-e	0.224ABC	0.181bcd	0.203a-d	0.192A
Promot2000ppm	0.160a	0.160a	0.160A	0.181a	0.171a	0.176A	0.192b	0.203b	0.198B	0.267ab	0.235b	0.251A	0.213cde	0.277ab	0.245AB	0.160d	0.235ab	0.198A
$CaCl_2$ 2%	0.160a	0.160a	0.160A	0.192a	0.171a	0.182A	0.213b	0.192b	0.203B	0.256ab	0.256ab	0.256A	0.224b-e	0.299a	0.262A	0.213a-d	0.203a-d	0.208A
$CaCl_2$ 4%	0.160a	0.160a	0.160A	0.213a	0.171a	0.192A	0.224b	0.288a	0.256A	0.245b	0.235b	0.240A	0.256a-d	0.192e	0.224ABC	0.245a	0.192a-d	0.219A
Control	0.160a	0.160a	0.160A	0.213a	0.171a	0.192A	0.245ab	0.224b	0.235AB	0.256ab	0.256ab	0.256A	0.235b-e	0.203de	0.219BC	0.224abc	0.192a-d	0.208A
Mean	0.160A	0.160A		0.198A	0.177A		0.213A	0.222A		0.247A	0.253A		0.216A	0.238A		0.195A	0.201A	

Values followed by the same letter (s) are not significantly different at 5 %

Ascorbic acid Content (mg/100g):-

Data presented in Tables (12, 13) showed that L-Ascorbic acid decreased with the progress of storage period till 15 days. The high contents of L-Ascorbic acid was obtained by $CaCl_2$ treatments of 2 or 4% (52.30, 53.05 mg/100g) without significant differences between them in the first season, but with significant differences between the used concentrations in the second season (49.80, 51.05 mg/100g). On the other hand, hot water 45ºC and 50ºC treated fruits exhibited the least value of L-Ascorbic acid [(46.15, 45.50 mg/100g) and (43.80, 51.05 mg/100g)] in the two seasons respectively.

In this respect, Siddiqui *et al.* (1991) noted that ascorbic acid content decreased progressively with the advance of storage period in all postures of guava fruits.

Regarding storage temperature effect, it is clear that fruits stored at low temperature (5± 1ºC) recorded higher values of L-Ascorbic acid than those stored at higher temperature (8± 1ºC) without significant differences between them during storage period.

Interaction between post-harvest treatments and storage temperatures, after 15 days of storage showed the highest values of L-Ascorbic acid (53.50, 53.40 mg/100g fresh weight) and (51.40, 50.40 mg/100g fresh weight) by fruits treated with $CaCl_2$ (4%, 2%) in the two seasons respectively when stored at 5± 1ºC without significant differences between them in the first season. There were slight differences between the two treatments in the second season. On the other hand, the least value of L-Ascorbic acid was recorded by fruits treated with hot water and promot and stored at 8± 1ºC.

The obtained results agreed with those reported by Salmah – Yusof *et al.* (1992) who noted that hot water and vapour heat treatment reduced fruit ascorbic acid contents in guava fruits. On the other hand, Nawar and Ezz (1994) reported that guava fruits treated with $CaCl_2$ had high ascorbic acid content compared with control.

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Table (12) Effect of some post-harvest treatments on fruit Ascorbic acid content mg/100g (F.Wt.) of Maamoura guavas stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2002 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	59.40a	59.40a	59.40A	52.40def	51.30fg	51.85CD	51.30e	50.40ef	50.85C	50.40cd	49.50cde	49.95C	49.50cd	47.10fg	48.30C	47.10def	45.20gh	46.15CD
Hot water 50°C	59.40a	59.40a	59.40A	51.50efg	50.60g	51.05D	50.20ef	49.30f	49.75D	49.30de	48.20e	48.75D	48.20def	46.30g	47.25D	46.30efg	44.70h	45.50D
Promot1000ppm.	59.40a	59.40a	59.40A	54.30bc	53.90bcd	54.10B	15.70de	51.70de	51.70C	48.50e	48.00e	48.25D	48.30def	47.30fg	47.80CD	47.70de	46.00fgh	46.85C
Promot2000ppm.	59.40a	59.40a	59.40A	53.10cde	52.00efg	52.55C	50.20ef	49.10f	49.65D	49.10de	48.00e	48.55D	48.00ef	46.90fg	47.45CD	46.90def	44.60h	45.75D
$Cacl_2$ 2%	59.40a	59.40a	59.40A	56.20a	56.80a	57.50A	57.00a	55.50b	56.25A	55.70a	54.00b	54.85B	54.70a	52.40b	53.55A	53.40a	51.20b	52.30A
$Cacl_2$ 4%	59.40a	59.40a	59.40A	58.40a	57.70a	58.05A	57.30a	56.10ab	56.70A	56.00a	55.70a	55.85A	54.60a	53.40ab	54.00A	53.50a	52.60a	53.05A
Control	59.40a	59.40a	59.40A	55.00b	54.10bc	54.55B	53.70c	52.90cd	53.30B	51.00c	50.20cd	50.60C	50.10c	49.10cde	49.60B	49.20c	48.30cd	48.75B
Mean	59.40A`	59.40A`		54.70 A`	53.77 A`		53.06A`	52.14A`		51.43A`	50.51 A`		50.49A`	48.93 B`		49.16 A`	47.51B`	

Values followed by the same letter (s) are not significantly different at 5 %

Table (13) Effect of some post-harvest treatments on fruit Ascorbic acid content mg/100g (F.Wt.) of Maamoura guavas stored at 5 ± 1°C or 8 ± 1°C and 90% RH during 2003 season.

Storage Temp. / Treatments	Storage period in days																	
	0			3			6			9			12			15		
	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M	5°c	8°c	M
Hot water 48°C	56.90a	56.90a	56.90A	53.30d	52.10e	52.70D	50.10d	50.10d	50.10C	49.50cd	48.40d	48.95C	42.10f	41.20f	41.65E	44.30def	43.50f	43.90E
Hot water 50°C	56.90a	56.90a	56.90A	54.20cd	53.20de	53.70C	52.20c	51.40cd	51.80B	50.20c	49.70cd	49.95BC	44.90e	42.10f	43.50D	45.20de	41.60g	43.40E
Promot1000ppm.	56.90a	56.90a	56.90A	55.00abc	54.40bcd	54.70AB	52.00c	52.10c	52.05B	50.90c	49.90cd	50.40B	48.10d	47.80d	47.95C	46.80c	45.90cd	46.35C
Promot2000ppm.	56.90a	56.90a	56.90A	55.30abc	54.30cd	54.80AB	52.40c	52.40c	52.40B	51.20bc	50.10c	50.65B	50.00c	49.10cd	49.55B	44.20ef	44.10ef	44.15DE
$CaCl_2$ 2%	56.90a	56.90a	56.90A	55.60ab	54.90abc	55.25A	54.30a	53.80a	54.50A	53.00a	52.70ab	52.85A	51.70ab	50.60bc	51.15A	50.40ab	49.20b	49.80B
$CaCl_2$ 4%	56.90a	56.90a	56.90A	55.80a	55.20abc	55.50A	54.70a	54.00ab	54.35A	53.60a	52.90a	53.25A	52.50a	51.80ab	52.15A	51.40a	50.70ab	51.05A
Control	56.90a	56.90a	56.90A	54.90abc	53.50d	54.20BC	52.60bc	52.60bc	52.60B	50.40c	50.90c	50.65B	47.70d	47.50d	47.60C	45.20de	44.90def	45.05D
Mean	56.90A	56.90A		54.87 A	53.94 B		52.61A	52.34A		51.26A	50.66A		48.14A	47.16A		46.79 A	45.70B	

Values followed by the same letter (s) are not significantly different at 5 %

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تاثير بعض معاملات ما بعد الحصاد على القدرة التخزينية لثمار الجوافة صنف منتخب المعمورة

محمد أبو رواش على[1] – روحية بديرمحمد [1]– محمود السيد صبيح[2] – فاطمة قرنى محمد[2]

[1]- قسم البساتين- كلية الزراعة – جامعة عين شمس- شبرا الخيمة – القاهرة – مصر

[2]- قسم تداول الفاكهة - معهد بحوث البساتين – مركز البحوث الزراعية- الجيزة – مصر

تم تقييم تاثير المعاملة بالماء الساخن على درجة 48° ، 50° م لمدة دقيقتين و المطهر الحيوى البروموت بتركيز 1000، 2000 جزء فى المليون لمدة دقيقتين و استخدم كلوريد الكالسيوم بتركيز 2 ، 4 % لمدة 4 دقائق كمعاملات قبل تخزين الثمار على درجتى الحرارة 5 ±1° او8 ±1° و رطوبة نسبية 90 % وذلك خلال موسمى 2002 ، 2003 .

وقد درس تاثير ذلك على التغير فى الصفات الطبيعية و الكميائية للثمار خلال التخزين المبرد حيث اعطت معاملة الثماربكلوريد الكالسيوم والمخزنة على 5 ±1° م اقل معدل لفقد الوزن الطازج للثمار كما اعطت اعلى صلابة للثمار . وبالنسبة للثمار التالفة اعطت معاملة الكنترول اعلى نسبة تلف للثمار مقارنتا بباقى المعاملات . وجد ان اطول عمر رف تحصل علية من معاملة الثمار بالماء الساخن و كلوريد الكالسيوم والمخزنة على 5 ±1° م .

اما بالنسبة للصفات الكميائية فقد وجد ان اعلى نسبة للمواد الصلبة الذائبة تحصل عليها من معاملة البروموت 2000 جزء فى المليون و الكنترول والمخزنة على 8 ±1° م و اقل نسبة من المعاملة بكلوريد الكالسيوم 4 % والمخزنة على 5 ±1° م . اقل نسبة حموضة تحصل عليها من معاملة الثمار بكلوريد الكالسيوم والمخزنة على 5 ±1° م فى الموسم الاول ومعاملة الثمار بالبروموت 2000 جزء فى المليون والمخزنة على 5 ±1° م فى الموسم الثانى. بينما اعطت معاملة الثمار بكلوريد الكالسيوم و المخزنة على 5 ±1° م اعلى نسبة لفيتامين ج .