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## Postharvest Treatments to Prolong Marketable Period and Keeping Fruit Quality of Costata Persimmon

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### ABSTRACT

*Persimmon cv. Costata* fruits were used to investigate control decay, delay fruit ripening and keeping their quality and extending marketing period (shelf life). Fruits were dipping in the solution of acetyl salicylic acid (ASA) levels 2, 3 and 0% as control. Selected fruits stored at room temperature "warm storage"  $26.3 \pm 1.4^{\circ}\text{C}$  and relative humidity (RH)  $45 \pm 2\%$  for 45 days. Results showed that fruits ASA treated prevent decay (%) up to 30 days of warm storage and had more effective to reduce the percentages of weight loss and decay as well as increasing total soluble solids, tannins and  $\beta$ -carotene and decreasing total acidity, firmness and ascorbic acid. The most effective treatment in reducing losses of persimmon fruit quality was found to be high level ASA treatment during the hot storage period. It was determined that under these conditions *Costata Persimmon* can be stored for 45 days without losing much of its quality.

**Keywords:** Costata Persimmon, Warm temperature, Acetylsalicylic, Vitamin C,  $\beta$ -carotene, Total tannins

### INTRODUCTION

Persimmon (*Diospyros kaki* L.) is deciduous fruit, the most widely cultivated species of the genus *Diospyros*, commonly cultivated in warm regions of the world. Also, it is one of the most nutritious fruits bestowed with strong antioxidant activity [1] having a great mystical power that can be harnessed to solve headaches, back pains and foot ache. So, its demand is increasing owing to consumer's awareness regarding its hidden health promoting potential. Persimmon *Costata* cultivar is the main and leading that consumed in the Egyptian market. It's ripening differently than other fruits. Really hard persimmons to ripen so expect to wait for several weeks for ripe. Immature persimmon fruits have a high proanthocyanidin-type tannin content which makes the immature fruit astringent and bitter [2]. The tannin levels are reduced as the fruit matures. Placing that persimmon in sunlight will remove the tannins very quickly [3]. Persimmon ripening is regulated by ethylene. During climacteric stage, rapid softening occurs resulting jelly-like flesh thus makes persimmon unmarketable within a few days. Thus, persimmon crop harvested at commercial maturity produces less ethylene production than that harvested at early mature stage releases higher amounts of ethylene [4]. The eating quality of persimmon is considered best at the end of the pre-climacteric stage owing to presence of maximum sugars and desired orange color [5,6].

Chemical treatments have been used to prevent insect attack and prolong postharvest shelf-life. Salicylic acid (SA) is considered as a plant hormone [7], inhibiting ethylene biosynthesis and delaying the fruit senescence [8] it considered as safe for food and environmental [9]. The pattern of decrease in endogenous SA level was related to accelerated softening while the application of acetylsalicylic acid (ASA) (a derivative of SA) slowed down the softening rate of kiwifruit by inhibiting ethylene production and maintaining higher endogenous of SA levels [10].

In the last decade, there has been increasing interest in the use of heat treatments to control insect pests, prevent fungal rots, increase resistance to chilling injury, delay fruit ripening, and extend postharvest shelf-life of fruits [11]. Heat treatments have been shown to inhibit fruit ripening and improve post-storage quality of fruit including apple [12], citrus fruit [13] and mangos [14]. Thus, heat treatment has potential for the commercial control of ripening of harvested persimmon fruits [3,15].

The main postharvest problems of persimmon are severe softening and disease incidence on the fruits during storage. Therefore, delay in softening and/or control of diseases result in the storage life extension of persimmon fruit. Thus, the target of this study was using three concentration of acetylsalicylic (0.01 and 3%) under room temperature (hot storage) to control decay, delay fruit ripening of persimmon cv. *Costata* for keeping their quality and extending marketing period (shelf life).

## MATERIALS AND METHODS

## Plant sample

Costata Persimmon fruits (*Diospyros kaki* L.), an astringent persimmon cultivar, were harvested from a private orchard located at Kalubia Governorate Egypt, at commercial maturity stage and coloring (two thirds of the surface) at October 2015. Greenish-yellow color maturity fruits were selected undamaged, uniformed in shape, freedom from blemishes, pathogen infection, and immediately transferred to the laboratory of Agriculture Development Systems (ADS) project in the Faculty of Agriculture, Cairo University.

## Treatments and storage condition

The fruits were divided into three groups and were treated by dipping in the solution of ASA 0 (as control), 2 and 3% for 5 min. Every treatment has five replicates, every replicate contained 6 fruits. Treated fruits were air-dried, both replicate per treatment were packed in fiberboard cartons and stored at room temperature warm storage  $26.3 \pm 1.4^\circ\text{C}$  and Relative Humidity (RH)  $45 \pm 2\%$  for 45 days, 15 random fruits of each treatment (as 3 replications each of 5 fruit) were transported to the laboratory of food industry, National Research Centre-Dokki Giza-Egypt, to determined fruit quality measurements at the end of study. The initial quality measurements were determined as shown in Table 1.

Table 1: Persimmon "Cv. Costata" fruit quality properties (in average) at harvest time

Total solids (%)	soluble	Total acidity (%)	Firmness (Lb/inch <sup>2</sup> )	Total sugars (g/100 g)	Ascorbic acid (mg/100 g)	Total tannins (mg/100 g)	$\beta$ -carotene (mg/100 g)
14		1.28	26.5	11.5	164.3	4.65	180

Data are means of three replicates of 15 fruits each

## Fruit quality assessments

## Physical characters

Weight loss: Fruits were periodically weighed and the loss in mass weight was recorded for each replicate. Data were calculated as percentage from the initial weight. Decay percentage: Fruits which were decayed by different physiological and pathological factors were periodically counted and discarded. Then percentage of fruits was calculated in relation to the total number of fruits. Fruit firmness: Was determined as Lb/inch<sup>2</sup> by using fruit pressure tester model FT 327 (3-27 Lbs), were determined at the end of warm storage.

## Chemical characters

Chemical properties were measured at the end of warm storage periods (after 45 days) such as: Total soluble solids percentage (TSS %): by using hand Refractometer. Total acidity (TA %): was estimated as percentage of Malic acid in fruit juice [16]. Total Sugars (g/100 g FW): was determined using the phenol and sulphoric acid [17]. Ascorbic acid (mg/100 g): Determination of vitamin C [16]. Total tannins (mg/100 g): Were determined by Folin-Ciocalteu method according to Miesan and Mohamed [18].  $\beta$ -carotene (mg/100 g): Carotenoids were extracted according to Moore et al. [19]. HPLC analysis was performed using Agilent 1100 HPLC system (Agilent Technologies, Palo Alto, CA). Separation was accomplished using an ODS C18 column and a mobile phase of  $\text{CH}_3\text{OH}:\text{CH}_3\text{CN}:\text{CHCl}_3$  (47:47:6). The flow rate was set at 1 ml/min and all readings were taken at 461 nm.

## Statistical analysis

The data were subjected to statistical analysis using computer based software "MS-Excel" and results were submitted to analysis of variance [20]. Differences among treatment means were determined by using the LSD test at a significance level of 0.05 [21].

## RESULTS AND DISCUSSION

## Fruit quality assessment during storage

## Weight loss (%)

Weight loss trends for Costata Persimmon fruit treated with ASA levels during warm storage as shown in Figure 1. Weight loss increased quickly and has showed a continual increasing trend towards the end of storage life, with no significant differ between 15 and 30 days of storage periods. Generally, untreated fruits were significantly higher than treated fruits especially at 45 days of storage. The lowest significant weight loss was observed in persimmon fruits treated with 3% ASA followed by 2% ASA. Similar results were also reported in grape [22] and in persimmon [3].

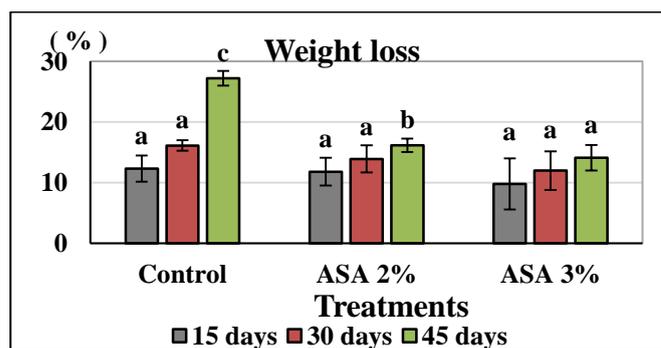


Figure 1: ASA concentrations on the percentage weight loss of Costata Persimmon fruits during warm storage

**Decay (%)**

Results in Figure 2 showed that the same trend in weight loss. In general, Costata Persimmon fruits ASA treated prevent decay up to 30 days of warm storage. The low level ASA (2%) had significant reduction in fruit decay than high level ASA (3%) and untreated fruits. Our results are harmony with those findings [23,24].

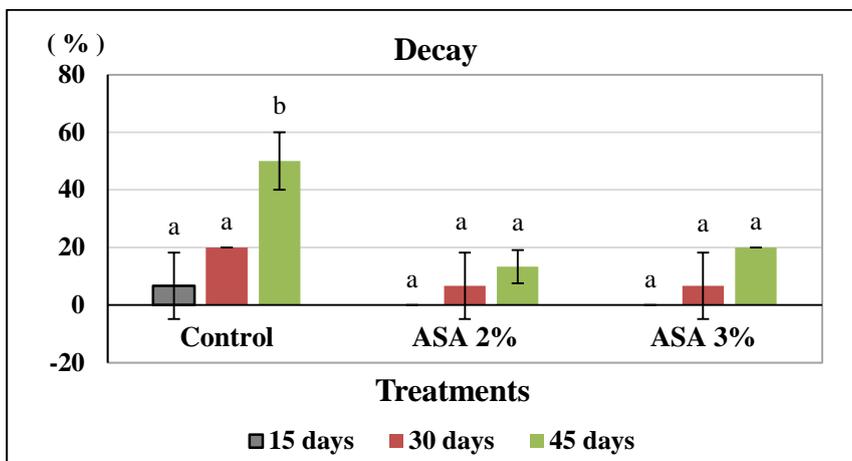


Figure 2: Effect of ASA concentrations on the decay percentage of Costata Persimmon fruits during warm storage

**Fruit quality assessment after storage**

**Firmness**

Fruit firmness is the best measurement of ripeness and eating. It is defined as the force necessary to break the flesh tissues and it is related to different ripening stages. So, it is one of the most common physical parameter to assess the progress of ripening. Slightly changes in Costata Persimmon fruit firmness treated with ASA concentrations and stored at room temperature up to 45 days are shown in Table 2. Control fruit were more softness than other treatments. While, fruits treated with low level ASA (2%) recorded moderate softness (2.30 Lb/inch<sup>2</sup>). Whereas, fruits treated the high level ASA (3%) achieved low softness (2.50 Lb/inch<sup>2</sup>) in this respect. From that evident, fruit softening was little inhibited by ASA treatments but there was no significant effect between all treatments. Similar results were also reported in other findings in mango [25], in persimmon [3,15].

Table 2: Effect of ASA concentrations on firmness, total soluble solids and total acidity of Costata Persimmon fruits at the end of warm storage

Treatments	Firmness (Lb/inch <sup>2</sup> )	TSS (%)	TA (%)	Total sugars (g/100 g FW)
Control	0.90 ± 0.03	32.1 ± 0.5	0.64 ± 0.04	27.7 ± 0.40
ASA 2%	2.30 ± 0.08	27.2 ± 0.4	0.72 ± 0.02	20.2 ± 0.35
ASA 3%	2.50 ± 0.05	24.4 ± 1.0	0.91 ± 0.04	19.5 ± 0.80
LSD <sub>0.05</sub>	0.06	1.70	0.03	1.40

Data represent means ± SD of three replications. TSS: Total Soluble Solids; TA: Total Acidity; FW: Fresh Weight

**TSS%**

It can be noticed in Table 2 that TSS% increased during storage in all treatments as compared in the initial experiment. After 45 days of warm storage, TSS% increased and it was more pronounced in control treatment recorded the highest significant values (32.1%) in this regard. Whilst, ASA treatments delayed TSS increase, statistical analysis showed TSS of 3% ASA treatment fruits were significantly lower (24.4%) than that of 2% ASA treated fruits (27.2%). These results are corroborated by Rossiter et al. [26]. According to these results, it may be misleading to determine simply TSS value for consumption eligibility.

**TA%**

In general, it is known that there is a reduction in malic acid content of persimmon during the storage period [27]. In study, TA content of Costata Persimmon exhibited reduction dependence on ripening and treatments towards the end of storage period (Table 2). ASA treatments greatly delayed the loss of TA which occurred during ripening. Statistical analysis showed TA of 3% ASA treatment fruit was significantly highest (0.91%) than that of 2% ASA treatment fruit (0.72%) and the control fruits (0.64%). These results are similar to those of Namdar and Ozcan; Bal and Celik [28,29].

**Total sugars (g/100 g FW)**

In this study, at the beginning of storage, a total sugar of persimmon fruits was (11.5 g/100 g FW). With persimmon fruit maturity, increasing total sugars depending on storage period, ripening and treatments. The highest significant values total sugars of persimmon fruits (Table 2) were detected in the control treatment (27.7 g/100 g FW). While, the lowest statistical values in this regard was obtained at high level ASA treated fruits (19.5 g/100 g FW) followed by the low level ASA treated fruits (20.2 g/100 g FW), with no significant among them. These results are in line with reported [30] in apple.

**Ascorbic acid (mg/100 g)**

At the initial of storage, ascorbic acid (VC) of persimmon fruits maturity was (164.3 mg/100 g FW). Whilst after storage life, all treatments showed decreased ascorbic acid of Costata Persimmon fruits. The significant maximum VC value (23.85 mg/100 g) was found in fruits treated with 3% ASA followed by 2% ASA (23.56 mg/100 g) and the statistical minimum (13.74 mg/100 g) in the untreated fruits (Table 3). Under such conditions, the antioxidant compounds including ascorbic acid usually get increased. The higher retention of ascorbic acid in the treated Costata

Persimmon fruits might be due to delayed ripening process caused by suppressed ethylene production. Similar retention of ascorbic acid with ASA treatment was also reported with several literatures [31] kiwifruit [32], apricot [33], plum and [34,35] mango.

**Table 3: Effect of ASA concentrations on ascorbic acid, total tannins and  $\beta$ -carotene of Costata Persimmon fruits at the end of warm storage**

Treatments	Ascorbic acid (mg/100 g)	Total Tannins (mg /100 g)	$\beta$ -carotene (mg/100 g)
Control	13.74 $\pm$ 0.03	66.06 $\pm$ 0.03	260.1 $\pm$ 0.004
ASA 2%	23.56 $\pm$ 0.01	88.17 $\pm$ 0.02	283.4 $\pm$ 0.011
ASA 3%	23.85 $\pm$ 0.04	54.28 $\pm$ 0.02	214.5 $\pm$ 0.003
LSD <sub>0.05</sub>	0.08	0.07	9.8

Data represent means  $\pm$  SD of three replications

**Total tannins (mg/100 g)**

Before storage, fruit showed a low level of soluble tannins responsible for their astringency. Among all treatments fruits astringency increased after storage (Table 3). Total Tannins were increasing depending on warm storage period, ripening and treatments. That result in line with the detected by Luo [3].

 **$\beta$ -carotene (mg/100 g)**

At the starting of storage, fruit showed a low level of  $\beta$ -carotene responsible for ripening. On the contrast, among all treatments  $\beta$ -carotene fruits increased at the end storage (Table 3), depending on storage period, ripening and treatments. Our results are in line with (Tatsumi, 2000) on citrus as well as on kaki [15,36].

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**CONCLUSION**

This study has shown that a warm storage and ASA treatments has the potential to control the ripening of Costata Persimmon fruits. It's significantly delayed the onsets of climacteric ethylene production in persimmon fruits. Also, these significantly retarded the increase in carotenoids content, TSS and decrease in firmness, TA, Weight loss and decay.

In conclusion, the research indicates that warm storage and ASA concentration treatments are effective methods of extending the marketable period of persimmon in warm storage (26.3  $\pm$  1.4°C) and 45  $\pm$  2% relative humidity (RH) up to 45 days. The most effective treatment in reducing losses of fruit quality was found to be high level ASA treatment during the storage period of persimmon. It was determined that under these conditions Costata persimmon can be stored for 45 days without losing much of its quality.

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