EFFECT OF SOME POSTHARVEST TREATMENTS ON IMPROVING QUALITY AND STORABILITY OF PERSIMMON FRUITS DURING COLD STORAGE

GEHAN A.M. EL-HADIDY[1] and ESHAK M. EL-HADIDY [2]

1. *Fruit Handling Res. Dept., Hort. Res. Institute, ARC, Giza-Egypt.*
2. *Hort. Crops Technol. Res. Dept., Food Technol. Res. Institute, ARC, Giza-Egypt.*

(Manuscript received 16 May 2018)

Abstract

Persimmon is an important seasonal fruit which often exhibits rapid softening during postharvest distribution, handling or sometimes on the trees. Storage treatments and packaging types are critical points on degradative pathways of bioactive components reflected to fresh fruits quality properties. The present investigation was conducted during two successive seasons (2015 and 2016) on persimmon (*Diospyros kaki* L.) fruits c.v. "Costata". Fruits were harvested at maturity orange color and were divided into two groups, the first group was dipped in hot water at 50°C for 10, 20 and 30 min., while the The second one was dipped in edible coating film consists of (10g maltodextrin, 5g methyl cellulose, 8ml glycerol, 2.5g ascorbic acid, 1g potassium sorbate and 1g calcium chloride/ distilled water liter) for 10, 20 and 30 min., in addition to the untreated fruits (as control). Fruits of all treatments were stored at 4±1°C and 90% relative humidity (RH) in polyethylene terephthalate (PET) punnets for 8 weeks. The changes in physical and chemical properties of fruits were evaluated as fruits color, weight loss, firmness, total soluble solids (TSS) and titratable acidity percentage also antioxidant components (total phenols, total tannins, flavonoids, ascorbic acid and carotenoids) were studied during storage period every two weeks. The obtained results illustrated that all fruits had storage life eight weeks at cold storage 4±1°C and 90% relative humidity (RH)**,** fruits treated with edible coated film for 30 mins. have gained best quality in comparison with other treatments its. Since, it's observed delayed in increasing total soluble solids percentage, reduced titratable acidity percentage and fruits firmness. On the other hand, the decrement of antioxidant contents including ascorbic acid, total phenols, flavonoids, were higher in persimmon fruits treated with hot water and control. Therefore, some postharvest treatments such as hot water or edible coating film to improve fruits sensorial quality through reducing the astringency and bitterness components in persimmon.

Keywords: Persimmon, Postharvest treatments, Edible coating film, Hot water, Cold storage, Storability and fruit quality.

INTRODUCTION

Persimmon is considered good source for β-carotene, potassium and vitamin C (Yakushiji and Nakatsuka, 2007). Persimmons are considered good source of readily

available carbohydrates and high content of bioactive compounds, such as tannins, polyphenols, steroids, dietary organic acids, minerals and carotenoids, which contribute to the high antioxidant potential of these fruits. Persimmon phenols being mainly responsible for the antioxidant effect of this fruit (Gorinstein *et al*., 2011).

Persimmon is an important seasonal fruit often exhibits rapid softening during postharvest distribution, handling or sometimes on the trees. This is a major problem in the marketing of persimmon (Pang *et al*., 2007).

Preliminary results for the cultivar Karaj fruits treated with hot water at 50°C for 10 min, 20 min and 30 min indicated that postharvest quality was maintained during storage for up to 2 months (Khademi *et al*., 2012). Heat treatments have been shown to inhibit fruit ripening and improve postharvest quality of fresh fruits. Thus, heat treatments have potential for the commercial control of ripening of postharvest persimmon fruits (Luo, 2006). El-Oraby *et al*., (2005), found that, hot water treatments accelerated peel and pulp color of Mesk and Mabroka mango fruits.

Many edible coatings materials have added advantage of providing a moisture barrier that reduces dehydration in the fruits during storage. Many studies have been conducted demonstrating that edible coatings can be used as a less costly modified atmosphere package to provide some control of ripening and lengthening of storage life (Rojas-Crau *et al*., 2009). The use of polysaccharide and protein based coating materials on several types of fruits has been developed in last few years, particularly, sucrose, fatty acids and esters (on bananas) and cellulose (on mango). The use of polysaccharide-based edible coating increased the water vapor resistance and reduced ethylene production of coated fresh cut pear (Oms-Oliu *et al*., 2008).

Edible film coatings are applied on many products to control moisture transfer, gas exchange or oxidation processes. One major advantage of using edible films and coatings is that several active ingredients can be incorporated into the polymer matrix and consumed with the food, thus enhancing safety or even nutritional and sensory attributes. Rojas-Crau *et al*., (2009) discussed the use of edible coatings as carriers of functional ingredients on fresh-cut fruits, including the recent advances in the incorporation of antimicrobials, antibrownings, texture enhancers and nutraceuticals to improve quality and functionality of fresh-cut fruits.

Thus, the aim of this investigation is to study the effect of some postharvest treatments such as hot water or edible coating film to improve fruit eating quality through reducing the astringency and bitterness components in persimmon and it effect on storability**.**

MATERIALS AND METHODS

Preparation of materials:

The present investigation was conducted during (2015 and 2016) on persimmon (*Diospyros kaki* L.) fruits cv. "Costata". Fruits which were harvested at maturity orange color stage from a private farm located at Cairo-Alex. dessert road, Egypt. The fruits were selected with the uniformity in shape, size and free from defects. Fruits were divided into two groups, the first group was dipped in hot water (HW) 50°C for10, 20 and 30 min., respectively. While, the second one is dipped in film consist of 10 g maltodextrin, 5g methyl cellulose, 8 ml glycerol, 2.5g ascorbic acid, 1g potassium sorbate and 1g calcium chloride were dissolved in one liter distilled water, for 10, 20 and 30 min., in addition to the untreated fruits (control). All fruits were packed in PET (poylethelene terephalate) punnets, each one contains six fruits. Every treatment consists of nine punnets. All treatments were stored at 4±1°C and 90% relative humidity (RH). The changes in physical and chemical properties of fruits were evaluated every two weeks, till the end of storage period (8 weeks).

Measurements:

Weight loss percentage: Fruits were periodically weighed and the percentage of weight loss was calculated by the difference between the initial weight and that recorded on sampling date.

Color: Hue angle was estimated using Minolta calorimeter (Minolta co. Ltd., Osaka, Japan) as described by Mc Gire, (1992).

Firmness (g/cm^2): Bramlage (1983) determined Pulp firmness by using fruit pressure tester as g/cm^2.

Total soluble solids (TSS): Abbe refractometer was used to determine the percentage of total soluble solids in fruit juice according to AOAC (2010).

Titratable acidity (%): Total acidity was determined by titrating 5 ml of the extracted juice against 0.1 N of NaOH using phenolphthalein indicator, titratable acidity was expressed as percentage of malic acid (g malic acid/100ml) according to AOAC (2010).

Bioactive components: Total phenolic content was determined by the Folin-Ciocalteau method of Slinkard and Singleton, (1997). The extracted samples were mixed with Folin-Ciocalteau reagent for 6 min, then 7% sodium carbonate ($NaCO_3$) was added. The absorbance was measured at 760 nm after 90 min of incubation at room temperature. Results were expressed as mg gallic acid equivalents (GAE) per 100 g sample. Content Total tannins content (mg/100g) was evaluated according to

the method of Taira (1995). While, total flavonoids were determined using the method of Ordonez *et al*. (2006). Briefly, 0.5 ml of sample, 0.5 ml of 2% $AlCl_3$ and methanol solution was added. After 1 h at room temperature, the absorbance was measured at 420 nm. Total flavonoids content was calculated as quercetin equivalent from a calibration curve and expressed as quercetin equivalents (QE) per 100g. Ascorbic acid (vitamin C) mg/100 g) was determined of according to A.O.A.C. (1990). Also, carotenoids as β-carotene (mg/100 g) were extracted according to Moore *et al*. (2005).

Statistical analysis: The complete randomized design was adopted and the obtained data were statistically analyzed as factorial experimental design according to Sendecor and Cochran (1980). Means were compared by LSD (least significant differences) multiple range tests at the level of 5% probability with the procedure of MSTAT-C Program.

RESULTS AND DISCUSSION

Weight loss percentage:

Data in Table (1) showed the effect of edible coating film and hot water treatments on weight loss percentage of persimmon' Costata' cv. fruits during 2015 and 2016 seasons. Weight loss percentage was gradually increased by increasing the storage periods with significant differences among all storage periods in both seasons. All treatments reduced weight loss% than control fruits, with significant difference between them in the two seasons. Control fruits had the highest values of weight loss followed by fruits treated with hot water after 8 weeks in the two seasons.

Also, edible coating film treatments were better than hot water treatments in different dipping time. Fruits treated with edible coating film at for 30 mins recorded the lowest significantly values of weight loss compared with other treatments and control during the first season. The differences between dipping times in the first season none significantly and slight difference in the second season this may be due to fruits.

The weight loss attributed mainly to water loss from the fruit tissues and partially for the respiration. The results of effect of hot water on fruit weight loss are in agreement with those reported by Tiwari *et al*., (2008) and Naglaa and Fatma (2016) on persimmon fruits. According to Ayranci and Tunc, (2003) and Abbas *et al*., (2011), the coating film reduces this action because it forms a film on the top of skin as an additional barrier to moisture loss.

Table 1. Effect of some postharvest treatments on weight loss (%) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

	Storage period (weeks)/ Season 2015						Storage period (weeks)/ Season 2016					
Treatments	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***
Control	0.00	1.92	2.97	3.02	3.18	**2.21**	0.00	1.90	2.53	3.02	3.39	**2.17**
(T) 10 min	0.00	1.22	1.68	1.72	1.95	**1.31**	0.00	2.53	1.63	1.80	2.00	**1.60**
(T) 20 min	0.00	1.15	1.60	1.65	1.91	**1.26**	0.00	1.63	1.70	1.87	2.11	**1.46**
(T) 30 min	0.00	1.05	1.57	1.61	1.88	**1.22**	0.00	1.05	1.42	1.79	1.93	**1.24**
(HW) 10 min	0.00	2.15	2.65	2.84	3.05	**2.13**	0.00	1.69	2.32	2.92	3.14	**2.01**
(HW) 20 min	0.00	1.98	2.42	2.68	2.89	**1.99**	0.00	1.48	2.15	2.80	2.91	**1.87**
(HW) 30 min	0.00	1.73	1.95	2.22	2.77	**1.73**	0.00	1.13	1.99	2.44	2.78	**1.67**
Means B**	**0.00**	**1.74**	**2.12**	**2.24**	**2.51**		**0.00**	**1.60**	**1.96**	**2.37**	**2.60**	
LSD at 5% A= 0.0767 B= 0.06484 AXB= 0.1715							LSD at 5% A = 0.08013 B= 0.06772 AXB= 0.1792					

T= Coated Film Treatment HW=Hot Water
A* Means of storage period B Means of treatments AXB Interaction**

Firmness (g /cm^2):

As shown in Table (2) it was clearly observed that firmness decreased significantly with the progress of storage period during the two seasons. Fruits treated with edible film possessed the highest values of firmness after 8 weeks in comparison with other treatments .Control fruits had the Lowest values of firmness in comparison with edible film and hot water treatments. These results agreed with those reported by Rojas-Crau *et al.*, (2009). Who found that, edible coating can be used to control fruit ripening Yaman and Bayoindirli (2002) reported that hot water can affect fruit ripening by the retention of firmness which occurred during storage could be due to the retarded degradation of insoluble protopectins to the more soluble pectic acid and pectin during fruit ripening deploymerization or shortening of chain length of pectin substances.

Table 2. Effect of some postharvest treatments on firmness (g/cm^2) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***
Control	15.33	14.40	13.12	11.23	10.43	**12.88**	15.35	14.32	13.22	11.30	10.29	**12.90**
(T) 10 min	15.33	14.66	13.90	13.80	13.38	**14.12**	15.35	14.74	13.79	13.73	13.00	**14.12**
(T) 20 min	15.33	14.98	14.76	14.15	13.90	**14.63**	15.35	14.96	14.86	14.18	13.88	**14.65**
(T) 30 min	15.33	15.16	14.88	14.38	14.08	**14.76**	15.35	15.22	14.90	14.40	14.12	**14.79**
(HW) 10 min	15.33	14.20	13.54	12.97	12.70	**13.75**	15.35	14.15	13.40	12.89	12.63	**13.68**
(HW) 20 min	15.33	14.32	13.86	13.27	12.84	**13.92**	15.35	14.26	13.47	13.10	12.82	**13.80**
(HW) 30 min	15.33	14.56	13.90	13.28	13.05	**14.02**	15.35	14.64	13.88	13.30	13.07	**14.01**
Means B**	**15.33**	**17.05**	**16.32**	**15.51**	**15.06**		**15.35**	**17.05**	**16.25**	**15.48**	**14.97**	
LSD at 5% A = = 0.08 B= 0.07 AXB= 0.19							LSD at 5% A = 0.11 B= 0.09 AXB= 0.24					

T= Coated Film Treatment HW=Hot Water

A* Means of storage period B Means of treatments AXB Interaction**

Color changes (hue angle) during cold storage:

The data in Table (3) indicated that hue angle **(**h°) decreased (increase density of orange color) with the advance in cold storage periods especially at the end of storage periods. While, hot water at 50°C for 30 min treatment gave the lowest value of h° in the two seasons compared to coated film treatments. It means that, this treatment accelerate coloring. These results are in agreement with El-Oraby *et al.*, (2005). Who found that, hot water treatments accelerated peel and pulp color on mango. Also Tiwari *et al.*, (2008) who reported that the fruit color is one of the main attributes of persimmon fruits, which can determine the consumer acceptability and serving as an indicative of the harvest point of some fruits. Our results also agreed with Naglaa and Fatma (2016) on persimmon fruits, who found that, hue angle **(**h°) decreased (increase density of orange color) with the advance in cold storage periods. Fruits treated with edible film at 30 min recorded the highest value of h° after 8 weeks in the two seasons, in comparison with control and other studies treatments. That means, this treatment delay development of fruit color. This effect may be due to that edible coating can be used as modified atmosphere packing to provide some control of ripening (Baldwin, 2005).

Table 3. Effect of some postharvest treatments on color changes hue angle (h°) of Persimmon c.v. Costata fruits during cold storage (4 ±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*
Control	60.43	65.31	63.40	60.22	58.57	**61.59**	62.42	56.31	63.93	61.22	59.17	**60.61**
(T) 10 min	60.43	58.07	57.92	56.88	56.25	**57.91**	62.42	58.35	57.52	56.38	56.25	**58.18**
(T)20 min	60.43	59.97	58.86	57.40	56.75	**58.68**	62.42	59.19	58.36	57.60	56.75	**58.86**
(T) 30 min	60.43	62.43	64.01	64.72	64.97	**63.31**	62.42	62.23	63.98	64.29	64.97	**63.58**
(HW) 10 min	60.43	61.17	61.17	58.32	58.57	**59.93**	62.42	61.17	60.72	59.17	58.00	**60.30**
(HW) 20 min	60.43	59.28	59.28	57.33	57.18	**58.70**	62.42	59.28	58.89	56.25	56.80	**58.73**
(HW) 30 min	60.43	57.50	57.50	55.23	55.00	**57.13**	62.42	57.50	56.75	56.75	54.22	**57.53**
Means B**	**60.43**	**60.53**	**60.31**	**58.59**	**58.18**		**62.42**	**59.15**	**60.02**	**58.81**	**58.02**	
LSD at 5% A= 1.69 B =1.43 AXB =3.78							LSD at 5% A = 2.04 B= 1.72 AXB= 4.55					

T= Coated Film Treatment HW=Hot Water

A* Means of storage period B Means of treatments AXB Interaction**

Total soluble solids percentage:

Data in Table (4) showed that, total soluble solid (TSS %) of fruits increased gradually with the advance of cold storage with significant differences between storage periods during the two seasons and all treatments. The highest values of TSS were recorded in control fruits during the two seasons, in comparison with all treatments. The rate of increase was slow in treated fruits. The increase in TSS% content of the control fruits over the storage duration than other treatments might be due to accelerate the ripening process and losses the water content (Khan *et al.*, 2016). Using hot water and edible film in fruits reduced softness and water loss from fruits (Naglaa and Fatma, 2016). The prolonged storage might lead to the softening of the cell walls and membranes (Omaima *et al.*, 2017).

Table 4. Effect of some postharvest treatments on TSS (%) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks) / Season 2016					
Treatments	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*	Initial time	2weeks	4weekss	6weeks	8weeks	Means A*
Control	19.85	20.12	20.62	21.24	22.01	**20.77**	19.61	19.89	20.22	21.00	21.80	**20.50**
(T) 10 min	19.85	20.05	20.35	20.71	20.94	**20.38**	19.61	19.82	20.02	20.18	20.76	**20.08**
(T) 20 min	19.85	20.50	20.98	21.14	21.32	**20.76**	19.61	20.15	20.65	20.95	21.29	**20.53**
(T) 30 min	19.85	20.93	21.25	21.30	21.47	**20.96**	19.61	20.53	20.70	21.20	21.85	**20.78**
(HW) 10 min	19.85	19.82	20.18	20.23	20.86	**20.19**	19.61	19.82	20.02	20.18	20.76	**20.08**
(HW) 20 min	19.85	20.15	20.88	21.28	21.42	**20.72**	19.61	20.15	20.65	20.95	21.29	**20.53**
(HW) 30 min	19.85	20.53	20.97	21.20	21.96	**20.90**	19.61	20.53	20.70	21.20	21.85	**20.78**
Means B**	**19.85**	**20.30**	**20.75**	**21.01**	**21.43**		**19.61**	**20.13**	**20.42**	**20.81**	**21.37**	
LSD at 5% A = 0.04 B= 0.03 AXB= 0.08							LSD at 5% A = 0.08 B= 0.07 AXB= 0.19					

T= Coated Film Treatment HW=Hot Water

A* Means of storage period B Means of treatments AXB Interaction**

Titratable acidity percentage during cold storage:

The titratable acidity (TA%) values decreased significantly along with increasing storage time in both treated and untreated fruits in both seasons (Table 5). Changes in TA % values with prolonging of storage differed between storage periods which could be due to the increase its consumption in respiration activities**.** The least TA % was recorded by using hot water at 50°C for 30 mins treatment in both seasons. Our results agree with Tiwari *et al*., (2008) and Naglaa and Fatma, (2016). They found that, the least values of (TA %) values was recorded in persimmon treated with hot water and acetaldehyde**.** Who reported that, fruits treated with edible film for 10 mins had the highest values of (TA %) values at the end of storage period (8 weeks). Also, these results could be supported by Omaima *et al*., (2017) they found that TA content (%) of Costata persimmon exhibited reduction dependence on ripening stage and treatments.

Table 5. Effect of some postharvest treatments on Titratable acidity (%) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*
Control	0.246	0.230	0.224	0.218	0.216	**0.227**	0.240	0.231	0.223	0.215	0.209	**0.224**
(T) 10 min	0.246	0.213	0.215	0.210	0.222	**0.221**	0.240	0.211	0.215	0.211	0.220	**0.219**
(T) 20 min	0.246	0.198	0.195	0.193	0.190	**0.204**	0.240	0.194	0.188	0.195	0.183	**0.200**
(T) 30 min	0.246	0.193	0.189	0.185	0.182	**0.199**	0.240	0.190	0.180	0.183	0.172	**0.193**
(HW) 10 min	0.246	0.186	0.180	0.173	0.171	**0.191**	0.240	0.185	0.173	0.170	0.166	**0.187**
(HW) 20 min	0.246	0.183	0.176	0.170	0.168	**0.189**	0.240	0.180	0.170	0.163	0.160	**0.183**
(HW) 30 min	0.246	0.175	0.169	0.162	0.158	**0.182**	0.240	0.171	0.162	0.154	0.149	**0.175**
Means B**	**0.246**	**0.197**	**0.193**	**0.187**	**0.187**		**0.240**	**0.195**	**0.187**	**0.184**	**0.180**	
LSD at 5% A = 0.006 B= 0.005 AXB= 0.013 LSD at 5% A 0.005 B= 0.004 AXB= 0.011												

T= Coated Film Treatment HW=Hot Water

A* Means of storage period B Means of treatments AXB Interaction**

Changes in bioactive components in costata during cold storage:

Total phenols changes during cold storage:

Tables (6) concerning that, total phenols were high at the Initial of storage in all treatments and control, during the storage periods and at the end of storage all

treatments showed significant decreased during the two seasons, this may be due to control repining by edible coated film. These results) are in agreement with Sahar *et al.*, (2017) who attributed that the decrease of phenolic content to the oxidation by poly phenol oxidation processes.

Table 6. Effect of some postharvest treatments on total phenols (mg/100g fresh weight) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***
Control	905.43	883.25	870.20	737.44	643.05	**807.87**	890.30	875.43	862.97	728.50	683.05	**808.05**
(T) 10 min	905.43	867.29	853.73	840.25	825.20	**858.38**	890.30	860.50	848.80	832.28	825.20	**851.42**
(T) 20 min	905.43	842.55	825.32	825.22	799.23	**839.55**	890.30	833.48	821.85	810.82	799.23	**831.14**
(T) 30 min	905.43	820.23	799.20	785.30	776.32	**817.30**	890.30	809.00	787.51	771.00	776.32	**806.83**
(HW) 10min	905.43	784.64	762.00	754.24	733.89	**788.04**	890.30	780.69	752.63	738.63	733.89	**779.23**
(HW)20 min	905.43	733.60	710.30	699.51	682.33	**746.23**	890.30	768.71	730.99	689.50	682.33	**752.37**
(HW) 30min	905.43	709.25	685.27	672.08	649.25	**724.26**	890.30	727.39	704.70	662.47	649.25	**726.82**
Means B**	**905.43**	**805.83**	**786.57**	**759.15**	**729.90**		**890.30**	**807.89**	**787.06**	**747.60**	**735.61**	
LSD at 5% A = 18.54 B= 15.67 AXB= 41.46							LSD at 5% A = 20.16 B= 17.04 AXB= 45.08					

T= Coated Film Treatment HW=Hot Water

A* Means of storage period BMeans of treatments AXB Interaction**

Total tannins changes during cold storage:

Table (7) indicated that, total tannins were high at the Initial of storage in all treatments and control, during the storage periods and at the end of storage all treatments showed significant decreased. Fruits treated with edible coating film for 30 min least tannins followed by hot water for 30 min at the end of storage (in comparison of control fruits which had the highest significant values of tannins (major source of astringency. The data of total tannins in these results are in agreement with Osman (2017) on Costata persimmon fruits, who reported that, total tannins content was decreased gradually with the progress in storage periods. The beneficial of treatments with edible coated film may be due to increase in CO_2 concentration around the fruits which reduced the soluble tannins (Del Bubba *et al.*, 2009).

Table 7. Effect of some postharvest treatments on total tannins content (mg/100g fresh weight) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***
Control	118.20	116.68	115.20	112.42	110.68	**114.64**	119.51	117.23	115.32	112.42	107.54	**114.40**
(T) 10 min	118.20	94.50	90.24	87.83	82.70	**94.69**	119.51	94.55	93.20	88.74	83.73	**95.95**
(T)20 min	118.20	85.43	81.62	75.51	72.68	**86.69**	119.51	83.17	82.81	76.54	72.47	**86.90**
(T) 30 min	118.20	68.40	62.49	59.40	55.47	**72.79**	119.51	78.00	73.52	69.44	62.07	**80.51**
(W) 10 min	118.20	104.02	98.23	96.67	94.23	**102.27**	119.51	106.82	99.37	96.67	94.83	**103.44**
(W) 20 min	118.20	95.44	91.23	88.42	83.80	**95.42**	119.51	100.85	95.20	88.42	88.83	**98.56**
(W) 30 min	118.20	83.25	81.29	78.55	74.29	**87.12**	119.51	89.86	90.81	78.55	76.20	**90.99**
Means B**	**118.20**	**92.53**	**88.61**	**85.54**	**81.98**		**119.51**	**95.78**	**92.89**	**87.25**	**83.67**	
LSD at 5% A = 12.33 B= 10.42 AXB= 27.57							LSD at 5% A = 10.85 B=9.17 AXB= 24.26					

T= Coated Film Treatment HW=Hot Water

A* Means of storage period BMeans of treatments AXB Interaction**

Total flavonoids changes during cold storage:

In Table (8) data indicated that, total flavonoids were high at the Initial of storage in all treatments and control, during the storage periods and at the end of storage all treatments showed significant decreased. The highest total flavonoids content was obtained in fruits treated with edible film for 10 mins at the end of storage periods, while the least contents were recorded in fruits treated with hot water for 30 mins followed by the control fruits with significant differences in the two seasons. As certain flavanones are known to mask bitter taste sensorial, flavanones might act as bitter receptor antagonists (Roland *et al*., 2015). The data in Table (8) concerning total flavonoids could be supported by Denev and Yordanov, (2013), they found that flavonoids represent just a very small part of the total polyphenol in persimmon and it decreased after harvest stage and during storage.

Table 8. Effect of some postharvest treatments on Total flavonoids (mg/100g fresh weight) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***	**Initial time**	**2weeks**	**4weeks**	**6weeks**	**8weeks**	**Means A***
Control	4.03	3.65	3.00	2.54	2.11	**3.07**	4.21	3.85	3.59	3.14	2.93	**3.54**
(T) 10 min	4.03	3.80	3.73	3.70	3.66	**3.78**	4.21	3.77	3.68	3.61	3.56	**3.77**
(T)20 min	4.03	3.69	3.62	3.59	3.53	**3.69**	4.21	3.62	3.56	3.55	3.23	**3.63**
(T)30 min	4.03	3.44	3.40	3.38	3.31	**3.51**	4.21	3.40	3.32	3.26	3.01	**3.44**
(HW) 10 min	4.03	3.53	3.44	3.38	3.19	**3.51**	4.21	3.75	3.53	3.42	3.42	**3.67**
(HW) 20 min	4.03	3.40	3.32	3.10	2.88	**3.35**	4.21	3.50	3.42	3.35	3.24	**3.54**
(HW) 30 min	4.03	2.72	2.54	2.20	1.90	**2.68**	4.21	2.73	2.70	2.58	2.40	**2.92**
Means B**	**4.03**	**3.46**	**3.29**	**3.13**	**2.94**		**4.21**	**3.52**	**3.40**	**3.27**	**3.11**	
LSD at 5% A = 0.07 B= 0.06 AXB= 0.16 LSD at 5% A = 0.09 B= 0.08 AXB= 0.21												

T= Coated Film Treatment HW=Hot Water
A* Means of storage period BMeans of treatments AXB Interaction**

Ascorbic acid content changes during cold storage:

Data in Table (9) indicated that, ascorbic acid was high at the Initial of storage in all treatments and control, during the storage periods and at the end of storage all treatments showed significant decreased. The data indicated that, maximum ascorbic acid content was obtained in fruits treated with edible film for 10, 20 mins at the end of storage in the two seasons. While, the decrement of ascorbic acid content in hot water treatments was higher than edible coated film. The least contents were observed with hot water (30 mins) and control fruits with significant differences. The obtained results are in accordance with (Corrillo *et al.*, 2000). Who observed slower decrease in ascorbic acid in Haden mango coated with different concentration of Semper fresh as compared to non-coated fruits. These results are confirmed by those of Khan *et al.*, (2016) who observed that, during postharvest handling and storage the fruits can loss a significant amounts of antioxidants including ascorbic acid content.

Table 9. Effect of some postharvest treatments on ascorbic acid (mg/100g fresh weight) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*
Control	83.10	66.20	58.34	53.02	46.22	**61.38**	84.34	70.44	63.81	48.43	45.72	**62.55**
(T) 10 min	83.10	79.34	74.53	68.23	65.34	**74.11**	84.34	80.00	77.87	70.27	65.60	**75.62**
(T) 20 min	83.10	80.36	72.87	65.22	59.32	**72.17**	84.34	75.34	71.53	68.90	64.64	**72.95**
(T) 30 min	83.10	70.00	68.34	62.30	60.22	**68.79**	84.34	72.80	65.34	63.30	59.71	**69.10**
(HW)10min	83.10	73.43	68.43	59.00	52.75	**67.34**	84.34	72.40	65.40	59.50	55.70	**67.47**
(HW)20 min	83.10	69.45	66.54	54.97	48.40	**64.49**	84.34	69.62	65.94	61.97	50.42	**66.46**
(HW)30 min	83.10	63.21	60.40	52.61	42.88	**60.44**	84.34	64.29	61.11	58.60	46.68	**63.00**
Means B**	**83.10**	**71.71**	**67.06**	**59.34**	**53.59**		**84.34**	**72.13**	**67.29**	**61.57**	**55.50**	
LSDValues at 5% level A = 2.04 B= 1.72 AXB= 4.55 LSD at 5% A = 2.89 B= 2.44 AXB= 6.46												

T= Coated Film Treatment HW=Hot Water
A* Means of storage period BMeans of treatments AXB Interaction**

β-carotene contents during cold storage:

Data in Table (10) indicated that, β-carotene was high at the Initial of storage in all treatments and control, during the storage periods and at the end of storage all treatments showed significant decreased. Carotenoids content were decreased gradually in fruits treated with either in coated film or hot water treatments. The decrement of β-carotene in hot water treatment was higher than in coated film treatments in both seasons. Among all treatments β-carotene decreased at the end of storage due to cold storage period, ripening stage or maturation period (Jomori *et al*., 2016). β-carotene may converted to provitamin A within cold treatments in mature stage and provitamin A carotenoids are not very stable during storage and their loss compromises nutritional quality (Li *et al*., 2012).

Table 10. Effect of some postharvest treatments on carotenoids (mg/100g fresh weight) of Persimmon c.v. Costata fruits during cold storage (4±1°C).

Storage period (weeks)/ Season 2015							Storage period (weeks)/ Season 2016					
Treatments	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*	Initial time	2weeks	4weeks	6weeks	8weeks	Means A*
Control	19.38	16.00	13.73	11.10	10.20	**14.08**	21.38	17.98	14.28	13.99	13.20	**16.17**
(T) 10 min	19.38	19.86	19.63	19.55	19.14	**19.51**	21.38	20.63	19.83	19.43	18.94	**20.04**
(T) 20 min	19.38	18.52	18.37	18.12	17.98	**18.47**	21.38	18.90	18.58	18.02	17.63	**18.90**
(T) 30 min	19.38	17.98	17.90	17.78	17.10	**18.03**	21.38	18.32	18.00	17.80	17.32	**18.56**
(HW) 10 min	19.38	17.76	17.03	16.22	15.54	**17.19**	21.38	17.96	17.63	16.90	15.46	**17.87**
(HW) 20 min	19.38	14.32	13.99	13.11	13.00	**14.76**	21.38	15.88	14.95	13.88	12.87	**15.79**
(HW) 30 min	19.38	12.90	12.12	11.97	11.41	**13.56**	21.38	14.90	13.82	12.67	11.25	**14.80**
Means B	**19.38**	**16.76**	**16.11**	**15.41**	**14.91**		**21.38**	**17.80**	**16.73**	**16.10**	**15.24**	
LSD at 5% A = 1.02 B= 0.86 AXB= 2.28 LSD at 5% A = 1.09 B= 0.92 AXB= 2.43												

T= Coated Film Treatment HW=Hot Water
A* Means of storage period BMeans of treatments AXB Interaction**

CONCLUSION

In conclusion, the research indicated that, coststa persimmon can be stored for 8 weeks at cold storage 4±1°C and 90% relative humidity (RH) in all treatments. Edible film at 30 minute gained best eating quality.

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تأثير بعض معاملات ما بعد الحصاد على تحسين جودة والقدرة التخزنية لثمار الكاكى أثناء التخزين المبرد

جيهان عبد الملك الإمام الحديدى [1] - إسحق مراد الحديدي [2]

1. *قسم بحوث تداول الفاكهة- معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر.*
2. *قسم بحوث تكنولوجيا الحاصلات البستانيه-معهد بحوث تكنولوجيا الأغذية- مركز البحوث الزراعية – الجيزة – مصر.*

الكاكي فاكهة موسمية غالباً ما تظهر طراوتها وليونتها سريعا خلال توزيعها ما بعد الحصاد أو تداولها أو في بعض الأحيان وهي علي الشجر. تعتبر معاملات التخزين وأنواع التعبئة من النقاط الهامة التي تؤثر علي تحلل المركبات الحيوية مما ينعكس علي خصائص جودة الثمار الطازجة . وقد أجريت هذه الدراسة خلال موسمى 2015 و2016 على ثمار الكاكى صنف كوستاتا تم حصاد الثمار عند مرحلة إكتمال النمو (اللون البرتقالي) .حيث قسمت الثمار إلى مجموعتين: المجموعة الأولى تم غمرها فى الماء الساخن على درجة (50 درجة مئوية) لمدة 10 ق و20 ق و 30 ق.

المجموعة الثانية تم غمرها فى فيلم يتكون من 10 جم ملتودكسترين –5جم ميثيل سليلوز– 8مللى جليسرول–2.5جم حمض الأسكوبيك –1جم بوتاسيوم سوربات –1جم كلوريد كالسيوم لكل لتر ماء مقطر لمدة 10 ق –20 ق –30 ق. بالإضافة إلى ثمار غير المعاملة (المقارنة). خزنت ثمارجميع المعاملات على 4± 1 درجة مئوية ورطوبة نسبية90% في عبوات بولي إيثلين تراي فثلات (PET) لمدة 8 أسابيع. تم تقييم التغيرات الطبيعية والكيمائية للثماروهى: نسبة الفقد فى الوزن–اللون – الصلابة – المواد الصلبة الذائبة الكلية – الحموضة الكلية –أيضأ تم دراسة مجموعة مضادات الأكسدة (تشمل الفينولات الكلية – التانينات الكلية– الفلافونيدات – فيتامين ج والكاروتنيدات) كل إسبوعين خلال فترة التخزين.

أظهرت النتائج أن جميـــع الثمار لها عمر تخزين 8 أسابيـــع على التخزين المبرد الثمار 4 ± 1 درجة مئوية ورطوبة نسبية 90% الثمار المعاملة بالفيلم المغلف لمدة 30 ق أعطت أفضل الصفات بالمقارنة بالثمار غير المعاملة ولوحظ ذلك فى تأخير الزيادة فى نسية المواد الصلبة الذائبة الكلية وتقليل الحموضة الكلية فى حين أن إنخفاض محتوى مضادات الأكسدة التى تشمل حمض الأسكوربيك والفلافونويدات كانت أعلى من ثمار الكنترول و المعاملة بالماء الساخن. لذلك بعض معاملات ما بعد الحصاد مثل الماء الساخن أو الفيلم المغلف يمكن أن تحسين الجودة الحسية من خلال تقليل المركبات القابضة وخفض المرارة في ثمار الكاكي.