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ASTRINGENCY REMOVAL AND RIPENING PROCESS OF PERSIMMONS TREATED WITH ETHEPHON AND ETHANOL

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ABSTRACT

The present study was carried out during 2006 and 2007 seasons to evaluate the effect of dipping persimmon fruits in different concentrations of ethephon and ethanol solutions as post harvest treatment to remove astringency and hasten fruit ripening.

The data indicated that ethephon at 750 ppm was superior effect for reducing fruit firmness and total tannins with increasing total soluble solids and enhancing ripening process than dipping fruits in 500 or 1000 ppm. Moreover, ethanol application at 25 % was suitable to accelerate fruit ripening with increasing soluble solids than dipping fruits in 50 % concentration. Since, these treatments were more effective to remove fruit astringency through reducing tannin content. Also, these solutions are save for human health.

INTRODUCTION

The Japanese persimmon (*Diospyros kaki*, L.) is one of the deciduous fruit trees with low chilling requirements about 350 effective chilling units (George *et al.*, 1994). The trees are cultivated throughout the warmer parts of the world, e.g., in the south of France and other Mediterranean countries, as well as in USA.

In Egypt, the cultivated area increased gradually at the last few years and reached about 1431 feddans out of which about 750 feddans (more than 50 % of total area) under Dakahlia governorate, according to the last statistics of Ministry of Agriculture (2006).

Persimmon fruits are a good source of fiber, vitamins A and C and contain good amounts of sugars (Homonova *et al.*, 1990). Therefore, there is a high interest to increasing cultivation and production of persimmon for commercial market in Egypt. Since, the climate and environmental conditions are suitable for persimmon growing and economic production.

Several treatments have been used to remove astringency from persimmon fruit and hasten ripening process. In this respect, dipping Costata persimmon fruits in ethephon solution was more effective in reducing firmness and enhanced fruit ripening (EL-Wahab *et al.*, 1983). Furthermore, ethylene gas had released the compounds which successfully used to remove astringency in Costata persimmon fruits (Park Seo Jun *et al.*, 2003).

Moreover, ethanol vapor was also be used to remove the astringency of Hiratanenashi fruit (Yamada *et al.*, 2002). Also, Ali (2005) mentioned that ethanol and ethylene applications removed the astringency of persimmon fruits due to increasing ethylene production after the treatment.

The present investigation was carried out to study the effect of different concentrations of ethephon and ethanol as post harvest treatments to enhance fruit ripening of Tanenashi persimmon fruit and knowing the suitable concentration to hasten ripening.

MATERIALS AND METHODS

The present study was carried out during the seasons of 2006 and 2007 to evaluate the effect of ethephon and ethanol applications for enhancing ripening process of Tanenashi persimmon fruits.

In this study, persimmon fruits were obtained from a private orchard near EL-Mansoura city, Dakahlia governorate. About 100 kg of fruits were harvested at maturity stage when tannin content reached about (1.40–1.60) and soluble solids in fruit juice about (12-14%) according to (Homonova *et al.*, 1990) and transported to the laboratory of Pomology Dept., Fac. of Agric., Mansoura Univ. Fruits were sorted to discard any defective and mechanical damaged fruits.

Therefore, uniform fruits in size and colour were washed with tap water and air dried using an electric fan. Then, fruits were divided to six groups, each one was dipped for 5 minutes in one of the following solutions :

1- Control (Dipping in water). 2- Ethephon at 500 ppm.
3- Ethephon at 750 ppm. 4- Ethephon at 1000 ppm.
5- Ethanol at 25 %. 6- Ethanol at 50 %.

After treatments, fruits were air dried using an electric fan and then were put in ventilated plastic bags, all bags with fruits were weighed and every 6 bags were put in ventilated carton box 50 x 30 x 12 cm. The total number of carton boxes was 12 for all treatments, each treatment consists of two carton boxes, each box contains 6 plastic bags. All boxes were held at room temperature at (16-18 °C) and (75-80 % R.H) to study the effect of ethephon and ethanol solutions on ripening process. At 5 days intervals, 3 bags from each treatment were taken to determine the following parameters :

I. Total loss in fruit weight :

It was calculated by determining loss in fruit weight and decayed fruits.

II- Changes in physical properties :

1- Fruit firmness :

It was determined by using a hand Effegi–penetrometers supplemented with a plunger 5 mm diameter and estimated as lb/inch^2.

2- Ripening index (R.I.) :

Samples from each replicate were taken and divided into five stages according to colour as follow :

Yellow **(1)**, 3/4 Yellow – 1/4 orange **(2)**, 1/2 Yellow – 1/2 orange **(3)**; 1/4 Yellow - 3/4 orange **(4)**, Orange **(5)**.

Fruit ripening index was estimated using the following equation according to Abou-Aziz *et al.*, (1982) :

$$(R.I.) = \frac{\text{No. of fruits in each grade colour x grade colour score}}{\text{Total number of fruits}}$$

III- Changes in chemical constituents :

1- Soluble solids content (SSC) :

It was measured by using Carlzeiss hand refractometer as %.

2- Total tannins :

It was determined by titrating 5 ml of fruit juice with 0.1 N of potassium permanganate using Indigo Carmen as an indicator. Tannin content was calculated as grams tannin per 100 ml juice according A.O.A.C. (1980).

Statistical analysis :

All the obtained data of the study were statistically analyzed according to Sendecor and Cochran (1971).

RESUTES AND DISCUSSION

This study was carried out to evaluate the effect of dipping fruits in ethephon and ethanol solutions on ripening process. The obtained results are presented and discussed as follow :

1- Loss in fruit weight percentage :

Data from Table (1) presented that loss in fruit weight was gradually increased as the storage period advanced from harvest till 15 days at room temperature. Similarly, El-Morsy *et al.* (2002) found that weight loss percent of both persimmon cvs. Truimph and Costata increased as the time of storage advanced. Furthermore, both ethephon and ethanol significantly increased the loss in fruit weight than the control during the period of ripening.

Table (1) : Effect of postharvest treatments on weight loss percentage of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	0.00	2.61	5.37	7.42	0.00	2.29	5.68	7.45
Ethephon 500 ppm	0.00	3.29	6.54	8.12	0.00	3.33	6.66	7.59
Ethephon 750 ppm	0.00	2.05	6.18	8.32	0.00	1.66	6.65	7.65
Ethephon 1000 ppm	0.00	2.15	6.70	9.53	0.00	1.28	5.41	8.20
Ethanol 25 %	0.00	2.58	7.63	10.03	0.00	2.53	7.05	7.71
Ethanol 50 %	0.00	3.04	6.74	10.60	0.00	3.17	7.86	9.92
L.S.D at 5 %	Treatment = 0.284				Treatment = 0.317			
	Storage period = 0.232				Storage period = 0.259			

Yet, dipping fruits in ethephon gave a lower percent of loss in fruit weight than obtained from dipping in ethanol. Thus, dipping persimmon fruits in ethephon at 500 or 750 ppm presented a significant lower loss in fruit weight than dipping fruits in ethephon at 1000 ppm during the both seasons under study. Moreover, dipping fruits in ethanol at 50 % gave a higher loss percentage in fruits than dipping in ethephon, ethanol at 25 % and the control.

The data go in line with those reported by Ali (2005) which mentioned that both ethanol at 30 % or ethylene at 100 ppm reduced weight loss

percentage of Costata persimmons fruit. Since, the loss in fruit weight is mainly due to water loss as a result of transpiration and respiration processes (Takata, 1982).

2- Decay percentage :

It is clear from Table (2) that no decayed fruit was noticed from fruits held for 5 days at room temperature. Yet, the percent of decayed fruits was almost lower than loss in fruit weight during the storage period.

Table (2) : Effect of postharvest treatments on decay percentage of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	0.00	0.00	0.00	6.31	0.00	0.00	0.00	4.66
Ethephon 500 ppm	0.00	0.00	0.00	4.04	0.00	0.00	0.00	4.53
Ethephon 750 ppm	0.00	0.00	3.29	6.77	0.00	0.00	0.00	5.28
Ethephon 1000 ppm	0.00	0.00	4.36	7.59	0.00	0.00	3.71	6.08
Ethanol 25 %	0.00	0.00	0.00	6.98	0.00	0.00	0.00	6.39
Ethanol 50 %	0.00	0.00	5.46	6.94	0.00	0.00	5.72	7.91
L.S.D at 5 %	Treatment = 0.420				Treatment = 0.361			
	Storage period = 0.343				Storage period = 0.295			

Dipping persimmon fruits in ethephon at 500 ppm gave a lower significant decayed fruits than dipping fruits in the other concentrations of ethephon or ethanol. Whereas, ethephon application at 1000 ppm or ethanol at 50 % gave a higher significant decayed fruits than the other treatments used under the study.

3- Total loss percentage :

Total loss in fruit weight is mainly due to the loss in fruit weight and decayed fruit percentages are presented in Table (3). In this aspect, it is clear that dipping persimmon fruits in ethephon solution at 500 ppm gave a lower percent of total loss in fruit weight than the other treatments. Since, these treatments gave a lower decayed fruits. Yet, ethephon at 1000 ppm gave a higher significant loss in fruit weight than dipping in ethephon at 500 or 750 ppm. Thus, dipping fruits in ethanol solution at 50 % gave a higher total loss in fruit weight than ethanol at 25 % or ethephon applications as mean of two seasons. The increment in total loss due to this treatment is mainly due to the effect on increasing both loss in fruit weight and decayed fruits.

The data go in line with those reported by EL-Wahab *et al.*, (1983) who mentioned that a continues loss in fruit weight, decay and total loss as storage period of Costata fruit advanced, so, ethephon at 500 ppm presented best result than 1000 and/or 1500 ppm.

Table (3) : Effect of postharvest treatments on total loss percentage of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	0.00	2.61	5.37	13.73	0.00	2.29	5.68	12.11
Ethephon 500 ppm	0.00	3.29	6.54	12.16	0.00	3.33	6.66	12.12
Ethephon 750 ppm	0.00	2.05	9.47	15.09	0.00	1.66	6.65	12.93
Ethephon 1000 ppm	0.00	2.15	11.06	17.12	0.00	1.28	9.12	14.28
Ethanol 25 %	0.00	2.58	7.63	17.01	0.00	2.53	7.05	14.10
Ethanol 50 %	0.00	3.04	12.20	17.54	0.00	3.17	13.58	17.83
L.S.D at 5 %	Treatment = 0.531				Treatment = 0.532			
	Storage period = 0.433				Storage period = 0.434			

Changes in physical properties :

1- Fruit firmness :

Data from Table (4) showed that fruit firmness was gradually reduced after treatments till 15 days under room temperature. The data also confirmed that dipping persimmon fruits in ethephon and ethanol solutions reduced fruit firmness significantly during ripening period than the control which dipped in tap water.

In this respect, dipping fruits in ethephon at 750 or 1000 ppm presented a lower significant fruit firmness than dipping fruits in ethephon at 500 ppm or ethanol. Yet, dipping fruits in ethanol especially at 50 % gave a higher fruit firmness than those obtained from ethephon but lower than the control. The reduction in fruit firmness resulted from these treatments may be due to decomposition of enzymatic degradation in insoluble protopectins to more soluble pectins as a result of increasing pectin esterase activity (Deshpande & Salunkhe, 1964).

Table (4) : Effect of postharvest treatments on fruit (lb/inch^2) firmness of persimmon during storage.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	18.7	17.3	16.1	14.4	17.6	16.1	15.6	12.6
Ethephon 500 ppm	18.7	17.7	14.4	13.4	17.6	16.5	15.1	12.4
Ethephon 750 ppm	18.7	16.2	14.5	10.6	17.6	14.2	13.4	10.1
Ethephon 1000 ppm	18.7	15.2	12.3	11.1	17.6	12.8	11.3	10.1
Ethanol 25 %	18.7	16.7	13.3	12.8	17.6	13.1	12.6	10.8
Ethanol 50 %	18.7	16.6	14.9	13.7	17.6	15.1	14.5	12.1
L.S.D at 5 %	Treatment = 0.509				Treatment = 0.622			
	Storage period = 0.415				Storage period = 0.508			

Furthermore, Sudzuki & Castro (1987) reported that ethanol vapor significantly reduced fruit firmness of persimmon fruits. Likewise, Kato (1990) found that treated astringent persimmons with ethylene application decreased fruit firmness. Also, Taira *et al.* (1987) mentioned that fruits softened more rapidly with alcohol application.

2- Ripening index :

Data from Table (5) indicated that dipping persimmon fruits in ethephon and ethanol solutions increased fruit ripening 15 days from harvest. From this data, ethephon at 750 ppm enhanced ripening process more than dipping fruits in the other concentration of ethephon or ethanol. So, dipping fruits in ethephon at 750 ppm solution gave a better ripening index than other treatments. Since, these treatments showed 4.5 degree of ripening index (nearly $^3/_4$ to full orange). Thus, dipping fruits in ethanol at 50 % or water which left as a control presented a lower ripening score. So, they gave about 3.8 degree which presented nearly 3/4 (1/4 yellow – $^3/_4$ orange).

Table (5) : Effect of postharvest treatments on ripening index of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	0.0	1.1	2.7	3.4	0.0	1.1	3.0	3.3
Ethephon 500 ppm	0.0	1.3	2.9	3.8	0.0	1.3	3.1	4.1
Ethephon 750 ppm	0.0	1.6	3.4	4.5	0.0	1.2	3.4	4.5
Ethephon 1000 ppm	0.0	1.4	3.2	4.4	0.0	1.4	3.3	4.3
Ethanol 25 %	0.0	1.2	3.5	4.0	0.0	1.3	3.6	4.0
Ethanol 50 %	0.0	1.2	2.7	3.8	0.0	1.4	2.8	3.8
L.S.D at 5 %	Treatment = 0.108				Treatment = 0.162			
	Storage period = 0.088				Storage period = 0.132			

The attained data agree with those mentioned by Takata (1982) who mentioned that treated fruits with 100 ppm ethylene after harvest stimulated respiration and increased ethylene production and chemical fruit ripening than the untreated ones. Yet, dipping fruit in ethanol solution at 25 % enhanced fruit ripening than ethanol at 50 %. Since, ethanol at 25 % showed ripening index similar to those obtained from dipping fruits in ethephon at 500 ppm as mean of two seasons. Furthermore, Kato (1987) mentioned that ethanol enhanced ripening of persimmon fruits.

Changes in chemical compositions :

1- Soluble solids content :

Concerning the effect of ethephon and ethanol on changes in SSC in fruit juice, data from Table (6) showed that soluble solids content was significantly increased after harvested till 15 days at room temperature. This may be due to the loss in water from fruits through respiration and evaporation during storage. The data also disclosed that dipping persimmon fruits in ethephon and ethanol solutions increased the soluble solids content in fruit juice significantly than the control.

Table (6) : Effect of postharvest treatments on soluble solids content in juice of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	11.3	12.5	13.6	15.2	12.5	13.8	15.6	15.2
Ethephon 500 ppm	11.3	12.7	13.9	17.3	12.5	14.0	15.4	17.8
Ethephon 750 ppm	11.3	13.5	16.9	19.7	12.5	13.8	17.6	21.6
Ethephon 1000 ppm	11.3	12.7	17.5	18.8	12.5	12.2	18.2	18.8
Ethanol 25 %	11.3	13.8	15.0	18.9	12.5	15.6	17.8	20.0
Ethanol 50 %	11.3	12.0	14.1	16.9	12.5	13.0	14.5	16.8
L.S.D at 5 %	Treatment = 0.437				Treatment = 0.748			
	Storage period = 0.357				Storage period = 0.611			

In this respect, dipping persimmon fruits in ethephon at 750 ppm or ethanol at 25 % gave higher values of soluble solids content than the other treatments used. Whereas, dipping fruits in ethephon at 500 ppm or ethanol at 50 % gave a lower soluble solids content but almost higher than the control. Also, the data presented that dipping fruits in ethephon at 750 ppm was superior for increasing the soluble solids in fruit juice than the other treatments. Similarly, Takata (1982) found that treated persimmon fruits with ethylene at 1-100 ppm, increased the soluble solids content. Also, EL-Wahab *et al.* (1983) reported that dipping fruits in ethephon at 500, 1000 and 1500 ppm markedly increased SSC of Costata fruits.

2- Total tannins :

Data from Table (7) showed that dipping fruits in ethephon and ethanol reduced tannin content from harvest till 15 days later. Similarly, Hribar *et al.* (2000) found that the amount of soluble tannins decreased during storage. Furthermore, the data also reveal that all treatments reduced the content of tannin content in fruit juice than dipping fruits in ethephon solution at 1000 ppm or the control.

Moreover, dipping fruits in ethephon at 750 ppm was superior for reducing tannin content than the other treatments. So, the values of total tannins were about 0.77 gm for these treatments and 1.27 for the control as the mean of two seasons under study. In this respect, Park Seo Jun *et al.* (2003) mentioned that treated persimmon fruits with ethylene most tannin cells disappeared.

Also, ethanol application gave lower tannin content than ethephon at 1000 ppm or the control. Since, no significant differences in total tannins was obtained for treated fruits with ethanol at 25 or 50 % during the both season under the study.

Table (7): Effect of postharvest treatments on tannin content of persimmon fruits.

Treatment	Season 2006				Season 2007			
	Storage period in days				Storage period in days			
	0	5	10	15	0	5	10	15
Control	1.82	1.64	1.38	1.28	1.90	1.70	1.40	1.26
Ethephon 500 ppm	1.82	1.41	1.10	0.80	1.90	1.31	1.05	0.90
Ethephon 750 ppm	1.82	1.57	1.20	0.75	1.90	1.43	1.10	0.80
Ethephon 1000 ppm	1.82	1.50	1.37	1.05	1.90	1.61	1.45	1.00
Ethanol 25 %	1.82	1.45	1.15	0.85	1.90	1.20	0.95	0.80
Ethanol 50 %	1.82	1.33	1.16	0.86	1.90	1.23	0.93	0.83
L.S.D at 5 %	Treatment = 0.023				Treatment = 0.051			
	Storage period = 0.018				Storage period = 0.042			

Likewise, Kato (1990) stated that there was a relative correlation between the degree of astringency and tannin concentration. He also presented that treated persimmon fruits with ethylene and ethanol at 50 % decreased tannin content at short time. Furthermore, Dauriach (1986) mentioned that spraying boxes of fruits with 40 % alcohol solution caused astringency to disappear after 10 days from treatments. Similarly, Yamada *et al.* (2002) found that ethanol treatment decreased soluble tannin and removed astringency of persimmon fruits. Moreover, Ali (2005) presented that ethanol at 30 % and ethylene at 100 ppm markedly reduced tannin content compared with the control.

From the obtained data it is clear that, in spite of both ethephon and ethanol increased loss in weight, decayed fruits and total loss percentage of persimmons but enhanced fruit ripening due to their effect on reducing fruit firmness and tannins content with increasing soluble solids content. Since, it is recommended to use ethephon at 750 ppm to accelerate fruit ripening of persimmon fruits. Furthermore, ethanol application at 25 % also enhanced fruit ripening and increased soluble solids content in fruit juice.

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إزالة المادة القابضة وإنضاج ثمار الكاكى بالمعاملة بالإثيفون والإيثانول

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أجريت هذه الدراسة خلال موسمى ٢٠٠٦ ، ٢٠٠٧ لتقييم غمس ثمار الكاكى فى تركيزات مختلفة من الإثيفون والإيثانول بغرض إزالة المادة القابضة وتحسين نضج ثمار الكاكى.

أوضحت النتائج أن غمس ثمار الكاكى فى الإثيفون بتركيز ٧٥٠ جزء فى المليون كان له أثر واضح فى إنضاج ثمار الكاكى وخفض صلابة الثمار وخفض محتوى الثمار من المواد القابضة بالمقارنة بغمس الثمار فى الإثيفون بتركيز ٥٠٠ ، ١٠٠٠ جزء/مليون.

علاوة على ما سبق فإن غمس ثمار الكاكى فى محلول الإيثايل بتركيز ٢٥ % كان له أثر أفضل فى زيادة محتوى الثمار من المواد الصلبة الذائبة وإزالة المادة القابضة من خلال خفض محتوى الثمار من التانينات وإسراع نضج الثمار مقارنة بغمس الثمار فى الإيثانول بتركيز ٥٠ % علاوة على أنه محلول آمن صحيا.