J. Plant Production, Mansoura University Vol.1 (10): 1409 - 1418, 2010

INFLUENCE OF MANGO MATURITY AND LOCATION ON ITS BEHAVIOR DURING COLD STORAGE

Lo'ay, A. A.
Pomology Dept., Fac. Agric., Mansoura Univ. El-Mansoura, Egypt
E-mail: Loay_arafat@mans.edu.eg Web: www.mans.edu.eg

ABSTRACT

This investigation was carried out during 2006 and 2007 on two mango cultivars 'Ewais' and 'Hindi Be-Sennara' to study the effect of two stage maturity, half mature (M2) and full mature fruit (M3) which were harvested from three different locations (sunny, shadow and inside tree) on fruit behavior during prolong cold storage at 4°C. Both CVs present different responses during storage period. Since, Ewais CV presents more injuries than Hindi Be-Sennara especially with M3 compared to M2 for both CVs at chilled temperature. Increased, chilling injury symptoms of M3 fruits which were harvested from sunny side of tree than the same fruit that harvested form shadow and inside tree. The profits of these differences by which can be classified fruits into three classes according to fruit position on tree. The Full mature fruits which were harvested from sunny side of tree were more sensitive to low storage temperature compared other fruits harvested from shadow and inside of trees.

INTRODUCTION

Mangoes, the fruit of the tropical tree *Mangifera indica*, have a global production which place them amongst the ten most important fruits in the world (Saúco, 2002). However, in contrast to other major fruits such as apples, pears or various species of citrus (Kader, 2002). Many various problems encountered throughout the fruit chain as a whole. The practical problems relation to fruit are conveniently classified into those which are largely pre and post-harvest (Litz, 1997). The important is pre-harvest factor such as: production seasons are short, variable maturation, irregular flowering and fruiting and fluctuation in yield which are affected fruit behavior after harvesting. These factors are transportation, handling, packaging and retailing (Hodges, *et al.*, 2004). So, during handling many physiological processes were occurred such as oxidative stress of fruits. Post-harvest phase has been associated with pre-harvest factors which is generated (Hodges, 2003). Oxidative stress occurs when the generation of active oxygen species (AOS) exceeds the capacity of the fruit to maintain cellular redox homeostasis (Foyer and Noctor, 2003) or, more simply, when the production of AOS exceeds the capacity of the fruit to scavenge them. Lipids, proteins, carbohydrate, and nucleic acids are all targets of AOS (Hodges, 2003).

Development of appropriate post-harvest technologies for mangoes has been only poorly studied. This results in problems in fruit chains during marketing of mangoes and thus less profit and restricted export opportunities for mango producers (Lo'ay, 2005).

This study will investigate how fruit locations on tree and maturation at harvest time affect post-harvest behavior of fruits for two mango cultivars Hindi Be-Sennara and Ewais during cold storage, even the ability to classify fruits for minimizing fruit losses during handling and marketing.

MATERIALS AND METHODS

Fruits from two mango (*Mangifera indica* L.) cultivars, Hindi Be-Sennara and Ewais, were harvested on August 2006 and 2007 from trees more than 20 years old growing in sandy soil. The orchard was located in Sharkia province, east Egypt (30.35 *N* and 31.30 *E*). Fruits were harvested at two harvest maturity stages (half, M2 and full mature, M3) from three positions on the tree (sunny, shadow side and inside tree) when the average filed temperature was 38°C. The maturity stages were classified as half-mature (M2) and fully mature (M3),according to morphological development of fruit shoulder (Kader, 2002). The fruits were collected and washed with water at 10-13°C to reduce both fruit temperature and the microbial load on the fruit surface.

Storage condition

The 480 fruits were divided into two groups, the 240 fruits were divided in three batches for non-destructive measurement (chilling injury index); each one was composed of 120 Hindi and 120 Ewais fruits (60 fruits of each maturity stage from three positions on the tree). The Destructive measurements were measured on two mango cultivars 120 fruits for Hindi, 120 for Ewais fruits, with 60 fruits of each maturity stage from three positions. 20 fruits of each position were picked every 5 days intervals for measuring chemical compositions. Fruits were stored at low temperature 4°C and RH 90±5 for 35 days.

Chilling injury index

A visual assessment of external peel damage, such as pitting, water soaked areas is often used to assess chilling injury. The method requires that from a batch are scored for injury according to following scale: 0 = No damage (ND); 1 = very light damage (VLD); 2 = Light damage (LD) (< 5% area affected); 3 = Moderate damage (MD)(6-25% surface affected); 4 = Severe damage (SD)(26-50% surface affected) and 5 = Very Severe damage (VSD) (>50% surface affected). The CI-index is then calculated using the following formula (Hakim, *et al.*, 1999.Lo'ay, 2005):

CI index = (1*FN VLD/FN) + (2*FN LD/FN) + (3*FN MD/FN) + (4*FNSD/FN) + (5*FNVSD/FN)

Where VLD, LD, MD, SD and VSD were the percentage of fruits presenting the different degrees of CI and the FN means the total fruits in treatment. The CI index was measured every 5 days up to a maximum of 35 days.

Protein oxidation

Protein carbonyl group was measured according to (Levine, *et al.*, 1994). Precisely weighed mango samples (peel or pulp) of about 2.5 g were ground in a mortar and mixed with 10 ml of 20 mM potassium phosphate buffer (pH 7.0) to extract soluble proteins. The homogenates were then centrifuged at 16000 rpm for 5 min. One ml samples of the supernatant, to which 500 µl of 10 mM 2,4-dinitrophylhydrazine in 2 M HCl had been added, were allowed to stand at room temperature for 1 hour, with vortexing every 10-15 min. 500 µl of 20% trichloroacetic acid was then added and the mixture centrifuged at 11000g for 3 min. The supernatant was removed and the precipitate washed 3 times with 1:1 v/v ethanol/ethyl acetate mixture to

remove any un-reacted dinitrophenol. The sample was then allowed to stand for 10 min before centrifugation after which the supernatant was discarded. The washed precipitated protein was then allowed to dissolve in 0.6 ml guanidine solution (6 M) for 15 minutes at 37°C, after the mixture was centrifuged to remove any undissolved material. Afterwards, the spectrum was measured spectrophotochemically against the complementary blank in case of cured (without sample) samples or against water in case of purified proteins. The carbonyl content of the protein was calculated from the absorbance of the dinitrophenylhydrazone measured at 390nm and assuming an extinction coefficient of 22000 M^{-1} cm^{-1}.

Lipid pre-oxidation

Exactly weighed 2.5 g mango (peel or pulp) samples were ground in a mortar and mixed with 25 ml of 5% (w/v) metaphosphoric acid, 500 µl of 2% (w/v) butylated hydroxyltoluene in ethanol, and finally homogenized by a mixer. The homogenates were filtered and centrifuged at 15000 rpm for 20 min. Then chromogen was formed by mixing 1 ml of the supernatant solution, 100 µl of 2% (w/v) butylhydroxytoluene, 0.50 ml of 1% (w/v) TBA (thiobarbituric acid) in 50 mM NaOH and 0.50 ml of 25% (v/v) HCl, and incubating the reaction mixture at 95°C for 30 min. The reaction blank was prepared by replacing the sample with extraction medium and the control for each sample were prepared by replacing TBA with 50 mM NaOH. The calibration curves made by measuring 1,1,3,3-tetraethyoxypropane (Sigma) in the range 0-2 mM (TBARS) which was equivalent to 0-1 mM malondialdehyde (MDA). Tetraethyoxypropane is stoichiometrically converted into MDA during the acid-heating step of the assay (Iturbe-Ormaetxe, *et al.*, 1998).

Ion leakage percentage

Disks samples (7 mm diameter) of peel and pulp tissue were cut from five different parts of each fruit using a cork-borer. The disks were washed three times in demineralized water and placed in 10 ml 0.4 M mannitol in demineralised water at 24°C for 3h (Hakim, et al., 1999). Electrical conductivity of the aqueous phase was measured using a conductivity meter, after which the tissue samples were killed by heating in water bath at 100°C for 20 minutes. This cooking process allows the release of all electrolytes from the tissue. Once cooled to room temperature the conductivity was re-measured and the relative electrolyte leakage from the uncooked pulp and peel samples was calculated as follows:

$$IL\ \% = \left(\frac{\text{Conductivity after 3 hour}}{\text{Conductivity after boiling}}\right) * 100$$

Statistical analysis

The data were subjected to analysis of variance. Then storage temperature, time, fruit locations, cultivars maturity stages are effect on chilling injury and cell membrane composition (lipid per-oxidation and protein oxidation). The interaction was assessed within the analysis of variance. The comparisons of difference means were undertaken using the least significant differences (LSD) at p=0.05. linear regression analysis and ANOVA were

analyzed at 5% probability level. The statistical software package GenStat 11 (Lawes Agriculture Trust, Rothamsted Experimental Station, UK) was used.

RESULTS AND DISCUSSION

Chilling injury index

Chilling injury index (CI), as function of storage time in days for all fruit positions on trees and the maturity stages of both mango cultivars at storage temperature (4°C) is shown in figure (1).

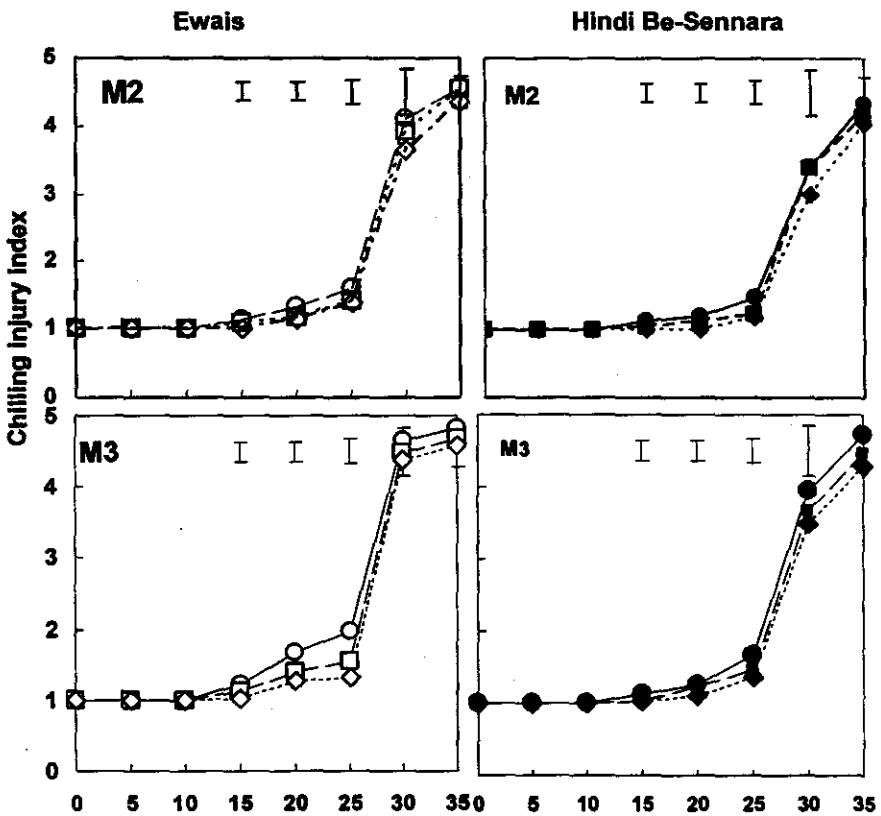

Figure 1: chilling injury index versus storage time of two mango cultivars Ewais and Hindi Be-Sennara harvested at different maturity stages: Half-mature (M2) and full mature fruit (M3) from three different fruit locations on tree: sunny (SYS), shadow (SHS) and inside sides (INS). Symbols represent the fruit locations are (Ewais: -○-, -□- and -◇-) and (Hindi Be-Sennra: -●-, -■- and -◆-). Chilling injury index expressed as mean (n=3). The vertical bars indicated to L.S.D. (*P*=0.05)

CI index shows a significant interaction at $P \leq 0.05$ when storage factors were considered. It is clear that Half-mature stage of fruit (M2) of both cultivars is more resistant to damage compared with full mature stage (M3). Also, fruits were harvested from inside trees of both mango cultivars are more tolerant to injury compared to the fruits harvested from sunny and shadow sides of trees. At storage temperature (4°C), there was no sign for CI on fruits before 10 days of storage time in both maturity stages of both CVs harvested from different locations. The first symptoms that appeared after 10 or 20 days were black spots on the fruit peel. Though prolong storage period from 10 up to 20 days, chilling injury symptoms was slight.

After 20 days differences emerged between the CVs and maturity stages with respect to the fruit locations on tree dependency of damage. At that time, CI developed and differentiated more rapidly in Ewais than Hindi Be-Sennara. The sensitivity of fruit of both CVs was independent of maturity stages and fruit locations on trees. The interpretation of this response is that though low storage temperature generates the oxidative reactions in fruits during long storage period (Lo'ay, 2005). Since the ascorbic acid is an important water antioxidant that scavenge directly active oxygen species under cold stress (Foyer and Noctor, 2003). When, mango fruits contain a different amount of ascorbic acid according to maturity stages, it is more amount in half mature compared with full mature fruit (Kader, 2002). Also different CVs contain different amount of ascorbic acid (Lo'ay, 2005). On the other hand, heat stress on fruits located on sunny side of tree by which ascorbic acid decreased during fruit growth than other locations shadow and inside the tree (Kader, 2002).

Ion leakage percentage (IL %)

Table 1 shows the ion leakage percentage plotted as function of storage time at different fruit maturity stages of both mango cultivars were harvested at low maturity stages (M2 and M3) from three different locations on tree. It is apparent from the figure that fruit peel has less ion leakage compared with fruit pulp. Also, IL% increases with storage duration, but when considered in more details there are some interesting differences between cultivars, maturity stages and fruits locations. IL% had an overall linear or curvilinear increase with time. Leakage from peel of either CV was not strongly affected by temperature in M2 but in M3 stage there was increased fruits location dependency in both CVs. In M3 stage, it was clear that both Ewais and Hindi Be-Sennara, 4°C storage promoted the greatest increases in leakage of fruit located in sunny side than shadow and inside trees.

The next most severe injured by low storage temperature was observed on full M3 fruit on sunny side of tree of both CVs. So, maturity stages and fruit locations had clear affect on the progression of the increase in leakage during storage. It might be explained that chilling temperature damage cell membrane by generating the oxidative reaction and disruption in cell membrane integrity (Purvis, 2004). This dysfunction associated with lipid peroxidation and protein oxidation of cell membrane structure, thereafter, cell death (Toivonen, 2004).

Table 1: Effect of fruit maturaty and location on ion leakage percentage of two *mango* cultivars Hindi Be-Sennara and Ewais stored at 4°C for 35 days

Cultivars	Fruit Mat.	Fruit Pos.	Ion leakage % of fruit pulp during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	36.00	41.00	47.00	48.00	54.00	63.67	79.00	95.00
		SHS	31.00	36.67	40.33	43.67	46.67	52.33	63.67	80.67
		INS	25.00	32.00	35.33	39.00	40.33	45.33	51.67	62.00
	Fully Mature	SYS	43.00	49.33	57.00	65.67	75.33	82.67	87.00	95.33
		SHS	37.00	42.33	47.00	54.33	62.33	68.33	76.67	93.33
		INS	31.00	36.00	38.67	44.00	52.67	60.67	67.00	78.00
Ewais	Half Mature	SYS	34.00	40.00	43.33	49.33	56.33	62.33	72.67	79.00
		SHS	29.00	35.00	38.00	43.00	51.00	53.67	62.33	69.67
		INS	24.00	30.33	34.67	39.00	46.00	48.67	52.33	58.33
	Fully Mature	SYS	44.00	45.00	51.00	62.67	71.67	83.00	91.33	97.33
		SHS	39.00	41.33	44.33	54.33	57.33	67.67	76.33	88.00
		INS	33.00	36.67	38.33	45.67	50.67	60.00	66.67	74.33
LSD at 5% 4.186										
Cultivars	Fruit Mat.	Fruit Pos.	Ion leakage % of fruit peel during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	20.00	25.00	31.00	32.00	38.00	47.67	63.00	79.00
		SHS	18.00	23.67	27.33	30.67	33.67	39.33	50.67	67.67
		INS	14.00	21.00	24.33	28.00	29.33	34.33	40.67	51.00
	Fully Mature	SYS	25.00	31.33	39.00	47.67	57.33	64.67	69.00	87.33
		SHS	21.00	26.33	31.00	38.33	46.33	52.33	60.67	77.33
		INS	18.00	23.00	25.67	31.00	39.67	47.67	54.00	66.67
Ewais	Half Mature	SYS	18.00	24.00	27.33	33.33	40.33	46.33	56.67	63.00
		SHS	16.00	22.00	25.00	30.00	38.00	40.67	49.33	56.67
		INS	13.00	19.33	23.67	28.00	35.00	37.67	41.33	47.33
	Fully Mature	SYS	26.00	27.00	33.00	44.67	53.67	65.00	73.33	82.67
		SHS	23.00	25.33	28.33	38.33	41.33	51.67	60.33	72.00
		INS	20.00	23.67	25.33	32.67	37.67	47.00	53.67	61.33
LSD at 5% 4.345										

Fruit location on tree SYS= sunny side, SHS= shadow side and INS= inside side

Lipid peroxidation (MDA) and protein oxidation (PCG)

Table 2 and 3 show the change of lipid peroxidation and protein oxidation expressed as the concentration of malondialdalyde equivalent (MDA) and protein carbonyl group (PCG), in both mango cultivars which harvested at two maturity stages (M2 and M3) from three different fruit location on trees as a function of storage time In both fruit parts (peel and pulp) of the same fruit. In fact, both MDA and PCG show a significant interaction at $P<0.001$ when the pervious storage factors were considered. In view of, the changes in fruits stored at chilling temperature (4°C) in fruit parts (peel and pulp) either the rate of MDA and PCG accumulation increased as storage time. The accumulation was higher in Ewais than Hindi Be-Sennara fruits as two maturity stages and fruits location on trees. However, M3 presents more accumulation than M2 which were harvested from sunny side of trees compared to shadow and inside sides in both in both fruit parts.

The rate of accumulations was rapidly Increased after day 20 up to end of storage period. Moreover, an interesting aspect was observed that the accumulation of MDA and PCG in peel was less than found in fruit pulp. These responses might be attributed to the oxidative reaction procedures in

stressed fruit. Consequently, a dysfunction of the balances between generating AOS and scavenging them (Hodges, 2003). So, the increases of AOS of stressed fruits, was reacted directly to cell membrane structure (lipids and protein). Therefore lipid peroxidation and protein oxidation generate (Purvis, 2004). A dysfunctional cell membrane might happened thereafter, more losses of membrane functions and more leakage at cell death (Toivonen, 2004). This process could be occurred on fruit that harvested at M3 from sunny side of trees more than shadow and inside trees.

Table 2: Effect of fruit maturaty and location on lipid peroxidation (malondialdalyde equivalent MDA of two mango cultivars Hindi Be-Sennara and Ewais stored at 4°C for 35 days

Cultivars	Fruit Mat.	Fruit Pos.	MDA content of fruit pulp (µM g^{-1} FW) during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	0.38	0.51	0.52	0.56	0.67	0.75	0.88	0.97
		SHS	0.35	0.44	0.47	0.50	0.60	0.64	0.72	0.80
		INS	0.22	0.37	0.42	0.46	0.53	0.60	0.65	0.72
	Fully Mature	SYS	0.38	0.74	1.05	1.16	1.33	1.40	1.38	1.57
		SHS	0.35	0.42	0.48	0.66	0.75	0.97	1.13	1.38
		INS	0.22	0.39	0.44	0.56	0.69	0.82	0.88	1.00
Ewais	Half Mature	SYS	0.65	0.67	0.69	0.59	0.66	0.70	1.07	1.23
		SHS	0.53	0.58	0.65	0.68	0.78	0.80	0.89	0.99
		INS	0.41	0.53	0.58	0.76	0.80	0.87	0.71	0.74
	Fully Mature	SYS	0.65	0.58	0.59	0.70	0.97	1.15	1.19	1.26
		SHS	0.53	0.50	0.56	0.66	0.83	1.00	1.03	1.14
		INS	0.41	0.42	0.52	0.62	0.66	0.71	0.78	0.93
LSD at 5% 0.049										

Cultivars	Fruit Mat.	Fruit Pos.	MDA content of fruit peel (µM g^{-1} FW) during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	0.31	0.47	0.49	0.59	0.63	0.67	0.71	0.75
		SHS	0.31	0.44	0.48	0.54	0.57	0.61	0.65	0.71
		INS	0.31	0.34	0.38	0.41	0.43	0.46	0.56	0.67
	Fully Mature	SYS	0.31	0.49	0.60	0.65	0.73	0.83	1.22	1.34
		SHS	0.31	0.44	0.52	0.61	0.71	0.78	1.02	1.26
		INS	0.31	0.34	0.48	0.56	0.69	0.72	0.76	0.77
Ewais	Half Mature	SYS	0.42	0.41	0.44	0.50	0.52	0.58	0.61	0.69
		SHS	0.42	0.50	0.51	0.55	0.56	0.60	0.64	0.69
		INS	0.42	0.51	0.54	0.58	0.60	0.62	0.67	0.71
	Fully Mature	SYS	0.42	0.47	0.51	0.58	0.65	0.74	0.81	0.97
		SHS	0.42	0.50	0.57	0.63	0.71	0.80	0.87	1.24
		INS	0.42	0.51	0.64	0.72	0.78	0.85	0.98	1.43
LSD at 5% 0.087										

Fruit location on tree SYS= sunny side, SHS= shadow side and INS= inside side

Water loss %

As with other measurements described above the responses of stressed fruits at 4°C which were generally presented different behaviors during storage time. Since the fruit maturation and location were considered (Table 4). In fact the CV Ewais showed higher water loss than Hindi Be-Sennara.

Table 3: Effect of fruit maturity and location on protein oxidation (protein carbonyl group PCG) of two mango cultivars Hindi Be-Sennara and Ewais stored at 4°C for 35 days

Cultivars	Fruit Mat.	Fruit Pos.	PCG content of fruit pulp (mM 100g- FW) during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	0.47	0.60	1.13	1.37	2.30	2.95	3.50	4.35
		SHS	0.43	0.53	1.07	1.21	2.07	2.85	3.24	3.90
		INS	0.40	0.50	0.99	1.10	1.79	2.22	2.58	3.51
	Fully Mature	SYS	0.73	0.84	1.04	1.34	2.97	4.07	5.61	5.72
		SHS	0.60	0.68	0.74	0.75	0.89	0.94	2.27	3.34
		INS	0.51	0.61	0.64	0.69	0.80	0.85	1.43	2.64
Ewais	Half Mature	SYS	0.28	0.87	1.84	2.12	2.64	4.41	5.56	6.54
		SHS	0.27	0.55	1.37	1.61	2.45	3.88	4.94	6.44
		INS	0.26	0.49	1.15	1.51	2.32	2.91	4.06	6.04
	Fully Mature	SYS	0.49	0.61	0.68	0.77	0.78	1.98	2.89	5.01
		SHS	0.43	0.52	0.57	0.65	0.68	1.36	2.11	3.80
		INS	0.40	0.48	0.50	0.60	0.63	0.89	0.99	2.68
LSD at 5% 0.325										

Cultivars	Fruit Mat.	Fruit Pos.	PCG content of fruit peel (mM 100g- FW) during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	0.34	0.47	1.00	1.24	2.17	2.82	3.37	4.22
		SHS	0.30	0.40	0.94	1.08	1.94	2.72	3.11	3.77
		INS	0.27	0.37	0.86	0.97	1.66	2.09	2.45	3.38
	Fully Mature	SYS	0.50	0.61	0.81	1.11	2.74	3.84	5.38	5.49
		SHS	0.37	0.45	0.51	0.52	0.66	0.71	2.04	3.11
		INS	0.28	0.38	0.41	0.46	0.57	0.62	1.20	2.41
Ewais	Half Mature	SYS	0.10	0.69	1.66	1.94	2.46	4.23	5.38	6.36
		SHS	0.09	0.37	1.19	1.43	2.27	3.70	4.76	6.26
		INS	0.08	0.31	0.97	1.33	2.14	2.73	3.88	5.86
	Fully Mature	SYS	0.21	0.33	0.40	0.49	0.50	1.70	2.61	4.73
		SHS	0.15	0.24	0.29	0.37	0.40	1.08	1.83	3.52
		INS	0.12	0.20	0.22	0.32	0.35	0.61	0.71	2.40
LSD at 5% 0.325										

Fruit location on tree SYS= sunny side, SHS= shadow side and INS= inside side

Even fruit maturity and location affected water loss. M3 fruits present higher water losses compared with M2 which were harvested from sunny side than shadow and inside trees. Increases of water loss were increased after day 20 of storage duration. Different responses of fruits during cold storage were independency to cultivars, fruit maturity and location on trees. Many studies have been shown that a relationship between water loss during storage fruit and AOS generation. Low humidity has been shown to increased chilling injury symptoms (Lo'ay, 2005), especially by H_2O_2 (Yan, *et al.*, 2003), for example in mango (Pesis, *et al.*, 2000).

It may be conclude that M3 (Majeed and Jeffery, 2002) showed more chilling symptoms and sensitive (Nair, *et al.*, 2003) to prolong cold storage at 4°C when harvested from sunny side of trees compared with fruits harvested from other locations. Economically, fruits can be categorized into two classes according to fruit location of trees during harvesting. So, fruit harvesting might in flue in two/three times. M3 fruit could be directed to local market to avoid

therefore, the point needs more focus to increase storage ability based on these differences of fruit locations to minimize fruits losses during harvesting and handing.

Table 4: Effect of fruit maturity and location on fruit water loss percentages of two mango cultivars Hindi Be-Sennara and Ewais were stored at 4°C for 35 days

Cultivars	Fruit Mat.	Fruit Pos.	Water loss% of fruit during storage time (days)							
			0	5	10	15	20	25	30	35
Hindi Be-Sennara	Half Mature	SYS	0.00	0.46	0.92	1.37	1.83	2.29	2.75	3.21
		SHS	0.00	0.46	0.91	1.37	1.83	2.28	2.74	3.20
		INS	0.00	0.60	1.20	1.80	2.40	3.00	3.60	4.20
	Fully Mature	SYS	0.00	0.43	0.85	1.28	1.71	2.13	2.56	2.98
		SHS	0.00	0.42	0.84	1.26	1.68	2.10	2.51	2.93
		INS	0.00	0.54	1.09	1.63	2.17	2.72	3.26	3.80
Ewais	Half Mature	SYS	0.00	0.50	0.99	1.49	1.99	2.49	2.98	3.48
		SHS	0.00	0.50	0.99	1.49	1.99	2.48	2.98	3.48
		INS	0.00	0.66	1.32	1.98	2.64	3.30	3.96	4.62
	Fully Mature	SYS	0.00	1.33	2.66	3.99	5.33	6.66	7.99	9.32
		SHS	0.00	0.61	1.23	1.84	2.45	3.06	3.68	4.29
		INS	0.00	0.60	1.20	1.81	2.41	3.01	3.61	4.22
L.S.D. at 5%			---	0.010	0.019	0.029	0.039	0.048	0.058	0.068

Fruit location on tree SYS= sunny side, SHS= shadow side and INS= inside side

REFERENCES

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

Hakim, A., Purvis, A.C. and Mullinix, B.G., 1999. Differences in chilling sensitivity of cucumber cultivars depends on storage temperature and the physiological dysfunction evaluated. Postharvest Biology and Technology, 17: 97-104

Hodges, D.M., 2003. Overview: oxidative stress and postharvest produce. In :D.M. Hodges (ed). Postharvesst oxidative stress in horticultural crops. Food Products Press, New York., 1-12

Hodges, D.M., Lester, G.E., Munro, K.D. and Toivonen, P.M.A., 2004. Oxidative stress: Importance for postharvest quality. HortScience, 39: 924-929

Iturbe-Ormaetxe, I., Escuredo, P.R., Arrese-Igor, C. and Becana , M., 1998. Oxidative damage in pea plants exposed to water deficit or paraquat. Plant Physiology., 116: 173-181

Kader, A.A., 2002. Postharvest Technology of Horticulture Crops. Third Edition, ISBN 6-8799.6-51-1,

Levine, R.L., Williams, J.A., Stadtman, E.R. and Schacter, E., 1994. Carbonyl assay for determination of oxidatively modified proteins. Methods Enzymol, 233: 346-357

Litz, R.E., 1997. The Mango: Botany, Production and Uses. Edited by R.E. Litz. ISBN:0-85199-127-0.

Lo'ay, A.E., 2005. Chilling injury and mangoes. Ph.D. Thesis. Wageningen University. The Netherlands, 1-226

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

Nair, S., Singh, Z. and Tan, S.C., 2003. Aroma volatiles emission in relation to chilling injury in 'Kensington Pride' mango fruits. The Journal of Horticultural Science and Biotechnology, 78: 866-873

Pesis, E., Aharoni, D., Aharon, Z., Ben-Arie, R., Aharoni, N. and Fuchs, Y., 2000. Modified atmosphere and modified humidity packaging alleviates chilling injury symptoms in mango fruit. Postharvest Biology and Technology, 19: 93-11

Purvis, A.C., 2004. Regulationof oxidative stress in horticultural crops. Horti Science, 39: 930-932

Saúco, V.G., 2002. Mango: Emerging tropical export crop. Chronica Horticulturae, 42: 14-17

Toivonen, P.M., 2004. Postharvest storage procedures and oxidative stress. Horti Science, 39: 938-942

Yan, J.Q., Wang, J., Tissue, D., Holiday, A.S., Allen, R. and Zhang, H., 2003. Photosynthesis and sed production under water-deficit condition in transgenic tobaco plants that over-express an Arabidopsis ascorbate peroxidase gene. crop Science, 43: 1477-1483

تأثير إكتمال نمو ثمار المانجو و موقعها على سوكها خلال التخزين المبرد

لؤى عبد اللطيف عرفات

قسم الفاكهة – كلية الزراعة – جامعة المنصورة

اجريت هذه الدراسة خلال موسمى ٢٠٠٦ و ٢٠٠٧ على صنفى مانجو عويس و هندى بسنارة بهدف دراسة سلوك الثمار عند مرحلتى إكتمال النمو (نصف مكتملة و مكتملة النمو) و التى جمعت من ثلاثة مواضع مختلفة من الشجرة (الجانب المشمس و المظلل و داخل الشجرة) و تأثير ذلك على سوك الثمار خلال التخزين المبرد على درجة ٤ مئوى لمدة ٣٥ يوما. قد لظهرت النتائج ان صنف العويس اكثر اصابة باعراض البرودة عن الهندى بسنارة و خاصة عند إكتمال النمو مقارنة بالثمار نصف مكتملة النمو التى حصدت من الجانب المشمس من الاشجار بخلاف الثمار التى حصدت من الجانب المظلل و وسط الاشجار عند نهاية التجربة، مما يعنى ان هذه الاختلافات بين الصنفين و درجة إكتمال النمو و المواقع المختلفة للثمار لها تاثير ايضا على كافة القياسات التى اجريت خلال التجربة، ويمكن التركيز على تدريج الثمار على حسب عمرها وموقعها وقت الحصاد، اذ يمكن القول ان إكتمال النمو للثمار فى كلا الصنفين الموجودة فى الجانب المشمس للأشجار جعلها اكثر حساسية لتخزين المبرد وبالتالى يمكن تسويقها فى اقصر وقت ممكن مقارنة بالموجودة فى الجانب المظلل و داخل الأشجار، و بالنسبة الى العمر الثانى (النصف مكتملة النمو) افضل فى التخزين المبرد و بخاصة الموجود منها فى الجانب المظلل و داخل الشجرة.

قام بتحكيم البحث

أ.د / نبيل رشاد السيد سمرة — كلية الزراعة – جامعة المنصورة

أ.د / على محمد كامل الخريبى — كلية الزراعة – جامعة قناة السويس