J. Agric. Sci. Mansoura Univ., 34 (12): 11301 - 11310, 2009

ASCORBIC ACID AND TISSUE BROWNING IN MANGO CV HINDI BE-SENNARA FRUITS (*Mangifera indica* L.) UNDER COLD STORAGE

Arafat, L. A.
Pomology Department, Faculty of Agriculture, Mansoura University 35516 Box, El-Mansoura, Egypt +20-10-9036059 +20-50-2220812
E-mail: Loay_arafat@mans.edu.eg Web: www.mans.edu.eg

ABSTRACT

This study was conducted to find out the relationship between ascorbic acid (AA), and internal browning (IB) incidence in Hindi Be-sennara mango fruits (*Mangifera indica* L.) during cold storage (4ºC). Ascorbic acid content in two main parts (stem and calyx end of fruit) and three sub-main parts (peels, inner and outer pulps) of the fruits were measured. Internal browning in mango fruits found to be dependant on the fruit AA content. Exogenous application of AA (5.6 mM) decreased IB incidence when the fruits immersed for 24 hour compared to these immersed in water for the same time and stored at ambient conditions for 35 days. Mango fruits pre-storage immersing in diluted AA (5.6 mM), water is absorbed throughout the peel cells causing an increase on AA content and a decrease on its concentration. The decrease of IB incidence was appeared due to such increase on AA content in inner and outer parts of the fruit. This protection of the treated fruits may be related to the consumption of the externally added AA. Therefore, it could be said that the application of AA increases mango fruit quality, through protecting the from development of IB, also, the obtained results indicated that such treatment maintain the total phenols (TP) content in fruits during cold storage constant.

INTRODUCTION

Internal browning (IB) is considered to be an endogenous brown spot or black heart. It is one of the most important physiological disorders against many fruits such as pears (Veltman *et al*., 2000), apples (Gonzalez *et al*., 2001), peaches (Selvarajah *et al*., 2001), which is considered a limiting factor in fruit storage and marketing life. Prolonged cold storage period may promotes some alternative physiological changes to cell wall composition and structure, mostly due to enzymatic modification of the phenolic compounds (Franck *et al*., 2007). The mechanism of IB, is due to the enzymatic oxidation of phenolic compounds by polyphenoloxidase enzyme (PPO) to *o*-quinones. The latter compounds are very reactive to form internal brown, colour (Selvarajah *et al*., 2001). Initially browning reaction is catalyzed by PPO, using O_2 as co-substrate. The important factors involved in enzymatic browning are the phenolics concentration, the PPO activity and other factors such as L-Ascorbic acid (AA) which is able to convert *o*-quinones back to diphenols and peroxidases (Franck *et al*., 2007). Therefore, the causes of browning must be thought in the processes which affect the membrane integrity. The balance among the production of harmful reactive oxygen species (ROS), the efficiency of the antioxidant system and the available energy is of great importance for maintenance plant cell healthy (Foyer and Noctor, 2003).

Ascorbic acid can prevent some physiological disorders such as superficial scald in apple fruits, as well as, it has been effective to maintain a number of important quality characteristics; berry firmness, soluble solids, acidity, freshness and may reduce fungal decay (Agar *et al*., 1990). Due to its principal importance, it is widely used in the fruits processing industry, and there is a need to preserve the original AA in fruits during long-term storage and shelf-life period (Chinoy, 1984).

Several investigations have been published on the role of the antioxidant system, in particular, AA in the development of browning disorders (Franck, *et al*., 2007). The general hypothesis is that AA can protect and play apparent role against browning so that browning does not occur unless the AA concentration reaches below a certain threshold value. The function of AA is done as an antioxidant alone or/and in combination with other antioxidant enzymes such as superoxide dismutase, catalase, peroxidase, ascorbate peroxidase and glutathione reductase. The combined action of these enzymes guarantees the neutralization of ROS by converting them towards H_2O (Davey *et al*., 2000). Phenolic substrates also seem to play an ambiguous role with respect to browning disorders, since they protect the fruit by scavenging ROS, but the corresponding brown colored oxidation products are the actual cause of the browning symptoms.

The aim of this study is to minimize the internal browning (IB) of Hinidi Be-sennara mango fruits by treating them with diluted solution of AA prior commence of storage even at low temperature. Also, this aim extends to exploit the physiological roles of AA in fruit cell metabolism and its association them with the biological changes inside fruits to delay IB during storage and prolong storability of mango fruits.

MATERIALS AND METHODS

The present study was carried out in two successive seasons of 2006 and 2007 from trees at 20-year- old growing in sandy soil. The orchard was located in Sharkia Province, El-Sharkia governorate East Egypt. Fruits of Hindi Be-sennara mango cultivar (*Mangifera indica* L.) were harvested in August at fully mature green stages (fruit shoulders were above the stem end) when the average field temperature is reached 38^{o}C (Majeed and Jeffery, 2002).

Experiment I: Ascorbic acid distribution in mango fruit

Samples of twenty fully mature green fruits each were collected in order to set AA mapping of fruit. Fruits in each sample were divided into two main batches (stem and calyx end). Each batch was separated to three sub-main parts, peel, outer pulp (1cm from peel) and inner pulp (1cm from seed), in which AA content was determined (mg per 100 g^{-1} FW) according to the method described by (Rangana, 1979).

1.1. **Experiment II: Ascorbic acid absorption**

The experiment was carried out in order to understand how the initial AA content in fruits is affected when they are treated by diluted solutions of AA. Fully mature green mango fruits (72) were harvested and divided into three equal batches, 24 fruits each. One batch was treated by immersing

fruits in AA solution at 5.6 mM for 24 hr, the fruits in second one were immersed in water for 24 hr at 4°C to be used as the control and the last batch fruits were held at ambient condition. The treated fruits were stored at 4°C for 35 days to follow the IB symptoms. The AA content was determined at three sub-main parts of fruit (peel, outer and inner pulp) and presented as mg 100 g^{-1}FW.

1.2. Experiment III: Effect of ascorbic acid treatment on internal browning incidence

Fruit samples (270 fruits) were selected in August 2007 and divided into three batches to measure IB-index. A batch of 120 fruits were immersed in AA solution at 5.6 mM for different immersing times (6, 12, 18 and 24 hours at 4°C), and other batch of 120 fruits were immersed into water at the same immersing time . The last batch of 30 fruits was held in ambient conditions. The treated fruits in the first two batches were stored at 4°C, and IB incidence was measured at 5-day intervals up to 35 days (storage period).

1.3. Measurements

A visual assessment of internal IB rates was recorded using the method outlined by(Chaplin *et al*., 1991). It was depend on the formation of visible brown spots in fruit core around the fruit seed Total phenol (TP) in the treated fruits were measured spectrophotometrically using the Folin–Ciocalteu reagent with gallic acid as standard (Singleton and Rossi, 1965). The phenols were measured at the wavlength750nm. The results were reported as mg of gallic acid equivalents (GAE) 100 g^{-1} FW.

1.4. Statistical analysis

Data for evaluating of AA, TP and IB index in time were analyzed using analysis of variance (ANOVA). The means were compared using the least significant differences (L.S.D.) at $p \leq 0.05$ level of probability. The statistical software package GenStat ver 11 (Lawes Agricultural Trust, Rothamsted Experimental station, UK) was used.

RESULT AND DISCUSSION

1.5. Ascorbic acid distribution in mango fruits

The results of experiment I, concerned with AA distribution in mango fruits were illustrated in Figure (1). From this figure, it was cleared that AA content (mg per 100 g^{-1} FW), clearly differed between fruits sub-main parts (peel, outer and inner pulp). Apparently, AA shows a significant interaction at $p \leq 0.05$ with respect to main location in fruit (stem and calyx end of fruit) in this experiment. Generally, the AA content in fruit calyx end was higher than in stem end. The fruit peel contained the highest amount of AA compared with outer and inner pulps in both main locations. The outer pulp came to the next order, whereas the inner pulp was the last in at respect. This AA distribution can be attributed to biological behavior changes in AA content were presented among fruit parts at harvest time. Hindi Be-sennara cultivar strongly previously appeared these biological changes of AA content among fruit parts, peel and pulp (Arafat, 2005). It was quantitatively differed due to different parts of fruits.

1.6. Effect of AA treatment on the appearance of internal browning

The concerned results of AA contain in fruit parts were illustrated in Figure (2), a significant interaction at p≤0.05 level of probability between fruit parts and the tested treatments. From this figure, it was cleared that a positive variation in AA content of the three sub-main parts (peel, outer and inner pulp) in fruits subjected to the treatment of storing at ambient conditions, immersing in water and in AA solution for 24hr at 4ºC.

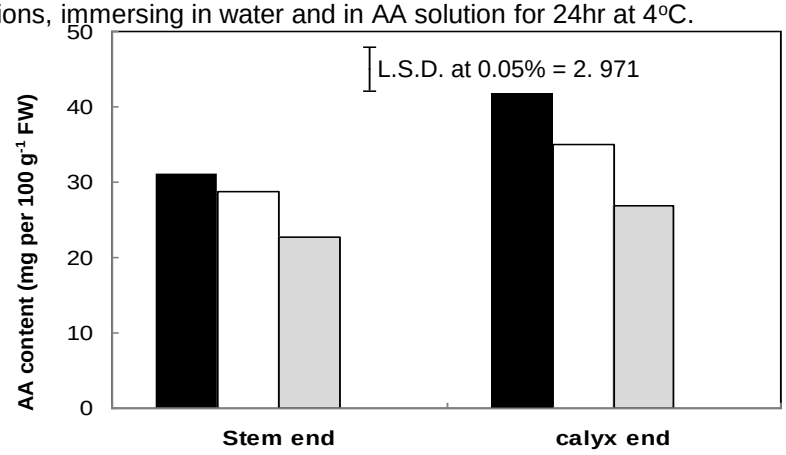

Figure (1): Diagram showing ascorbic acid distributions in the main location (stem and calyx ends) and sub-main parts (■ peel, □outer and ▒inner pulp) of Hindi Be-Sennara mango fruit in fully mature green stage at harvest time. The vertical bar represent the L.S.D. at p=0.05%

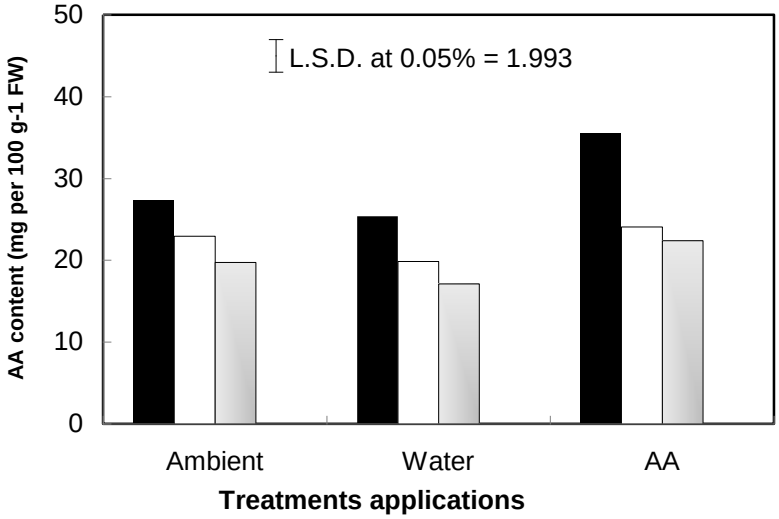

Figure (2): Diagram showing effects of holding fruits at ambient conditions and of pre-storing treatments immersing fruits in water or in AA solution (5.6 mM) for 24 hr stored at 4ºC for 35 days on AA content in sub-main fruit parts (■ peel, □outer and ▒inner pulp) of Hindi Be-Sennara mango fruits. The vertical bar represents the LSD at p=0.05% of an interaction between fruit parts and tested treatment

The fruits under the three tested treatments recoded AA content in their peel higher than in outer or inner pulp. The comparison study on the effect of such treatments, clearly, indicated that pre-storing immersing fruits in water for 24 hr at 4°C lead to an obvious decrease in the peel AA content. Otherwise, an increase was clearly observed in peel of fruits treated with AA solution at 5.6 mM compared to those under water and ambient condition treatments. As for, the outer and inner pulp AA content, slight differences were observed among the fruits under the three tested treatments if compared with differences between peel AA content.

Internal browning index (IB) as presented in Table (1), and the development of IB as illustrated in figure (3) clearly, indicated a significant interaction at $p \leq 0.05$ between storage period and the treatments under the study with respect to IB incidences. Data in table (1) as well as their illustration in figure (3) proved that the incidence of IB were greatly decreased in fruits pre-storing immersing in AA (IB-index = 1.33) if compared with those immersed in water (IB-index =3.87) or holding at ambient conditions (IB-index =4.64) at the end of storage period (35 days). These index values indicated also that fruits immersed in water for 24 hr at 4°C resulted in IB value higher then those under holding at ambient conditions.

The inferiority of immersing in water treatment in that respect can be attributed to a partial dilution on AA content in the treated fruits as a result of water absorption by fruit peel tissues which in turn resulted in AA concentration in this part of fruit. According to Foyer and Noctor (2003) a great decrease on AA content in the peel part of fruit stored at 4oC due to some consumption by reactive oxygen species (ROS).

Table 1: Effect of pre-storing fruit treatments of immersing in water or in AA solution (5.6 mM) for 24 hr and holding in ambient conditions on internal browning incidence in Hindi Be-Sennara mango fruits stored at 4°C for 35 days.

Treatments	Storage period (days)							
	0	5	10	15	20	25	30	35
Ascorbic acid	1.00	1.00	1.00	1.00	1.00	1.02	1.17	1.33
Ambient air	1.00	1.00	1.00	1.13	1.24	1.91	2.62	3.87
Water	1.00	1.00	1.00	1.27	1.56	2.02	3.13	4.64
*L.S.D. at 5%	-	-	-	0.14	0.27	0.4	0.27	0.37

Thereafter, less AA content falls to be functioning as an antioxidant then the oxidation reaction increases and it leads to loss cell membrane integrity cussing browning reaction processes (Möller, 2001). It is a point of interest to report herein the suggestion of Brummell *et al*., (2004) and Foyer and Noctor (2003) that the damage in tissue of fruit core and cell death by ROS reactions is related to internally activated physiological processes. In the same line, (Franck *et al*., 2007) reported that the ROS reaction would altered the physical and chemical properties of cell membrane that in turn leads to an alteration in the cellular mechanism and afterword IB incidences is accelerated in fruit

On the other hands, the superiority of AA treatment over the others is a result of pre-storing immersing fruits in AA solution significantly increased the level of AA in fruit peel and other sub-main parts it compared with the other to treatments (Figure 2). Therefore, the consumption of AA due to scavenger ROS is slightly lesser in the stored fruits at 4^{o}C and its levels are still sufficient to be function as antioxidant. Consequently, the oxidative reactions are decreased keeping the cell membrane integrity which in suppressed browning reactions. Accordingly, it can be said that the fruit response toward the tested various treatments depends on the rate of AA consumption against oxidative reactions, in the present experiment, it can be referred to two sources of AA which usually is produced and consumed via physiological processed in fruits ad the exogenous AA applied through the treatment. The later some partially is consumed during storage period. The fruit can only creates AA when the natural AA is consumed. The addition of exogenous AA may be increased the ability of AA to convert *o*-quinones (main compound of IB) back to diphenols and peroxidases (Franck *et al*., 2007).The fact that natural antioxidants especially AA play a key role in IB resistance in certain fruits and mangoes are one of them (Veltman et al., 2000).

Considering the different immersing times 0, 6, 12, 18 and 24 hr, the concerned results in Table (2) showed that fruits of AA treatment at the successive immersing in water treatment for the same times. These values of the IB-index treatment were 2.22, 1.76, 160 and 1.13 for 6, 12, 18 and 24 hr respectively at 35 day storage period. Te corresponding values of the later treatment were 3.44, 3.73, 3.87 and 4.64. During this part of study, it was cleared that IB symptoms incidence depend on immersing and storage periods. These appearance were started at 10 days of storage period in fruits of immersing in water treatment for while, this appearance in case of AA treatment (immersing for 24 hr) was less pronounced different time with special emphasis to 24 hr period and delayed by 10 days more. Such symptoms were considered through the formation of visible brown spots around the fruit seed.

Internal browning is a phenomenon which is related to the AA content of the fruit (Franck *et al*., 2007). The effect of AA treatment on the IB incidence which is often observed in Hindi Be-sennara fruits as presented in (Table 2). It can be seen that the IB in Hindi fruits is significantly reduced when this fruits are treated with diluted AA solution. In the current experiment, the treatment of mango fruits by diluted solution of AA which was delayed the occurrence of IB symptoms. Greatly confirmed that AA content in fruit is considered one of the factors affecting IB (Manganaris *et al*., 2006). Low IB incidences were observed in fruits immersed 24 h compared with other immersing periods (0, 6, 12 and 18 hr). The exogenous applied AA to fruit causes more quenching to ROS which is generated during storage at low temperature (Foyer and Noctor, 2003). Also, it protect functionally cell membrane integrity with other enzymatic antioxidants (Franck *et al*., 2007), then low incidence of IB in fruits during storage. On the hands, the treated fruits with water were presented more incidence of browning. This may be caused by the fruit AA content diluted during immersed treatment.

Consequently, increased IB symptoms (Figure 3) compared with fruit hold at ambient conditions.

Table 2: Internal browning index values in mango fruits pre-storage immersing in ascorbic acid solution (AA) and in water at 4ºC for four successive periods (0, 6.12, 18 and 24 hr) and storage time (days) at $p \leq 0.05$ as to internal browning index.

Treatment	Immersing time	Storage time (days)							
		0	5	10	15	20	25	30	35
Ascorbic acid	0 hr	1.00	1.00	1.00	1.13	1.42	1.91	2.62	3.86
	6 hr	1.00	1.00	1.00	1.07	1.16	1.33	1.98	2.22
	12 hr	1.00	1.00	1.00	1.04	1.09	1.16	1.49	1.76
	18 hr	1.00	1.00	1.00	1.00	1.09	1.11	1.16	1.60
	24 hr	1.00	1.00	1.00	1.00	1.00	1.02	1.07	1.13
Water	0 hr	1.00	1.00	1.00	1.13	1.42	1.91	2.62	3.86
	6 hr	1.00	1.00	1.00	1.16	1.24	1.56	2.38	3.44
	12 hr	1.00	1.00	1.00	1.18	1.29	1.56	2.62	3.73
	18 hr	1.00	1.00	1.00	1.22	1.38	1.98	2.73	3.87
	24 hr	1.00	1.00	1.00	1.27	1.56	2.06	3.13	4.64
	LSD at 5%	**0.16683**							

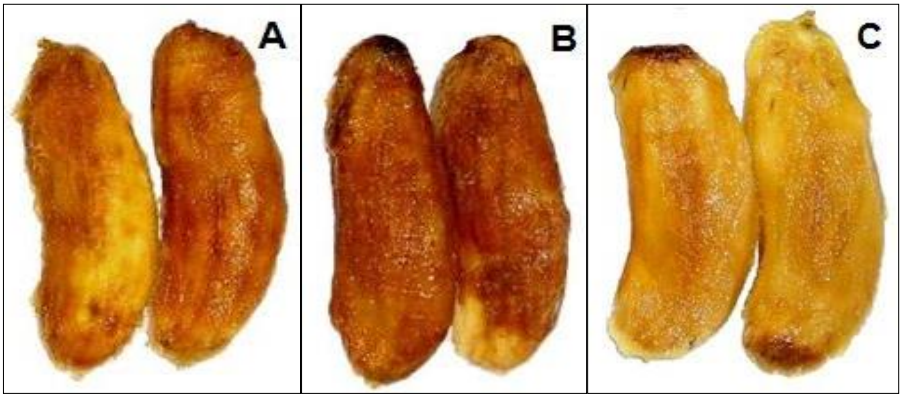

Figure (3): Photograph of vertical sections represent the internal browning incidence in Hindi Be-Sennara mango fruits under the treatment of holding at ambient conditions (A), pre-storing immersed in water (B) and in AA solution at 5.6mM (C)for 24 hr at 4ºC.

1.7. Total phenols

Total phenols content in fruit immersed in AA solution at 5.6 mM for 24 hr was significantly higher than that observed in other immersing periods (Table 3). However, increasing treatment period in water increased losses of total phenols. The highest decreases were at 24 hours immersing in water compared with AA application during the storage period, although, some fluctuations were observed during the whole period. Ascorbic acid treatment of 24 hr was 79.82 mg exhibited a minimum reduction in total phenol levels, showing less decreases than control (0hr immersing; 25.9 mg) and more reduction with water treatment with all durations at the end of the storage.

Phenols are previously determined their distribution in fruits and vegetables. Their beneficial effects on health have been indicated in several studied indicated that. The control (0hr immersing in water or AA) showed appreciable browning after 15 days of storage and increased rapidly up to

the end of storage period. However, IB was delayed with AA treatment (24 hr; immersing) at 30th day of storage and it was shafted due to treatment duration (0hr and 6hr, at 15th day; 12hr, at 20th day; and 18hr, at 25th day). The mechanisms involved in browning inhibition by antioxidants may due to an indirect effect on PPO activity, where AA reduces *o*-quinones formation from diphenols (Hu and Jiang, 2007). This is the major benefit of immersing fruits pre-storing into AA solution. This treatment has been succeeded with different fruit, such as pineapple, banana and mangoes *(González-Aguilar et al.*, 2008)

Table 3: Total phenol values in mango fruits pre-storage immersing in ascorbic acid solution (5.6mM) and water at 4^{o}C for four successive period at 5 day intervals till 35 days storage period at 4^{o}C.

Treatments	Immersing time	Total phenol at storage time (days)							
		0	5	10	15	20	25	30	35
Ascorbic acid	0 hr	49.79	58.04	45.28	40.77	38.82	31.41	31.13	25.99
	6 hr	51.30	63.51	62.62	61.07	61.64	61.74	61.64	59.24
	12 hr	56.74	67.16	75.75	72.15	69.39	72.81	70.09	66.45
	18 hr	52.92	76.11	77.02	80.63	81.20	83.17	78.14	71.18
	24 hr	56.51	85.05	88.99	84.81	87.98	88.47	89.55	79.82
Water	0 hr	49.79	58.91	46.46	29.00	39.68	31.03	33.56	26.17
	6 hr	51.30	51.34	45.86	44.62	41.21	38.05	33.56	29.81
	12 hr	56.87	56.53	41.08	39.44	35.72	32.01	25.69	19.72
	18 hr	52.92	46.06	44.80	41.34	38.07	38.09	31.57	21.99
	24 hr	56.51	40.54	35.73	36.16	33.58	28.87	19.21	17.74
	LSD at 5%	**6.813**							

.

Conclusion

According to the limited published investigation on the treatments that can minimized IB incidence in mango fruits and the fact that natural antioxidants play a key role in that respect (Veltman *et al*., 2000), the present study was designed. The obtained results confirmed the successful application of exogenous AA (antioxidant) at 5.6 mM to reduce and delay the incidence of IB in fruit of mango cv. Hindi Be-Sennara. Pre-storage immersing such fruits in AA solution for 24 hr at 4^{o}C delayed the incidence of IB up to 30 days, whereas non-treated fruits rapidly appeared IB at 15 days during storage period (35 days). The same results also indicated that the main effect of such treatment is appearing the phenol compounds in the treated fruits from oxidation processes during storage period. This can be attributed to the increase of endogenous AA content in the sub-main parts of fruit (peel, outer and inner pulp).

The mechanism of AA treatment and the biological activity of bioactive compounds remaining IB in minimum incidence during storage mango fruits prolonging period are still unknown and needs further studies to be explained. But in the current research the success of pre-storage AA treatment to prolong storage period of mango fruits and it can be extended to treat other fruits is of a great economic value in the marketability of mango fruits and others.

REFERENCES

Agar, I.T., Garcia, J.M., Miedtke, U. and Streit, J. (1990). Effect of high CO_2 and low O_2 concentration on the growth of *Botrytis cinerea* at different temperatures. *Gartenbauwissenschaft*, 55, 219-222.219-222

Arafat, L.A. (2005). Chilling injury in mangoes. *Ph.D. Thesis. Wageningen University.*, The Netherlands, ISBN:90-8504-309-3, 1-224.1-224

Chaplin, G.R., Cole, S.R., Landrin, M., Nuevo, P.A., Lam, P.F. and Graham, G. (1991). Chilling injury and storage of mango (*Mangifera indica* L.) held under low temperatures. *Acta Horticulturae*, 291, 461-471.461-471

Chinoy, J.J. (1984). Enzymes involved in oxidation of ascorbic acid. In:NJ Chinoy (Editor), The Role of Ascorbic Acid in Growth, Differentiation and Metabolism of Plants. Matinus Nijhoff/ Dr. W. Jank Dordrecht. 81-89.81-89

Davey, M.W., Van Montagu, M., Inzé, D., Sanmartin, M., Kanellis, A., Smirnoff, N., Benzie, I.J.J., Strain, J.J., Favell, D. and Fletcher, J. (2000). Plant L-ascorbic acid: chemistry, function, metabolism, bioavailability and effects of processing. *J. Sci. Food Agric.*, 80, 825-860.825-860

Foyer, C.H. and Noctor, G. (2003). Redox sensing and signalling associated with reactive oxygen in chloroplasts, peroxisomes and mitochondria. *Physiologia Plantarum*, 119, 355-364.355-364

Franck, C., Lammertyn, J., Ho, Q.T., Verboven, P., Verlinden, B. and Nicolai, B.M. (2007). Browning disorders in pear fruit. *Postharvest Biol. Technol.*, 43, 1-13.1-13

González-Aguilar, G.A., Celis, J., Sotelo-Mundo, R.R., de la Rosa, L.A., Rodrigo-Garcia, J. and Alvarez-Parrilla, E. (2008). Physiological and biochemical changes of different fresh-cut mango cultivars stored at 5^{o}C. *Int. J. Food Sci. Technol.*, 43, 91–101.91–101

Gonzalez, J.J., Valle, R.C., Bobroff, S., Biasi, W.V., Mitcham, E.J. and McCarthy, M.J. (2001). Detection and monitoring of internal browning development in 'Fuji' apples3using MRI. *Postharvest Biol. Technol.*, 22, 179-188.179-188

Hu, W. and Jiang, Y. (2007). Quality attributes and control of fresh-cut produce. *Stewart Postharvest Rev.*, 3, 1–9.1–9

Majeed, M. and Jeffery, K.B. (2002). Reduction of chilling injury in " Tommy Atkins' mangoes during ripening. *Scientia Horticulturae*, 95, 297-308.297-308

Manganaris, G.A., Vasilakais, M., Diamantidis Gr. and Mignani, I. (2006). Cell wall physicochemical aspects of peach fruit related to internal brakdown symptoms. *Postharvest Biol. Technol.*, 39, 69-74.69-74

Möller, I.M. (2001). Plant mitochondria and oxidative stress: electron transport, NADPH turnover and metabolism of reactive oxygen species. *Ann. Rev. Plant Physiol. Plant Mol. Biol.*, 52, 561-591.561-591

Rangana, S. (1979). Manual of analysis of fruit and vegetable products. Tata McGraw-Hill, New Dehi,.

Selvarajah, S., Bauchot, A.D. and John, P. (2001). Internal browning in cold-stored pineapples is suppressed by a postharvest application of 1-methylcyclopropene. *Postharvest Biol. Technol.*, 23, 167-170.167-170

Singleton, V.L. and Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic–phosphotungstic acid reagents. *Am. J. Enol. Vitic.*, 16, 144–158.144–158

Veltman, R.H., Kho, R.M., Van Schaik, A.C.R. and Sanders, M.G. (2000). Ascorbic acid and tissue browning in pear (*Purus communis* L.cvs Rocha and Conference) under controlled atmosphere conditions. *Postharvest Biol. Technol*, 19, 129-137.129-137

حمض الاسكوربيك و التلون البنى فى ثمار المانجو صنف الهندى بسنارة تخت التخزين البارد

لؤى عبد الطيف عرفات
قسم الفاكهة – كلية الزراعة – جامعة المنصورة

أجريت هذه الدراسة على معاملات ما بعد الحصاد خلال موسمى ٢٠٠٦ – ٢٠٠٧ على ثمار المانجو صنف الهندى بسنارة المنزرعة بمزرعة خاصة بمحافظة الشرقية بهدف دراسة ظاهرة التلون البنى التى تظهر داخل ثمار المانجو اثناء التخزين كاحد الاثار السلبية للتخزين على درجات حرارة منخفضة لفترات طويلة والتى تعد احد المشكلات التى تواجة هذه العملية لهذا الصنف، وقد تمت هذه الدراسة من خلال سلسلة من التجارب المعملية:

(١) التجربة الاولى أجريت بهدف دراسة الاختلافات البيولوجية و توزيع تركيزات حمض الاسكوربيك فى مناطق مختلفة من الثمرة (الطرف الزهرى و الطرف الساقى وكذلك القشرة و اللحم الخارجى و الداخلى).حيث وجد ان تركيز حمض الاسكوربيك فى الطرف الزهرى اعلى بدرجة معنوية عن الطرف الساقى و كذلك القشرة اعلى من طبقتى اللحم الخارجى و الداخلى.

(٢) التجربة الثانية و تهدف الى دراسة الاختلافات البيولوجية الكمية من تركيز حمض الاسكوربيك فى اجزاء ثمار المانجو المختلفة للوقوف على اهمية حمض الاسكوربيك فى التقليل من ظهور اعراض التلون البنى وقد اجريت هذه التجربة على ثمار مانجو كاملة النضج Full mature حيث تم معاملتها قبل التخزين بالنقع فى محلول حامض الاسكوربيك (٥,٦ مللى مول) لمدة ٢٤ ساعة على درجة حرارة ٤٥م والنقع فى الماء لنفس الفترة ودرجة الحرارة و تركت للتخزين بدون اى معاملات. و اظهرت النتائج التى تم التحصل عليها ان معاملة حامض الاسكوربيك قللت من شدة حدوث ظاهرة التلون البنى فى الثمار و اخرت ظهور الاعراض الى اليوم ٣٠ من التخزين بدرجة معنوية عن باقى المعاملات الاخرى و ذلك من خلال المحاظة على عدم اكسدة المركبات الفينولية المرتبطة بظاهرة التاون البنى فى الثمار.

(٣) التجربة الثالثة وتهدف الى دراسة افضل فترة نقع لمعاملة الثمار بحمض الاسكوربيك ودراسة فترات النقع (٠ – ٦ – ١٢ – ١٨ -٢٤ ساعة) على درجة حرارة ٤٥م وأيضا النقع فى الماء و التخزين بدون اى معاملات، وقد اظهرت النتائج ان افضل فترة نقع للثمار فى محلول حامض الاسكوربيك هى ٢٤ ساعة حيث قللت من ظهور التلون البنى فى انسجة الثمار الى اليوم ٣٠ من التخزين على درجات حرارة منخفضة.

النتائج المتحصل عليها من خلال هذه الدراسة و التى توصى بنقع الثمار المانجو الهندى بسنارة كاملة النضج فى محلول حمض الاسكوربيك بتركية ٥,٦ مللى مول لمدة ٢٤ ساعة لتقليل من حدوث التلون البنى فى الثمار خلال فترة التخزين لمدة ٣٠ يوم على درجة حرارة ٤ م مما يؤدى الى اطالة فترة التخزين و بجودة عالية و يساعد على مد فترة التسويق مما يوفر عائد اقتصادى عالى للثمار.

قام بتحكيم البحث

أ. د/ لطيف جرجس سمعان — **كلية الزراعة – جامعة المنصورة**
أ. د/ سمير زكي العجمي — **كلية الزراعة – جامعة أسيوط**