J. Agric. Sci. Mansoura Univ., 34 (7): 7875 - 7884, 2009

EFFECT OF EXOGENOUS ANTIOXIDANTS ON SHELF LIFE OF WASHINGTON NAVEL ORANGE FEUITS (*Citrus sinensis* L. OSBECK) SRORED UNDER AMBIENT CONDITIONS.

Mostafa, M. F. M.
Pomology Department, Faculty of Agriculture, Mansoura University

ABSTRACT

Postharvest saoking treatments in 2, 4 and 6 mmol L^{-1} acetyl salicylic acid and 1, 2 and 3 mmol L^{-1} tannic acid were investigated on Washington navel orange fruits stored under ambient conditions (25-27 ^{o} C+75-80% RH). Postharvest treatments of Washington navel orange fruits with tannic acid at 2 mmol L^{-1} and acetyl salicylic acid at 6 and 4 mmol L^{-1} gave significant decrease in loss weight %, decay % and total loss weight at the end of storage period as compared with control. Tannic acid at 2 mmol L^{-1} gave significant increase in SSC % in fruit juice, while acetyl salicylic acid at 2 and 4 mmol L^{-1} gave significant decrease in acidity content % of fruit juice at the end of storage period by comparison with control. Tannic acid at 2 and 1 as well as acetyl salicylic acid at 6 and 4 mmol L^{-1} gave the lowest decrement in the Vitamin C content % in juice during the two seasons 2008 and 2009 comparing with control.

INTRODUCTION

Washington navel orange fruits are considered one of the popular citrus fruits in the worldwide. In Egypt, the citrus growers to put the market price under control always leave the mature fruits on their trees irregardless services which are necessary and essential for trees in winter season such as pruning, soil hoeing and organic materials addition period. Antioxidants used in the present study basing on the fact that an antioxidant is a compound that can neutralize free radicals by donating an electron before they can cascade into cell damage. The fruit creates its own collection of antioxidant chemicals such as Vitamins C, E, beta carotene; carotenoids and flavonoids. Other phytochemicals induced Lycopene, Lutein, tannins, and Lignans are also antioxidants. Unfortunately these own antioxidants products are not enough to neutralize all free radicals. Over time, free radicals damage accumulates in the cells and strains the fruit, ability to repair itself. Therefore, previous antioxidatives were used to keep fruits in the storage after directly harvest, where induction of natural disease resistance in harvested horticultural crops using physical and /or chemical elicitors has received increasing attention over recent years, it being considered a preferred strategy for disease management, Terry and Joyce (2004).

Accordingly with the hope to prevent storing ripe fruits on trees, this investigation was designed to test the effect of two antioxidants, Salicylic acid and tannic acid on shelf life of Washington navel orange fruits postharvest stored under ambient conditions. Previous studies in this respect reported that applied antioxidants to fruits have received increasing attention over recent years. It is considered a strategy for diseases management. The efficient antioxidant system contributes to delaying the senescence process

at harvest time (Srilaong and Tatsumi, 2003). The antioxidants activity of salicylic acid with peach fruits was indicated by Sticher *et al*. (1997) and Han *et al*. (1997). They reported that preharvest and / or postharvest application of salicylic acid at 2.0 mg/L^{-1} on peach fruits increased the storage period under room temperature conditions (26-30^{o}C) for 10-11 days. Wang *et al*. (2006) with peach fruits that postharvest immersing at different concentrations of salicylic acid for 5 min and then stored at 0^{o}C for 28 days and moved to 20^{o}C for 3 days, found that significantly higher firmness during storage period at the used concentrations of 1.0 mM/l^{-1}.

Preharvest and / or postharvest applications at 2.0 mg/L^{-1} of salicylic acid tended to suppress disease caused by *Alternaria* and *Epicoccum sp* in Geraldton waxflowers cv CWA pink (*Chamelaucium uncinatum*) flowers (Beasley *et al*., 1999). Also, Huang *et al*. (2007) treated Cara cara navel orange (*Citrus sinensis* L. Osbeck) fruit stored at 6^{o}C and 20^{o}C with 2.0 mM/l^{-1} salicylic acid for about 30 min to study the effect of salicylic acid on active oxygen metabolism and the antioxidant system in the pulp, indicated that low storage temperature and exogenous salicylic acid can reduce liquid peroxidation by regulation the antioxidant system, and pretreatment with salicylic acid with lower storage temperature might provide a useful of maintaining beneficial antioxidant activity during storage of Cara cara navel orange. Martin-Diana *et al*. (2008) studied the effect of green tea extract as a natural antioxidant (Tannic acid) at 0.25, 0.5 and 1g/100mL^{-1} on stored fresh-cut lettuce at 20^{o}C temperature; they concluded that there were not significant differences between chlorine and green tea extract at 0.25g/100 mL^{-1} in 20^{o}C.

MATERIALS AND METHODS

This investigation was carried out in two successive seasons 2008 and 2009 to study the effect of some antioxidants on Washington navel orange shelf life under ambient conditions.

Fruit samples were harvested at maturity stage on January 15-20 of 2008- 2009 seasons of study, respectively. The selected fruits were almost of equal volume and apparently insect and pathogen injury free.

They were prepared for the postharvest treatments through a direct washing and complete cleanup with tap water in the orchard and then air dried. The cleaned fruits were divided into 3 replicates 15 fruits each and subjected to 7 treatments, 3 replicates each put in 7 ventilated carton boxes. These boxes were held under ambient conditions at 25$\pm$ 1^{o}C and 75-80 % relative humidity (RH). The postharvest treatments could be explained as follows:

1- Soaking fruits into water at 45^{o}c/30min to serve as control.
2- Soaking fruits into acetyl salicylic acid at 2 mmol L^{-1} solution (45^{o}C/ 30min).
3- Soaking fruits into acetyl salicylic acid at 4 mmol L^{-1} solution (45^{o}C/ 30min).
4- Soaking fruits into acetyl salicylic acid at 6 mmol L^{-1} solution (45^{o}C/ 30min).
5- Soaking fruits into tannic acid at 1 mmol L^{-1} solution (45^{o}C/30min).
6- Soaking fruits into tannic acid at 2 mmol L^{-1} solution (45^{o}C/30min).
7- Soaking fruits into tannic acid at 3 mmol L^{-1} solution (45^{o}C/30min).

Washington navel orange fruits under treatments during storage period were subjected to certain measurements used to evaluate the efficiency of the tested antioxidant on fruit shelf life under ambient conditions. Such measurements included:

1- Total loss in fruit weight: It was measured by recoding fruit weight of each replicate for all treatments under study twice, at the beginning (January 15 and 20) and end (February 17 and 15) of experiment in 2008 and 2009 seasons, respectively. Meanwhile, the decayed fruits in each treatment when reached approximately 50% of total fruit number per treatment, their weight was recorded, and then the total loss was calculated according to the following equations:

$$\text{A- Weight loss of fruits \%} = \frac{\text{Initial weight} - \text{Weight at holding period end}}{\text{Initial fruit weight}} \times 100$$

$$\text{B- Weight of decayed fruits \%} = \frac{\text{Weight of decayed fruits}}{\text{Initial fruit weight}} \times 100$$

C- Total loss in fruit weight percentage:

Total loss % = loss in fruit weight % + decayed fruit weight %

2- SSC % content in fruit juice: It was determined by Hand refracometer at the beginning and end of the experiment.

3- Total titratable acidity: It was determined as g citric acid/100 ml fruit juice according to (A.O.A.C., 1980) at beginning and end of the experiment.

4- SSC/acid ratio: It was determined as ratio between SSC% and acidity % at beginning and end of the experiment.

5- Vitamin C %: It was determined according to A.O.A.C., (1980) as mg/100 ml of fruit juice at beginning and end of the experiment.

The study was designed as complete randomized design and the data were analyzed according to Gomes and Gomez (Mstat ptogram) (1984), and revised LSD value was calculated at 5% level of probability according to Waller and Dunan (1969).

RESULTS AND DISCUSSION

Antioxidants are increasingly important in biological processes. Their traditional role is based on their capacity to neutralize excess free radical which is stole electrons from the molecules that make up genes, proteins and cell membranes can damage in fruit cells. Consequently, if oxidation affects many molecules within a cell, the cell itself may become unable to function properly and could be deteriorated (Kondo *et al*., 2002 and Anat *et al*., 2006).

The antioxidants activity of acetyl salicylic acid and tannic acid at successive concentrations during storage of Washington navel orange at ambient conditions were examined in the present investigation. The effect of such antioxidants on changes in certain fruit characteristics during the storage period was studied. Such effects could be expressed and discussed as follows:

1-Effect of acetyl salicylic and tannic acids on total weight loss of Washington navel orange fruits stored under ambient conditions:

The concerned results in table 1 for loss in fruit weight % indicated that all the tested acetyl salicylic acid (ASA) treatments almost significantly reduced fruit weight loss % compared with the control and among the tested treatments those of ASA at 6 mM/L^{-1} in the first season (6.6%) and ASA at 4 mmol L^{-1} in the second one (7.7%) were the most effective ones to decrease fruit weight loss % during storage period. The control values of both seasons, respectively, 11.3 and 6.8 %. The positive effect of ASA in that respect is attributed to its ability of control respiration rate in fruits which is strongly associated with water loss from the stored fruits. This result greatly agreed with those reported in the study of Zhang *et al*. (2003) on postharvest treatments of Kiwi fruit with acetyl salicylic acid. They attributed the decreasing effect of such antioxidant to low production of 1-aminocyclopropane-1-carboxylic acid oxidase and decreases ethylene production in fruit tissue.

As for tannic acid effect, also all the tested concentrations showed a similar trend to that of ASA one, since they recorded values for fruit weight loss % fewer than the control in the two tested seasons. The most effective treatment in both seasons was that of tannic acid at mmol L^{-1} with the values, respectively, 5.5 and 6.6 %. This finding is in line with the results of Martin-Diana *et al.* (2008) who worked with fresh-cut lettuce treated with green tea extract (excellent source of polyphonols such as tannic acid antioxidants).

Concerning the results of decay fruit loss %, the same table once again revealed that all postharvest treatments of both antioxidants lowered decay percentages significantly than the control which recorded 33.1 and 38.5%, respectively, in 2008 and 2009 seasons. These decreasing effects of treatments on decay fruit loss % are in complete agreement with Zheng and Zhang (2004) who worked with Ponkan mandarin fruits postharvest treated with salicylic acid at 4oo mg/L^{-1}, found that treated fruits gave 3.5% weight loss and 2% decay loss in comparison to control fruits which were recorded 11.0% and 15.5% for fruit weight and decay losses, respectively. Likewise, Yao and Tian (2005) with Sweet cherry fruits came to similar results since they found that postharvest application of salicylic acid reduced disease percentage on fruits stored at 25^{o}C compared with control ones.

According to the results of the above weight loss elements and the concerned ones in table 1, it could be concluded that the total fruits weight loss of Washington navel orange subjected to different treatments of 2 antioxidant acids under ambient conditions for almost one month, obviously decreased by the tested treatments compared with the control fruits.

Such decreasing effect for the tested treatments as an average value of both seasons is in ascending order, tannic acid at 3 mmol L^{-1} (25.1%), tannic acid at 2 mmol L^{-1} (26.1%), tannic acid at 1 mmol L^{-1} (27.9%), ASA at 4 mmol L^{-1} (30.8%), ASA at 6 mmol L^{-1} (31.0%), ASA at 2 mmol L^{-1} (41.5%). The average value for control was 49.9%.

2-Effect of acetyl salicylic and tannic acid on SSC % in juice of Washington navel orange fruits under storage at room temperature:

Data in table 2 clearly proved in both seasons that soaking fruits into tannic acid at 2 mmol L^{-1} for 30 min is the most effective treatment on SSC% in fruit juice during storage period comparing with other treatments under study. It was tabulated the percentages 12.93 and 12.80 % for the two tested seasons, respectively. On the other hand, the treatments of ASA at 2 mmol L^{-1} and 4 mmol L^{-1} caused the best effect in that respect with the values 12.26 and 12.46 % in the first season along with 11.86 and 12.06 % in the second one, respectively. As for the rest treatment, they recorded SSC% of values between these extremes.

Table 1: Effect of acetyl salicylic and tannic acids on total loss elments in weight of Washington navel orange fruits stored under ambient conditions during 2008 and 2009 seasons

Characters. / Antioxidant treatments	Loss elements 2008			Loss elements 2009		
	Weight loss %	Decay loss (%)	Total weight losses (%)	Weight loss %	Decay loss (%)	Total weight losses (%)
ASA at 2 mmol L^{-1}	8.8	31.6	40.4	12.0	30.5	42.5
ASA at 4 mmol L^{-1}	8.0	20.0	28.0	7.7	25.8	33.5
ASA at 6 mmol L^{-1}	6.0	20.3	26.3	11.4	24.3	35.7
Tan at 1 mmol L^{-1}	9.3	18.8	28.1	10.0	17.7	27.7
Tan at 2 mmol L^{-1}	5.5	18.7	24.2	6.6	21.4	28.0
Tan at 3 mmol L^{-1}	9.6	13.2	21.8	13.4	15.1	28.5
Control	11.3	33.1	44.4	16.8	38.5	55.3
RLSD5%	3.3	6.9	5.4	5.8	9.3	8.6

ASA= acetyl salicylic acid, tan= tannic acid

The superiority of tannic acid at 2 mmol L^{-1} treatment to ASA ones is agreed with the results of Srivastava and Dwivedi (2000) on Banana fingers, found that dipping in salicylic acid at 500, 1000 mg/L and kept in plastic containers at room temperature, found that decreased led to a reduce sugar contents by 25-42% for these two concentrations, respectively, compared with the control of banana fingers (without treatment).

3- Effect of acetyl salicylic and tannic acids on acidity % in juice of Washington navel orange fruits stored under ambient conditions:

Table 3 cleared that acetyl salicylic acid at 2 and 4 mmol L^{-1} gave significant decrease in acidity content % of fruit juice at the end of storage period followed by tannic acid at 2 mmol L^{-1} treatment compared with either the other treatments or control one in both seasons of study. The determined values for previous 3 treatments, respectively, were 0.441, 0.448 and 0.517 mg/100ml juice in the first season, whereas such values with the rest treatments including control were ranged from 0.533 to 0.584 mg/100 ml juice in the same season. The corresponding values of the second season were 0.448, 0.405 and 0.512 mg/100ml juice.

Table 2: Effect of acetyl salicylic and tannic acids at different concentrations on SSC % of Washington navel orange fruits under ambient conditions during 2008 and 2009 seasons

Characters. / Antioxidant treatments	SSC% 2008			SSC% 2009		
	SSC at the beginning (%)	SSC at the end (%)	Increment in SSC (%)	SSC at the beginning (%)	SSC at the end (%)	Increment in SSC (%
ASA at 2 mmol L^{-1}	11.8	12.26	+ 3.89	11.0	11.86	+ 7.81
ASA at 4 mmol L^{-1}		12.46	+ 5.59		12.06	+ 9.63
ASA at 6 mmol L^{-1}		12.60	+ 6.77		12.33	+ 12.08
Tan at 1 mmol L^{-1}		12.73	+ 7.88		12.33	+ 12.08
Tan at 2 mmol L^{-1}		12.93	+ 9.57		12.80	+ 16.36
Tan at 3 mmol L^{-1}		12.80	+ 8.47		12.46	+ 13.27
Control		12.53	+ 6.18		11.33	+ 2.99
RLSD5%	---	0.38	---	---	0.69	---

ASA= acetyl salicylic acid, tan= tannic acid

As for the rest treatments, they were ranged from 0.533 to 0.597mg/100ml juice. The results in table 3 generally indicated also that the treated fruits with the two tested antioxidants contained acidity % in their juice at the end of storage period lower than in juice of the control fruits. These results were attributed to that antioxidants reduced the respiration rate relatively resulted in lower organic acids such as citric acid in fruit juice, therefore the acidity % was reduced in treated-fruits after held under ambient conditions.

4- Effect of acetyl salicylic and tannic acids on SSC/acid ratio in fruit juice of Washington navel orange fruits stored under ambient conditions:

According to the concerned values of fruit juice SSC % (Table 2) and acidity % (Table 3) the current juice characteristic was calculated and presented in table 4. From the later Table, it was observed a behavior for the tested treatments very similar to that on acidity %.

The best treatments to calculate SSC/acid ratio with higher values than the rest treatments were ASA at 2 mmol L^{-1} followed by tannic at 2 mmol L^{-1} in the two tested seasons. Such super treatments tabulated, respectively, the ratio values 27.8, 27.8 and 25.0 in the first season, whereas such ratio with the rest treatments including control was ranged from 21.45 to 23.90 in the same season. The corresponding ratios of the second season were 26.47, 29.78 and 25.00. In case of the rest treatments they were ranged from 18.98 to 23.38. Data in table 4 also showed, in general, that fruits under antioxidant treatments their juice had a positive increment on SSC/acid ratio higher than in juice of the control fruits.

Table 3: Effect of acetyl salicylic and tannic acids at different concentrations on acidity % of Washington navel orange fruits stored under ambient conditions during 2008 and 2009 seasons.

Characters. / Antioxidant treatments	Acidity mg/ 100 ml juice 2008			Acidity mg/ 100 ml juice 2009		
	Acidity at the beginning mg/ 100 ml juice	Acidity At the end mg/ 100 ml juice	Decrement in Acidity (%)	Acidity at the beginning mg/ 100 ml juice	Acidity at the end mg/ 100 ml juice	Decrement in Acidity (%)
ASA at 2 mmol L^{-1}	0.642	0.441	- 31.3	0.755	0.448	- 40.7
ASA at 4 mmol L^{-1}		0.448	- 30.2		0.405	- 46.4
ASA at 6 mmol L^{-1}		0.545	-15.1		0.555	- 26.5
Tan at 1 mmol L^{-1}		0.533	-16.9		0.597	- 20.9
Tan at 2 mmol L^{-1}		0.517	-19.5		0.512	- 32.2
Tan at 3 mmol L^{-1}		0.571	-11.1		0.533	- 29.4
Control		0.584	-9.03		0.597	- 20.9
RLSD5%	---	0.052	---	---	0.145	---

ASA= acetyl salicylic acid, tan= tannic acid

Effect of acetyl salicylic and tannic acid on Vitamin C % of Washington navel orange fruits stored under ambient conditions:

The concerned results in table 5 showed insignificant differences among the values of VC content in fruit juice at the of storage period under all the tested treatments in both seasons of study. Regardless to these results, the comparison study concerning the effect of antioxidant treatments and control on this juice characteristic pointed to fruits juice of tannic acid at 2 mmol L^{-1} and ASA at 6 mmol L^{-1} relatively are best to have highest VC content. They tabulated in the first season VC values of 26.14 and 25.57% for tannic acid 2 mmol L^{-1} and ASA at 6 mmol L^{-1}, respectively. The corresponding values of the rest treatments ranged from 24.20 to 24.86 %. As for the second season, these characterized treatments gave VC values of 25.33 and 26.25 %, whereas the rest treatments determined the range values from 23.16 to 24.66 %.

Data in the same comparison also indicated that the next order in that respect was to the treatments of ASA at 4 mmol /L^{-1} and tannic at 1 mmol /L^{-1} with VC values of 24.86 for each of both treatments in the first season along with 24.33 and 24.66 %, respectively, in the second one. These results were in line with Zheng *et al*., (2007) who found that respiration rate decreased and ascorbate peroxidase activity increased in Peach fruits cv. Bayuecui when postharvest treated with 1 and 5 mmol L^{-1} of salicylic acid and stored at room temperature (25^{o}c).

Likewise, Martin-Diana et al., (2008) working on green tea extract at 0.50 and 1g/mL^{-1} as a preservative treatment for fresh-cut Lettuce at 20^{o}c, they found that both used concentrations were succeeded to aviod ascorbic acid loss in fresh-cut lettuce.

Table 4: Effect of acetyl salicylic and tannic acid at different concentrations on SSC/acid ratio in juice of Washington navel orange fruits stored under ambient conditions during 2008 and 2009 seasons.

Characters. / Antioxidant treatments	SSC/acid ratio 2008			SSC/acid ratio 2009		
	SSC/acid ratio at the beginning (%)	SSC/acid ratio at the end (%)	Increment in SSC/acid ratio (%)	SSC/acid ratio at the beginning (%)	SSC/acid ratio at end (%)	Increment in SSC/acid ratio (%)
ASA at 2 mmol L^{-1}	18.87	27.80	+47.44	14.57	26.47	+ 81.66
ASA at 4 mmol L^{-1}		27.80	+49.61		29.78	+ 104.38
ASA at 6 mmol L^{-1}		23.10	+24.04		22.22	+ 52.50
Tan at 1 mmol L^{-1}		23.90	+31.66		20.65	+ 41.73
Tan at 2 mmol L^{-1}		25.00	+37.64		25.00	+ 71.58
Tan at 3 mmol L^{-1}		22.40	+25.68		23.38	+ 60.46
Control		21.45	+19.15		18.98	+ 30.27
RLSD5%	---	3.04	---	---	9.26	---

ASA= acetyl salicylic acid, tan= tannic acid

Table 5: Effect of Acetyl salicylic and tannic acid at different concentrations on Vitamin C content % of Washington navel orange fruits under storage in room temperature during 2008 and 2009 seasons.

Characters / Antioxidant treatments	vitamin C mg/100ml juice 2008			vitamin C mg/100ml juice 2009		
	Vitamin C at the beginning	Vitamin C at the end	Decrement % in vitamin C	Vitamin C at the beginning	Vitamin C at the end	Decrement% in vitamin C
ASA at 2 mmol L^{-1}	30.87	24.75	19.82	30.75	23.16	24.68
ASA at 4 mmol L^{-1}		24,86	19,46		24.33	20.87
ASA at 6 mmol L^{-1}		25.57	17.16		26.25	14.63
Tan at 1 mmol L^{-1}		24.86	19.46		24.66	19.80
Tan at 2 mmol L^{-1}		26.14	15.32		25.33	17.62
Tan at 3 mmol L^{-1}		24.20	21.60		24.16	21.39
Control		24.42	20.89		23.16	24.68
RLSD5%	---	NS	---		NS	---

ASA= acetyl salicylic acid, tan= tannic acid

Considering the previous results obtained in the present investigation, proved the successful application of antioxidants, acetyl salicylic and tannic acids to prevent or reduce weight and decay losses in the postharvest treated fruits of Washington navel orange stored under ambient conditions almost for one month. Moreover, such treatments were succeeded to maintain the held fruits in a good quality as they increased SSC %, decreased acidity %, increased SSC/acid ratio and relatively increased VC in fruit juice. This positive effect of antioxidant treatments in this respect could be lead to delay the treated fruits to reach senescence stage early. Consequently, shelf life

prolongation of such fruit under ambient conditions and so increase the marketability of Washington navel orange fruits for local market or exportation.

It may be interesting to record herein that among the tested treatments that used tannic acid at 2 mmol L^{-1} to postharvest treated fruits before storage generally is consider the most effective in this respect. It kept most fruit and juice characteristics measured in better qualities. The obtained results pointed to acetyl salicylic acid at 4 and 6 mM/L^{-1} as the next order with partial positive effect on some of these characteristics.

REFERENCES

Anat, S., Golubowicz, S., Yablowicz, Z., Grossman, S., bergman, S., Gottlieb, H.E., Altman, A., Kerem, Z. and Flaishman, M.A. (2006). Antioxidant activities and anthocyanins content of fresh fruits of common Fig (*Ficus carica* L.). J. Agric. Food Chem. 54 (20): 7712- 7723.

A.O.A.C. (1980). Association of Official of Analytical Chemist. 14th ed. Published by A.O.A.C., P.O. ox 540, Washington, 4D.C., USA.

Beasley, D.R., Joyce, D.C. Coates, L. M. and Wearing, A.H. (1999). Effect of salicylic acid treatment on postharvest disease of Geraldton waxflower. In: Proceeding of the 12th Australasian Plant Pathology Conference. Canberra, p. 222.

Gomez,K.N. and Gomez, A. A. (1984).Statistical procedures for agricultural research .John Wiley and Sons, New York, 2nded., 68P.

Han, T., Wang, Y., Li, L. and Ge, X. (2003). Effect of exogenous salicylic acid on postharvest physiology of peach. Acta Horticulture. 628.

Haug, R.H., Liu, J.H., Lu, Y.M. and Xia, R.X. (2007). Effect of salicylic acid on the antioxidant system in the pulp of Cara cara navel orange (*Citrus sinensis* L. Osbeck) at different storage temperatures.

Postharvest Biol. and Technol. Available online at www.sciencedirect.com Kondo, S., Tsuda, K., Muto, N. and Ueda, j. (2002). Antioxidative activity of apple skin and flesh extracts associated with fruit development on selected apple cultivars. Scientia Horticulture. 96(1-4): 177- 185).

Martin-Diana, A. B., Rco, D. and Barry-Ryan, C. (2008). Green tea extract as a natural antioxidant to extend the shelf-life of fresh-cut Lettuce. Innovative Food Sci. and Emerging Technol. 9: 593-603.

Srivastava, M. K. and Dwivedi, N. U. (2000). Delayed ripening of banana fruit by salicylic acid. Plant Science. 158: 87- 96.

Srilaong, V. and Tatsumi, Y. (2003). Changes in respiratory and antioxidative parameters in cucumber fruit (*Cucumis sativus* L.) stored under high and low oxygen concentrations. J. of the Japanese Society for Horticultural Science. 72: 525- 532.

Sticher, C., Mauch-Mani, B. and Metraux, J. P. (1997). Systemic acquired resistance. Ann. Rev. Phytopathol. 35: 235- 270.

Terry, L. A. and Joyce, D. C. (2004). Elicitors of induced disease resistance in postharvest horticulture crops: a brief review. Postharvest Biol. And Technol. 32: 1-13.

Waller, R.A. and Dunan, D. B. (1969**)**. A ways rule for the symmetric multiple Comparison problems. J. Amer. Assoc., 64:1484-1503.

Wang, L., Chen, S., Kong, W., Li, S. and Archold, D. D. (2006). Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peaches during cold storage. Postharvest Biol. and Technol. 41: 244-251.

Yao, H. and Tian, S. (2005). Effect of pre-and postharvest application of salicylic acid or methyl jasmonate on inducing disease resistance of Sweet cherry fruits in storage. Poathavest boil. and Technol. 35: 253-263.

Zhang, Y., Chen, K., Zhang S. and Ferguson, I. (2003). The role of salicylic acid in postharvest ripening of Kiwifruit. Postharvest Bio. and Techno. 28: 67- 74.

Zheng, X., Tian, S., Meng, X. and Li, B. (2007). Physiological and biochemical responses in peach fruit to oxalic acid treatment during storage at room temperature. Food Chemistry. 104: 156-162.

Zheng, Y. and Zhang, Q. (2004). Effect of polyamines and salicylic acid on postharvest storage of Ponkan mandarin.

تأثير الإضافة الخارجية لمضادات الآكسدة على إطالة العمر التخزينى لثمار البرتقال بسرة تحت ظروف بالغرفة.

محسن فهمى محمد مصطفى

قسم الفاكهة- كلية الزراعة- جامعة المنصورة

أجريت تجربة على ثمار برتقال بسرة بعد الحصاد مباشرة بإستخدام مضادين للأكسدة هما حمض السلسيلك آسيتيل بتركيزات من٢، ٤، ٦ مليمول/ لتر وحمض التانيك بتركيزات من ١ ، ٢، ٣ مليمول/لتر، حيث تم نقع الثمار بعد الجمع مباشرة لمدة فى المحاليل السابقة لمدة ٣٠ دقيقة، وخزنت تحت ظروف الغرفة وذلك لدراسة تأثير هذه المعاملات على إطالة فترة حياة الثمار بعد الحصاد.

وقد اوضحت النتائج المتحصل عليها ما يلى:

١- أدت المعاملة بحمض السلسيلك آسيتيل كمعاملات بعد الحصاد بتركيزات ٤، ٦ مليمول/ لتر وحمض التانيك بتركيز ٢ مليمول/ لتر لتقليل النسبة المئوية للفقد فى الوزن، والثمار التالفة، وبالتالى الوزن الكلى المفقود بعد إنتهاء فترة التخزين.

٢- أظهرت المعاملة بحمض التانيك كمعاملات ما بعد الحصاد بالمقارنة بالمعاملات الأخرى بما فيها الكنترول ذيادة معنوية فى محتوى المواد الصلبة بعصير الثمار، أما المعاملة بحمض السلسيلك آسيتيل بعد الجمع بتركيزات ٢، ٤ مليمول/ لتر أدت لتقليل نسبة الحموضة فى عصير الثمار بعد إنتهاء فترة التخزين بالمقارنة بالمعاملات الأخرى بما فيها الكنترول.

٣- أدت المعاملات بحمض التانيك بتركيزات ١،٢ مليمول/ لتر والسلسيليك آسيتيل بتركيزات ٦، ٤ مليمول/ لتر إلى تقليل الفقد فى محتوى الثمار من فيتامين ج بالمقارنة بالكنترول بعد إنتهاء فترة التخزين.