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EFFECT OF HOT WATER DIP TREATMENTS ON REDUCING CHILLING INJURY AND DECAY AND KEEPING QUALITY OF NON-ASTRINGENT CHOCOLATE PERSIMMONS DURING COLD STORAGE

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ABSTRACT

The experiment was carried out during 1997 and 1998 seasons on Chocolate persimmons (*Diospyros kaki L.*) to study the effect of some prestorage heat treatments through hot water dips (dipping in hot water at 60°C for 10 min; 55°C for 20 min; 50°C for 30 min; 45°C for 40 min or 40°C for 50 min) on reducing chilling injury and decay and keeping quality of the fruits under test during storage at 0°C and 85-90% RH.

Either heat treated or non treated fruits remained 50 days of storage. The unmarketable fruits of all treatments appeared for the first time at the end of storage period. The best treatment for reducing decay was at 40°C for 50 min, while the best one for reducing chilling injury was at 55°C for 20 min. However, the differences were insignificant among unmarketable fruits of all treatments.

As the storage period advanced weight loss % increased, while firmness, tannines and malic acid % decreased. TSS% and vitamin C content increased at the start of storage period then, TSS % decreased while vitamin C content tended to remain constant and thereafter increased. Hot water dip, had no significant effect on weight loss and firmness. Slight differences in TSS , vitamin C,tannines and malic acid contents between heat treated and untreated fruits were noticed.

Keywords: Persimmon; non-astringent; hot water; storage, quality, chilling injury and decay.

INTRODUCTION

The persimmon belongs to the family *Ebenaceae*, genus *Diospyros* and to nearly 190 different species. However, only four species have been used commercially for the production of fruits. They are *D. kaki L.; D. lotus L.; D. virginiana L.* and *D. oleifera cheng.*

Persimmons (*Diospyros kaki L.*) are popular in Japan, Asia and South America. Unlike the smaller, seedier American persimmon (*D. virginiana L.*), noted for its astringent character, the non-astringent oriental persimmons are noted for their delicate flavour. There is an interest in increasing cultivation and production of persimmons in Egypt for commercial markets. Increasing production of persimmons in Egypt is feasible due to requirements of the fruit for moderate climate and temperatures. Persimmons are almost disease and insect free, requiring little care as a commercial crop. The fruits are a good known source of fiber as well as vitamins A and C (Homnava *et al.*, 1990). Therefore, the total cultivated area was increased from 29 feddans in 1979 to 1368 feddans in 2000, which produced 139 and 6761 tons, respectively, (According to statistics of Ministry of Egyptian Agriculture, 2001).

Diospyros kaki which is known as the Japanese persimmon cv. can be divided into 2 groups, astringent and non-astringent, according to their astringency at maturity, (Tanaka *et al.*, 1994). Chocolate persimmon (*Diospyros kaki L.*) is from the non-astringent group.

Heat or cold treatments, anoxia and irradiation are some possibilities being explored. Heat treatments include dipping or soaking the commodity in heated water, holding commodity in heated saturated water vapor or holding the commodity in heated air with controlled low humidity levels (Paull, 1990). The main objectives which can be achieved by prestorage heat treatments are: a. Increasing the storage period of climactric fruits, b. Reducing the sensitivity of subtropical fruits to chilling injury (during low temperature), c. Reducing postharvest rots and d. Controlling insect pests as a quarantine treatment.

Few studies have been done on improving storability of persimmon fruits by using heat treatments. Therefore, this research was carried out to study the effect of heat treatments through hot water dips on reducing chilling injury and decay, and keeping quality of Chocolate persimmon fruits during storage at 0°C and 85-90 RH.

MATERIALS AND METHODS

The present study was carried out during the two successive seasons 1997 and 1998 on Chocolate persimmon fruits (*Diospyrus kaki L.*). The fruits were picked from 20 years old trees grown in a private orchard at El-Mamoura, Alexandria Governorate. In the forth week of December of both seasons of study, 930 fruits at maturity stage, uniform in size, colour and free from any visible blemishes were selected. Thirty fruits were used as an initial sample for physical parameters and chemical analysis every season. The remaining fruits (900 ones) were divided into 6 equal groups (treatments) i.e. each treatment contained 150 fruits. Each of these groups treated with one of the following treatments:

1. Dipping the fruits in hot water (60°C) for 10 min.
2. Dipping the fruits in hot water (55°C) for 20 min.
3. Dipping the fruits in hot water (50°C) for 30 min.
4. Dipping the fruits in hot water (45°C) for 40 min.
5. Dipping the fruits in hot water (40°C) for 50 min.
6. Dipping the fruits in tap water (20°C) for 30 min (control).

All the groups were then air dried by the aid of an electric fan. Each group was divided into small ones, 30 fruits each (10 fruits for each replicate) i.e. there were five small groups for each treatment. Each small group (30 fruits) were put in small wood tray, (50x30x5 cm), in one layer, i.e. there were 5 trays x 6 treatments = 30 trays*. The fruits were stored at 0°C with relative humidity of 85-90%. One tray for each treatment, i.e. six trays for all treatments, were taken at random. Fruits of each treatment were evaluated at a 10 days-interval throughout the storage period. A sample of 30 fruits (10 fruits for each replicate) was taken for each treatment, to study the following properties:

*The treatments were arranged in randomized complete block design

1. Physical properties:

a. Weight loss

Fruits were weighed at 10 day-intervals in each sample during storage and the loss in fruit weight was recorded and calculated as a percentage from the initial weight.

b. Fruit firmness

Firmness measurements were made on two opposite sides of the fruits by using the Effegi pressure tester with an eight mm. plunger (Effegi, 48011 Alfonsine, Italy). The mean of firmness measurements made at the two sides was reported in Newtons (N).

c. Unmarketable fruits

The number of unmarketable fruits due to chilling injury and decay was recorded and calculated as percentage from the total number of each sample.

d. Decayed fruits

The number of decayed fruits was recorded and calculated as percentage from the total number of each sample.

e. Chilling injured fruits

The number of injured fruits was recorded and calculated as percentage from the total number of each sample.

2. Chemical properties:

a. Total soluble solids (TSS)

The percentage of total soluble solids (TSS) were determined by using a hand refractometer.

b. Ascorbic acid (V.C)

It was determined by titration against 2,6 dichlorophenol indophenol blue dye, according to A.O.A.C. (1985).

c. Tannines

The percentages of total tannines were determined by the colorimetric method used by Hillis and Swain (1959).

d. Titratable acidity

It was determined by titration against 0.1 N NaOH, according to A.O.A.C. (1985).

All data obtained were statistically analyzed according to Snedecor and Cochran (1971).

RESULTS AND DISCUSSION

1. Physical properties:

a. Weight loss

The data presented in Tables (1 and 2) declared that, in both years of study, a continuous loss in weight existed in all fruits with the extend of storage period. The differences of weight loss percentages were significant among the storage periods, as an average for all applied treatments. Fruit weight loss occurred naturally mainly as a result of water loss from the fruit tissues during storage and partially during respiration process. The results were confirmed

with those found on persimmons by Lyon *et al* (1992) on cv. Fuyu; Moura *et al.* (1997a) on cv. Taubate and Aly *et al.* (2000) on cv. Costata.

Table (1): Effect of various treatments on percent weight loss of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	-	-	-	-	-	-	-
10	1.92	1.90	2.02	2.29	1.94	2.30	2.06 e
20	3.60	3.56	3.73	4.26	3.66	4.02	3.80 d
30	5.11	5.14	5.29	6.42	5.27	5.50	5.45 c
40	6.76	6.64	6.87	8.15	6.78	7.04	7.04 b
50	9.76	9.62	9.85	11.67	9.36	9.85	10.02 a
Average	5.43 b	5.37 b	5.55 b	6.56 a	5.40 b	5.74 b	

L.S.D	Treatments	Storage period	Interaction
0.05	0.800	0.170	0.861
0.01	1.121	0.226	1.180

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

Table (2): Effect of various treatments on percent weight loss of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	-	-	-	-	-	-	-
10	1.91	2.10	2.34	2.06	1.90	2.27	2.10 e
20	3.57	3.96	4.31	3.77	3.49	4.21	3.89 d
30	5.32	5.62	5.99	5.37	5.13	5.97	5.56 c
40	6.88	7.25	7.98	7.09	6.47	7.69	7.23 b
50	9.83	10.63	11.46	10.04	9.11	10.51	10.26 a
Average	5.50	5.91	6.41	5.67	5.22	6.13	

L.S.D	Treatments	Storage period	Interaction
0.05	NS	0.188	0.870
0.01		0.252	1.191

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

In both experimental seasons, as an average of all storage periods (50 days), the differences were insignificant among the weight loss percentages of fruits of all treatments including control, except in the first season, the weight loss percentages of fruits dipped in hot water at 45°C for 40 min, were significantly the highest. The insignificant effect of hot water treatments on weight loss was previously reported by Gonzalez-Aguilar *et al.* (1997) on Fortune mandarins. However, the results were not in harmony with those obtained by McGuire (1991a) on mangoes and Tayel (2001) on peaches.

b. Firmness

The data recorded in Tables (3 and 4) indicated that, as an average for all treatments, the firmness of Chocolate persimmon fruits significantly decreased as the storage period progressed. In both years of study, the fruits still firmed during the first 10 days of storage, thereafter they gradually lost their firmness. Flesh softening was most rapid to be less than 4.45 N. at the end of storage period.

Table (3): Effect of various treatments on flesh firmness (N.) of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	47.46	47.46	47.46	47.46	47.46	47.46	47.46 a
10	42.29	44.86	44.49	45.60	45.36	41.52	44.02 a
20	39.68	30.78	43.76	38.20	42.28	30.78	37.58 b
30	26.39	21.92	38.14	27.80	23.87	20.65	26.46 c
40	14.71	13.84	14.21	14.58	11.14	13.23	13.62 d
50	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >
Average	34.11	31.77	37.61	34.73	34.02	30.73	
L.S.D		Treatments		Storage period		Interaction	
0.05		NS		5.720		NS	
0.01				7.626			

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

Table (4): Effect of various treatments on flesh firmness (N.) of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	50.03	50.03	50.03	50.03	50.03	50.03	50.03 a
10	45.60	44.12	46.68	48.57	49.72	49.68	47.39 a
20	32.83	35.60	28.93	30.41	37.14	36.85	33.63 b
30	20.66	21.48	18.71	17.20	25.04	23.12	21.04 c
40	4.45	4.45	9.02	6.19	8.17	6.93	6.53 d
50	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >	4.45 >
Average	30.71	31.14	30.67	30.48	34.02	33.32	
L.S.D		Treatments		Storage period		Interaction	
0.05		NS		3.073		NS	
0.01				4.111			

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

The decrease in fruit firmness with the progress of storage period is due mainly to decomposition enzymatic degradation of insoluble protopectins to more simple soluble pectins, solubilization of cell and cell wall contents as a

result of the increasing in pectin esterase activity (Deshpande and Salunkhe, 1964). An investigation on the changes enzyme activities, pectins and structure of persimmon fruit during softening indicated that polygalacturonase activity in mature and softened persimmons was 55.01 and 206.7 units/100 g, respectively, beta-Galactosidase activity was 21.79 and 380.23 units/100 g, respectively. An increase in the total and insoluble pectins content of persimmons was observed during maturation; these values decreased during softening. Water soluble-pectin content of persimmons increased during maturation and softening. Ripening was associated with an increase in the intercellular space, the middle lamella was degraded in mature persemmons and cells of soft fruits were separated from each other (Shin *et al.,* 1993).

The reduction in fruit firmness, through the experimental period, was previously reported by Shaybany *et al.* (1978) on persimmon fruits; Tian *et al.* (1991) on *Diospyross kaki* fruits; Forbus JR *et al.* (1991) on Japanese persimmon cultivars (3 non-astringent, Fuyu, Jiro and Ichi Kijiro and 2 astringent, Aizumi Shiraza and Giambo); Ruth Ben and Zutkhi (1992) and Turk (1993) on Fuyu persimmon and Moura *et al.* (1997b) on Taubate persimmon fruits.

Fruit firmness was not influenced by any of the heat treatments, as the differences were insignificant among all treatments, in both experimental seasons. These findings were confirmed by those found by Teitel *et al.* (1989) on Galia melons. Furthermore, Seo and Rye (2002) on Fuyu persimmons reported that firmness was not affected by hot water dip treatment (45°C for 10 and 20 min) during cold storage. However, Paull (1990) stated that the fruit softening enzymes are sometimes not produced following heating. Whereas, Irving *et al.* (1991) on kiwi fruit, noticed that the fruits dipped in hot water (45°C for 8 min) were softer than control ones (20°C for 8 min), after 8 weeks of storage at 0°C.

C. Unmarketable fruits

The data illustrated in Tables (5 and 6) showed that, in both seasons, the unmarketable fruits appeared for the first time at the end of storage period (50 days) in fruits of all treatments. The unmarketable fruits percentages of all treatments ranged from 63.33 to 80% in the first season and from 60.00 to 73.33% in the second. However, the differences of unmarketable fruits percentages were insignificant among all treatments including control.

Non-astringent persimmon fruits are generally susceptible to physiological disorbers, especially blackening and browning during storage (Yamamura *et al.*, 1984). The disorders are reported to have some relationship with orchard factors (Ueno and Ishisaki, 1963) and low temperature storage, fungus were detected in black spots.

The results were confirmed with those obtained by Ruth Ben and Zutkhi (1992). They noticed that internal discoloration and breakdown of the Fuyu persimmon became appeared in the fruits after 6 weeks of storage at 0°C. The results were also agreed with those found by McLauchlan *et al.* (1997) on Eureka Lemons. They found that heat treatment (47-53°C for 1-3 min) had no significant effect on the incidence of diseases at all durations of storage.

However, the results were not in harmony with those noticed by Lay-Yee *et al.* (1997) on Fuyu persimmons. They immersed the fruits in hot water at temperatures ranging from 47 to 54°C, for 2.5 to 120 min (depending on temperature). Control ones dipped in water at 20° for 60 min. The fruits were stored at 0°C for 6.5 weeks. They found that whereas a number of hot-water treatments caused damage in the form of skin or flesh browning, no damage was observed with certain treatments which showed potential as disinfestatio treatments (47° for 90 or 120 min, 50° for 30 or 45 min, 52° for 20 or 30 min, and 54° for 20 min). These treatments also reduced the incidence and severity of chilling injury. In addition Woolf *et al.* (1997) found that, browning of fuyu persimmon increased with greater heat treatment with dry air and duration (34-50° C for 0.5-10 h.). The least chilling injury and external browning occurred at 47°C for 0.5-3h. They recommended that heat damage, needs to be reduced before the heat treatment can be commercially applied.

Table (5): Effect of various treatments on percentage of unmarketable Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	80.00	70.00	63.33	76.67	66.67	73.33
L.S.D 0.05 0.01	Treatments NS					

NS: Not significant

Table (6): Effect of various treatments on percentage of unmarketable Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	73.33	66.67	60.00	73.33	66.67	66.67
L.S.D 0.05 0.01	Treatments NS					

NS: Not significant

d. Decayed fruits

The data obtained from Tables (7 and 8) disclosed that the fruits of all treatments didn't show any visual decay during the first 40 days of storage. Decayed fruits appeared for the first time at the end of storage period, in both experimental seasons.

Table (7): Effect of various treatments on decay percent of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	46.67 a	53.33 a	26.67 b	46.67 a	13.33 c	46.67 a
L.S.D	Treatments					
0.05	12.579					
0.01	17.635					

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

Table (8): Effect of various treatments on decay percent of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	43.33 a	53.33 a	26.67 b	46.67 a	16.67 b	43.33 a
L.S.D	Treatments					
0.05	10.271					
0.01	14.399					

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

Treatments gave the significantly highest percentages of decayed fruits were 60°C for 10 min; 55°C for 20 min; 45°C for 40 min and control, as they were 46.67, 53.33, 46.67 and 46.67% in the first season and 43.33, 53.33, 46.67 and 43.33% in the second one, respectively. The differences were insignificant among decayed fruit percentages of these treatments in both years of study. On the other hand, the best treatment which gave the least significant percentages of decayed fruits was 40°C for 50 min, (13.33 and 16.67% in 1997 and 1998, respectively), however the differences were insignificant between the decayed fruit percentages of this treatment and those

of 50°C for 30 min in the second season. These findings were in line with those found by Irving *et al.* (1991) on kiwi fruit. They noticed that the best treatment for controlling decay of fruits stored at 0°C for 8 weeks was dipping them in hot water at 46-50°C for 8 min. Reducing the incidence of decay and skin blackening of Fuyu persimmon by using hot water dip treatment was previously reported by Seo and Rye (2002).

e. Chilling injured fruits

The data presented in Tables (9 and 10) revealed that, the injured were fruits noticed for the first time at the end of storage period (50 days). Similary, Ruth Ben and Zutkhi (1992) found that internal discoloration and break down of Fuyu persimmon fruits flesh became apparent in the fruits after 6 weeks of storage at 0°C.

Table (9): Effect of various treatments on chilling injury percent of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	33.33 bc	16.67 d	36.67 b	30.00 bc	53.33 a	26.67 c
L.S.D	Treatments					
0.05	9.376					
0.01	13.145					

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

Table (10): Effect of various treatments on chilling injury percent of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments					
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
50	30.00 b	13.33 c	33.33 b	26.67 b	50.00 a	23.33 bc
L.S.D	Treatments					
0.05	11.094					
0.01	15.553					

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

The fruits treated with hot water at 40°C for 50 min gave significantly the highest percentages of injured fruits in both seasons (53.33 and 50.0% in 1997 and 1998, respectively). Whereas, those treated with hot water at 55°C for 20 min showed the lowest significant percentages of injured fruits (16.67 and 13.33% respectively). However, the differences were not significant between injured fruit percentages of this treatment and those of control, in the second season. The rest of other treatments gave intervening values (26.67-36.67% in 1997 and 23.33-33.33% in 1998). These findings partially agreed with Burmeister *et al.* (1997) on Fuyu persimmon. They noticed that hot water dip treatments ameliorated chilling injury. In additions Woolf *et al* (1997) on Fuyu persimmon, mentioned that hot air heat treatment is beneficial in protecting against low temperature.

2. Chemical properties:

a. Total soluble solids (TSS)

The data nominated in Tables (11 and 12) indicated that the TSS percentages, as an average for all treatments, significantly increased at the start of storage period till it attained a peak after 20 days of storage, thereafter they tended to lessen at the last period of storage. The reduction in TSS values may be a result of the hydrolysis of insoluble solids to soluble form. The results were in agreement with those found by Makscud (1981); Kamal and Rabeh (1989) and Turk (1993) on persimmon fruits.

As an average for all storage period, the data showed that, in the first season, the treatment 50°C for 30 min gave the lowest TSS percentage ,however the differences were not significant between TSS percentage of this treatment on one hand and those of 55°C for 20 min and 40°C for 50 min, on the other. In the second season the differences were insignificant among TSS percentages of all treatments, except those of 60°C for 10 min which were the highest significant percentages. These findings were in harmony with Teitel *et al.* (1989) on Galia melons and Huang-wanrong *et al.* (1993) on Okuba peaches. They reported that there was no effect of heat treatments on TSS percentages. Furthermore, Obenland *et al.* (1999) on California nectarines noticed minor differences in soluble solids content between heat treated and untreated control fruits.

Table (11): Effect of various treatments on the percentage of total soluble solids of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	24.67	24.67	24.67	24.67	24.67	24.67	24.67 b
10	25.33	25.00	25.33	26.67	27.00	26.33	25.94 a
20	24.67	26.33	26.00	26.67	27.33	27.00	26.33 a
30	24.00	25.00	23.00	24.33	23.33	25.33	24.17 b
40	22.00	21.33	20.33	20.00	20.00	22.00	20.94 c
50	25.00	18.67	20.00	24.67	20.33	19.67	21.39 c
Average	24.28 ab	23.50 bc	23.22 c	24.50 a	23.78 abc	24.17 ab	

L.S.D	Treatments	Storage period	Interaction
0.05	0.847	0.765	1.964
0.01	1.188	0.018	2.685

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

Table (12): Effect of various treatments on the percentage of total soluble solids of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	24.00	24.00	24.00	24.00	24.00	24.00	24.00 b
10	26.00	26.00	26.33	26.33	25.67	27.67	26.33 a
20	26.67	26.00	25.67	25.00	25.33	25.33	25.67 a
30	24.33	22.67	23.00	21.33	20.33	22.00	22.28 c
40	20.00	18.67	17.67	18.00	18.00	18.00	18.39 e
50	24.33	19.67	19.00	21.33	19.67	18.67	20.44 d
Average	24.22 a	22.83 b	22.61 b	22.67 b	22.17 b	22.61 b	

L.S.D	Treatments	Storage period	Interaction
0.05	0.775	0.683	1.761
0.01	1.087	0.909	2.408

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

b. Ascorbic acid (V.C)

The data in Tables (13 and14) revealed that, as an average for all treatments, the initial V.C content significantly increased at the start of storage period then it almost remained constant within 40 days of storage and thereafter increased. The increase in V.C content affirmed by El-Zorkani (1968) on seedless guava; Ashraf *et al.* (1981) and El-Helaly (1984) on mangoes. Abd El-Hafez (1992) on Costata persimmon, noticed a gradual increase in V.C content till it reached a beak after 48 days of cold storage. In addition, Artes *et al.* (1993) reported that the concentration of ascorbic acid in Primofori lemons increased during storage after warming treatment. On the other side, the constant of V.C was also confirmed by Izumi *et al.* (1990). They noticed that ascorbic acid content of Hayashi mandarins remained constant during storage at 5°C for 3 months. However,

the results were not in line with Terglazova (1988) and Sivakov *et al.* (1992) who noticed a reduction in V.C content of persimmon fruits during storage.

In the first season, as an average for all storage periods, the treatments 60°C for 10 min; 55° for 20 min and 50°C for 30 min gave significantly the highest values of V.C, the differences were insignificant among the V.C values of these treatments. On the other side, the untreated fruits had significantly the lowest values. In the second season, the differences were insignificant among V.C values of all treatments including control, except 55°C for 20 min which showed significantly the highest values. The results were in harmony with those noted before by McGuire (1991b) on grapefruits. He reported that heat treatment had little effect on juice characteristics (except acidity). However, Kawada and Kitagawa (1986) noticed that warming citrus fruits reduced the V.C content, while Artes *et al.* (1993) found that V.C content of Primofiori lemons increased after warming treatment during storage.

Table (13): Effect of various treatments on V.C (mg/100 ml juice) of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	22.08	22.08	22.08	22.08	22.08	22.08	22.08 cd
10	33.12	30.65	25.72	22.04	21.79	17.99	25.22 b
20	28.05	22.88	27.27	25.55	25.88	21.94	25.26 b
30	26.01	21.40	27.07	24.86	22.33	19.86	23.59 bc
40	23.70	23.70	27.26	17.78	19.93	13.74	21.02 d
50	39.38	42.44	39.74	33.24	38.71	23.96	36.24 a
Average	28.72 a	27.19 a	28.19 a	24.26 b	25.12 b	19.93 c	

L.S.D	Treatments	Storage period	Interaction
0.05	1.904	2.047	5.119
0.01	2.670	2.723	7.001

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

Table (14): Effect of various treatments on V.C (mg/100ml juice) of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	20.16	20.16	20.16	20.16	20.16	20.16	20.16 c
10	28.76	27.33	24.32	21.28	23.05	21.53	24.38 b
20	19.11	24.30	15.41	15.70	22.23	23.70	20.08 c
30	19.03	24.78	19.94	17.90	23.02	22.76	21.24 c
40	19.16	21.08	21.50	17.57	21.08	20.22	20.10 c
50	34.24	52.08	35.18	36.97	31.25	22.96	35.45 a
Average	23.41 b	28.29 a	22.75 b	21.60 b	23.47 b	21.89 b	

L.S.D	Treatments	Storage period	Interaction
0.05	2.190	1.815	4.732
0.01	3.070	2.414	6.471

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

C. Tannines

The data in Tables (15 and 16) clearly indicated that in both experimental seasons, as an average for all treatments, the tannin percentages were significantly decreased continuously as the storage period advanced. The reduction in tannines depends on their dilution in the flesh tissue, (Yonemori and Matsushima, 1987). The results agreed with those reported by Sivakov *et al.* (1992); Abd El-Hafez (1992) and Moura *et al.* (1997b) on persimmon (*Diospyros kaki L.*).

Table (15): Effect of various treatments on the percentage of tannines of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	6.40	6.40	6.40	6.40	6.40	6.40	6.40 a
10	5.49	5.60	6.15	3.60	3.80	3.80	4.74 b
20	5.30	5.50	5.53	3.13	3.80	3.76	4.50 b
30	5.20	4.80	5.02	2.90	2.87	3.30	4.01 c
40	3.50	2.60	2.63	2.70	2.65	3.01	2.85 d
50	2.40	2.53	2.53	2.50	2.60	2.17	2.46 d
Average	4.72 a	4.57 a	4.71 a	3.54 b	3.69 b	3.74 b	
L.S.D		Treatments		Storage period		Interaction	
0.05		0.492		0.463		1.180	
0.01		0.690		0.616		1.614	

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

Table (16): Effect of various treatments on the percentages of tannines of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	6.15	6.15	6.15	6.15	6.15	6.15	6.15 a
10	5.57	5.65	4.17	4.93	3.33	4.13	4.63 b
20	5.10	5.28	3.80	4.00	3.10	3.78	4.18 c
30	4.47	4.43	3.43	3.80	3.10	3.20	3.74 d
40	3.85	2.80	3.11	3.17	2.95	3.04	3.15 e
50	2.70	2.60	3.00	2.27	2.90	2.23	2.62 f
Average	4.64 a	4.49 ab	3.94 c	4.05 bc	3.59 c	3.76 c	
L.S.D		Treatments		Storage period		Interaction	
0.05		0.490		0.423		1.094	
0.01		0.686		0.563		1.497	

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

The data indicated that, in the first season, as an average for all storage periods, the treatments 60°C for 10 min, 55°C for 20 min and 50°C 30 min, on one side gave significantly higher percentages of tannines than those of 45°C for 40 min; 40°C for 50 min and control, on the other. The differences

among each side were insignificant. In the second season, the same trend almost found with two exception, first the differences were insignificant between tannines percentage of fruits heated at 55°C for 20 min and those heated at 45°C for 40 min, second, the differences were insignificant among the treatments 50°C for 30 min;45°C for 40 min;40°C for 50 min and control.

D. Titratable acidity

The data illustrated in Tables (17and18) indicated that, as an average for all treatments, the initial malic acid percentages decreased from 0.82 to 0.32% and from 0.63 to 0.38% in 1997 and 1998, respectively, at the end of storage period (50 days). There may be connection between the inhanced respiration with the progress of storage period and decrease in titratable acidity.

Table (17): Effect of various treatments on percent malic acid of Chocolate kaki fruits during cold storage in 1997.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	0.82	0.82	0.82	0.82	0.82	0.82	0.82 a
10	0.74	0.69	0.78	0.71	0.63	0.67	0.70 b
20	0.85	0.74	0.74	0.87	0.82	0.82	0.81 a
30	0.74	0.70	0.68	0.74	0.75	0.76	0.73 ab
40	0.60	0.48	0.52	0.26	0.27	0.28	0.40 c
50	0.33	0.31	0.40	0.31	0.37	0.22	0.32 c
Average	0.68	0.62	0.66	0.62	0.61	0.60	
L.S.D		Treatments		Storage period		Interaction	
0.05		NS		0.099		NS	
0.01				0.132			

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

Table (18): Effect of various treatments on percent malic acid of Chocolate kaki fruits during cold storage in 1998.

Days in storage	Treatments						
	60°C for 10 min	55°C for 20 min	50°C for 30 min	45°C for 40 min	40°C for 50 min	Control	Average
0	0.63	0.63	0.63	0.63	0.63	0.63	0.63 c
10	0.72	0.71	0.75	0.71	0.69	0.69	0.71 ab
20	0.74	0.76	0.81	0.67	0.70	0.75	0.74 a
30	0.71	0.73	0.74	0.65	0.67	0.68	0.70 b
40	0.49	0.47	0.49	0.29	0.30	0.18	0.37 d
50	0.31	0.32	0.45	0.37	0.54	0.27	0.38 d
Average	0.60 ab	0.60 ab	0.64 a	0.56 bc	0.59 b	0.53 c	
L.S.D		Treatments		Storage period		Interaction	
0.05		0.048		0.035		0.094	
0.01		0.068		0.047		0.129	

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

Acidity reflects the level of organic acid in fruit tissues, partticularly malic acid. These acids are the substrate for respiratory cycle and enhanced respiration would lead to decrease in their levels. Similary, McGuire (1991b) on grapefruits; Schirra and Mulas (1995) on "Di Massa" lemons and Woolf *et al.* (1997) on Fuyu persimmon. They all recorded a reduction in titratable acidity during storage the fruits after prestorage heat treatments. On the contrary, Moura *et al.* (1997b) noticed that there was an increase in titratable acidity of Taubate persimmon throughout the storage period.

In the first season, as an average for all storage periods, hot water treatment had no significant effect on malic acid content. These results were in a completely agreement with those previously reported by El-Zayat (1996) on prunes; Schirra *et al.* (1997) on oranges; Borthakur and Ranjit (1998) on lemons and Tayel (2001) on peaches. They all emphasized that acidity was not significantly influenced by hot water dip treatments. Besides, Kluge *et al.* (1996) concluded that intermittent warming had no effect on total titratable acidity of peach fruits. In the second season, the data showed that heated fruits had significantly higher percentages of malic acid than untreated ones, except those at 45°C for 40 min. These findings were in line with those found by El-Zayat (1996). He noticed that acidity percentages of UV treated prunes were higher than control (but not significantly, especially for medium and high dose of UV). However, Obenland *et al.* (1999) emphasized that minor differences in acidity between heat treated and untreated control nectarines fruits were detected.

CONCLUSION

Heat treatment through hot water dips (60°C for 10 min; 55°C for 20 min; 50°C for 30 min; 45°C for 40 min and 40°C for 50 min) had no great effect on physical and chemical changes of Chocolate persimmons during cold storage.

- The best treatment in reducing decay was at 40°C for 50 min, whereas the best one in reducing chilling injury was at 55°C for 20 min. The least decay and the highest chilling injury occurred at 40°C for 50 min. However, there were no significant differences among the unmarketable fruits of all treatments.
- More effort should be paid for improving storability of persimmon fruits by using other temperatures and durations of hot dip treatments.

REFERENCES

Abd El-Hafez, A.E.A.E. (1992). Physiological studies on the handling and storage of persimmon fruits. M.SC. Thesis, Fac. Agric. Al-Azhar University, Cairo, Egypt.

Aly, E.Z., A.M. El-Siginy and M.A. Naiema (2000). Effect of some foliar fertilization on persimmon yield, fruit quality and behaviour during storage. Minufiya J. Agric. Res. 25(5): 1299-1311.

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

Artes, F., A. Escriche and J.G. Marin (1993). Treating Primofiori lemons in cold storage with intermittent warming and carbon dioxide. Hort. Sci., 28(8): 819-821.

Ashraf, M., N. Khan, M. Ahmed and M. Elahi (1981). Studies on the pectinesterase activity and some chemical constituents of some Pakistani mang varieties during storage ripening Jour. Agric. Food Chem. 29: 526-528.

Borthakur, P.K. and K. Ranjit (1998). Effect of postharvest treatments on few biochemical constituents of Baramasi lemon fruits during storage. Journal of the Agricultral Science Society of North East India. 11(2): 193-196. (Hort. Abst. 69(10): 9053).

Burmeister, D.M., S. Ball, S. Green And A.B. Woolf (1997). Interaction of hot water treatments and controlled atmosphere storage on quality of "Fuyu" persimmons. Postharvest Biology and Technology. 12(1): 71-78.

Deshpande, P.B. and D.K. Salunkhe (1964). Effects of maturity and storage on certain biochemical changes in apricots and peaches. Food. Tech. 18(18): 85-88.

El-Helaly, A.A.E. (1984). Delay of postharvest ripening of Alphonse and Hindy mango fruits. M. Sc. Thesis Coll. Agric. Univ. Alex.

El-Zayat, H.E. (1996). Effects of some antidecay treatments on peaches and plums quality after cold storage. J. Agric. Sci. Mansoura Univ. 21(8): 2935-2945.

El-Zorkani, A.S. (1968). A preliminary report on vitamin C, sugars, pectin and acid contents of guava (*Psidium guava*). Agric. Res. Rev., Cairo. 46(3): 107-126.

Forbus JR, W.R., J.A. Payne and S.D. Senter (1991). Nondestructive evaluation of Japanese persimmon maturity by delayed light emission. Journal of Food Science. 56(4): 985-988.

Gonzalez-Aguilar, G.A., L. Zacarias., M. Mulas and M.T.Lafuente (1997). Temperature and duration of water dips influence chilling injury, decay and polyamine content in "Fortune" mandarins. Posharvest Biology and Technology. 12(1): 61-69.

Hillis, W.E. and T. Swain (1959). The phenolic contituents of *Prunus domestica*. II. The analysis of tissue of the Victoria plum tree. J. Sci. Fd. Agric. 10: 135-144.

Homnava, A., J. Payne, P. Koehler and R. Eitenmiller (1990). Provitamin A (a-carotene, B-carotene and B-eryptozanthin) and ascorbic acid content of Japanese and American persimmons. J. Food Qual. 13: 85.

Huang-Wanrong, Bai-Jinyum and Han-Tao (1993). Effect of temporary heat treatment on the storage behaviour of "Okuba" peach fruits. Journal of Fruit Science. 10(2): 73-76.

Irving, D.E., J.C. Pallesen and L.H. Cheah (1991). Respiration and ethylene production in kiwi fruit following hot water dips. Postharvest Biol. Technol. 1: 137-142.

Izumi, H., T. Ito and Y. Yoshida (1990). Changes in fruit quality of Satsuma mandarin during storage, after harvest from exterior and interior canopy of trees. Journal of the Japanese Society for Horticultural Science. 58(4): 885-893.

Kamal, H.A. and M. R.M. Rabeh (1989). Effect of cold storage temperature on storability and fruit quality of persimmon fruits. Bull. Fac. Agric. Univ. of Cairo. 40(2): 347-360.

Kawada, K. and H. Kitagawa (1986). Effects on juice composition of postharvest treatments for reducing acidity in citrus fruits. Technical Bulletin of the Faculty of Agriculture, Kagawa University. 38(1): 1-4. (Hort. Abst. 59(2): 1615).

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 Agropectuaria Brasileira. 31(8): 543-547. (Hort. Abst. 67(10): 8284).

Lay-Yee, M., S. Ball, S.K. Forbes and A.B-Woolf (1997). Hot water treatment for insect disinfestation and reduction of chilling injury of "Fuyu" persimmon. Postharvest Biology and Technology. 10(1): 81-87.

Lyon, B.G.,S.D. Senter and J.A. Payne (1992). Quality characteristics of oriental persimmons (*Diospyros Kaki L.* cv. Fuyu) grown in the southeastern United States. Journal of Food Science. 57(3): 693-695.

Makscud, M.A. (1981). Physiological studies on persimmon fruits. M.Sc. Thesis, Fac. Agric. Cairo Univ.

McGuire, R.G. (1991a). Concomitant decay reductions when mangoes are treated with heat to control infestations of Caribbean fruits flies. Plant Disease. 75(9): 946-949.

McGuire, R.G. (1991b). Market quality of grapefruit after heat quarantine treatments. Hort.Science.26(11):1393-1395.

McLauchlan, R.L., S.J. Underhill, J.M. Dahler and J.E. Giles (1997). Hot water dipping and low temperature storage of "Eureka" lemons.Australian Journal of Experimental Agriculture. 37(2): 249-252. (Hort Abst. 67(9): 8069).

Moura, M.A., L.C. Lopes, A.A. Cardoso and L.C.G. Miranda (1997a). Effect of wrapping and storage on ripening of persimmon. Pesquisa Agropecuaria Brasileira. 32(11): 1105-1109. (Hort. Abst. 68(8): 7174).

Moura, M.A., L.C. Lopes, L.C.G. Miranda and A.A. Cardoso (1997b). Effect of packing and storage at room temperature on ripening of persimmon (*Diospyros kaki L.*) cultivar Taubate. Revista Ceres. 44(252): 180-190.

Obenland, D.M., M.L. Arpain and L.H. Aung (1999). Quality of nectarine cultivars subjected to forced-air heat treatment for Mediterranean fruit fly disinfestation. Journal of Horticultural Science and Biotechnology. 74(5): 553-555.

Paull, R.E. (1990). Postharvest heat treatments and fruit ripening. Postharvest News and Information. 1(5): 355-363. (Hort. Abst. 61 (2): 933).

Ruth Ben, A. and Y. Zutkhi (1992). Extending the storage life of Fuyu persimmon by modified-atmosphere packaging. Hort Science 27(7): 811-813.

Schirra, M. and M. Mulas (1995). Influence of postharvest hot water dip and imazalil fungicide treatments on cold-stored "Di Massa" lemons. Advances in Horticultural Science. 9(1)43-46.

Schirra, M., M. Agabbio, G. D'Hallewin, M. Pala and R. Ruggiu (1997). Response of Tarocco oranges to picking date, postharvest hot water

dips and chilling storage temperature. Journal of Agricultural and Food Chemistry. 45(8): 3216-3220.

Seo, P.Y. and K.S. Rye (2002). Effects of prestorage conditioning and hot water dip on fruit quality of non-astringent "Fuyu" persimmons during cold storage. Journal of the Korean Society for Horticultural Science. 43(1): 58-63.

Shaybany, B., I. Rouhani and H. Azarakhsh (1978). Effect of storage temperature and container type on storage and shelf life of persimmon fruits. Iranian Journal of Agric. Res. 6(2): 123-127.

Shin, S.R., K.D. Moon, K.H. Lee and K.S. Kim (1993). Changes in the enzyme activities, pectins and structure of persimmon fruit during softening. Journal of the Korean Society of food and Nutrition. 22(5): 611-616.

Sivakov, L., V. Petrovska, D. Georgiev and N. Vesova (1992). Changes in the chemical composition and transpiration of persimmon during storage. Godisen Zbornik na Zemjodelskiot Fakultet na Univerzitetot vo Skopje. 37: 103-111. (Hort. Abst. 64(6): 5000).

Snedecor, G.W. and W.G. Cochran (1971). Statistical methods. 6th Ed., Fourth Priniting the Iowa State Univ. Press Ames., Iowa USA. 1-593.

Tanaka, T.,R. Takahashi, I. Kounol and G. Nonaka (1994). Chemical evidence for the de-astringency (insolubilization of tanmines) of persimmon fruit. Journal of the Chemical Society, Perkin Transactions. 1(20): 3013-3022.

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, Alexandria University, Alexandria, Egypt.

Teitel, D.C., Y. Aharoni, and R. Barkai-Golan (1989). The use of heat treatments on extend the shelf life of "Galia" melons. Journal of Horticultural Science. 64(3): 367-372.

Terglazova, N.V. (1988). Changes in the composition of persimmon fruit during storage. Subtropicheskie Kultury. 3: 128-131. (Hort.Abst. 59(2): 1635).

Tian, J.W., M.X. Xu and P.C. He (1991). Study on the physiology of pastharvest softening of Diospyros kaki fruits. Plant Physiology Communications. 2: 109-111.

Turk, R. (1993). The cold storage of persimmons (*Diospyros kaki* cv. Fuyo) harvested at different maturities and the effect of different CO_2 applications on fruit ripening. Acta Horticulurae. 343: 190-194.

Ueno, H. and M. Ishisaki (1963). Black spot on "Fuyu" persimmon. Research Report of Hwagayamaker. Fruit Tree Research Station. 137-140.

Woolf, A.B., S. Ball, K.J. Spooner, M. Lay-Yee, I.B. Ferguson, C.B. Watkins, A. Gunson and S.K. Forbes (1997). Reduction of chilling injury in the sweet persimmon Fuyu during storage by dry air heat treatments. Postharvest Biology and Technology. 11(3): 155-164.

Yamamura, H., H. Bessho and R. Naito (1984). Occurrence of black stain on fruit skin (black spots) in relation to growth and development of pericarp tissues in Japanese perisimmon. J. Japan. Soc. Hort. Sci. 53(2): 115-120.

Yonemori, K. and J. Matsushima (1987). Changes in tannin cell morphology with growth and development of Japanese persimmon fruit. J. Amer. Soc. Hort. Sci. 112(5): 818-821.

تأثير معاملات الماء الساخن على خفض اضرار البرودة و العفن و المحافظة على جودة ثمار كاكى شكولات الغير قابضة أثناء التخزين بالتبريد

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أجريت هذه الدراسة خلال موسمى ١٩٩٧، ١٩٩٨ على ثمار الكاكى صنف شكولات لدراسة تأثير بعض المعاملات الحرارية (غمس الثمار فى ماء ساخن درجة حرارته ٦٠°م لمدة ١٠ق، ٥٥°م لمدة ٢٠ق، ٥٠°م لمدة ٣٠ق، ٤٥°م لمدة ٤٠ق أو ٤٠°م لمدة ٥٠ق)، هذا بالأضافة لمعاملة المقارنة غمس الثمار فى ماء الصنبور (٢٠°م لمدة ٣٠ق) على خفض أضرار البرودة و العفن و ا لمحافظة على جودة الثمار أثناء التخزين بالتبريد (صفر°م ورطوبة نسبية ٨٥-٩٠%) وأظهرت النتائج الآتى:

١- أستمرت الثمار سواء المعاملة حرارياً أو المقارنة ٥٠ يوم فى التخزين.
٢- ظهرت الثمار الغير قابلة التسويق للمرة الأولى عند نهاية فترة التخزين.
٣- بتقدم فترة التخزين زاد الفقد فى الوزن بينما قلت الصلابة والنسبة المئوية للتانينات وكذلك الحموضة. ارتفع محتوى الثمار من فيتامين C ، المواد الصلبة الذائبة عند بداية فترة التخزين ثم انخفضت النسبة المئوية للمواد الصلبة الذائبة بينما اتجهت قيم فيتامين C للثبات ثم زادت.
٤- لم يكن هناك تأثير معنوى للمعاملة بالماء الساخن على فقد الوزن أو الصلابة بينما لوحظت تأثيرات طفيفة على النسبة المئوية للمواد الصلبة الذائبة والحموضةوالتانينات وكذتك قيم فيتامين C.
٥- -أظهرت معاملة الماء الساخن عند ٤٠°م لمدة ٥٠ق أقل نسبة مئوية للثمار المصابة بالأعفان وأعلى نسبة مئوية لتلك المصابة بأضرار البرودة.
٦- أفضل المعاملات فى خفض عفن الثمار كانت عند ٤٠ °م لمدة ٥٠ ق. و بالنسبة لخفض اضرار البرودة كانت عند ٥٥°م لمدة ٢٠ ق. و عموما كانت الفروق غير معنوية بين النسب المئوية للثمار الغير قابلة للتسويق لكل المعاملات.