TRIALS TO IMPROVE MARKETING CHARACTERISTICS AND PROLONGING STORAGE LIFE OF PERSIMMON AND MANGO FRUITS

By

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1. INTRODUCTION

Persimmon (*Diospyros kaki*, L.) is one of the most important species of genus Diospyros and family Ebonaceae from the statistical standpoint. Persimmon acreage is about 1465 feddans, out of which 1289 feddans are fruiting area produce about 8846 metric ton fruits with an average 6.86 ton fruits per feddan according to the latest statistics of the Ministry of Agriculture, Egypt (2005)*.

In the last few years, the interest for persimmon cultivation has increased in the Mediterranean area, both for the favourable trend of the market and for the ease of adaptability to the Mediterranean climate. Moreover, the fruit compounds having nutraceutical effects have increased the interest of consumers for this fruit. The main nutraceutical compounds are carotenoids, tannins and fiber, active in the prevention of chronic- degenerative diseases and they have antiradical and antibacterial activity. Fruits are not left to ripe on the trees, thus fruit ripening is a major problem for persimmon cultivation and distribution. The fruits are harvested at mature stage to be artificially ripened for commercial production and marketing. Ethephon was reported to bring the fruits to ripening stage through hastening fruit colouration, reducing fruit firmness through the conversion of protopectin to soluble pectin (Kamal and Rabeh, 1989), disappearance of astringency (tannin content) through accelerating the coagulation of tannins to insoluble tannins (Miyabayashi, 1971), increasing fruit total sugar content due to the hydrolysis of starch and the accumulation of sugars (Srinivasan *et al.,* 1974) who mentioned that ethephon treatments caused higher glucose and fructose content (the constituent of non astringent persimmon fruits). Moreover, calcium carbide is known as the precursor of acetylene and ethylene ripening gases.

Thereupon, the First Experiment of this study was initiated to throw some light on the efficiency of ethephon treatments at 500 or 1000 ppm and calcium carbide at 2.5 or 5g/box fruit on inducing an early and uniform ripening and marketability of Costata persimmon fruits.

No doubt that the process of fruit handling and storage for local market and export is as important as horizontal and vertical extension of agriculture production. The extension of marketing period using cold storage enriched with post harvest treatments i.e. calcium chloride, active yeast suspension and sodium hypochlorite.

The storage life of most fruits is lengthened, if they are cooled quickly after harvest. Temperature has a direct effect on the respiration rates of fruits and on the activity of decay caused by organisms. The respiration rate is an index of the rate at which the fruit is using up its stored reserves of sugars and other metabolites and consequently an index of the loss in shelf life. The chemical reactions associated with respiration result in the production of heat. The amount of generated heat varies with the commodity and with its temperature. In general, the respiration rate increases two to four times for each 10°C increase in temperature. Thus, more heat is produced at high temperatures and less at low temperatures at which the product is stored. Microbial organisms also are more active at high than at low temperature. Therefore, cold storage is required to reduce this generation of heat and fruit decay (El-Seidy, 1994).

Furthermore, calcium appears to have an important regulating role in the metabolism of persimmon fruits. Metabolic disorders are severity reduced if calcium is present in sufficiently high quantities in fruit. Several of metabolic disorders are associated with the high rate of respiration or over maturity of the fruit. This suggests that calcium may regulate respiration and perhaps other metabolic process in the mature fruit (Miklos Faust and Shear, 1972).

In addition, yeast and sodium hypochlorite were reported as efficient substances in enhancing fruit storability through their biological control mechanism (Sugar *et al.,* 1994).

Consequently, the main target of the Second Experiment of this study is prolonging marketing period with the maintenance of eating traits of Costata persimmon fruits through cold storage at 5°C or 0°C (in comparison with ambient room storage) enriched with some post harvest treatments namely calcium chloride at 2 & 4%, active yeast suspension at 1 & 2 % and sodium hypochlorite at 2% (in comparison with tap water "control")

The mango (*Mangifera indica* L.) is considered one of the choicest fruits of the world, because of its attractive colour, delicious taste and excellent nutritional value. In Egypt, mango cultivated area is about 139433 feddan, out of the total fruit cultivated area which amounted 1.250003 feddans. Mango fruiting area is 99427 feddans produces about 416951 metric ton fruits with an average 4.19 ton fruits per feddan according to the latest statistics of Ministry of Agriculture, Egypt (2005). Moreover, the

world fruit trade has been extended, but mango sales are restricted by improper handling and storage (Mitra, 1997). Besides, as a result of increasing the demand on mango fruits and the relatively shorter marketing period, there is a desperate need for studying how the marketing period could be extended and how to reduce the loss of fruits and supply mango fruits frequently and over a long period of time. Consequently, several attempts were conducted to prolong the marketing season of mango fruits. Among these attempts - besides cold storage - are the use of some pre-harvest treatments *i.e.* gibberellin, calcium chloride and yeast.

Gibberellin as a pre-harvest treatment was reported as an efficient growth substance in enhancing fruit storability and marketability through its action on cell juvenility and retardation of senescence, fruit colouration and softness (Macleod and Millar, 1962).

On the other hand, during the last decade an increased attention has been devoted to the effect of nutritional status of fruits on quality maintenance and it has become focused on the important relationship between fruit calcium level and quality retention. Calcium occupies a central position in fruit nutrition and the known effects of nitrogen, potassium, magnesium, phosphorus and boron on fruit quality occur largely through their interaction with calcium in fruit cells. A simplified scheme summarizing the role of calcium in maintaining the cell wall structure and membrane integrity. Calcium treatments help to retain fruit firmness, increase vitamin C content, reduce carbon dioxide and ethylene evolution and reduce storage breakdown and rot (Hulme, 1970). Also, it is suggested that calcium may regulate respiration and perhaps other metabolic process in mature fruits. Besides, it is evident that calcium is indeed involved in regulating the respiration of fruits (Miklos Faust and Shear, 1972).

Moreover, yeast is reported to prolong the storage life of fruits through its mechanism as biological control (Sugar *et al.,* 1994).

Thereupon, the Third Experiment of this study was performed as a trial to prolong the marketing period of Zebda mango fruits through cold storage at 15°C or 10°C (in comparison with ambient room storage) supported with preharvest spray treatments namely gibberellin (GA_3) at 25, 50 and 75 ppm, calcium chloride at 1 & 2% and active yeast suspension at 1 & 2% (in comparison with tap water "control").

2-REVIEW OF LITERATURE

The present study aims to evaluate some prospective trials of improving some fruit quality traits and simultaneously prolonging storage life of two fruit species namely persimmon fruits (*Diospyros kaki, L.*) and mango fruits (*Mangifera indica,* L.). In other words, this investigation handled enhancing fruit ripening of persimmon fruits through getting rid of astringency taste and improving some fruit quality parameters (*i.e.* colour, firmness, sugars content, …etc.) besides, prolonging storage life of persimmon fruits through some post harvest treatments. Furthermore, this study included a trial to increase the storage ability of mango fruits using some pre-harvest treatments. Thereupon, the review of literature of the present investigation have been handled under two main parts as follows:

Part I 2.1. Improving marketing characteristics and prolonging storage life of fruits.

The review of literature of this part have been subdivided into two parts as follows:

2.1.1. Effect of some chemical treatments on enhancing fruit ripening and fruit quality.

2.1.1.1. Effect of ethephon (CEPA)

(a) Fruit ripening.
(b) Weight loss.
(c) Fruit decay.
(d) Fruit quality.

2.1.1.2. Effect of calcium carbide (CaC_2)

(a) Fruit ripening.
(b) Weight loss.
(c) Fruit decay.
(d) Fruit quality.

2.1.2. Effect of some post harvest treatments on prolonging storage life of fruits.

2.1.2.1. Effect of calcium chloride ($CaCl_2$)

(a) Weight loss.
(b) Fruit decay.
(c) Shelf life.
(d) Fruit quality.

2.1.2.2. Effect of active yeast

2.1.2.3. Effect of sodium hypochlorite (NaOCl)

(a) Weight loss.
(b) Fruit decay.
(c) Shelf life.
(d) Fruit quality.

Part II 2.2. Effect of some pre-harvest treatments on fruit storability.

2.2.1. Effect of gibberellic acid (GA)

(a) Weight loss. (b) Fruit decay.
(c) Shelf life. (d) Fruit quality.

2.2.2. Effect of calcium chloride ($CaCl_2$)

(a) Weight loss. (b) Fruit decay.
(c) Shelf life. (d) Fruit quality.

2.2.3. Effect of active yeast

Part I 2.1. Improving marketing characteristics and prolonging storage life of fruits.

2.1.1. Effect of some chemical treatments on enhancing fruit ripening and fruit quality.

2.1.1.1. Effect of ethephon (CEPA)

2.1.1.1.a. Fruit ripening

As for persimmon fruits, Wakamatsu *et al.* (1973), Srinivasan *et al.* (1974), Forlani (1976), Kato (1987), Kamal and Rabeh (1989) and Park *et al.* (1998) studied the efficacy of ethrel (ethephon) treatment as a pre-harvest treatment either as a pre-harvest treatment at 15-50 ppm or as dipping in ethephon solution (250-5000 ppm) with different dipping times (5-60 minutes) on the time required for persimmon fruits cvs. Hiratanenashi, Costata . . . etc. to reach ripening stage. They concluded that ethephon-treated fruits needed 1-8 days to reach ripening according to ethephon concentration and time of dipping, whereas untreated fruits "control" failed to reach ripening stage one month after storage at room temperature and deteriorated before ripening.

Concerning other fruit species, Bal *et al.* (1992), Hartmann (1992), Sergent *et al.* (1993), Pal (1998-a&b), Joon *et al.* (2001), Lakshmana *et al.* (2001), Zora *et al.* (2001), Undurraga and Olaeta (2003) and Kulkarni *et al.* (2004) made trials to induce uniformity in fruit ripening within shorter time in green and greenish-yellow pawpaw fruits, cherry fruits cv. Bigarreau Napoleon, mango

fruits cvs. Keitt, Dashehari, Rataul, Dashehari and Kensington, loquat fruits cv. Golden Nugget and mango fruits cv. Neelum, respectively through immersing the fruits in ethephon solutions (250-2000 ppm) for 1-30 minutes according to ethephon concentration. They abstracted that ethephon treatments induced the best ripening attributes and sensory quality in shorter time as compared with the control.

2.1.1.1.b. Weight loss

Regarding persimmon fruits, Kamal and Rabeh (1989) soaked persimmon fruits cv. Costata in ethephon solutions (500, 1000 and 2000 ppm). They found that ethephon treatments exhibited greater loss in moisture content than those soaked in water (control). The higher the ethephon concentration, the greater was the moisture loss.

With respect to other fruit species, Pal (1998-b) demonstrated that treating mango fruits cv. Rataul with ethrel (ethephon) at 500, 1000 or 1500 ppm. Ethrel treatments slightly promoted physiological weight loss. Besides, Gala *et al.* (2001) studied the effect of ethrel concentration (250, 500, 1000 and 1250 ppm) on physical and chemical properties of banana varieties Hindi, Maghrabi and Williams. They realized that weight loss percentage was increased with increasing ethrel concentration.

2.1.1.1.c. Fruit decay

Referring to persimmon fruits, Abd El-Wahab *et al.* (1983) immersed Costata persimmon fruits for 30 minutes in ethephon solutions at 100, 500, 1000 or 1500 ppm. The fruits were then air dried and stored at room temperature. The non treated fruits (control) shriveled, whereas the ethephon treated ones showed less decay. Moreover, Kamal and Rabeh (1989) dipped Costata persimmon fruits for five minutes in ethephon solutions at 500, 1000 or 2000 ppm and the fruits were then stored at room temperature for one week. They showed that in all ethephon treatments, there was a continuous deterioration in fruit quality and a graduate increase in decay percentage with extending storage period. The best results were obtained with 500 ppm ethephon treatment.

2.1.1.1.d. Fruit quality

Referring to firmness of persimmon fruits cvs. Costata, Fuyugaki, Hiratanenashi, Cheongdobansi, Tonewase ….etc, Edgerton and Blanpied (1968), Wakamatsu *et al.* (1973), Rouhani *et al.* (1975), Abd El-Wahab *et al.* (1983), Kato (1987), Zhang (1988), Kamal and Rabeh (1989), Kato (1990), Itamura *et al.* (1991), Lee and Kim (1991), Lim *et al.* (1993), Park *et al.* (1998), Shiesh *et al.* (2000) and Imagawa *et al.* (2003) dipped persimmon fruits in ethephon solutions at 100-2000 ppm for 1 up to 30 minutes according to ethephon concentration. They found that the higher the ethephon concentration used, the greater was the efficacy on accelerating fruit softness and senescence. On the contrary, check treatment maintained high fruit firmness for a long time, and was effective in prolonging the period of fruit storage. Besides, the non-treated fruits "control" shriveled whereas the ethephon-treated ones showed less firmness. They added that ethephon treatment produced an increase in ethylene and carbon dioxide evolution even though the fruits were still firm.

With respect to fruit firmness of other fruit species, Mann *et al.* (1990), Sergent *et al.* (1993), Pal (1998-a), Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) treated pear fruits and mango fruits cvs Keitt, Dashehari, Kensington and Neelum, respectively with ethrel at 50-4000 ppm for 1-5 minutes. Data showed that fruit firmness was decreased in a shorter period with all ethephon treatments compared with untreated fruits "control".

As for colour development of persimmon fruits cvs. Aizumishirazu, Hiratanenashi, Fuyugaki, Costata … etc., Awad and Suzukawa (1975), Abd El-Wahab *et al.* (1983), Kato (1984), Zhang (1988), Kamal and Rabeh (1989) and Lee and Kim (1991) studied the correlation between ethephon concentration and time required for degreening of persimmon fruits. The fruits were treated with ethylene evoluted from different sources i.e. ethephon, ethanol ...etc. at 100-2000 ppm. They found that total chlorophyll was decreased rapidly after ethylene treatment, then gradually leveled off, but the greatest reduction in total chlorophyll was achieved by ethephon treatment. Carotenoid levels were increased with ethylene treatment. They added that the fruits lost their green colour within 3-5 days due to ethephon treatment at 500 and 1000 ppm for two minutes, meanwhile

the lower ethephon concentration (250 ppm) required 10-12 days to induce similar effect in this respect. In other words, the higher the ethephon concentration, the more was the brightness of fruit colour.

Regarding fruit colouration of other fruit species, Bal *et al.* (1992), Zora *et al.* (2001) and Kulkarni *et al.* (2004) worked on papaya fruits and mango fruits cvs. Kensington and Neelum, respectively. They treated the fruits with ethephon solutions (250-2000 ppm) for different times (2-30 minutes) according to ethephon concentration. They cleared that fruit colour index was significantly enhanced with ethephon treatment and the total carotenoids showed increasing trend up to eight days during ripening.

With respect to astringency of persimmon fruits cvs. Aizumishirau, Hiratanenashi, Costata, Cheongdobansi, Saijo . . . etc, Hulme (1971), Awad and Amenomori (1972), Srinivasan *et al.* (1973), Kato (1984), Kato (1987), Kamal and Rabeh (1989), Kato (1990), Itamura *et al.* (1991), Taira *et al.* (1991), Lim *et al.* (1993), Park *et al.* (1998) and Tamura *et al.* (1999) studied the effect of ethylene treatment from different sources i.e. ethephon, ethanol, ethylene generating kits at different concentrations (100-5000 ppm) for different periods on the relationship between the decrease in tannin concentration and loss in astringency of persimmon fruits. Data illustrated that there was a relatively high correlation between the degree of astringency and tannin concentration when fruit tissue was homogenized and extracted with 70% ethanol and then heated fruits containing about 2% tannin were slightly astringent and those containing < 0.1% were almost non-astringent. The higher the ethanol concentration, the shorter was not only, the time required to induce reduction in tannin concentration, but also the rate of reduction. They added that the disappearance of fruit astringency (tannin content) was remarkable with higher ethephon concentration (1000 and 2000 ppm). In such fruits, the tannins in cells are coagulated to insoluble tannins. The higher ethephon concentrations greatly accelerated tannin coagulation process and the disappearance of astringency of persimmon fruits.

Referring to fruit total soluble solids of persimmon fruits, Rouhani *et al.* (1975), Abd El-Wahab *et al.* (1983), Kamal and Rabeh (1989) and Shiesh *et al.* (2000) dipped persimmon fruits cvs. Costata and Syh Jou in ethephon solutions at

100-200 ppm for different periods according to ethephon concentrations. The results showed a progressive and constant increase in total soluble solids throughout the storage period of all tested ethephon treatments and control. The rate of increase being rapid in ethephon-treated fruits and at the end of storage period. These fruits exhibited higher percentages than untreated ones "control". Highly significant differences were observed between the tested treatments in this respect. They added that the high ethephon concentrations, despite their pronouncing effect on increasing soluble content resulted in the lowest T.S.S. values in fruit juice. This may be due to the great tendency of ethephon to convert the soluble tannins into insoluble form, the matter which directly affects the T.S.S. values.

Concerning fruit total soluble solids of other fruit species, Mann *et al.* (1990), Bal *et al.* (1992), Sergent *et al.* (1993), Gala *et al.* (2001), Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) treated the fruits of pear, pawpaw, mango cv. Keitt, banana cvs. Hindi, Maghrabi and Williams, mango fruits cvs. Kensington and Neelum, respectively with ethephon at 50 up to 4000 ppm for 1-30 minutes according to ethephon concentration. They realized that total soluble solids showed a constant and progressive increase until nine days, then decreased gradually during ripening period.

Regarding acidity content of persimmon fruits, Unrath (1972), Shaybany and Sharifi (1973),Shanmugavelu *et al.* (1976) and Kamal and Rabeh (1989) mentioned that a gradual decrease was noticed in titratable acidity of persimmon fruits due to ethephon treatments (250–2000 ppm) and untreated fruits through the whole storage period. The decrease in fruit acidity was in proportional with ethephon concentration.

As for fruit acidity of other fruit species, Mann *et al.* (1990), Gala *et al.* (2001), Joon *et al.* (2001),Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) immersed fruits of pear, banana cv. Hindi, Maghrabi and Williams, mango cv. Kensington and Neelum, respectively in ethephon solutions (50–2000 ppm). They observed that ethephon treatments succeeded in decreasing fruit acidity compared with the control.

Concerning fruit sugars content of persimmon fruits, Srinivasan *et al.* (1974), Abd El-Wahab *et al.* (1983), Kamal and Rabeh (1989), Lee and Kim (1991) and Park *et al.* (1998) immersed persimmon fruits in ethephon solution (100-2000 ppm) for different periods. Data cleared that a progressive and consistant increase in total sugars throughout the storage period of all treatments and control. The rate of increase being rapid in ethephon treated fruits and at the end of storage period. These fruits exhibited higher percentages than control and highly significant differences were gained due to the tested treatments. They added that the most striking chemical changes which occur during post harvest ripening of persimmon fruits seem to be due to the hydrolysis of starch and the accumulation of sugars.

Regarding fruit sugars content of other fruit species, Bal *et al.* (1992), Gala *et al.* (2001), Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) treated fruits of papaya cvs. CO_1 and CO_2, banana varieties Hindi, Maghrabi and Williams and mango cvs. Kensington and Neelum with ethephon solutions at 250-2000 ppm for 5-30 minutes. They reported that all ethephon treatments improved fruit content of reducing, non reducing and total sugars compared with untreated fruits "control".

2.1.1.2. Effect of calcium carbide (CaC_2)

2.1.1.2.a. Fruit ripening

In this respect, Nagaraj *et al.* (1984), Mann (1985), Chacon *et al.* (1988), Tauqir *et al.* (1989), Ashwani *et al.* (1995), Padmini and Prabha (1997), Guha and Bhuiyan (1997), Pal (1998b), Amarakoon *et al.* (1999) and Joon *et al.* (2001) treated mango fruits cv. Alphonso, mango fruits cv. Dashehari, banana fruits, mango fruits cvs. Desi and Dusehi, mango fruits cv. Dashehari, mango fruits cv. Alphonso, mango fruits cv. Aswina, mango fruits cv. Rataul, mango fruits cvs. Velleicolomban and Willard and mango fruits cv. Dashehari, respectively with calcium carbide at 2 or 4 g CaC_2/kg fruits. They found that CaC_2 treatments induced an early and uniform ripening of the treated fruits

2.1.1.2.b. Fruit weight loss

In this field, Valverde *et al.* (1986), Tauqir *et al.* (1989), Ashwani *et al.* (1995) and Joon *et al.* (2001) treated mango fruits cvs. Keitt, Desi and Dusehi, Dashehari and Dashehari, respectively with CaC_2 at 2 or 4 g/kg fruits. They realized that calcium carbide treatments resulted in higher weight loss percentage during the ripening period.

2.1.1.2.c. Fruit decay

In this concern Ashwani *et al.* (1995), Pal (1998-b) and Joon *et al.* (2001) studied the efficacy of CaC_2 treatment on fruit decay percentage of mango cvs. Dashehari, Rataul and Dashehari, respectively. They showed that decay loss was minimum in the control and maximum in CaC_2 (4 g/kg)-treated fruits.

2.1.1.2.d. Fruit quality

Concerning fruit firmness, Randhawa *et al*. (1984) and Ashwani *et al*. (1995) treated pear fruits cv. Nakai and mango fruits cv. Dashehari, respectively with calcium carbide at 1-4 g/kg fruits. They concluded that fruit firmness was decreased with CaC_2 treatments and prolonging storage period.

As for fruit colour, Nagaraj *et al*. (1984), Tauqir *et al*. (1989), Ashwani *et al*. (1995) and Padmini and Prabha (1997) evaluated the efficacy of calcium carbide treatment at 2 or 4g/kg fruits on colour development of mango fruits cvs. Alphonso, Desi and Dusehi, Dashehari and Alphonso, respectively. Data recorded at four days intervals indicated that carotenoids concentration was increased with increasing storage duration. Fruits treated with calcium carbide had higher concentrations of carotenoids than the other tested treatments by the fourth day of storage. Such fruits maintained in a good colour even up to the eighth day of storage.

Referring to fruit total soluble solids, Nagaraj *et al*. (1984), Ashwani *et al*. (1995), Guha and Bhuiyan (1997) and Joon *et al.* (2001) studied the response of mango fruits cvs. Alphonso, Dashehari, Ashwina and Dashehari, respectively to CaC_2 treatment at 2 or 4 g/kg fruits. They found that the highest content of total soluble solids was achieved by CaC_2 treatment as compared with control.

Regarding fruit acidity, Nagaraj *et al*. (1984), Ashwani *et al*. (1995) and Joon *et al*. (2001) studied the response of total acidity of mango fruits cvs. Alphonso and Dashehari to calcium carbide treatment at 2 or 4g/kg fruits. They realized that total acidity was decreased with CaC_2 treatments and increasing storage duration.

2.1.2. Effect of some post-harvest treatments on prolonging storage life of fruits.

2.1.2.1. Effect of calcium chloride ($CaCl_2$)

2.1.2.1.a. Fruit weight loss

As for persimmon fruits, Ali (2005) stated that dipping persimmon fruits cv. Costata in 4% $CaCl_2$ for three minutes succeeded in decreasing fruit weight loss during storage at 0°C or under room temperature (20°C).

With respect to other fruit species, Mootoo (1991) and Salem and El-Khoreiby (1991) immersed mango fruits cv. Julie and seedless grapefruit cv. Marsh, respectively in 1-8% $CaCl_2$ solutions. They found that $CaCl_2$ treatments caused further reduction in weight loss. Moreover, Mir *et al.* (1993) and Akl *et al.* (1995) studied the effect of $CaCl_2$ concentration on fruit storability of Red Delicious apple and "Le Conte" pear fruits, respectively. Fruits were dipped in calcium chloride solutions at 1-4%. They reported that Ca-treatments reduced the rate of weight loss during storage. This effect was more pronounced with increasing $CaCl_2$ concentration. Furthermore, Bhartiya *et al.* (1998), Mehaisen (1999), El-Zaabalawy (2001), Choudhury *et al.* (2003), Tajinder *et al.* (2003) and Shaaban (2006) evaluated the efficacy of calcium solutions as a post-harvest treatment in the form of calcium chloride on storage behaviour of apple fruits cv. Red Delicious, pear fruits cv. "Le Conte", date fruits cvs. Zaghloul, Hayani and Samani, Sapota fruits cv. Pala, pear fruits cv. Patharnakh and guava fruits cv. Maamoura, respectively. They revealed that $CaCl_2$ treatments reduced physiological weight loss.

2.1.2.1.b. Fruit decay

In this concern, Conway *et al.* (1993) studied the role of calcium in decreasing the decay percentage of apple fruits. They demonstrated that both total and cell wall bound calcium of apple fruit tissue when the fruits were treated with calcium chloride solutions at varying amounts as pressure infiltration at harvest.

They added that the effect of calcium in reducing decay is associated with maintaining cell wall structure by delaying or modifying chemical changes in cell wall composition. Besides, Sams *et al.* (1993), Montasser *et al.* (1993), Akl *et al.* (1995) and Daood (1995) dipped apple fruits cv. Golden Delicious, apple fruits cv. Anna, pear fruits cv. "Le Conte" and date fruits cv. Zaghloul, respectively in $CaCl_2$ solutions at 1-4%. Results showed that Ca-treatments were effective in reducing fruit decay percentage. Furthermore, Saftner *et al.* (1998) carried out an investigation on the effect of post-harvest pressure infiltration of $CaCl_2$ solutions of Golden Delicious apples on peel injury, quality attributes, respiration and internal atmospheres after storage for 2-6 months. They realized that $CaCl_2$ treatments (0.14-0.34 mol/liter) reduced internal and involved ethylene and softening of fruits and caused distinctive injury to the fruit surface. In addition, $CaCl_2$ treatments reduced respiration and ethylene production rates. Moreover, Mehaisen (1999), Dhaka *et al.* (2001), El-Zaabalawy (2001), Choudhury *et al.* (2003), Gautam *et al.* (2003), Tajinder *et al.* (2003) and Shaaban (2006) studied the effect of dipping pear fruits cv. "Le Conte", mango fruits cv. Totapuri, date fruits cvs. Zaghloul, Hayani and Samani, Sapota fruits cv. Pala, mango fruits cv. Banggapalli, pear fruits cv. Patharnakh and guava fruits cv. Maamoura, respectively in $CaCl_2$ solutions as a post-harvest treatment at 0.5-4.0% for 2-5 minutes on fruit storability. They found that calcium chloride treatments achieved a remarkable reduction in fruit decay percentage, fruit rotting and spoilage.

2.1.2.1.c. Fruit shelf life

In this field, Akl *et al.* (1995) dipped "Le Conte" pear fruits in different calcium salts solutions (chloride, nitrate, hydroxide and sulphate) at 0, 1, 2 and 3% and the fruits were kept under cold storage. Results showed that increasing calcium salt concentration caused a gradual prolongation in fruit-shelf life. The best results with regard to prolonging shelf life was achieved by dipping the fruits for five minutes in 2% calcium chloride solution and stored at 0°C. Moreover, Suntharalingams (1996), Abdul *et al.* (1997), Freire-Junior and Chitarra (1999), Mehaisen (1999), Jagadeesh *et al.* (2001), Choudhury *et al.* (2003) and Shaaban (2006) investigated the effect of post-harvest treatments of $CaCl_2$ up to 8% on fruit shelf life of mango fruits cv. Willard, Fazli and Ashwina, pear fruits cv. "Le Conte", guava fruits cv. Sardar, Sapota cv. Pala and guava fruits cv.

Maamoura, respectively. They concluded that calcium treatments succeeded in prolonging fruit shelf life.

2.1.2.1.d. Fruit quality

Regarding persimmon fruits, Ali (2005) dipped Costata persimmon fruits for three minutes in 4% $CaCl_2$ solution then the fruits stored at cold storage (0°C) or under room temperature (20°C). The results showed that $CaCl_2$ treatment was superior in maintaining fruit firmness and fruit total soluble solids (T.S.S.) percentage, increasing total sugars and decreasing fruit tannins content during storage either at cold storage (0°C) or room temperature (20°C).

Concerning other fruit species, using calcium chloride as a post-harvest treatment through dipping the fruits in $CaCl_2$ solutions (1-12%) for 1-120 minutes according to $CaCl_2$ concentration showed to be effective in reducing the rate of loss of Red Delicious apple fruits firmness during storage. This effect was increased as the $CaCl_2$ concentration increased (Mir *et al.,* 1993). Calcium chloride treatment proved to be effective in improving colour and quality of Dashehari mango fruits (Mahajan and Sharma, 1995), enhancing fruit firmness of apricot fruits (Souty *et al.,* 1995), increasing fruit Ca content and fruit firmness compared with untreated control (Ait-Oubahou *et al.*, 1995). Furthermore, $CaCl_2$ appeared a positive correlation between Red Delicious apple fruits firmness and $CaCl_2$ concentration (Pirmoradian and Babalar, 1995). Besides, $CaCl_2$ was effective in retarding colour development and textural softening of mango fruits cv. Willard (Suntharalingams, 1996), increasing fruit total soluble solids (T.S.S.) content and decreasing fruit acidity and ascorbic acid content of mango fruits cvs. Fazli and Ashwina (Abdul *et al.,* 1997), increasing total soluble solids and Ca content of two grape cultivars namely Keshmeshy Bidaneh and Shahroudy (Babalar *et al.*, 1999), delaying colouration, improving fruit firmness, T.S.S., sugar content and acidity and increasing peel and flesh calcium content of Bartlett pear fruits (Farooq *et al.*, 1999). Moreover, a positive correlation was noticed between calcium chloride concentration on one hand and fruit calcium content, flesh fruit firmness, pectin and acidity levels of different pear varieties and a negative correlation was observed between calcium chloride concentration and brix and reducing sugar of fruits on the other one (Nickhah *et al.,* 1999). Besides, calcium chloride was effective in

maintaining fruit firmness of plum fruits (Xu *et al.,* 2000), enhancing fruit quality but, failed to affect fruit total soluble solids, total sugars, titrable acidity and tannins content of Zaghloul, Hayani and Samani date fruits (El-Zaabalawy, 2001), decreasing augmented biochemical attributes such as total soluble solids, acidity and sugar contents of sapota fruits cv. Pala (Choudhury *et al.,* 2003), maintaining the highest fruit firmness and fruit quality of pear fruits cv. Patharnakh (Tajinder *et al.*, 2003) and increasing total acidity and ascorbic acid content of guava fruits cv. Maamoura (Shaaban, 2006).

2.1.2.2. Effect of yeast suspension

Stretch (1989) investigated the effect of bacteria, yeasts and fungi isolated from leaf, stem and fruit tissue of blueberry and cranberry on the control of fruit rots caused by *A. alternata*, *A. tenuissima*, *Apostrasseria lunata* and *Strasseria oxycocci*. Fruits were dipped in a suspension of a given isolate, allowed to incubate for at least 2 h, then inoculated with the target pathogen at the stem scar on blueberry or at an artificial wound on cranberry. Data showed that excellent control of *Alternaria* rot was achieved with a *Pseudomonas cepacia* isolate and with several unidentified isolates from blueberry.

Cheah *et al.* (1994) mentioned that out of more than 120 yeast isolates screened for control of *Botrytis cinerea* on kiwi fruits, *Kluyveromyces marxianus* and *K. fragilis* were most effective for reducing storage rot incidence from 30 to 6%.

Kampp and Sass (1994) stated that the bacterium "*Erwinia* sp." provided completely protection against *B. cinerea* on apples while yeast "*Rhodotorula*" was effective against *P. expansum* at low temperature and also reduced rotting at higher temperature. The efficiency of the two antagonists was lower when they were tested against the pathogens on pear fruits. They added that although *Erwinia* sp. produced antibiotic metabolites *in vitro*, it was not possible to demonstrate the role of these metabolites in biocontrol on the fruit.

Sugar *et al.,* (1994) mentioned that the least decay of Bosc pear fruits was obtained by using a cell suspension of the yeast *Cryptococcus laurentii*.

Lima *et al.,* (1998) reported that more than 200 yeasts were selectivity isolated from microbial populations on the surface of different fruits. Fifty of these

isolates were tested against blue mould *(Penicillium expansum)* of wounded apples. Isolates LS-11 of *Rhodotorula glutinis* and LS-28 of *Cryptococcus Laurentii* were the most effective antagonists. They were further evaluated at 20ºC on different fruits (apples, pears, strawberries, kiwi fruits and table grapes) against several of the main post- harvest pathogens *(Botrytis cinerea, Penicillium* expansum, *Rhizopus stolonifer* and *Aspergillus niger)* and at 4ºC on apples inoculated with *P. expansum*. At 20ºC, the antagonists significantly reduced rot incidence and showed a wide range of activity on different host pathogens combinations. Isolate LS-28 exhibited a higher and more stable activity than LS-11. Both yeasts were also effective against *P. expansum* in cold storage conditions. Populations of the two yeasts were assessed on wounded surfaces of apples kept at both 20 and 4ºC at either temperature, isolate LS-28 reached greater densities in wounded tissues than LS-11, but had a lower ability to colonize unwounded apple skin.

El-Neshawy and Michalczuk (1999) studied the effect of a pre-storage dip yeast suspension on control of natural infections of apricot cv. Amaar. They postulated that yeast treatment succeeded in protecting the fruits from decay.

Mehaisen (1999) realized that dipping "Le Conte" pear fruits in yeast suspension at 2% succeeded in decreasing the decay percentage and induced a remarkable effect on reducing weight loss and fruit firmness. Besides, yeast treatment slightly improved. Moreover, treatment exerted an enhancing effect on reducing sugar, fruit total sugar and increased fruit acidity, but failed to effect fruit total soluble solids percentage.

Sharma and Bhardwaj (2000) compared between nine different plant extracts and three yeast antagonists for their efficacy as post-harvest dip treatment against the development of scab (*Venturia inaequalis*) lesions and rots on apple fruits during storage for 60 days at ambient conditions. Studies revealed that water extract of *Emblica officinalis* leaves (15%) was highly effective against storage scab and provided complete control up to 60 days of storage. However, water extracts of *Artemisia vulgaris*, *Melia dubia* leaves and *Phyllanthus officinalis* seeds at 15% were not effective against storage scab, but effectively controlled fruit rotting with a decay reduction index (DRI) of 85.7, 80.9 and 70.8%, respectively,

after 60 days of storage. A yeast antagonist, *Rhodosporidium toruloides* (1.0×10^5 cells/ml) was also effective in controlling storage fruit rot and gave a DRI of 74.1%.

Usall *et al*. (2000) investigated the biocontrol potential of the *yeast Candida sake* against *Penicillium expansum* decay of apples under several controlled atmosphere conditions. In a laboratory trial under different commercial cold storage conditions, increasing concentrations of *C. sake* improved decay control. A maximum reduction of decay was achieved at 3% O_2-3% CO_2 atmosphere. It amounted to a 97% lesion reduction after treatment with a suspension containing 2.4×10^6 CFU/ml of *C. sake*. In a semi-commercial trial at 1°C with wounded fruits, the reduction in decay diameter caused by *C. sake* exceeded 80% after 60 days at 21% O_2 and 60% after 120 days of storage under controlled atmosphere conditions. For seven controlled atmosphere conditions studied, a significant influence by *C. sake* on the *P. expansum* decay was observed, and the lesion size was reduced more than 70% by *C. sake* at 10^7 CFU/ml. This proved the capacity of *C. sake* to colonize the surface of apples under various storage conditions. The ability to colonize was even higher in apple wounds.

Dwivedi *et al.* (2001) postulated that in vivo an experiment was conducted for biocontrol of soft rot of guava by *S. cerevisiae*. Different concentrations of yeast fungus (*S. cerevisiae)* showed varied level of antagonistic activity against soft-rot (*R. stolonifer)* of guava fruit. In vivo condition, different concentrations 2000 ppm, 1000 ppm, 500ppm and 250 ppm of yeast fungus showed to be effective in inhibiting the infection of soft-rot causing fungus *(R. stolonifer)* on the treated guava fruit. Poor infection was observed at 125 ppm concentration. No significant differences were observed in the nutritive value of guava (vitamin C, Acidity) and other parameters *i.e.* pH, shape and size.

Nunes *et al.* (2001) demonstrated that the yeast *Pantoea agglomerans* was very effective against *Botrytis cinerea*, *Penicillium expansum* and *Rhizopus stolonifer* on pear fruits. The three tested concentrations of the yeast ($2x10^7$, $8x10^7$ and $1x10^8$ CFU ml^{-1}) gave complete control on wounded pears inoculated with 10^3, 10^4 and 10^5 conidia ml-1 of *P. expansum* and *R. stolonifer*. At $8x10^7$ CFU ml^{-1} of the yeast reduced *B. cinerea* decay by more than 80% at the three concentrations of the pathogen. Over three years of experiments in semicommercial trials, the yeast provided excellent control against *B. cinerea* and *P. expansum* under cold

storage, either in air or in low oxygen atmospheres. Equal control was obtained with the yeast at 8 x 10^7 CFU ml, as with the fungicide imazalil at commercial doses, against both pathogens. The yeast grew well inside wounds on pears at both room and cold temperatures and under modified atmospheres. On contrast, it grew poorly on the surface of intact fruit.

2.1.2.3. Effect of sodium hypochlorite (NaOCl)

2.1.2.3.a. Fruit weight loss

In this respect, Nnodu and Nwankiti (1986) investigated the efficacy of sodium hypochlorite as a post-harvest treatment at 10% on storage behaviour of yam tubers. They concluded that sodium hypochlorite treatment was very effective in decreasing weight loss. Moreover, Mehaisen (1999) mentioned that dipping "Le Conte" pear fruits in sodium hypochlorite solution (NaOCl) at 1.5% succeeded in decreasing the weight loss percentage compared with the control.

2.1.2.3.b. Fruit decay

In this field, Nguyen and Souty (1985) studied the effect of sodium hypochlorite solution on reducing decay percentage of peach fruits cvs. Klamt (a cling stone) and Fayette (a free stone). They concluded that using sodium hypochlorite treatment is being very effective for controlling *Rhizopus stolonifer* which caused rot of peach fruits. Moreover, Roberts and Reymond (1989) and Mehaisen (1999) evaluated the efficacy of NaOCl at 0.025 – 1.5 % as a post-harvest treatment on fruit storability of red Delicious apple and "Le Conte" pear fruits, respectively. They abstracted that using sodium hypochlorite induced a negative effect on fruit decay percentage as compared with the control.

2.1.2.3.c. Fruit shelf life

In this concern, Mehaisen (1999) investigated the effect of post-harvest treatments of $CaCl_2$ (2 or 4%), NaOCl (1.5%) and yeast suspension (2%) on shelf life of pear fruits cv. "Le Conte" after storage. Data showed that $CaCl_2$ treatments succeeded in prolonging fruit shelf life, followed by NaOCl treatment.

2.1.2.3.d. Fruit quality

In this field, Sandhu and Randhawa (1992) mentioned that sodium hypochlorite at 2% as a post-harvest treatment proved to be effective in

maintaining fruit quality of litchi fruits cv. Seedless late during storage period. Besides, Mehaisen (1999) showed that NaOCl treatment (1.5%) was effective in improving pear fruit firmness and exerted a remarkable increment of fruit acidity and tannins content. Also, NaOCl treatment enhanced fruit total sugar and induced insignificant effect on fruit total soluble solids percentage.

Part II 2.2. Effect of some pre- harvest treatments on fruit storability.

2.2.1. Effect of Gibberellic acid (GA)

2.2.1.a. Fruit weight loss

In this field, Al-Juboory *et al.* (1990), Bhanja and Lenka (1994), El-Kassas *et al.* (1995), Choudhury *et al.* (2003), Mohd-Amir *et al.* (2003) and Shaaban (2006) studied the efficacy of spraying GA_3 at 20-200 ppm as a pre-harvest treatment in reducing weight loss during storage of grape, sapota, pomegranate, mandarin and guava fruits, respectively. They concluded that gibberellin as a pre-harvest treatment succeeded in decreasing physiological loss in weight.

2.2.1.b. Fruit Decay

Referring to mango fruits, Khader (1991) sprayed mango trees cv. Dashehari with 100, 200, 300 or 400 mg/litre after fruit set followed by another spray 10 days later. They realized that GA_3 retarded the ripening of mango fruits for up to 6 days of storage under ambient temperatures between 36±2 and 40±3°C. Increasing GA_3 concentrations significantly delayed post harvest ripening during the first 6 days and decreased decay percentage.

Kumar and Singh (1993) mentioned that spraying mango trees cv. Amrapalli with GA_3 at 50 or 75 ppm as a pre-harvest treatment reduced spoilage losses during storage.

With respect to other fruit species, Coggins and Henning (1985), Ranjit and Gupta (1987), Bhanja and Lenka (1994), Duarte *et al.* (1995), Wang *et al.* (1998), Massignan *et al.* (2001), Choudhury *et al.* (2003), Mohd-Amir *et al.* (2003) and recently Jayachandran *et al.* (2005) evaluated the effect of GA_3 sprays

at 20-200 ppm as a pre-harvest treatment on storage performance of Valencia orange, grapes, sapota, mandarin, peaches, oranges, Kinnow mandarin and guava, respectively. They abstracted that GA as a pre-harvest treatment induced a remarkable reduction in fruit decay percentage, fruit rotting and spoilage.

2.2.1.c. Shelf Life

Regarding mango fruits, Singh *et al.* (1995) made an experiment to study the effect of spraying Amrapalli mango fruits with GA_3 in the first week of June on fruit shelf life. They observed that GA_3 at 50 and 75 ppm improved the shelf life of fruits.

Concerning other fruit species, Bhanja and Lenka (1994), El-Kassas *et al.* (1995), Choudhury *et al.* (2003) and Shaaban (2006) investigated the effect of pre-harvest treatment with GA_3 at 25-200 ppm on shelf life of sapota, Manfalouty pomegranate and Maamoura guava, respectively. They found that gibberellin treatment succeeded in prolonging fruit shelf life.

2.2.1.d. Fruit Quality

As for mango fruits, Kumar and Singh (1993) showed that spraying mango trees cv. Amrapalli with GA_3 at 50 or 75 ppm brought forward fruit maturity by 8-11 days and ripening by 10-14 days compared with the control and significantly improved fruit quality (T.S.S., sugar, ascorbic acid and beta-carotene concentrations) during storage.

Singh *et al.* (1995) mentioned that spraying mango trees cv. Amrapalli in the first week of June with GA_3 at 50 and 75 ppm as a pre-harvest treatment improved fruit quality.

In regard to other fruit species, GA3 at 5-100 ppm as a pre-harvest treatment showed to be effective in enhancing fruit firmness of Valencia orange (Coggins and Henning, 1985), delaying pigmentation of mandarin fruits (Duarte *et al.*, 1995), enhancing the intensity of juice colour, total soluble solids and sugar content, besides a tendency for total acidity to be slightly decreased towards the end of the storage period of Manfalouty pomegranate fruits (El-Kassas *et al.*, 1995), improving fruit quality in terms of soluble solids and sugars of cherry fruits (Mir *et al.,* 1995), reducing total soluble solids of mandarin fruits (Modesto *et al.*, 1999), increasing peel firmness of orange fruits (Fidelibus *et al.,* 2002),

decreasing augmented fruit biochemical attributes such as total solids, acidity and sugar content of sapota fruits (Choudhury *et al.*, 2003), decreasing the loss of ascorbic acid content of mandarin fruits (Mohd-Amir *et al.*, 2003) and recording superior values of Brix : acid ratio and starch content of guava fruits (Jayachandran *et al.*, 2005).

2.2.2. Effect of calcium chloride ($CaCl_2$)

2.2.2.a. Fruit weight loss

With respect to mango fruits, Singh *et al.* (1993) recorded that spraying mango trees cv. Dashehari with calcium compounds ($Ca(NO_3)_2$ at 1 or 2% or $CaCl_2$ at 0.6 or 1.2%) 20 and 10 day before harvest reduced the weight loss during storage under ambient conditions (35± 3°C and 65± 5% RH).

Kluge *et al.* (1999) sprayed calcium chloride (7 applications) at 0.6 or 1.2% before harvest of Tommy Atkins mangoes. They cleared that weight loss was reduced by $CaCl_2$ treatments.

Chitarra *et al.* (2001) sprayed mango trees cv. Tommy Atkins with calcium chloride solutions (0.0, 2.5 or 5.0%) as a pre-harvest application at 40, 60 and 90 days after the flowering period. Harvested fruits were stored under 10°C and 90% RH for 35 days, during which the fruits were analysed weekly. They noticed that $CaCl_2$ at 5.0% resulted in lower mass loss (2.98%) and better texture than the 2.5% treatment.

Referring to other fruit species, Subburamu *et al.* (1990), Raychaudharyi *et al.* (1992), Bhanja and Lenka (1994), Chandra *et al.* (1994), Ali *et al.* (1995), Brar *et al.* (1997), Yadav and Singh (1999), Choudhury *et al.* (2003), Mohd-Amir *et al.* (2003) and Shaaban (2006) evaluated the efficacy of spraying calcium as a pre-harvest treatment in the form of calcium chloride ($CaCl_2$) at 0.6-4.0% or calcium nitrate [$Ca(NO_3)_2$] at 0.75-2.00% on storage behaviour of grape cv. Muscat, guava cv. L. 49, Sapota fruits, guava fruits cv. Allahabad Safeda, Red raspberry cv. Sceptar, peach fruits cv. Shan-1-Punjab, aonla fruits, Sapota cv. Pala, Kinnow mandarin fruits and guava fruits cv. Maamoura, respectively. They concluded that the tested calcium treatments induced a remarkable reduction in the rate of physiological weight loss during storage.

2.2.2.b. Fruit Decay

Concerning mango fruits, Singh *et al.,* (1987a) sprayed mango trees cv. Amrapalli with calcium nitrate or calcium chloride at rates of 0.5 – 2.0%, a week before harvesting. They reported that Ca treatments decreased fruit decay percentage and increased storage life of fruits six days over the control.

Ray *et al.* (1993) sprayed mango trees cv. Bombay green with calcium compounds as a pre harvest treatment and stored the treated fruits under artificial epiphytotic conditions. They noticed that both calcium nitrate and calcium chloride at 2500 and 5000 ppm significantly increased the incidence of disease on mango fruits. Disease incidence was increased with increasing rates of the calcium compounds and spraying twice was more effective than a single spray.

Singh *et al.* (1993) sprayed mango trees cv. Dashehari with calcium compounds ($Ca(NO_3)_2$ at 1 or 2% or $CaCl_2$ at 0.6 or 1.2%) 20 and 10 days before harvest, then harvested fruits were stored under ambient conditions. They reported that Ca-treated fruits had a lower respiration rate than control fruits. Fruits from the best treatment ($CaCl_2$ at 0.6%) could be stored for 10 days. For the other Ca treatments, this was 8 days, while control fruits were over ripe by this time and could be stored for 6 days only.

Sanjay *et al.* (1998) sprayed Amrapalli mango trees with calcium compounds as a pre-harvest treatment. They concluded that $CaCl_2$ (1.5%) and $Ca(NO_3)_2$ (1.5%) were most effective treatments for improving the storage life and decay percentage of mango fruits.

Chitarra *et al.* (2001) studied the effect of spraying mango trees cv. Tommy Atkins with calcium chloride solutions (2.5 or 5.0%) in three times (40, 60 and 90 days) after the flowering periods on biochemical changes and decay percentage under cold storage (10°C and 90% RH) for 35 days. They emphasized that the control fruits showed internal breakdown after three weeks of storage, while $CaCl_2$-treated fruits did not show breakdown symptoms and still firm and suitable for consumption at the end of storage period after five weeks.

With respect to other fruit species, Ranjit *et al.* (1990) on grape cv. Delight, Subburamu *et al.* (1990) on grape cv. Muscat, Bhanja and Lenka (1994) on sapota, Mir *et al.* (1995) on cherry, Mir *et al.* (1996) on apple cv. Red Delicious,

Brar *et al.* (1997) on peach cv. Shan-1-Punjab Yadav and Singh (1999) on aonla fruits, Choudhury *et al.* (2003) on sapota cv. Pala, Mohd-Amir *et al.* (2003) on Kinnow mandarin and Recasens *et al.* (2004) on apple cv. Golden Smoothee. They sprayed the trees of these fruit species with calcium as a pre-harvest treatment in the form of calcium chloride at 0.3-5% or calcium nitrate at 1.0-2.5% to enhance fruit storage life. They abstracted that calcium- treated fruits had the lowest decay percentage and the longest storage life as compared with untreated ones "control".

2.2.2.c. Shelf Life

Regarding mango fruits, Sanjay *et al.* (1998) revealed that spraying mango trees cv. Amrapalli with calcium compounds (particularly, $CaCl_2$ and Ca $(NO_3)_2$) enhanced the fruit shelf life as judged from the pattern of physiological loss in weight, total soluble solids, acidity, total sugar, ascorbic acid and beta carotene content.

Concerning other fruit species, Callan (1986), Gupta *et al.* (1987a), Singh *et al.* (1987b), Gupta *et al.* (1988), Bhanja and Lenka (1994), Chandra *et al.* (1994), Yadav and Singh (1999), Choudhury *et al.* (2003) and Recasens *et al.* (2004) investigated the effect of calcium as a pre harvest treatment in the form of calcium chloride at 1-4% or calcium nitrate at 1.0-2.5% on marketability "shelf life" after storage of sweet cherry cv. Lambert, Jack fruits, Blood Red orange, ber fruits, Sapota fruits, guava fruits cv. Allahabad Safeda, aonla fruits, Sapota fruits cv. Pala and apple fruits cv. Golden Smoothee. They concluded that calcium treatment was the most effective treatment in maintaining (shelf life) marketability for longer time as compared with the control.

2.2.2.d. Fruit Quality

As for mango fruits, Singh *et al.* (1993) sprayed Dashehari mango trees with water, $Ca(NO_3)_2$ (1 or 2%) or $CaCl_2$ (0.6 or 1.2%) 20 and 10 days before harvest, then harvested fruits were stored under ambient conditions (35± 3°C and 65± 5% RH). They mentioned that all Ca treatments delayed ripening and improved fruit quality during storage.

Kluge *et al.* (1999) studied the effect of spraying calcium chloride as a pre-harvest applications (7 times) at 0.6 or 1.2% on mango fruit quality cv. Tommy

Atkins. They showed that total soluble solids, total titratable acidity and pulp firmness were positively affected by the tested treatments.

Evangelista *et al.* (2000) reported that spraying Tommy Atkins mango fruits with 5% $CaCl_2$ as a pre harvest treatment gave firmer fruits and resulted in lower activity of polygalacturonase and β-galacturonase, when compared with 2.5% $CaCl_2$ or untreated fruits (control) during storage at 10°C.

Silva and Menezes (2000) sprayed mango trees cv. Tommy Atkins with 1 or 2% $CaCl_2$ 2, 3 or 4 times at 15 day intervals from 35 days of blooming. They observed that $CaCl_2$ concentration did not affect fruit quality, but the number of applications affected the content of soluble sugars.

Chitarra *et al.* (2001) showed that spraying mango trees cv. Tommy Atkins with calcium chloride solutions at 5.0% as a pre-harvest treatment, three times (40, 60 and 90 days) after flowering periods succeeded in reducing the less of firmness fruits during storage at 10°C and 90% RH than 2.5% treatment or control.

Silva and Menezes (2001) investigated the influence of pre-harvest spray (2, 3 or 4 sprays) with $CaCl_2$ (0, 1, 2%) on quality of mango fruits cv. Tommy Atkins. They realized that fruit firmness was higher with 2 applications of 1% and 3 or 4 applications of 2% $CaCl_2$ than other treatments. Concentration of soluble solids and soluble sugars were not affected by $CaCl_2$ concentration, but soluble solids were increased by 4 applications after 30 days of storage and soluble sugars were increased by 4 applications immediately after harvest. Total titratable acids were decreased by 3 or 4 applications of 2% $CaCl_2$.

Referring to other fruit species, $Ca(OH)_2$ sprays as a pre-harvest treatment three times a year on sweet cherry trees cv. Lambert succeeded in increasing fruit soluble solids content (Callan, 1986). Moreover, pre-harvest treatment with calcium sprays at 1.7 g/litre as chloride, sulphate or phosphate retained high T.S.S. and ascorbic acid in ber fruits for longer periods than the control (Gupta *et al.,* 1987a). Besides, $Ca(NO_3)_2$ sprays on jack fruit trees at 2% resulted in the best fruit firmness and flavour (Gupta *et al.,* 1987b). Furthermore, calcium sprays as a pre-harvest treatment in the form of calcium chloride at 0.6-2% or calcium nitrate at 0.75-2.50% was effective in maintaining fruit quality of per fruits during storage (Gupta and Neena, 1988), enhancing fruit quality infinitely of grape cv. Delight during storage (Ranjit *et al.,* 1990), improving fruit quality traits and inducing the

highest TSS and total sugar content of guava fruits cv L.49. (Raychaudharyi *et al.,* 1992) maintaining flesh firmness of Red Delicious apple fruits during storage (Tripathi and Bhargava, 1993) maintaining eating quality of guava fruits cv. Allahabad Safeda (Chandra *et al.,* 1994), decreasing the rate of reduction in flesh firmness and ascorbic acid of Red raspberries cv. Sceptar during storage (Ali *et al.,* 1995), improving juice colour intensity, total soluble solids and sugar content of pomegranate fruits cv. Manfalouty (El-Kassas *et al.,* 1995), increasing fruit firmness of Golden Delicious apples (Siddiqui and Bangerth, 1995), reducing fruit organic acid content and fruit firmness and increasing fruit total soluble solids and sugar content of peach fruits cv. Shan-1-Punjab (Brar *et al.,* 1997), decreasing the augmented biochemical attributes such as total soluble solids, acidity and sugar of Sapota fruits cv. Pala (Choudhury *et al.,* 2003) and decreasing the loss of ascorbic acid content of Kinnow mandarin (Mohd–Amir *et al.,* 2003).

2.2.3. Effect of yeast suspension

The review of literature dealing with the effect of yeast suspension as a pre-harvest treatment on fruit behaviour during storage i.e. fruit weight loss, decay percentage, shelf life and other fruit quality traits are rare. However, the available review of literature in this concern were handled by Lima *et al.* (1997) who made a trial to evaluate the activity of *A. pullulans* (isolate L 47) and the yeast *C. olephila* (isolate L66) against grey mould of table grapes. The antagonists were sprayed on bunches in the field before harvest time and the grapes were either cold stored (0°C) or left on the vines under plastic covering. The epiphytic population of the total yeasts (including yeast- like fungi), filamentous fungi and bacteria on the berries were periodically evaluated. Isolate L 47 applied five days before harvest showed a high and durable activity against *B. cinerea* in both field and cold storage, meanwhile L 66 showed some activity only in the first year, when the disease incidence was low. The higher activity of isolate L 47 may attributed to its higher survival rate on the berries under the different conditions of the trials. This antagonist also showed some activity in containing the natural population of fungi and bacteria on the berries. Moreover, El-Neshawy *et al.* (2003) reported that a yeast, strain ID 244 of *Candida oleophila*, isolated from the surface of dry date fruit was evaluated for its potential biological control activity against the grey mould

(*Botrytis cinerea*) of grape (*Vitis vinifera*) cultivar Ruby seedless under cold storage conditions. A low rate of Euparen (dichlofuanid)- tolerant cells of *C. oleophila* with a low dose of Euparen 50% WP (250 ppm) gave significantly better mould control at 0ºC than either Euparen or the yeast alone and was comparable to disease control achieved using a commercially recommended high dose of Euparen (1250 ppm). The combination also, maintained some of the fruit quality characteristics. The population dynamics of the yeast on grapes were studied in the orchard and during storage following the application of 3 $x10^5$ cfu/ml. The population size of the yeast under the yeast treatment and the yeast- Euparen (250 ppm) combined treatment increased from approximately 10^3 cfu/g of berries in the orchard to $6.5x10^5$ cfu/g and $2.5x10^4$ cfu/g after 30 days of storage, respectively, while it declined to 10^1 cfu/g for the yeast- Euparen (1250 ppm) treatment.

3- MATERIALS and METHODS

This study included two main parts as follows:-

Part I Trials to improve some marketing characteristics (ripening) and enhancing storage ability of Costata persimmon fruits.

This part of study was in turn subdivided into two parts as follows:-

3.1.1. Effect of some chemical substances on some marketing characteristics (ripening) of Costata persimmon fruits.

3.1.2. Effect of some post harvest treatments on storage ability of Costata persimmon fruits.

Part II Trials to enhance storability of Zebda mango fruits through some pre-harvest treatments.

Thereupon, this study was handled as follows:-

Part I Trials to improve some marketing characteristics (ripening) and enhancing storage ability of Costata persimmon fruits.

3.1.1. Effect of some chemical substances on some marketing characteristics (ripening) of Costata persimmon fruits.

In 2003 and 2004 seasons, persimmon fruits (*Diospyros kaki, L.*) cv. Costata were harvested at mature stage i.e., mid-October from productive Costata persimmon trees, 15-year-old and grown in a clay-loamy soil in the farm of Barrage Research Station of the Horticulture Research Institute, Kalubia Governorate. The productive trees were similar in growth vigour, have good physical condition and received similarly the recommended horticultural practices. Harvested fruits were brought as soon as possible to the Fruit Handling and Storage Unit, Horticulture Department, Faculty of Agriculture, Benha University Kalubia Governorate.

Tested fruits were sorted (all malformed, crushed and diseased fruits were discarded) and the uniform fruits were chosen, quickly washed with tap water and

then dipped in borax solution at 5% as a fungicide, then rewashed with tap water and dried through the exposure to air from an electric ventilator. A second sorting was done to recheck the fruits for any defects.

Thereafter, these fruits were divided into two main groups, the first one was subjected to perform fruit ripening study .i.e. an evaluation of the efficiency of some chemical treatments in accelerating ripening process and producing an early and uniform ripened fruits with good quality. Besides, the second group of prepared fruits were subjected to evaluate the efficiency of some post harvest treatments on prolonging the storage life of persimmon fruits.

The first group of selected persimmon fruits cv. Costata was divided into five subgroups to receive one of the following ripening treatments:

(1) Ethephon (CEPA)

The effect of ethephon (2-chloroethyl phosphonic acid) on ripening of "Costata" persimmon fruits was investigated; hence mature and uniform fruits were dipped for five minutes in 500 or 1000 ppm ethrel (ethephon) solution.

(2) Calcium carbide (CaC_2)

Calcium carbide was added at 2.5 or 5.0 g/box fruits (about 4 kg fruits) to bring up acetylene and ethylene (ripening gases) according to Medlicott (1986).

(3) Control treatment

Selected persimmon fruits were dipped in water for five minutes as a control to be compared with treated fruits (ethephon and calcium carbide). All treatments of this study were held at ambient temperature (30±3°C & 65-70% R.H.). The initial values of the studied fruit parameters were determined before treatment application and periodically at two days intervals throughout the ripening period. All treated fruits in this study were packed carefully after receiving the tested treatments in plastic boxes "42 x 28 x 12 cm" wrapped with polyethylene film, previously treated with Cifadex as a fungicide, and each box contained 35 fruits.

Consequently, this investigation included five ripening treatments namely; 500 & 1000 ppm ethephon and 2.5 & 5.0 g calcium carbide as well as the control treatment. The tested treatments were arranged in a completely randomized block design and each treatment was replicated three times and each replicate was represented with two boxes, one of these two boxes was employed to determine the changes in fruit physical properties *i.e.* ripening percentage, weight loss percentage, decay percentage

and fruit firmness, whereas the second one was devoted for the determination of fruit chemical properties *i.e.* carotenoids, total sugars content, total soluble solids, titratable acidity, ascorbic acid (V.C) and tannins content.

The fruit physiochemical changes associated with tested treatments were determined as follow:

3.1.1.1. Fruit physical properties

3.1.1.1.1. Ripening percentage of persimmon fruits

The percentage of ripened fruits under the different tested ripening treatments was determined according to fruit colour (reddish orange) and fruit texture (fruit firmness). Thereupon, the number of well coloured and less firm fruits under each tested ripening treatment was counted and the ripening percentage was calculated.

3.1.1.1.2. Fruit weight loss percentage

The initial weight of Costata persimmon fruits i.e. before storage was determined, then the weight was determined periodically i.e. every two days throughout ripening period of all treatments under ambient room conditions. The percentage of fruit weight loss was calculated in relation to its original weight, and the average fruit weight loss percent was calculated for each treatment according to the following equation:

$$\text{Fruit weight loss \%} = \frac{\text{Initial weight} - \text{Weight at each specific interval}}{\text{Initial weight}} \times 100$$

3.1.1.1.3. Fruit decay percentage

The decayed fruits under each treatment were discarded and weighted, then fruit decay percentage was calculated.

3.1.1.1.4. Fruit firmness

Three fruits were taken at the previously mentioned two days intervals to determine the fruit firmness. Flesh firmness was determined by peeling the two opposite sides of the fruit and the firmness of each side was measured by using the Effegi firmness tester with an 5/16" plunger (Effegi 48011 Alfonsine, Italy). The average flesh firmness of each sample of fruits was estimated. Fruit firmness was expressed as pounds / square inch.

3.1.1.2. Fruit biochemical properties

3.1.1.2.1. Fruit carotenoids content

Total carotenoids were determined using colorimetric method (AOAC, 1985) as mg per 100 g fresh weight.

3.1.1.2.2. Sugars content

The sugars were extracted from five grams of fruit pulp as samples. The extraction was carried out using distilled water, according to Loomis and Shull (1937). For determination of sugars, the reducing as well as the total sugars of the extract were determined respectively, before and after hydrolysis with hydrochloric acid by the Nelson arseno molybdate colorimetyric method, described by Malik and Singh (1980). The non-reducing sugars were calculated through the difference between the total and the reducing sugars. Sugars content was expressed as grams per 100 g fresh weight of fruit flesh.

3.1.1.2.3. Fruit total soluble solids (T.S.S.)

Total soluble solids of fruit juice were measured using a hand refractometer, according to Chen and Mellenthin (1981). The total soluble solids were expressed as a percent.

3.1.1.2.4. Fruit titratable acidity

Fruit juice samples (5 ml) for each tested treatment were used to determine the titratable acidity. Hence, 0.1 N sodium hydroxide was used in the presence of phenolphthalein as an indicator, according to Chen and Mellenthin (1981). Fruit titratable acidity was expressed as grams of citric acid per 100 ml of juice.

3.1.1.2.5. Fruit ascorbic acid (V.C.)

Fruit juice samples (5 ml) were used and five ml of oxalic solution were added to each sample, then each sample was titrabled with 2, 6-dichlorophenol-indophenol dye solution. The ascorbic acid content was expressed as milligrams ascorbic acid per 100 ml fruit juice, according to AOAC (1985).

3.1.1.2.6. Fruit tannins content

Total tannins of Costata persimmon fruits were determined according to AOAC (1985).

3.1.1.3. Statistical Analysis

Data expressed as percentages were transformed into angles to be statistically analyzed owing to the polarization observed in the data scatter plot according to Clarke and Kempson (1997). All obtained data in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1989). Differences among means for the specific effect of ripening period, between the tested treatments and chemical substances were compared using Duncan multiple range test (Duncan, 1955) at 5% level. The interactions effect between treatments and ripening period were differentiated using L.S.D. method at 5% level.

3.1.2. Effect of some post-harvest treatments on storage ability of Costata persimmon fruits.

The second group of selected "Costata" persimmon fruits were immersed in 500 ppm ethephon solution for five minutes to bring the fruits to ripening stage, then the fruits were divided into six subgroups to receive one of the following storage treatments:

(1) Calcium chloride ($CaCl_2$)

Well sorted mature Costata persimmon fruits were dipped for five minutes in 2 or 4% calcium chloride ($CaCl_2$) solutions for five minutes, thereafter, fruits of each treatment were air dried.

(2) Yeast

Yeast suspension was prepared by using a technique allowed yeast cells (pure dry yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions. To produce denovo beneficial bioconstituents, *i.e.* (carbohydrates, sugars, proteins, amino acid, fatty acids, hormones. etc.). Hence allowed such constituents to release out of yeast cells in readily form. Such technique for yeast preparation based on:

1- Nutritional medium of glucose and casin as a favorite sources of C and N. and other essential elements (P, K, Ca, Mg, Fe, Mn, Zn, Cu, B, Mo as well as Na and Cl) in suitable balance (Barnett *et al.,* 1990).
2- Air pumping and adjusting incubation temperature.
3- Two cycles of freezing and thawing for disruption of yeast cells and releasing their content.

Procedure modified after Shady (1978), Spencer *et al.* (1983) and Fathy *et al.* (2000). Analysis of prepared yeast stock solution was: total protein (5.3%), total carbohydrates (4.7%), N (1.2%), P (0.13%), K (0.3%), Mg (0.013%), Ca (0.02%), Na (0.01%); micro-elements (ppm), Fe (0.13), Mn (0.07), Zn (0.04), Cu (0.04), B (0.016), Mo (0.0003). IAA (05 mg/ml) and GA (0.3 mg/ml). Such analysis was according to Cotton (1954) and atomic absorption method for mineral analysis; Nelson (1944) and AOAC (1985) for carbohydrates analysis and GLC method (Vogel, 1975) for IAA and GA_3.

Well sorted "Costata" persimmon fruits were dipped in yeast suspension at 1 or 2% (*Saccharomyces cerevisiae*) for five minutes. The fruits were then air dried.

(3) Sodium hypochlorite (NaOCl)

Mature and well sorted persimmon fruits were dipped in sodium hypochlorite (NaOCl) at 2% for five minutes, then the treated fruits were air dried.

(4) Control treatment

Well selected persimmon fruits were dipped in tap water for five minutes as a control (untreated fruits) to be compared with $CaCl_2$, yeast and NaOCl - treated fruits.

Conclusively, this investigation included three storage temperatures i.e. ambient room (30±3°C & 65-70 % R.H.), cold temperature at 5°C and cold temperature at 0°C. Besides, within each tested storage temperature six post harvest treatments were evaluated namely: 2 & 4% $CaCl_2$, 1 & 2% yeast suspension, 2% NaOCl and the control (untreated fruits). The initial values of fruit parameters of this study were determined before treatment application and periodically at weekly intervals throughout the storage period under each tested storage temperature (ambient room, 5°C and 0°C).

All treated fruits in this study were packed carefully after receiving the tested treatments in plastic boxes "42 x 28 x 12 cm", previously treated with cifadex as a fungicide, each box contained 35 fruits.

The tested post harvest treatments were arranged in a completely randomized block design and each treatment was replicated three times, each replicate was represented with two boxes, one of these two boxes was employed to determine the changes in fruit physical properties i.e. weight loss percentage, decay percentage, fruit firmness and shelf life, whereas the second one was devoted to determine some fruit

chemical properties i.e. carotenoids, total sugar content, total soluble solids, titratable acidity, tannins content and ascorbic acid (V.C).

The fruit physiochemical changes associated with post harvest treatments application and storage durations were determined as follow:

Fruit physical properties i.e. fruit loss percentage, fruit decay percentage and fruit firmness as well as fruit chemical properties namely fruit carotenoids content, fruit sugars, total soluble solids, titratable acidity and tannin content were determined using the previously mentioned procedures used in the case of ripening persimmon fruits study. Moreover, shelf life was determined using a sample of fifteen fruits per each replicate at the end of cold storage period and left at ambient temperature (30±3°C & 65-70 % R.H.) for six days. The percentage of decayed fruits were calculated and considered as an indicator for shelf life.

Statistical Analysis

Data expressed as percentages were transformed into angles to be statistically analyzed owing to the polarization observed in the data scatter plot according to Clarke and Kempson (1997).All obtained data in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1989). Differences among means for the specific effect of storage period and tested post harvest treatments were compared using Duncan multiple range test (Duncan, 1955) at 5% level. The interaction effect between treatment and storage period was differentiated using L.S.D. method at 5% level.

Part II 3.2. Trials to enhance storability of Zebda mango fruits through some pre-harvest treatments.

This study aims to evaluate the effect of some pre-harvest treatments on enhancing fruit storability and improving fruit quality of Zebda mango fruits stored under different storage temperatures. 20-years-old grafted Zebda mango trees (*Mangifera indica, L.*) grown in a sandy loam soil at Arab-El-Ghadery village, Kalubia Governorate were devoted for this study. Selected trees were uniform in

growth, had good physiological condition and receiving the recommended agricultural practices.

In 2003 and 2004 seasons, selected trees for this study sprayed with one of the following pre harvest treatments: (1) Gibberellic acid (GA_3) at 25, 50 and 75 ppm, (2)Calcium chloride ($CaCl_2$) at 1 and 2%, (3) Active yeast suspension at 1 and 2% and (4) Tap water was used for spraying the trees as a control treatment. Tween 20 as a surfactant was added at 0.01% to all treatment solutions including the tap water "control". The preparation of yeast suspension was previously explained in the first part (Persimmon Experiment).

In both seasons of this study, the spray of all tested treatments was performed three times a year, i.e. the first spray was done after fruit setting stability, meanwhile the others two sprays were carried out thereafter at three weeks intervals. Each treatment was represented by three replicates (one tree / replicate). The treatments were arranged in a completely randomized block design.

Zebda fruits were picked at mature green stage i.e. in mid August in both seasons. Selected fruits were free of obvious mechanical damage and defects and approximately homogenous in size and colour. Fruits were then brought as soon as possible to the Post-harvest Laboratory of Pomology Department (APHC), Faculty of Agriculture, Alexandria University "under the supervision of Prof. Dr. Awad Hussien".

Fruit parameters of pre-harvest treated Zebda mango fruits were initially determined (before storage) as follows: The average fruit weight (g) and the weight of fruit peel, pulp and seed (g) of mango fruit cv. Zebda in all pre harvest treatments and the control were determined and recorded and the percent of the weight of peel, pulp and seed in relation to the hole fruit was calculated and recorded. Also, pulp dry weight was determined according to Ranganna (1977). The average fruit dimensions (cm) of mango fruits as length, breadth and thickness, were measured by a caliper and as shown in Fig (1) according to Campbell, (1992).

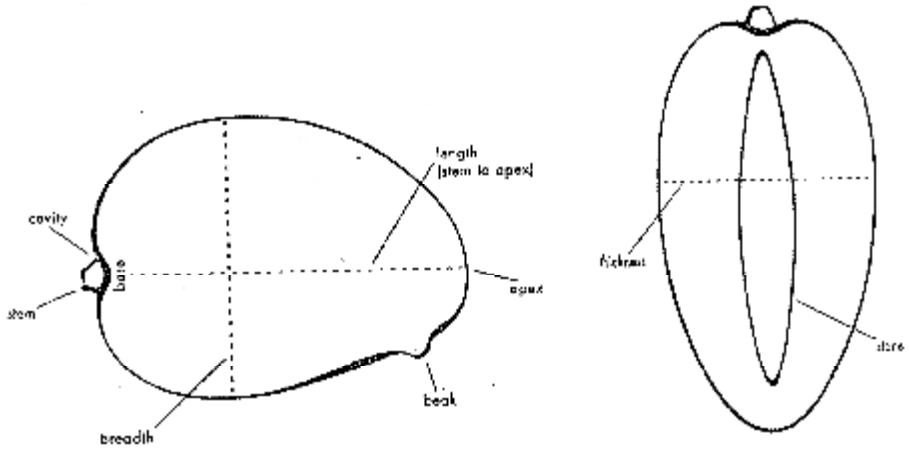

Fig (1): The measurement of length, breadth and thickness of mango fruits.

Furthermore, fruits with any insect infestation or defects were discarded. Sorted fruits were quickly washed with regular tap water, then air dried with the aid of an electric fan. A second sorting was done to recheck the fruits for any defects to be ready for storage study. This investigation included three storage temperatures i.e. ambient temperature (28±2°C & 75-80% RH), cold storage at 15 & 90-95% RH and 10°C & 90-95% RH Besides, within each storage temperature eight pre harvest treatments were evaluated namely 25, 50 and 75 ppm GA_3, 1 & 2% $CaCl_2$, 1 & 2% yeast suspension and the control. The treatments were arranged in a completely randomized block design with three replicates for each treatment and each replicate was represented with two boxes of fruits. All selected fruits for each treatment were packed in plastic boxes “42 x 28 x 12 cm”, previously treated with Cifadex as a fungicide, every box contained fifteen fruits. Each treatment included 36 boxes, which divided into three lots. The first one contained 6 boxes and kept at ambient temperature (28± 2°C & 75-80% RH), the second one contained 15 boxes and held at 15°C and 90-95% RH and the last one also contained 15 boxes and stored at 10°C and 90-95% RH.

The fruit physiochemical changes in response to pre-harvest treatments, storage period and days on shelf as well as their interaction were determined as follow:

3.2.1. Fruit physical properties

3.2.1.1. Fruit weight loss percentage

The initial weight of Zebda mango fruits i.e. before storage was determined, then the weight was determined periodically throughout the storage period and days on shelf of all treatments under different storage temperatures. The percentage of weight loss for each fruit was calculated in relation to its original weight and the average weight loss percent was calculated for each treatment according to the following equation:

$$\text{Fruit weight loss \%} = \frac{\text{Initial weight} - \text{Weight at specific interval}}{\text{Initial weight}} \times 100$$

3.2.1.2. Fruit decay percentage

The decayed fruits of each treatment were discarded and weighed. The weight of such discarded fruits related to the initial weight of fruits per each treatment was estimated and decay percentage was calculated.

3.2.1.3. Fruit firmness

Three fruits were taken at the previous mentioned intervals to determine the changes in fruit firmness. Flesh firmness of the treated fruits was determined by peeling the two opposite sides of the fruit and the firmness of each side was measured by using the Effegi firmness tester with an 7/16" plunger (Effegi 48011 Alfonsine, Italy). The average flesh firmness of each sample of fruits was estimated. Fruit firmness was expressed as pounds / square inch.

3.2.1.4. Days on shelf

A sample of 15 fruits per each replicate was taken out at weekly intervals after cold storage (15°C and 10°C) of Zebda mango fruits and left at ambient temperature (28±2°C & 75-80% RH) for three or six days. All parameters of fruits were determined, calculated and considered as an indicator for shelf life.

3.2.2. Biochemical properties

3.2.2.1. Chlorophylls and carotenoids content

Peel chlorophylls a, b and total carotenoids in peel and pulp were determined using colorimetric method (AOAC, 1985) and expressed as mg per 100g fresh weight.

3.2.2.2. Fruit total soluble solids (TSS)

Total soluble solids of fruit juice were measured using a hand refractometer, according to Chen and Mellenthin (1981). The total soluble solids was expressed as a percent.

3.2.2.3. Sugars content

The sugars were extracted from five grams of fruit fresh flesh as samples. The extraction was carried out using distilled water, according to Loomis and Shull (1937). For determination of sugars the reducing as well as the total sugars of the extract were determined respectively, before and after hydrolysis with hydrochloric acid by the Nelson arseno molybdate colorimetyric method, described by Malik and Singh (1980). The non-reducing sugars were calculated by subtracting reducing sugars from total sugars. Sugars content was expressed as grams per 100 g fresh weight of fruit flesh.

3.2.2.4. Fruit titratable acidity

Fruit juice samples (5 ml) were used and titrated with 0.1 N sodium hydroxide in the presence of phenolphthalein as an indicator, according to Chen and Mellenthin (1981). The titratable acidity was expressed as grams of citric acid per 100 ml of juice.

3.2.2.5. Fruit ascorbic acid (V.C) content

Samples of fruit juice (5 ml) were used. 5 ml of oxalic solution were added to each sample, then each sample was titrable with 2, 6-dichlorophenol-indophenol dye. The ascorbic acid content was expressed as milligrams ascorbic acid per 100 ml fruit juice, according to AOAC (1985).

3.2.3. Statistical Analysis

Data expressed as percentages were transformed into angles to be statistically analyzed owing to the polarization observed in the data scatter plot according to Clarke and Kempson (1997).All obtained data in both seasons were subjected to analysis of variance according to Snedecor and Cochran (1989). Differences among means for the specific effect of storage period, tested pre harvest treatments and days on shelf were compared using Duncan multiple range test (Duncan, 1955) at 5% level. The interactions effect between treatments, storage period and days on shelf were differentiated using L.S.D. method at 5% level.

4- RESULTS and DISCUSSION

Part I Trials to improve some marketing characteristics (ripening) and enhancing storage ability of Costata persimmon fruits.

4.1.1. Effect of some chemical substances on some marketing characteristics "ripening" of Costata persimmon fruits.

Effect of some ripening substances i.e., ethephon at 500 and 1000 ppm and calcium carbide at 2.5 & 5.0 g/box on ripening percentage of Costata persimmon fruits (indices of fruit ripening were reddish orange colour, softness of fruit texture and some physiochemical attributes) during 2003 and 2004 seasons is reported in Tables (1–10), illustrated in Figures (2–4) and exhibited in Photos (1-2). The effect of aforementioned factors of study namely ripening period (period in days after treatment with the tested chemical substances), ripening substances with their concentrations and the interaction between these three factors on some physiochemical attributes of Costata persimmon fruits i.e. ripening (%), weight loss (%), decay (%), firmness (lb/inch^2), pulp carotenoids content (mg/100 g fresh weight), total sugars (%), total soluble solids (%), total acidity (%), ascorbic acid content (mg/100 ml) and tannins content (g tannic acid/100 g fresh weight).

4.1.1.1. Ripening percentage of fruits

As for specific effect of ripening period, it is easy to notice from Table (1) that there was a steadily increment in fruit ripening percentage with the advancement of period after the treatment with the tested ripening chemical substances.

The recorded data emphasize this result, hence the highest percentages of fruit ripening (82.10 & 82.48) were scored after eight days of subjecting the fruits to the tested ripening chemical substances, followed descendingly by six days

Table 1

ripening period (65.52 & 65.03) against (12.57 & 13.32) for the analogous ones kept for two days after treatment with ripening chemical substances during 2003 and 2004 seasons, respectively. Furthermore, keeping treated Costata persimmon fruits with tested ripening chemical substances for four days induced an enhancing effect on fruit ripening percentage in comparison with the corresponding ones kept for two days only. The differences between the studied ripening periods in this respect were pronounced to be significant.

Referring to specific effect of the tested ripening substances, data in Table (1) demonstrate that the highest fruit ripening percentages were produced by ethephon- treated fruits (62.26 & 64.20) in comparison with those treated with tap water "control" and calcium carbide in the first and second seasons, respectively. Moreover, calcium carbide-treated fruits scored significantly higher ripening percentages (56.90 & 57.61) against (4.52 & 5.00) for untreated ones "control" during 2003 and 2004 seasons, respectively.

Looking at specific effect of the tested treatment concentrations, Table (1) illustrates that all tested treatment concentrations succeeded in increasing fruit ripening percentage in comparison with untreated fruits "control" in both seasons of study. The higher concentrations of both ethephon and calcium carbide surpassed the lower ones in enhancing fruit ripening percentage. Generally, 1000 ppm ethephon proved to be the superior concentration in this respect, hence it produced the highest ripening percentages (67.62 & 67.66), followed descendingly by 5.0 g/box calcium carbide treatment (60.47 & 60.00) when compared with control "untreated" fruits which produced the lowest values (4.52 & 5.00) during the first and second season, respectively. Besides, 500 ppm ethephon treatment predominated 2.5 g/box calcium carbide in enhancing fruit ripening percentage in 2003 season, only.

With respect to the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the resulted combinations reported in Table (1), exhibited in Photos (1-2) and illustrated in Fig (2) show that ripening period irrespective of ripening chemical substances and ripening treatment concentrations had the strong decision in determining the ripening percentage.

Thereupon, eight days ripening period interactions showed to be the most effective combinations in inducing the highest fruit ripening percentages, with the exception of untreated fruits “control” in both seasons, followed in descending order by those of six days ripening period.

Photo (1): Costata persimmon fruits before ripening treatments application.

Photo (2): Response of Costata persimmon fruits to some ripening treatments with the advancement of ripening period.

Fig (2)

On the opposite, the lowest fruit ripening percentages were scored by two days ripening period combinations, followed in an ascending order by four days ripening period interactions. The differences between the different combinations were pronounced to be significant in both seasons. It is important to notice that all tested combinations resulted from eight days repining period x repining chemical substances x repining treatment concentrations scored 100% ripening in both seasons against (10.48 & 12.38) for the combinations of eight days ripening period x control treatment in the first and second season, respectively.

The role of ethephon in enhancing ripening of persimmon fruits through encouraging the hydrolysis of starch and accumulation of sugars as well as the conversion of protopectin to soluble pectins. Besides, ethephon treatment enhanced persimmon ripening through the production of ethylene which accelerates ripening through loss of firmness, colour development and disappearance of astringency (Tannins) starch hydrolysis to sugars Abd-El-Wahab, *et al.,* (1983).The results of ethephon on fruit ripening go in line with earlier studies of Wakamatsu *et al.* (1973), Srinivasan *et al.* (1974), Forlani (1976), Kato (1987), Kamal and Rabeh (1989) and Park *et al.* (1998). They studied the efficacy of ethrel (ethephon) either as a pre-harvest treatment at 15-50 ppm or as dipping in ethephon solution (250 - 5000 ppm) with different dipping times (5-60 minutes) on the time required for persimmon fruits cvs. Hiratanenashi, Costata….etc. to reach ripening stage. They concluded that ethephon-treated fruits needed 1-8 days to reach ripening according to ethephon concentration and time of dipping, whereas untreated fruits "control" failed to reach ripening stage, one month after storage at room temperature and deteriorated before ripening. Besides, Bal *et al.* (1992)on pawpaw fruits cvs. CO1 and CO2, Hartmann (1992)on cherry fruits cv. Bigarreau Napoleon , Sergent *et al.* (1993) on mango fruits cv. Keitt, Pal (1998.a&b) on mango fruits cvs. Dashehari and Rataul, Joon *et al.* (2001) on mango fruits cv. Dashehari, Lakshmana *et al.* (2001) on banana fruits cv. Robusta, Zora *et al.* (2001) on mango fruits cv. Kensington, Undurraga and Olaeta (2003) on loquat fruits cv. Golden Nugget and Kulkarni *et al.* (2004) on mango fruits cv. Neelum. They mentioned that immersing the fruits in ethephon solutions (250-2000 ppm) for 1-30 minutes according to ethephon concentration induced the best ripening attributes and sensory quality in shorter time as compared with the control.

The role of calcium carbide in accelerating fruit ripening may be due to as a precursor of acetylene which known as a ripening gas. The commercial use of acetylene, as liberated from calcium carbide, often results in fruits that are soft and have good peel colour development (Medlicott, 1990). The obtained results of calcium carbide are in harmony with earlier reports of Nagaraj *et al.* (1984), Mann (1985), Chacon *et al.* (1988), Tauqir *et al.* (1989), Ashwani *et al.* (1995), Padmini and Prabha (1997), Guha and Bhuiyan (1997), Pal (1998-b), Amarakoon *et al.* (1999) and Joon *et al.* (2001). They mentioned that CaC_2 treatments at 2 or 4 g /kg fruits induced an early and uniform ripening of mango fruits cvs. Alphonso, Dashehari, banana fruits, mango fruits cvs. Desi and Dusehi, Dashehari, Alphonso, Aswina, Rataul, Velleicolomban and Willard and Dashehari, respectively.

4.1.1.2. Fruit weight loss percentage

Regarding specific effect of ripening period, it is quite clear from Table (2) that prolonging ripening period after the treatment with tested ripening chemical substances resulted in increasing fruit weight loss percentage of Costata persimmon fruits.

The obtained data emphasize this result, where the highest fruit weight loss percentages (8.56 & 9.55) were registered after eight days of subjecting the fruits to the tested ripening chemical substances, followed descendingly by those of six days ripening period (6.20 & 6.88) against (1.48 & 1.64) for the analogous ones kept for two days and (3.74 & 3.94) for those left for four days after treatment with ripening chemical substances in 2003 and 2004 seasons, respectively. The differences between the evaluated ripening periods in this concern were remarkable to be significant at 5% level.

Considering specific effect of the tested ripening substances, reported data in Table (2) indicate that weight loss percentage of Costata persimmon fruit was greatly increased due to using the two ripening chemical substances i.e. ethephon and calcium carbide as compared with control. Thus, ethephon-treated fruits scored the highest weight loss percentages (5.25 & 5.74), followed in descending order by calcium carbide-treated ones (5.06 & 5.61) when compared with untreated fruits “control” which lost the lowest percentage of their weight (4.34 & 4.82) in the first and second seasons, respectively. The differences between the tested treatments were obvious to be considered.

Table (2)

Looking at specific effect of the tested treatment concentrations, the obtained data show that all tested treatment concentrations resulted in increasing fruit weight loss percentage in comparison with untreated fruits "control" in both seasons. There was a steadily increment in fruit weight loss percentage with the increment of the tested ripening substance concentration. Anyhow, 1000 ppm ethephon-treated fruits lost the highest percentage of their weight (5.47 & 5.96), followed descendingly by 5.0 g/box calcium carbide-treated fruits (5.23 & 5.74) in comparison with untreated fruits "control" (4.34 & 4.82%) which showed the lowest fruit weight loss percentage during the first and second seasons, respectively. Moreover, 500 ppm ethephon-treated fruits lost higher percentage of their weight in comparison with 2.5 g/box calcium carbide-treated ones in both seasons.

Examining the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the resulted combinations reported in Table (2) and illustrated in Fig (3) indicate that ripening period had the strong decision in determining fruit weight loss percentage. Consequently, two days ripening period combinations proved to be the most pronouncing ones in inducing the lowest fruit weight loss percentage, especially control treatment (1.18 & 1.36), followed in an ascending order by the interactions of four days ripening period. On reverse, the highest percentages of fruit weight loss were recorded by the corresponding ones of eight days ripening period, particularly, 1000 ppm ethephon-treated fruits (9.18 & 10.03) in the first and second seasons, respectively.

Weight loss from harvested horticultural crops is mainly due to water loss through transpiration process, while some weight loss is due to loss of carbon in respiration process, but this is only a minor part of the total. High storage temperature causes a high respiration rate which leads to a fruit weight loss (Hardenburg *et al.,* 1990). Furthermore, the role of ethephon in increasing loss in weight of persimmon fruits may be due to the effect of ethephon on increasing respiration rate and accelerating fruit ripening. It is well known that ripe fruits loose their moisture content more quickly than unripe ones (Kamal and Rabeh, 1989).

Fig (3)

The obtained results of ethrel (ethephon) are coincided with earlier reports of Kamal and Rabeh (1989). They mentioned that dipping persimmon fruits cv. Costata in ethephon solutions (500, 1000 and 2000 ppm) for five minutes exhibited greater loss in moisture content than those dipped in water (control). They added that the higher the ethephon concentration, the greater was fruit loss percentage. Also, Pal (1998-b) and Gala *et al.* (2001) realized that ethephon treatment at 250-1250 ppm increased weight loss percentage of mango fruits cv. Rataul and banana fruits varieties Hindi, Maghrabi and Williams, respectively.

The obtained results of calcium carbide affects on fruit weight loss percentage are in agreement with the findings of Valverde *et al.* (1986) on mango fruits cv. Keitt, Tauqir *et al.* (1989) on mango fruits cv. Desi and Dusehi,, Ashwani *et al.* (1995) on mango fruits cv. Dashehari and Joon *et al.* (2001) on mango fruits cv. Dashehari. They concluded that calcium carbide treatments at 2 or 4 g /kg fruits resulted in higher weight loss percentage during the ripening period compared with untreated fruits.

4.1.1.3. Fruit decay percentage

With respect to specific effect of ripening period, it is worthy to notice from Table (3) that there was a steady increase in fruit decay percentage with prolonging the period after the application of the studied ripening chemical substances. The gained data confirmed this result, hence the highest fruit decay percentages (10.67 & 12.36) were recorded after eight days of subjecting the fruits to the tested ripening chemical substances, followed in descending order by six days ripening period (7.68 & 9.18) as compared with the analogous ones kept for two days after treatment with ripening chemical substances during the first and second seasons, respectively. The differences between the tested ripening periods were pronounced to be significant in both seasons.

Focusing on specific effect of the tested ripening substances, data in Table (3) show that fruit decay percentages were increased as a result of using the two tested ripening chemical substances when compared with control. In this respect, ethephon treatments produced the highest fruit decay percentages (7.13 & 8.59), followed descendingly by calcium carbide treatments (6.51 & 7.60) against (1.03 & 2.05) for the control treatment in 2003 and 2004 seasons, respectively. The differences between ethephon and calcium carbide treatments in this respect was significant in 2004 season, only.

Table (3)

Looking at specific effect of the tested treatment concentrations, data reported in Table (3) show that all tested treatment concentrations obviously increased fruit decay percentages in comparison with the control in both seasons. Fruit decay percentages was positively proportionated with the increment of ripening substance concentration. Consequently, ethephon at 1000 ppm induced the highest fruit decay percentages (8.92 & 10.74), followed descendingly by 5.0 g/box calcium carbide-treated fruits (7.83 & 8.76) against (1.03 & 2.05%) for the control in the first and second seasons, respectively.

Examining the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, data presented in Table (3) and illustrated in Fig (4) realize that the interactions of eight days ripening period especially 1000 ppm ethephon-treated fruits, recorded the highest fruit decay percentages (16.49 & 18.11), followed descendingly by 5.0 g/box calcium carbide-treated ones (14.61 & 15.44) in the first and second seasons, respectively. On the opposite, the lowest values of fruit decay percentage were registered by the combinations of two days ripening period particularly untreated fruits "control" in both seasons.

The other combinations occupied an intermediate position between the aforementioned categories in both seasons of study.

A continuous increase in decay percentage with the progress of ripening (storage) period. The principal cause of deterioration in untreated fruits was shriveling, whereas the main factor of ethephon treated fruits deterioration was fruit senescence due to loss of fruit firmness and the increase in respiration rate. Such fruits became weakened easy to be attack by decay pathogens, (Abd-El-Wahab, *et al.,* 1983).The gained results of ethephon in this respect are in accordance with the findings of Abd El-Wahab *et al.* (1983) and Kamal and Rabeh (1989) on Costata persimmon fruits. They mentioned that ethephon treatments (100-2000 ppm) induced a gradual increase in decay percentage with the extension of storage period.

The increase in fruit decay percentage during ripening period due to calcium carbide is in agreement with earlier reports of Ashwani *et al.* (1995) on mango fruits cv. Dashehari, Pal (1998-b) on mango fruits cv. Ratual and Joon *et al.* (2001) on mango fruits cv. Dashehari. They mentioned that the decay loss caused by rots was minimum in the control and maximum in CaC_2 (4 g/kg)-treated fruits.

Fig (4)

4.1.1.4. Fruit firmness (lb/inch^2)

Referring to specific effect of ripening period, it is easy to observe from Table (4) that Costata persimmon fruits lost its firmness with the advancement of ripening period. The gained data emphasize this result, hence the initial readings of fruit firmness i.e. before subjecting the fruits to the tested ripening chemical treatments were (12.40 & 11.53 lb/inch^2), whereas after eight days of subjecting the fruits to ripening treatments, firmness readings scored (5.39 & 5.29 lb/inch^2), followed ascendingly by six days ripening period (7.17 & 6.90 lb/inch^2) in 2003 and 2004 seasons, respectively. Also, two days ripening period produced more firm fruits (10.87 & 10.46 lb/inch^2) against (8.94 & 8.35 lb/inch^2) for four days ripening period in the first and second seasons, respectively. The differences between the four tested ripening periods were pronounced to be significant in both seasons.

With respect to specific effect of the tested ripening chemical substances, Table (4) illustrates that the treated fruits were less firm than the untreated ones "control". Fruit firmness of ethephon-treated fruits scored (7.22 & 6.86 lb/inch^2) against (7.55 & 7.23 lb/inch^2) for calcium carbide-treated ones in 2003 and 2004 seasons, respectively. Consequently, calcium carbide was more effective than ethephon in maintaining fruit firmness in both seasons.

Focusing on specific effect of the tested treatment concentrations, data in Table (4) show that all tested treatment concentrations significantly decreased fruit firmness as compared with control (10.93 & 10.58 lb/inch^2). Shortly, 2.5 g/box calcium carbide-treated fruits appeared to be the most promising treatment for inducing the highest fruit firmness (7.76 & 7.50 lb/inch^2), followed descendingly by 500 ppm ethephon-treated fruits (7.63 & 7.23 lb/inch^2) in the first and second seasons, respectively.

On the opposite, the lowest values of fruit firmness were registered by 1000 ppm ethephon-treated fruits (6.81 & 6.49 lb/inch^2) in 2003 and 2004 seasons, respectively. The differences between the four tested concentrations of ripening chemical substances and the control were obvious to be significant at the level of 5%.

Table (4)

With regard to the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the obtained results in Table (4) demonstrate that ripening period had the strong decision in determining firmness of Costata persimmon fruits. Thereupon, the resulted combinations of eight days ripening period had the lowest values of fruit firmness (except untreated fruits of the all ripening period combinations), followed in an ascending order by the analogous ones of six days ripening period. On reverse, the highest values of fruit firmness were recorded by the combinations of two days ripening period, especially untreated fruit, followed in descending order by the corresponding ones of four days ripening periods. The differences between the combination categories were pronounced to be significant.

The decrease in fruit firmness with the progress of ripening period is due mainly to decomposition of enzymatic degradation in insoluble protopectin to more simple soluble pectins and solubilization of cell and cell wall contents as a result of the increase in pectin estrase activity (Deshpande and Salunkhe, 1964). The role of ethephon in decreasing fruit firmness may be attributed to its activation to such decomposition and solubilization (Kamal and Rabeh, 1989).The recorded results dealing with ethrel (ethephon) affects on firmness of Costata persimmon fruits are in harmony with earlier studies of Edgerton and Blanpied (1968), Wakamatsu *et al.* (1973), Rouhani *et al.* (1975), Abd El-Wahab *et al.* (1983), Kato (1987), Zhang (1988), Kamal and Rabeh (1989), Kato (1990), Itamura *et al.* (1991), Lee and Kim (1991), Lim *et al.* (1993), Park *et al.* (1998), Shiesh *et al.* (2000) and Imagawa *et al.* (2003). They treated persimmon fruits cvs. Costata, Fuyugaki, Hiratanenashi, Cheongdobansi, Tonewase … etc, with ethylene from different sources as ethephon at 100 – 2000 ppm or ethylene generator. They concluded that the higher the ethylene or ethephon concentration used, the greater was the efficacy on accelerating fruit softness and senescence. On the contrary, check treatment not only maintained high fruit firmness for a long time, but also was effective in prolonging fruit storage period. Besides, the non-treated fruits “control” shriveled whereas the ethephon-treated ones showed less firmness. They added that ethephon treatment produced an increase in ethylene and carbon dioxide evolution even though the fruits were still firm. Carbon dioxide delayed the rate of fruit softening, whereas ethylene is thought to be an activator of the fruit softening

mechanism. Moreover, Mann *et al.* (1990) on pear fruits, Sergent *et al.* (1993) on mango fruits cv. Keitt, Pal (1998-a) on mango fruits cv. Dashehari, Zora *et al.* (2001) on mango fruits cv. Kensington, Suresh and Zora (2003) on mango fruits cv. Kensington and Kulkarni *et al.* (2004) on mango fruits cv. Neelum. They reported that dipping the fruits in ethephon solutions at 50 – 4000 ppm for 1-5 minutes decreased the fruit firmness in a shorter period compared with untreated fruits "control ".

The obtained results concerning the enhancing affect of calcium carbide as a ripe- treatment at 1 - 4 g/kg fruits on fruit quality in term of flesh firmness go in line with the findings of Randhawa *et al.* (1984) on pear fruits cv. Nakai and Ashwani *et al.* (1995) on mango fruits cv. Dashehari. They concluded that fruit firmness decreased with calcium carbide treatments.

4.1.1.5. Fruit carotenoids content

Considering specific effect of ripening period, it could be concluded that the fruit carotenoids content was linearly increased with prolonging the ripening period (Table, 5). The recorded data emphasize this result, hence the initial readings of fruit carotenoids content were (1.27 & 1.36 mg/100 g F.W) in the first and second seasons, respectively. Irrespective of the initial readings (zero day ripening period), the lowest values of fruit carotenoids content were registered by two days ripening period (1.61 & 1.64 mg/100 g F.W), followed ascendingly by four days ripening period (2.11 & 2.16 mg/100 g F.W) in the first and second seasons, respectively. On contrary, the greatest fruit carotenoids content was produced by eight days ripening period (2.67 & 2.66 mg/100 g F.W), followed descendingly by six days ripening period (2.57 & 2.52 mg/100 g F.W). The differences between the four tested ripening periods were so high to be significant.

Analyzing specific effect of the studied ripening substances, data in Table (5) indicate that the two ripening substances caused a progressive increment in fruit carotenoids content as compared with control in both seasons. Ethephon treatment proved to be the most promising one for enhancing fruit carotenoids content (2.43 & 2.50 mg/100 g F.W), followed descendingly by calcium carbide

treatment (2.41 & 2.35 mg/100 g F.W). On the opposite, the lowest values in this concern were recorded by the control (1.55 & 1.55 mg/100 g F.W).

Referring to specific effect of the tested treatment concentrations, the tabulated data in Table (5) demonstrate that all studied treatment concentrations succeeded in increasing fruit carotenoids content when compared with control in both seasons.

In 2003 season, all tested concentrations of both ethephon and calcium carbide induced similar effect in this respect from the statistical standpoint. Besides, in 2004 season, 1000 ppm ethephon treatment proved to be the superior in this concern, followed descendingly by 500 ppm ethephon. On contrary, 2.5 g/box CaC_2 showed to be the least effective treatment in enhancing carotenoids development.

Evaluating the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the resulted combinations illustrate that the combinations of eight days appeared to be the most promising one for inducing the greatest values of fruit carotenoids content, followed descendingly by the analogous ones of six days ripening period. On reverse, the lowest values of fruit carotenoids content were scored by the interactions of two days ripening period followed in an ascending order by the corresponding ones of four days ripening period in both seasons of study.

The enhancement of carotenoids development due to ethephon treatment was explained by Kamal and Rabeh (1989) and Lee and Kim (1991). They mentioned that total chlorophyll was decreased rapidly after ethylene treatment, then gradually leveled off. The greatest reduction in total chlorophyll was achieved by ethephon treatment, the matter which led to higher carotenoids concentration and the more was the brightness of fruit colour.

Fruit carotenoids content was in parallel with the ripening duration. This may be due to the fact that the synthesis of carotenoids is accompanied by changes in the ultrastructure of plastids. Consequently, as tubular structures visible in the plastids of unripe fruit are lost, while osmiophilic globules increase in size and number (Parikh *et al.,* 1990). Moreover, the synthesis of carotenoids involves mevalonic acid and geraniol as precursors, (Mattoo *et al.,* 1968). Besides, the role of ethephon in enhancing fruit carotenoids may be due to the fact that ethephon

Table (5)

accelerates the previously mentioned changes which lead to carotenoids synthesis (Kamal and Rabeh, 1989). The enhancement and positive affect of ethephon treatment on fruit colour is in agreement with the earlier reports of Awad and Suzukawa (1975), Abd El-Wahab *et al.* (1983), Kato (1984), Zhang (1988), Kamal and Rabeh (1989) and Lee and Kim (1991) on persimmon fruits cvs. Aizumishirazu, Hiratanenashi, Fuyugaki, Costata . . . ,etc. They treated persimmon fruits with ethylene evaluated from different sources i.e. ethephon, ethanol . . . etc. at 10-2000 ppm. They found that carotenoid levels were increased with ethylene treatment. They added that the fruits lost their green colour within 3-5 days due to ethephon treatment at 500 and 1000 ppm for two minutes, meanwhile the lower ethephon concentration (250 ppm) required 10-12 days to induce similar effect in this respect. Besides, Bal *et al.* (1992), Zora *et al.* (2001) and Kulkarni *et al.* (2004) treated papaya fruits and mango fruits cvs. Kensington and Neelum, respectively with ethephon solutions (250-2000 ppm) for different times (2-30 minutes) according to ethephon concentration. They observed that fruit colour index was significantly enhanced with ethephon treatment and the total carotenoids showed increasing trend up to eight days during ripening.

The obtained results dealing with the enhancement of fruit colour during ripening period due to calcium carbide at 2 or 4 g/kg fruits are in harmony with the findings of Nagaraj *et al.* (1984), Tauqir *et al.* (1989) , Ashwani *et al.* (1995) and Padmini and Prabha (1997) on mango fruits cv. Alphonso, (Desi and Dusehri), Dashehari and Alphonso, respectively.

4.1.1.6. Fruit total sugars (%)

Pointing to specific effect of ripening period, the obtained data in Table (6) reveal that the sweetness of Costata persimmon fruits enhanced as the ripening period advanced. In this respect, treated fruits kept for eight days ripening period were the richest ones in sugars content (15.86 & 15.97%), followed descendingly by six days ripening period (15.49 & 15.87%), four days ripening period (15.01 & 15.16%) and finally two days ripening period (14.27 & 14.36%) in comparison with the initial readings (zero day ripening period" which scored the lowest values of fruit total sugars content (13.80 & 13.91%) during 2003 and 2004 seasons,

respectively. The differences between the aforementioned ripening periods were so high to be significant in both seasons.

With respect to specific effect of the tested ripening chemical substances, the obtained results of total sugars content of Costata persimmon fruits in response to the different tested ripening chemical substances reported in Table (6) show that ethephon-treated fruits were the superior regarding their content of total sugars (15.48 & 15.70%), followed descendingly by calcium carbide treated fruits (15.26 & 15.48%) against (14.31 & 14.33%) for the control in 2003 and 2004 seasons, respectively. Moreover, the differences between the aforementioned ripening substances were significant in both seasons.

Concerning specific effect of the tested treatment concentrations, Table (6) reveals that all tested treatment concentrations succeeded in increasing fruit total sugars content. Generally 1000 ppm ethephon treatment showed to be the most promising one for enriching fruit content of total sugars (15.60 & 15.82%), followed in descending order by 500 ppm ethephon treatment (15.37 & 15.59%).

On contrary, the poorest fruits in total sugars content were produced by control treatment (14.31 & 14.33%), followed in an ascending order by 2.5 g/box calcium carbide treatment (15.10 & 15.41%). The remained treatment (5.0 g/box calcium carbide-treated fruits) occupied an intermediate position between the abovementioned treatments. The differences between 500 ppm ethephon and 5.0 g/box CaC_2 treatments were lacking from the statistical standpoint.

As for the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the resulted combinations reported in Table (6) illustrate that ripening period had the strong decision in determining the fruit total sugars content of Costata persimmon fruits. Therefore, the interactions of eight days ripening period induced statistically the highest fruit total sugars content (except the control), followed descendingly by the those of six days ripening period. On the contrary, the lowest values of fruit total sugars (%) were recorded by the combinations of the two days ripening period “especially untreated fruits” followed in an ascending order by four days ripening period interactions.

The improvement of fruit total sugars content due to ethephon treatment was discussed by Kamal and Rabeh (1989) and Park *et al.* (1998). They concluded that the most stricking chemical changes (fruit sweetness which occur due to ethephon treatment and during post harvest ripening of persimmon fruits seem to be due to the hydrolysis if starch and accumulation of sugars.

Table (6)

A progressive increase in total sugars along the whole ripening period of persimmon fruits. It seems that the most striking chemical changes which occur during the post harvest ripening of persimmon fruits are the hydrolysis of starch and the accumulation of sugars (Kamal and Rabeeh, 1989). The role of ethephon in increasing fruit total sugars content may be due to the increase of glucose and fructose content of non astringent ethephon treated fruits (Srinivasan *et al.,* 1974).The positive results of ethephon treatment on fruit sugar parameters are coincided with those mentioned earlier by Srinivasan *et al.* (1974), Abd El-Wahab *et al.* (1983), Kamal and Rabeh (1989) and Park *et al.* (1998) on persimmon fruits. They immersed persimmon fruits in ethephon solution(100-2000 ppm) for different periods. They cleared that a progressive and consistent increase in fruit total sugars content throughout the storage period of all treatments and control. The rate of increase being rapid in ethephon treated fruits and at the end of storage period. These fruits exhibited higher percentages than control and highly significant differences were gained due to the tested treatments. These results were also supported by Bal *et al.* (1992) on papaya fruits, Gala *et al.* (2001) on banana fruits, Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) on mango fruits.

4.1.1.7. Fruit total soluble solids (TSS) percentage

Looking at specific effect of ripening period, it is worthy to notice that prolonging the ripening period decreased the accumulation of total soluble solids in Costata persimmon fruits. Data recorded in Table (7) emphasize this result, where the initial readings of fruit total soluble solids recorded (26.20 & 25.60%) against (23.27 & 22.97%) for two days ripening period, (22.45 & 21.00%) for four days ripening period, (20.05 & 19.88%) for six days ripening period and finally (18.45 & 18.54%) for eight days ripening period during 2003 and 2004 seasons, respectively. The differences between the aforementioned ripening periods were obvious to reach the significance level in both seasons.

Discussing specific effect of the tested ripening substances, data reported in Table (7) demonstrate that untreated fruits “control” were the richest ones in total soluble solids content (23.48 & 22.98%), followed in descending order by calcium carbide-treated fruits (20.56 & 20.38%) and (20.34 & 19.63%) for ethephon-treated fruits. The differences between ethephon and calcium carbide were significant in the second season, only.

Table (7)

Pointing to specific effect of the tested treatment concentrations, Table (7) shows that all tested treatment concentrations significantly decreased the accumulation of fruit TSS content when compared with the control in both seasons. However, the highest fruit TSS percentages were recorded by untreated fruits (23.48 & 22.98%), followed in descending order by 2.5 g/box calcium carbide-treated fruits (20.88 & 20.52%), whereas, the lowest values of fruit TSS content were scored by 1000 ppm ethephon-treated fruits (20.07 & 19.62%) in the first and second seasons, respectively.

Considering the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, data in Table (7) illustrate that the highest fruit TSS percentages were produced by the combinations of two days repining period "particularly untreated fruit" followed descendingly by the corresponding ones of four days ripening period. On reverse, the lowest fruit TSS percentage were recorded by the interactions of eight days ripening period (regardless of the untreated fruits), followed in an ascending order by the combinations of six days ripening period.

The final negative effect of ethaphon on fruit total soluble solids content was explained by Kamal and Rabeh (1989) and Shieh *et al.* (2000). They demonstrated that ethephon treatment in spite of its positive effect on total soluble solids at the beginning, the final result is the reduction in TSS values. This may be due to the action of ethephon in conversion of soluble tannins into in soluble form, the matter which directly affects TSS values. They added that the total soluble solids content of persimmon fruits decreased gradually during the loss of astringency. The phenomenon appears to be linked with a reduction in soluble tannin content, which tends to alter the overall result. Loss of astringency changes soluble tannins by converting it to an insoluble polymer, thus causing a decline in the refractometer reading.

In spite of the pronouncing effect of ethephon on increasing soluble sugars content resulted in lower total soluble solids values in fruit juice. This may be due to the great tendency of ethephon to convert the soluble tannins into insoluble form, the matter which directly affects T.S.S values (kamal and Rabeh, 1989).The effect of ethephon on fruit total soluble solids content go in line with the findings of Rouhani *et al.* (1975), Kamal and Rabeh (1989) and Shiesh *et al.* (2000) on persimmon fruits. They dipped the fruits in ethephon solutions at 100-200 ppm for

different periods according to ethephon concentration. They reported that the higher ethephon concentrations caused positive effect on total soluble solids at the beginning, but the final result is the reduction in T.S.S. values. However, when fruits were dipped in water (control), the reverse result was obtained. On contrast, Abd El-Wahab *et al.* (1983) on persimmon fruits cv. Costata, Mann *et al.* (1990) on pear fruits, Bal *et al.* (1992) on pawpaw fruits, Sergent *et al.* (1993) on mango fruits cv. Keitt, Gala *et al.* (2001) on banana fruits varieties Hindi, Maghraby and Willams, Zora *et al.* (2001) on mango fruits cv. Kensington, Suresh and Zora (2003) on mango fruits cv. Kensington, and Kulkarni *et al.* (2004) on mango fruits cv. Neelum. They mentioned that total soluble solids were increased during ripening period as compared with untreated fruits " control".

The results of calcium carbide are out of line with the earlier reports of Nagaraj *et al.* (1984), Ashwani *et al.* (1995), Guha and Bhuiyan (1997) and Joon *et al.* (2001) on mango fruits cvs. Alphonso, Dashehari, Ashwina and Dashehari, respectively. They reported that there was an increase in total soluble solids of mango fruit as a result of treating the fruits with calcium carbide.

4.1.1.8. Fruit acidity percentage

As for specific effect of ripening period, it is clear from Table (8) that the decrease in fruit acidity (%) proportionates with the advancement of the ripening period. The tabulated data emphasize this result, hence the initial readings of fruit acidity i.e. before the beginning of ripening process were (0.46 & 0.44%), whereas fruit acidity readings, two days after ripening treatments application were (0.37 & 0.37%), (0.32 & 0.30%) after four days, (0.24 & 0.24%) after six days and the values became much lower when the ripening period extended up to eight days (0.22 & 0.20%) during 2003 and 2004 seasons, respectively.

Looking at specific effect of the tested ripening chemical substances, data in Table (8) reveal that fruit acidity percentages were reduced due to using the two ripening chemical substances in comparison with the control. Ethephon treatment recorded lower fruit acidity values (0.27 & 0.26%), followed in an ascending order by calcium carbide treatment (0.29 & 0.26%) against (0.33 & 0.33%) for control in 2003 and 2004 seasons, respectively. Moreover, the

differences between ethephon and calcium carbide treatments were so small to reach the significance level.

Examining specific effect of the tested treatments concentrations, analyzing data in Table (8) it could be concluded that all tested treatment concentrations succeeded in decreasing fruit acidity percentage when compared with the control in both seasons. Briefly, neither ripening substance, nor its concentration exerted a distinctive effect on fruit acidity hence, the differences between the concentrations of both ripening substances were lacking from the statistical standpoint, particularly in 2004 season.

Focusing on the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, data presented in Table (8) reveal that the combinations of eight days ripening period, especially 500 ppm ethephon-treated fruits in 2003 season, 1000 ppm ethephon-treated fruit in 2004 season, recorded the lowest values of fruit acidity percentages followed in an ascending order by the analogous ones of six days ripening period. On the opposite, the highest fruit acidity percentages were registered by the combinations of two days ripening period, particularly untreated fruit followed in descending order by the corresponding ones of four days ripening period.

The decrease in fruit total acidity content with the progress of ripening duration may be attributed to the fact that fruit acidity is used as a substrate in respiration process. Ethephon treatment increased the loss of fruit acidity through its activation affect on respiration rate (Kamal and Rabeh, 1989). The enhancement of total acidity content of Costata persimmon fruits due to ethephon treatment is in harmony with those mentioned earlier on persimmon fruit by Unrath (1972), Shaybany and Sharifi (1973), Shanmugavelu *et al.* (1976) and Kamal and Rabeh (1989). They cleared that a gradual decrease was noticed in titratable acidity of persimmon fruits due to ethephon treatment at 250 – 2000 ppm and untreated fruits "control" through the whole ripening period. The reduction in fruit acidity was more pronounced with ethephon treatment and proportionated with ethephon concentration. Also, Mann *et al.* (1990) on pear fruits, Gala *et al.* (2001) on banana fruits, Joon *et al.* (2001), Zora *et al.* (2001), Suresh and Zora (2003) and Kulkarni *et al.* (2004) on mango fruits. They observed that dipping the fruits in ethephon solutions (50 – 200 ppm) succeeded in decreasing fruit acidity compared with the control.

Table (8)

The recorded results of calcium carbide (CaC_2) in this respect are in agreement with the findings of Nagaraj *et al.* (1984), Ashwani *et al.* (1995) and Joon *et al.* (2001) on mango fruits. They realized that there was a sharp decline in acidity of mango fruits as a result of treating the fruits with calcium carbide at 2 or 4 g/kg fruits.

4.1.1.9. Fruit ascorbic acid content

Pointing to specific effect of ripening period, the gained data in Table (9) show that prolonging ripening period resulted in decreasing fruit ascorbic acid content. In this concern, the initial readings scored the highest values (17.53 & 16.32 mg/100 ml juice), followed descendingly by two days ripening period (15.43 & 14.10 mg/100 ml juice), whereas prolonging ripening period up to eight days recorded the lowest values (7.89 & 7.46 mg/100 ml juice) during 2003 and 2004 seasons, respectively. Besides, four days and six days ripening period occupied an intermediate position in this concern, but four days ripening period surpassed six days ripening period in enhancing fruit ascorbic acid content. The differences between the studied ripening periods were so high to be significant.

With respect to specific effect of the tested ripening substances, data in Table (9) indicate that the highest values of fruit ascorbic acid content were registered by untreated control (13.04 & 12.61 mg/100 ml juice) in both seasons. Moreover, in 2003 season, calcium carbide-treated fruits were richer than ethephon-treated ones, regarding their content of ascorbic acid. Besides, in 2004 season, the picture was completely reflected. The differences between the two tested ripening substances were significant in both seasons.

Referring to specific effect of the tested treatment concentrations, Table (9) indicates that all tested treatment concentrations significantly decreased fruit ascorbic acid content when compared with the control. However, the highest values of fruit ascorbic acid content were recorded by untreated fruits “control” in both seasons. Besides, in 2003 season, the lowest value of fruit ascorbic acid was produced by 1000 ppm ethephon treatment and the rest concentrations induced similar effect in this respect from the statistical standpoint. On the other hand, in 2004 season, the highest value of fruit ascorbic acid was noticed with 500 ppm ethephon treatment, whereas, the lowest value was shown with 5.0 g/box CaC_2 treatment. Other chemical concentrations occupied similarly an intermediate position.

Table (9)

Concerning the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, the resulted combinations reveal that ripening period had the strong role in determining the fruit ascorbic acid content. Consequently, two days ripening period combinations showed to be the most promising ones in producing the highest values of fruit ascorbic acid content especially untreated fruits (16.10 & 15.22 mg/100 ml juice) followed in descending order by the interactions of four days ripening period. On reverse, the lowest values of fruit ascorbic acid were scored by the combinations of eight days ripening period (irrespective of untreated fruits) followed in an ascending order by those of six days ripening period.

The reduction in fruit ascorbic acid content during ripening could be attributed to the increase in ascorbate oxidase activity. Ethephon treatment increases such oxidation process (Cardello and Cardello, 1998).

4.1.1.10. Fruit tannins content

With respect to specific effect of ripening period, it is worthy to notice from Table (10) that the bitterness of Costata persimmon fruits declined as the ripening period prolonged. The obtained data emphasize this result, hence the initial readings of fruit tannins content i.e. before subjecting the fruits to the tested ripening chemical treatments were (1.69 & 1.62 / g tannic acid/100 g fresh weight), whereas after eight days ripening period, tannin readings showed the greatest reduction and scored (1.24 & 1.23 g tannic acid/100 g fresh weight), followed descendingly by six days ripening period (1.32 & 1.27 g tannic acid/100 g fresh weight) in the first and second seasons, respectively. Moreover, two days ripening period recorded higher values (1.53 & 1.48 g tannic acid/100 g fresh weight), followed descendingly by four days ripening period (1.40 & 1.34g tannic acid/100 g fresh weight) in the first and second seasons, respectively. The differences between evaluated ripening periods were so high to be significant in both seasons.

Regarding specific effect of the studied ripening chemical substances, data presented in Table (10) indicate that fruit tannins content was decreased by using the two ripening chemical substances as compared with the control.

Table (10)

However, ethephon-treated fruits had the lowest values of fruit tannins content (1.32 & 1.27 g tannic acid/100 g fresh weight) followed descendingly by calcium carbide-treated fruits (1.34 & 1.29 g tannic acid/100 g fresh weight). The differences between the aforementioned two ripening chemical substances were so small to reach significant level.

Referring to specific effect of the studied treatment concentrations, data in Table (10) indicate fruit tannins content was greatly reduced by the tested treatment concentrations as compared with control in both seasons. Shortly, in 2003 season, the higher concentration of both ethephon (1000 ppm) and calcium carbide (5.0 g/box) induced similar and higher reductive effect on fruit tannins content as compared with the lower concentration of the aforementioned two ripening substances. On the other hand, in 2004 season, the concentrations of both ethephon and calcium carbide induced similar reductive effect in this concept from the statistical standpoint.

Pointing to the interaction effect between ripening period, ripening chemical substances and ripening treatment concentrations, data in Table (10) demonstrate that ripening period had the strong hand in determining fruit tannins content of Costata persimmon fruits. Thereupon, the resulted combinations of eight days ripening period, especially 1000 ppm ethephon treatment induced the lowest values (1.15 & 1.14 g tannic acid/100 g fresh weight) of fruit tannins content, followed descendingly by the analogous ones of six days ripening period. On the opposite, the interactions of two days ripening period induced the highest values of fruit tannins content particularly, untreated fruits followed descendingly by the corresponding ones of four days ripening period.

The role of ethephon in the disappearance of astringency (tannins content) in persimmon fruits may be due to the fact that tannins in the cells of treated fruits are coagulated to insoluble tannins, hence the remarkable astringency of persimmon fruits is due to the water soluble tannins present in the tannins cell. Besides, Hulme (1971) mentioned that soluble tannins are fluid and easily spread over cut surfaces. Ethephon treatment greatly accelerated the coagulation and disappearance of astringency from persimmon fruits (Kamal and Rabeh, 1989). The reductive effect of ethephon on fruit tannins content was explained by Park *et al.* (1998) and Tamura *et al.* (1999). They demonstrated that in ethephon-treated fruits, the tannins in cells are coagulated to

insoluble tannins. The higher ethephon concentrations greatly accelerated tannin coagulation process and the disappearance of astringency of persimmon fruits. The obtained results dealing with the reductive effect of ethephon on fruit tannins content and astringency removal are in harmony with earlier studies of Hulme (1971), Awad and Amenomori (1972), Srinivasan *et al.* (1973), Kato (1984), Kato (1987), Kamal and Rabeh (1989), Kato (1990), Itamura *et al.* (1991), Taira *et al.* (1991), Lim *et al.* (1993), Park *et al.* (1998) and Tamura *et al.* (1999). They studied the effect of ethylene treatment from different sources *i.e.* ethephon, ethanol, ethylene generating kits at different concentrations (100-5000 ppm) for different periods on the relationship between the decrease in tannin concentration and loss of astringency of persimmon fruits cvs. Aiumishirau, Hiratanenashi, Costata, cheongdobansi, Saijo … etc. They suggested that there was a relatively high correlation between the degree of astringency and tannin concentration when fruit tissue was homogenized and extracted with 70% ethanol and then heated fruits containing about 2% tannin were slightly astringent and those containing < 0.1% were almost non-astringent. The higher the ethanol concentration, the shorter was not only, the time to induce reduction in tannin concentration, but also the rate of reduction. They added that the disappearance of fruit astringency (tannins content) was remarkable with higher ethephon concentration (1000 and 2000 ppm).

4.1.2. Effect of some post harvest treatments on storage ability of Costata persimmon fruits.

Effect of some post harvest treatments i.e. calcium chloride ($CaCl_2$) at 2 & 4%, active yeast suspension at 1 & 2% and sodium hypochlorite at 2% in comparison with tap water “control” and storage duration as well as their interactions under one out of three tested storage temperatures namely: ambient room conditions (30 ± 3°C & 65 – 70 % R.H.), 5°C & 85 ± 2% R.H. and 0°C & 85 ± 2% R.H. on storage ability of Costata persimmon fruits during 2003 and 2004 seasons is reported in Tables (11-a, b and c- 20-a, b and c), exhibited in Photos (3-9)and illustrated in Figures (5-14) and. Such effect was evaluated through the following fruit traits, *i.e.* weight loss (%), decay (%), shelf-life (marketability), firmness (lb/inch2), carotenoids (mg/100 g F.W), total sugars (%), TSS (%), total acidity (%), Tannins (g tannic acid/100 g F.W) and ascorbic acid (mg/ 100 ml juice).

4.1.2.1. Weight loss percentage

a. Storage under ambient room conditions

Firstly, it is important to notice that storage life of Costata persimmon fruits under ambient room conditions extended up to twenty one and fourteen days in 2003 and 2004 seasons, respectively. As for specific effect of storage period, it is quite clear from Table (11.a) the Costata persimmon fruits showed loss in their weight with the advancement of storage period. The gained data indicate this result, hence the highest reduction in fruit weight percentage was recorded after twenty one days and fourteen days storage duration under ambient room conditions in the first and second seasons, respectively.

On the other hand, the lowest weight percentage was scored after seven days storage period in both seasons.

With regard to specific effect of the tested post harvest treatments, the statistical analysis indicates that there was indistinctive trend regarding the response of weight loss percentage to the studied post-harvest treatments throughout the course of study. One can conclude that in 2003 season, the highest fruit weight loss percentage were recorded by 1% yeast-treated fruits (14.23) followed equally by tap water-treated fruits "control" (13.98), 2% NaOCl-treated fruits (13.93) and 4% $CaCl_2$-treated ones (13.83). On contrary, 2% $CaCl_2$-treated fruits scored the lowest values (12.24%) in this concern. On the other hand, in the second season, 2% yeast-treated fruits recorded the highest weight loss percentage (11.32) followed descendingly by both 1% yeast-treated ones and water-treated fruits "control". The remained treatments occupied an intermediate position and scored statistically similar values in this respect.

Referring to interaction effect between storage period and tested post harvest treatments, data presented in Table (11.a) and illustrated in Fig (5) show that the interactions of seven days storage duration under ambient room conditions recorded statistically the lowest percentages of weight loss especially, tap water-treated fruits in the first season and 2% NaOCl-treated ones in the second season. On the opposite, the highest percentage of weight loss was observed those of twenty one days storage duration combinations ,particularly those treated with tap water "control" in 2003 season, followed descendingly by the combinations of fourteen days storage duration in 2004 season, particularly, those treated with 2 and 1% yeast treatments. The rest combinations showed an intermediate values in this concern.

Table (11.a)

Fig (5)

b. Cold storage at 5°C

One can observe that storability of Costata persimmon fruits under cold storage (5 or 0°C) extended up to forty two days in 2003 and 2004 seasons. Looking at specific effect of storage period, tabulated data indicate that weight loss percentage was steadily increased as the storage period prolonged, (Table 11.b). So, forty two days cold storage duration registered significantly the highest weight loss percentages (9.63 & 10.41), followed descendingly by thirty five days cold storage period (7.28 & 7.28) during 2003 and 2004 seasons, respectively. On contrary, the lowest weight loss percentages (1.37 & 1.47) were recorded by seven days cold storage duration followed ascendingly by fourteen days cold storage period (2.95 & 3.04) in the first and second seasons, respectively. The rest storage periods came inbetween in this sphere in both seasons of this study.

Discussing specific effect of the tested post harvest treatments, it is worthily to notice that in 2003 season, all the tested treatments including the control failed to affect weight loss percentage, with the exception of 2% NaOCl treatment (5.04) which scored statistically lower value of fruit weight loss percentage. Moreover, in 2004 season, 4% $CaCl_2$ treatment showed to be the superior one in producing the lowest weight loss percentage (5.31), whereas 2% yeast treatment showed the highest weight loss percentage (5.51). Other tested treatments showed more or less similar values in this respect.

Considering the interaction effect between storage period and the tested post harvest treatments, Table (11.b) and Figures (6&7) demonstrate that the interactions of seven days cold storage duration recorded statistically the lowest percentages of fruit weight loss, particularly 2% NaOCl-treated fruits (1.28) in 2003 season and 4% $CaCl_2$-treated fruits (1.37) in 2004 season. On the opposite, the highest percentages of fruit weight loss were produced by forty two days storage duration interactions, especially 2% yeast-treated fruits and 1% yeast-treated ones in 2003 and 2004 seasons, respectively. The other interactions of storage periods occupied an intermediate positions between the abovementioned two categories.

Table (11.b)

Fig (6)

Fig (7)

c. Cold storage at 0°C

With regard to the specific effect of storage period, Table (11.c) demonstrates that fruit weight loss percentage was increased as the storage period prolonged under cold storage at 0°C in both seasons of this study. The obtained data explain this result, hence seven days cold storage duration scored the lowest fruit weight loss percentages (1.26 & 1.28), whereas fourteen days cold storage period recorded (2.58 & 2.69), besides (3.98 & 4.30) for twenty one days cold storage duration, (5.23 & 5.65) for twenty eight days cold storage period, (6.75 & 7.06) for thirty five days cold storage duration and lastly (9.12 & 10.07) for forty days cold storage duration, in the first and second seasons, respectively. The differences between the evaluated storage periods were so high to be significant.

Concerning specific effect of the tested post harvest treatment, Table (11.c) illustrates that in both season, 4% $CaCl_2$ treatment proved to be the most efficient treatment in reducing weight loss percentage, followed descendingly by 2% NaOCl treatment. Anyhow, the differences between these treatments were so small to reach the significance level. Moreover, 2% yeast treatment scored significantly the highest fruit weight loss percentage in 2003 season, but in 2004 season 2% $CaCl_2$ exerted such effect, followed descendingly by tap water "control" and 2% yeast treatments without significant differences.

With respect to the interaction effect between storage period and tested post harvest treatments, it is obvious from Table (11.c) and Figures (8&9) that the interactions of seven days cold storage duration induced the lowest fruit weight loss percentages, especially 4% $CaCl_2$- treated fruits and 2% NaOCl-treated ones in 2003 and 2004 seasons, respectively. On contrary, the highest fruit weight loss percentages were registered by the interactions of forty two cold storage period, particularly tap water-treated fruits "control" and 2% $CaCl_2$-treated ones in the first and second seasons, respectively. The remained interactions of the tested storage periods came inbetween in both seasons.

The weight loss is mainly a result of water loss from the fruit tissues and partially of the respiration process. The higher, the storage temperature, the higher are the respiration rate and weight loss (Gac, 1955). He mentioned that the higher the air temperature, the more is water loss because of its capacity to evaporate water. Also, the higher the temperature of the fruit, the greater is its tendency to lose moisture.

Table (11.c)

Fig (8)

Fig (9)

The obtained results of calcium as a post harvest treatment in the form of $Ca(NO_3)_2$ at 1-3 % ,$Ca(OH)_2$ at 1-3 % $CaSO_4$ and $CaCl_2$ at 1-8 % which illustrate its affect on reducing weight loss percentage of Costata persimmon fruits during storage duration go in line with analogous ones mentioned by Mootoo (1991) on mango fruits cv. Julie, Salem and El-Khoreiby (1991) on grapefruits cv. Marsh, Mir *et al.* (1993) on apple fruits cv. Red Delicious, Akl *et al.* (1995) on pear fruits cv. Le Conte, Bhartiya *et al.* (1998) on apple fruits cv. Red Delicious, Mehaisen (1999) on pear fruits cv. Le Conte, EL-Zaabalawy (2001) on date fruits cvs. Zaghloul, Hayani and Samani, Choudhury *et al.* (2003) on sapota fruits cv. Pala, Ali (2005) on persimmon fruits cv. Costata and Shaaban (2006) on guava fruits cv. Maamoura. Moreover, the results of yeast go in line with those stated by sugar (1992) and Mehaisen (1999).

Finally, the obtained results of NaOCl are coincided with findings of Nnodu and Nwankiti (1986) and Mehaisen (1999). They reported that dipping yam tubers in sodium hypochlorite solution (NaOCl) at 10 % and Le Conte pear fruits at 1-5% as a post harvest treatments succeeded in decreasing the weight loss percentage as compared with the control.

4.1.2.2. Fruit decay percentage

a. Storage under ambient room conditions

Analyzing specific effect of storage period, Table (12.a) shows that fruit decay percentage was increased as the storage period prolonged, hence seven days storage period under ambient room conditions scored the lowest values (15.83 & 18.10%), followed ascendingly by fourteen days storage period (46.90 & 51.37%) in the first and second seasons, respectively. Lastly, the greatest fruit decay percentage was gained after twenty one days storage period under ambient room in the first season, only (70.15%).

Respecting specific effect of the studied post harvest treatments, data reported in Table (12.a) indicate that all tested post harvest treatments induced similar effect on fruit decay percentage in comparison with the control in both seasons from the statistical standpoint.

Table (12.a)

As for the interaction effect between storage period and the tested post harvest treatments, the reported data in Table (12.a), exhibited in Photos (3 & 4) and illustrated in Fig (10) show that the lowest fruit decay percentages were recorded by the interactions of seven days storage period, particularly those interacted with 2% NaOCl and 2% $CaCl_2$ treatments in the first and second seasons, respectively.

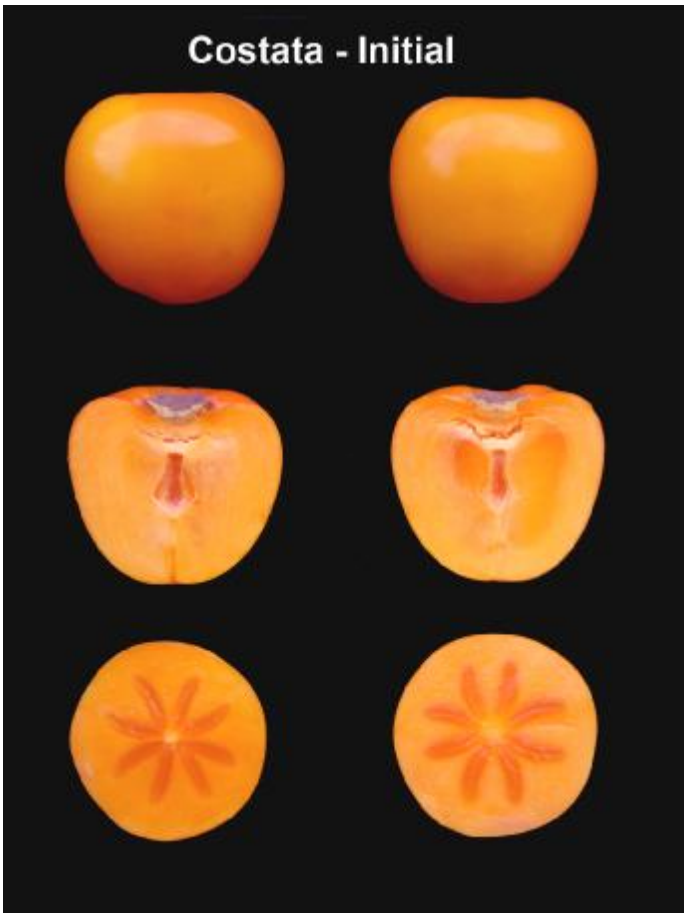

Photo (3): Costata persimmon fruits prior to some post harvest treatments application and storage at different storage temperature.

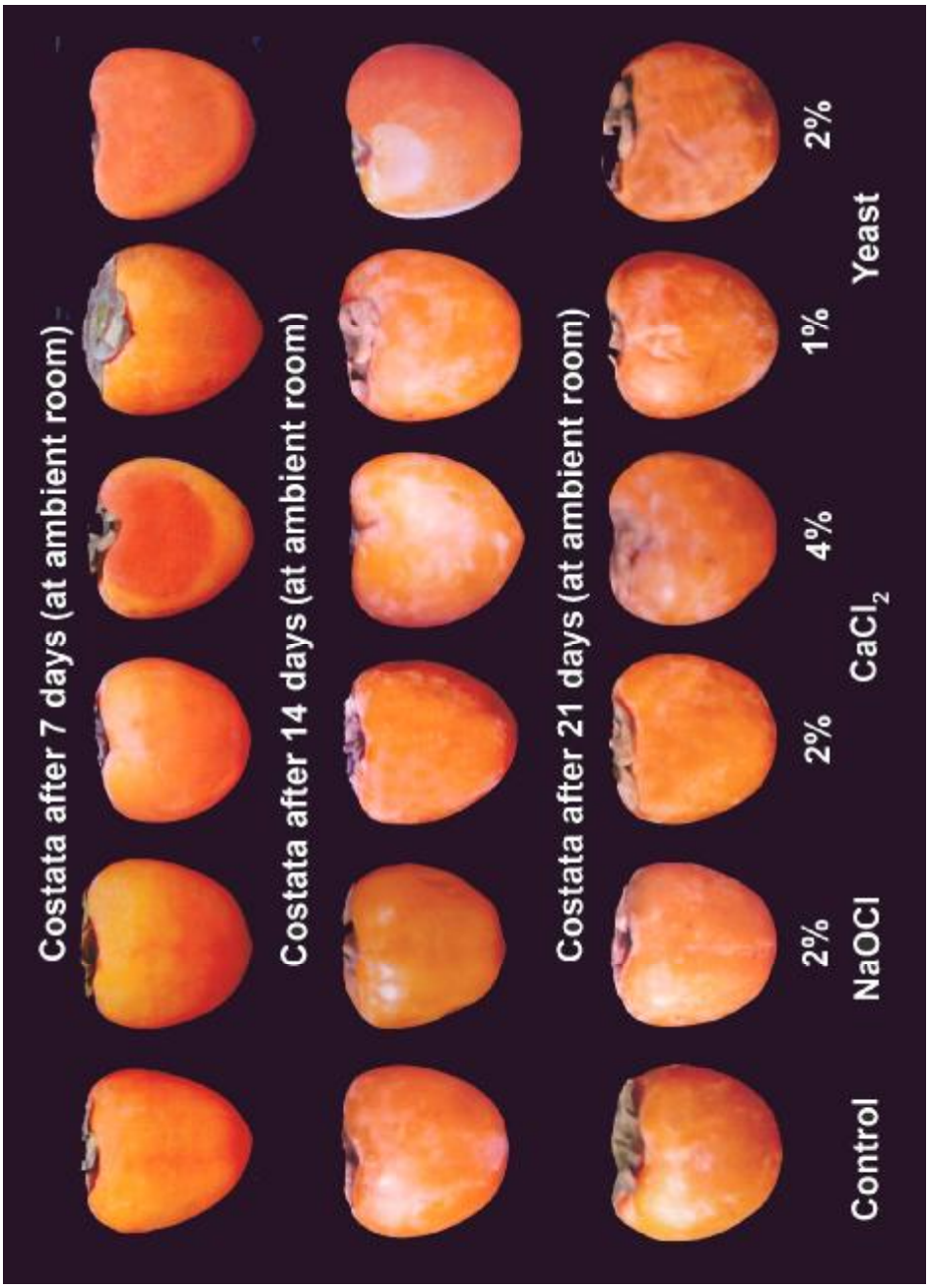

Photo (4): Physical changes in post harvest treated Costata persimmon fruits during storage under ambient room.

Fig(10)

On contrary, the highest fruit decay percentages were recorded by the interactions of twenty one days storage duration in 2003 season especially 2% NaOCl-treated fruits. Besides, the interactions of fourteen days storage period, particularly 1% yeast-treated fruits in 2004 season scored high fruit decay percentage. The rest interactions of the storage periods came inbetween in both seasons, but the differences within each specific column were insignificant.

b. Cold storage at 5°C

Looking to specific effect of storage period, Table (12.b) demonstrates that there was a steadily increment in decay percentage with prolonging the storage period in both seasons.

Thereupon, cold storage for forty two days at 5°C reduced the storability of Costata persimmon fruits, hence it registered the highest fruit decay percentages (54.73 & 54.27) when compared with the corresponding ones, cold stored for seven days (0.0 & 0.0) or fourteen days (4.76 & 4.69). The rest storage periods came inbetween in this concept in both seasons. The differences between the studied storage periods were pronounced to be significant.

Referring to the specific effect of the post harvest treatments, Table (12.b) shows that the statistical analysis indicate that 2% NaOCl- treated fruits showed to be the most effective treatment in producing the lowest fruit decay percentages, while 2% yeast-treated fruits had higher fruit decay percentages in both seasons. Moreover, 2 & 4% $CaCl_2$-treated fruits exerted similar and prospective effect in reducing fruit decay percentage when compared with tap water-treated fruits "control". Besides, 1 & 2% yeast treatments induced similar effect to that of the control from the statistical standpoint.

Regarding the interaction effect between storage period and tested post harvest treatments, it is clear from Table (12.b), Photos (5 &6) and Figures (11&12) that the interactions of forty two days storage period scored higher fruit decay percentages in comparison with the corresponding ones of thirty five days, twenty eight days, twenty one days and fourteen days storage durations in descending order. The differences within each storage duration in most cases were significant. Generally, all interactions of seven days storage duration produced healthy fruits free from decay fruits and recorded zero decay percentage. On the opposite, all interactions of forty two days storage duration, particularly 1 & 2% yeast- treated fruits in 2003 and 2004 seasons, respectively recorded statistically the highest fruit decay percentage. The remained interactions registered inbetween values in this concern.

Table (12.b)

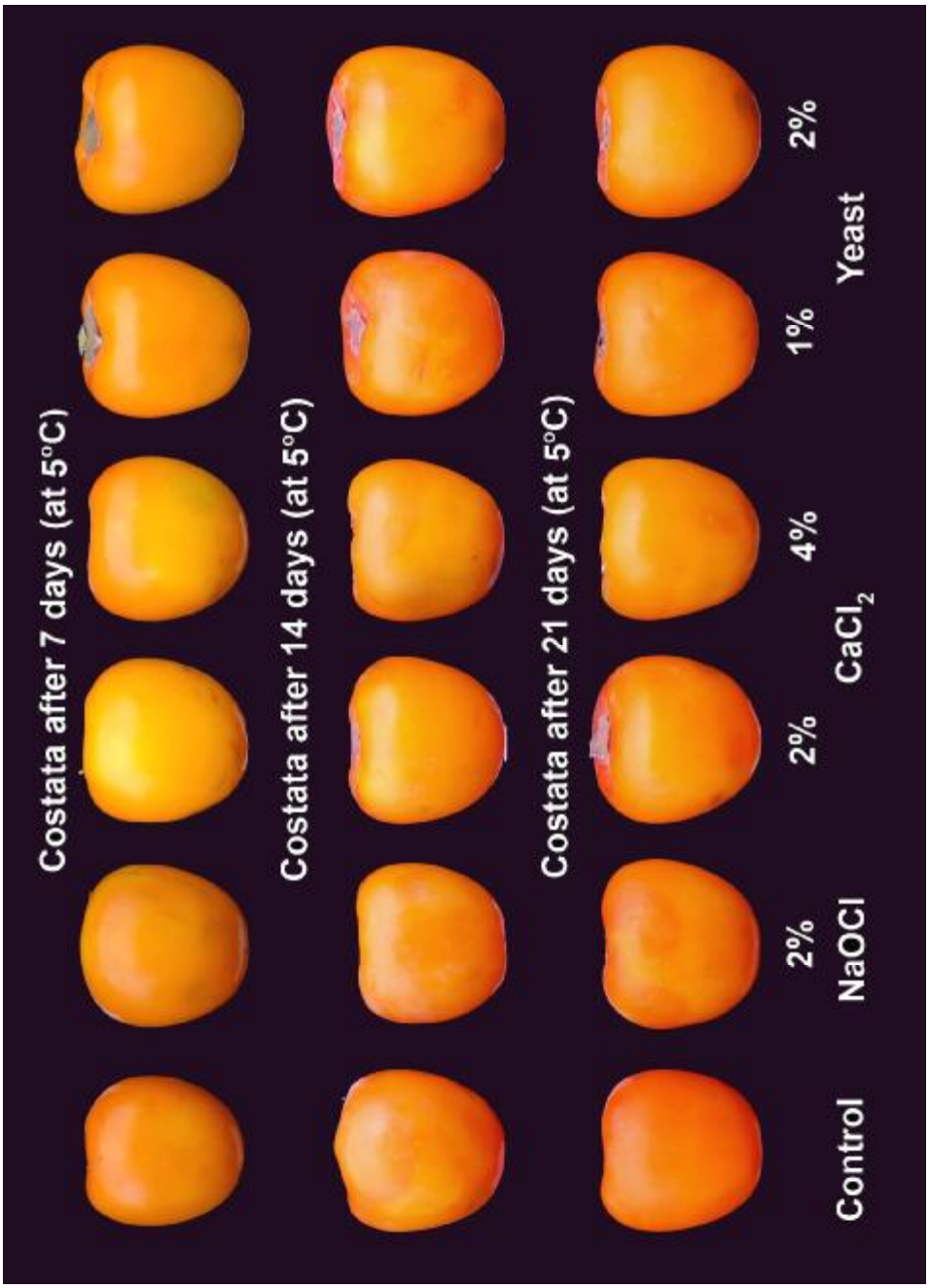

Photo (5): Physical changes in post harvest treated Costata persimmon fruits during cold storage (7, 14 and 21 days) at 5°C.

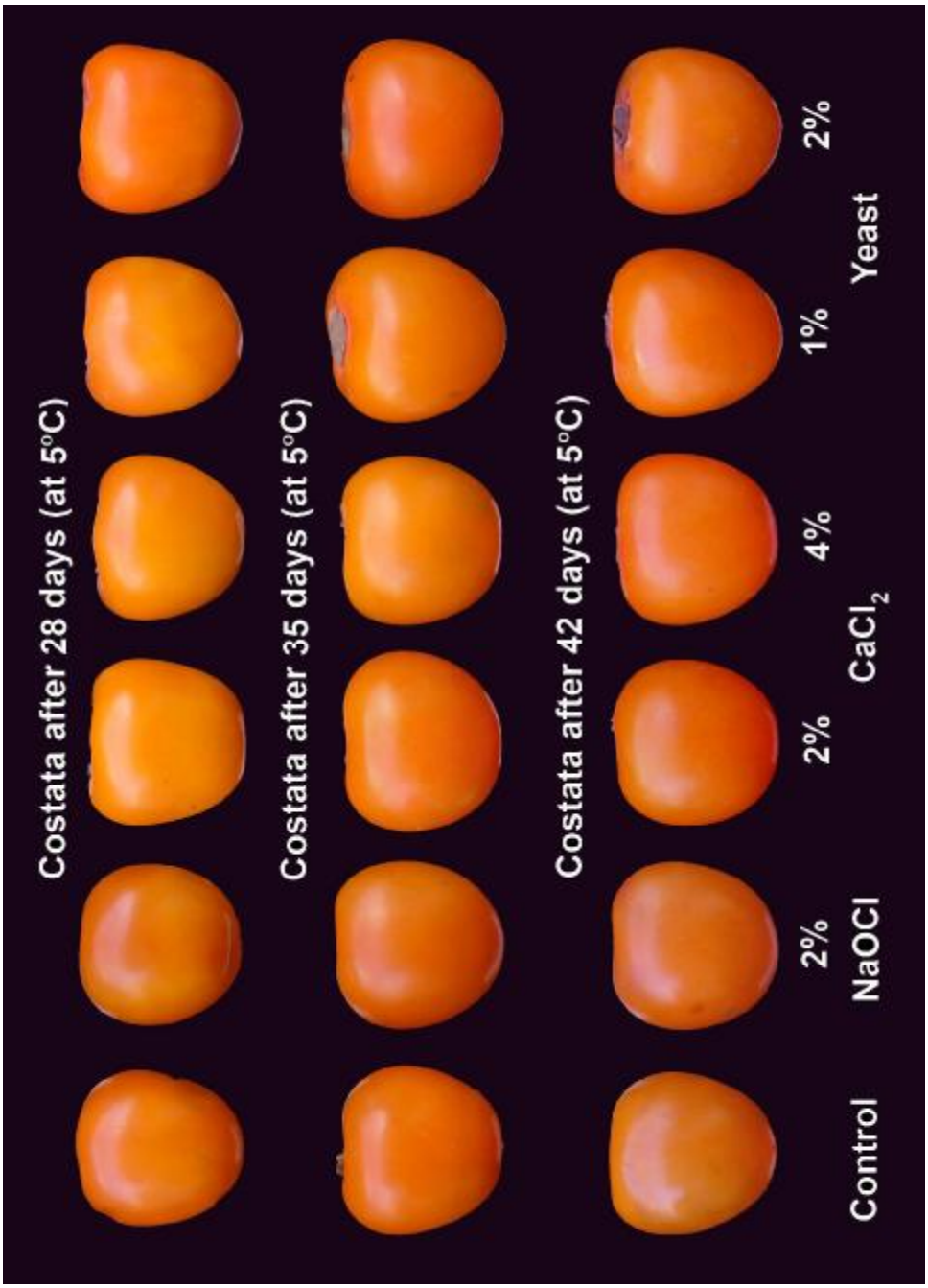

Photo (6): Physical changes in post harvest treated Costata persimmon fruits during cold storage (28, 35 and 42 days) at 5°C.

Fig (11)

Fig (12)

c. Cold storage at 0°C

Evaluating specific effect of storage period, data presented in Table (12.c) illustrate that fruit decay percentage showed a steadily increment with extending the storage duration in both season of this study. However, forty two days cold storage at 0°C scored significantly the highest fruit decay percentages (52.37 & 54.04), followed descendingly by those cold stored for thirty five days (35.72 & 37.08). On the other hand, seven days cold storage duration produced statistically the lowest fruit decay percentages (0.0 & 0.0), followed ascendingly by fourteen days storage period cold storage (4.17 & 3.95) in the first and second seasons, respectively. The rest storage periods came inbetween the aforesaid storage durations.

With regard to specific effect of the tested post harvest treatments, Table (12.c) indicates that tap water-treated fruits statistically recorded the highest fruit decay percentages (21.54 & 22.69)in both seasons. On contrary the lowest fruit decay percentages were recorded by 4% $CaCl_2$-treated fruits (19.29 & 19.83) in the first and second season, respectively. Moreover, 2% NaOCl-treated fruits and 2% $CaCl_2$-treated ones in 2003 and 2004 seasons, respectively exerted similar and lower fruit decay percentages.

Examining the interaction effect between storage period and the tested post harvest treatments, reported data in Table (12.c), exhibited in Photos (7& 8) and illustrated in Figures (13&14) show that the interactions of forty two days cold storage durations statistically induced the lowest fruit decay percentages, especially 2% NaOCl treatment (3.67 & 3.51), besides 4 & 2% $CaCl_2$ in 2003 and 2004 seasons, respectively induced similar and higher prospective affect in reducing fruit decay percentages.

On reverse, the interactions of forty two days cold storage period showed the highest fruit decay percentages, particularly those interacted with 1% yeast suspension treatment (54.03 & 57.44). Moreover, tap water treatment and 2% yeast treatment exerted similar and higher effect in increasing fruit decay percentage in both seasons of this study. Generally, the interactions of storage periods could be descendingly arranged regarding their positive effect on fruit decay percentage as follows: 7, 14, 21, 28, 35 and 42 days. The differences between the different storage period interactions were significant.

Table (12.c)

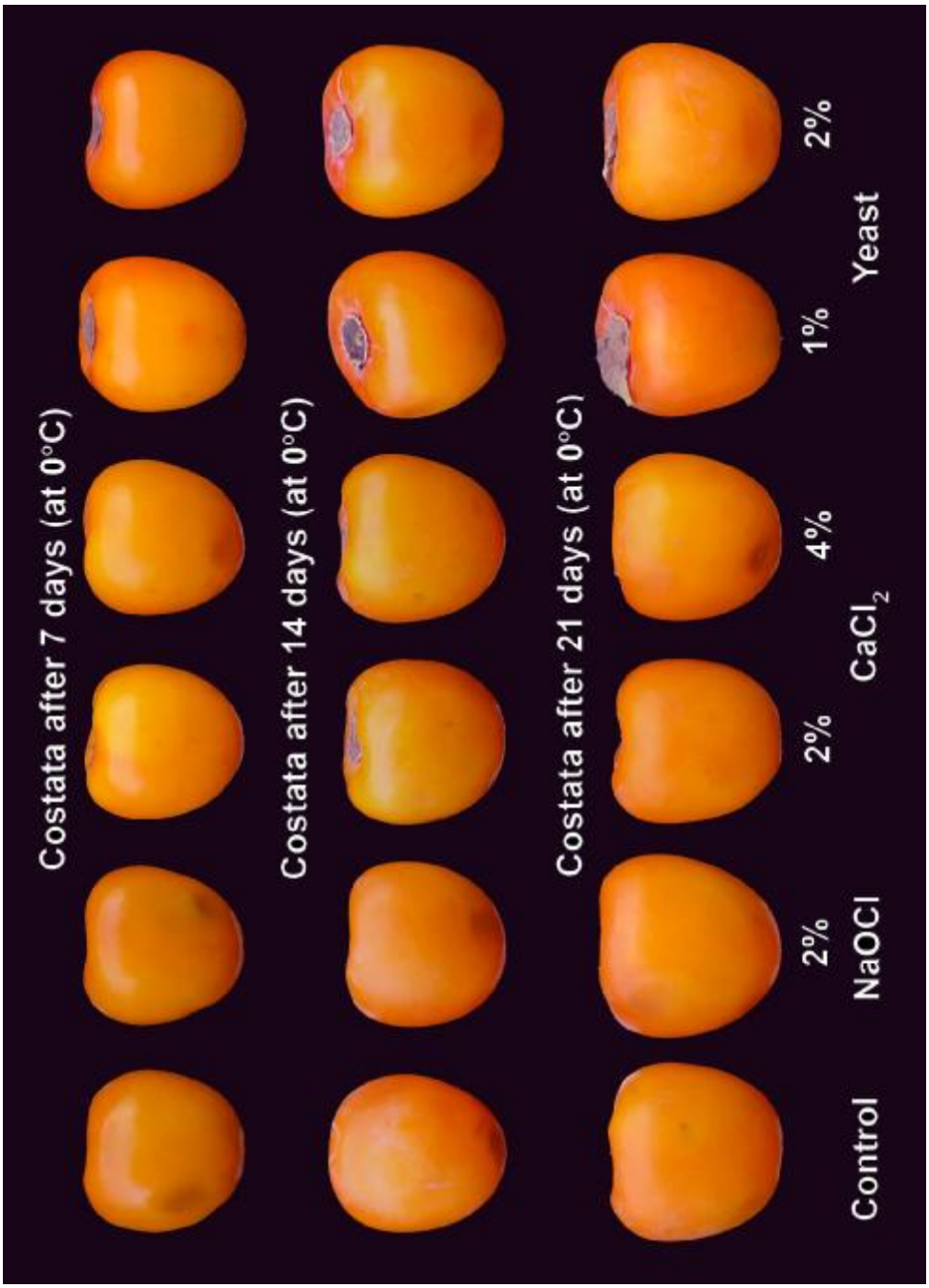

Photo (7): Physical changes in post harvest treated Costata persimmon fruits during cold storage (7, 14 and 21 days) at 0°C.

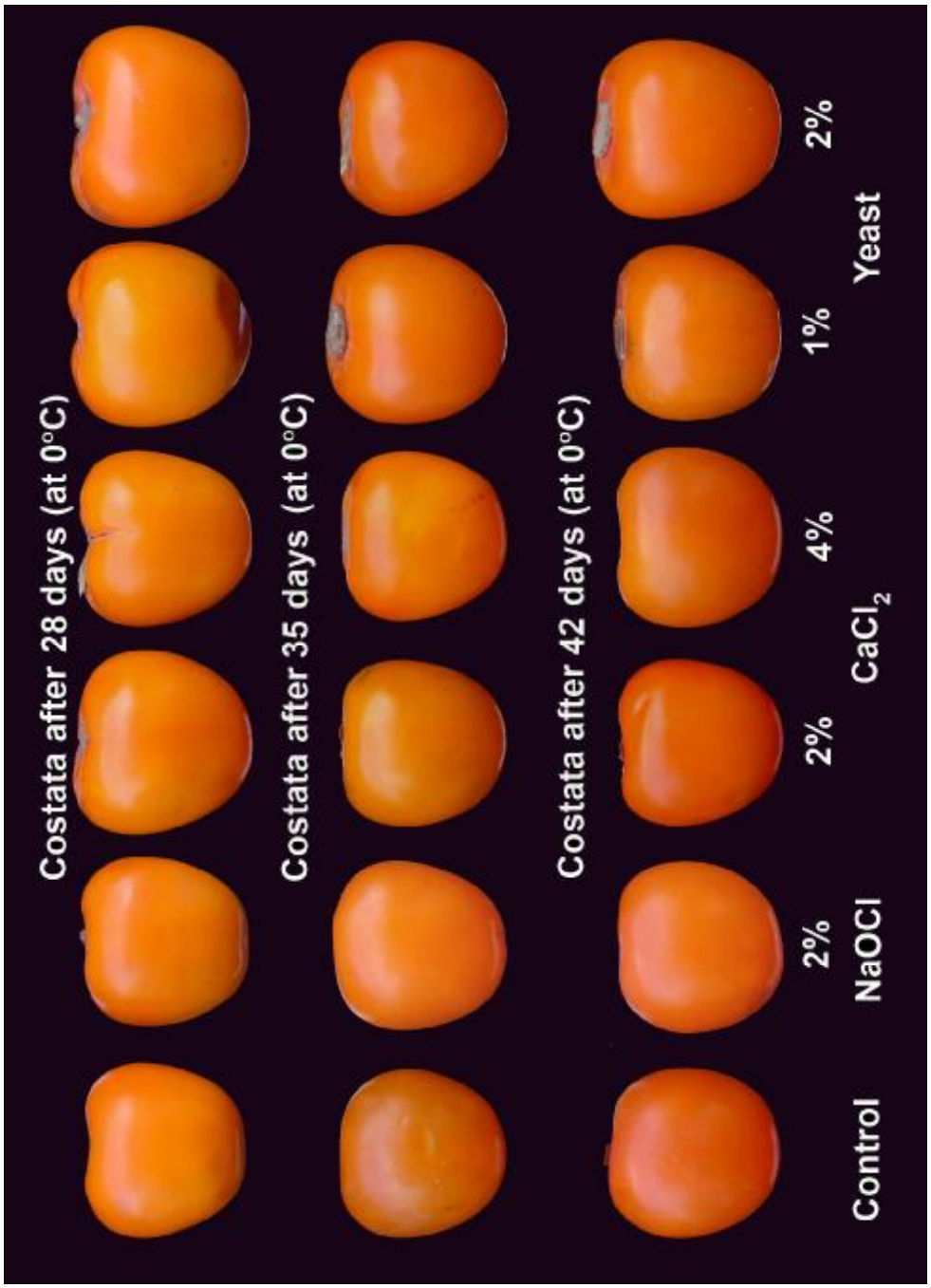

Photo (8): Physical changes in post harvest treated Costata persimmon fruits during cold storage (28, 35 and 42 days) at 0°C.

Fig (13)

Fig (14)

The role of cold storage in reducing decay percentage could be explained by the fact that the chemical reactions associated with respiration result in the production of heat. The amount of heat generated varies with the commodity and with its temperature. In general, the respiration rate increases two-four times for each 10°C increase in temperature. Thus, more heat is produced at high temperatures and less at low temperature at which the product is stored. Microbial organisms also are more active at high than low temperature. Therefore, cold storage is required to reduce this generation of heat and turn fruit decay (Sornsrivichai *et al.*, 1990).

In addition, the role of calcium chloride in reducing the decay percentage may be due to the fact that calcium appears to have an important regulating role in the metabolism of persimmon fruits-metabolic disorders. Such disorders are all severity reduced if calcium is present in sufficiently high quantities in fruit. Several of fruit disorders are associated with the high rate of respiration or over maturity of the fruit. This suggest that calcium may regulate respiration and perhaps other metabolic processes in the mature fruit. Also, it is evident that calcium is indeed involved in regulating the fruit (Miklos Faust and Chear, 1972). The results of $CaCl_2$ in this respect are in harmony with earlier works of Sams *et al.* (1993)on apple fruits cv. Golden Delicious, Montasser *et al.* (1993), Akl *et al.* (1995) on pear fruits cv. Le Conte, Daood (1995) on date fruits cv. Zaghloul, Saftner *et al.* (1998) on apple fruits cv. Golden Delicious, Mehaisen (1999) on pear fruits cv. Le Conte, EL-Zaabalawy (2001) on date fruits cvs. Zaghloul, Hayani and Samani, Choudhury *et al.* (2003) on sapota fruits cv. Pala, Gautam *et al.* (2003) on mango fruits cv. Bangapalli, Tajinder *et al.* (2003) on pear fruits cv. Patharnakh and Shaaban (2006) on guava fruits cv. Maamoura.

Furthermore, the role of yeast in reducing the decay may be through its mechanism in biological control (Sugar *et al.*, 1994). The gained results of yeast in this respect go in line with findings of Stretch (1989) on blueberry and cranberry fruits, Cheah *et al.* (1994) on kiwi fruits, Kampp and Sass (1994) on apple fruits, Sugar *et al.,* (1994) on Bosc pear fruits, El-Neshawy and Michalczuk (1999)on apricot cv. Amaar and Sharma and Bhardwaj (2000)on apple fruits. They postulated that yeast treatments succeeded in protecting the fruits from decay.

The recorded results of NaOCl go in line with findings of Nguyen and Souty (1985), Roberts and Reymond (1989), Mohammed *et al.* (1991), Mehaisen (1999) and Ray and Byju (2003). They concluded that sodium hypochlorite as a post harvest treatment was very effective in controlling diseases and rots and decreasing fruit decay percentage of peach, Red Delicious apple and "Le Conte" pear, respectively.

4.1.2.3. Fruit shelf life "fruit marketability"

Effect of some post harvest treatments i.e. calcium chloride at 2 and 4%, active yeast suspension at 1 and 2% and sodium hypochlorite at 2% in comparison with the control on shelf life (number of days that cold stored fruits at 5 or 0°C for forty two days could sustain ambient room conditions) of Costata persimmon fruits is illustrated in Table (13) and Photo (9).

Briefly, owing to the fluctuation of shelf life's trend i.e. the response to tested post harvest treatment from one season to another, it is preferable to discuss such trend on the basis of the average of two seasons. Consequently, it is easy to notice that shelf life of 0°C cold stored fruits is shorter than the analogous ones of 5°C cold stored fruits.

As for shelf life of cold stored Costata persimmon fruits at 5°C for forty two days, Table (13) illustrates that 2 and 4% CaCl2 and 2% NaOCl treatments induced statistically similar and prospective effect on enhancing shelf life in comparison with the control and 1 & 2% active yeast suspension treatments. On the other hand, shelf life of cold stored Costata persimmon fruits at 0°C for forty two days, Table (13) demonstrates that both 4% CaCl2 and 2% NaOCl treatments proved to be the superior ones in enhancing shelf life, followed by 2% CaCl2 and 1% active yeast suspension. On contrary, control and 2% active yeast suspension treatments scored high values of decayed fruits. The results achieved by calcium chloride in this respect are in agreement with the findings of Akl *et al.* (1995) on pear fruits cv. "Le Conte", Suntharalingams (1996) on mango fruits cv. Willard, Abdul *et al.* (1997) on mango fruits cvs. Fazli and Ashwina, Mehaisen (1999) on pear fruits cv. "Le Conte", Jagadeesh *et al.* (2001) guava fruits cv. Sardar, Choudhury *et al.* (2003) on sapota fruits cv. Pala and Gautam *et al.* (2003) on mango fruits cv. Bangapalli. They mentioned that Ca-treatments succeeded in increasing the shelf life when compared with control. On contrary Freire and Chitarra (1999) realized that calcium chloride application did not increase fruit shelf-life.

Table (13)

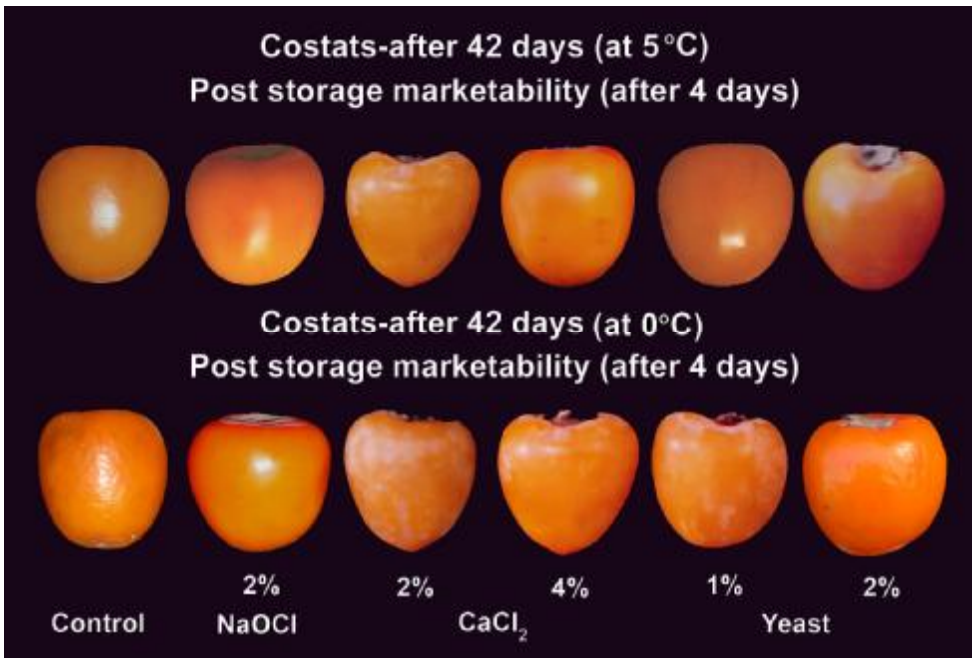

Photo (9): Effect of some post harvest treatment on post storage marketability (shelf life) of Costata persimmon fruits during storage at (0 & 5 ºC).

The obtained results of active yeast suspension as a post harvest treatment is in accordance with those mentioned by Sugar *et al.*(1994) on mango and Mehaisen (1999) on pear fruits cv. "Le Conte". They mentioned that active yeast suspension induced loss enhancing effect on shelf life of cold stored fruits.

The obtained results of sodium hypochlorite coincided with the findings of Mehaisen (1999) on pear fruits cv. "Le Conte".

4.1.2.4. Fruit Firmness (lb/inch^2)

a. Storage under ambient room conditions

Concerning specific effect of storage period, it is clear from Table (14.a) that Costata persimmon fruits showed gradual loss in their firmness with the advancement of storage period.

The obtained results indicate this fact, hence, the initial readings of fruit firmness i.e. before subjecting to room storage were (6.80 & 6.10 lb/inch^2), whereas after seven days room storage, the readings showed a marked reduction and scored (3.89 & 4.06 lb/inch^2). Besides, fourteen days room storage recorded a further lower values of fruit firmness (1.85 & 1.84 lb/inch^2) in the first and second seasons, respectively. Finally, the greatest reduction of fruit firmness were recorded after twenty one days in the first season. The differences between the studied storage periods were significant.

Regarding specific effect of the studied post harvest treatments, data in Table (14.a) show that in the first season all tested treatments including the control induced similar effect in this respect. Meanwhile, in the second season, 4% $CaCl_2$-treated fruits induced the highest value in this respect (3.23 lb/inch^2) when compared with other treatments especially, 2% yeast-treated fruits which exerted the lowest values in this concern (2.70 lb/inch^2).

As for the interaction effect between the tested post harvest treatments and storage period, it is easy to realize that the freshly harvested fruits i.e. before storage under ambient room conditions were more firm than those kept under ambient for seven day or fourteen days in both seasons or twenty one days in the first season. Additionally, the lowest values were noticed with the interactions of twenty one days storage duration in 2003 season, especially tap water-treated fruits (control), while in 2004 season, the lowest firmness were recorded when the fruits stored under ambient room conditions for fourteen days, particularly 2% NaOCl-treated fruits.

Table (14.a)

b. Cold storage at 5°C

With regard to specific effect of storage period, data reported in Table (14.b) illustrate that there was reverable correlation between fruit firmness and storage duration. Thereupon, fruit firmness showed a remarkable decrease as the storage period advanced. In this respect, the initial fruit firmness value for those kept zero day under cold storage (5°C) scored (6.80 & 6.10 lb/inch^2) against (5.50 & 4.96 lb/inch^2) for those stored for seven days and (4.68 & 4.18 lb/inch^2) for those cold stored for fourteen days in 2003 and 2004 seasons, respectively. Lastly, the lowest fruit firmness were produced by cold stored for forty two days (1.62 & 2.06 lb/inch^2) in the first and second seasons, respectively. The differences between all storage periods were pronounced to be significant.

As for specific effect of the tested treatments, results in Table (14.b) declare that 4% $CaCl_2$-treated fruits approved to be the most effective treatment for recorded the highest values of fruit firmness (4.00 & 3.58 lb/inch^2), whereas the lowest values of fruit firmness were produced by tap water-treated fruits in the first season (3.22 lb/inch^2) and 1% yeast-treated fruits in the second one (3.09 lb/inch^2). The rest treatments occupied an intermediate position between the abovementioned treatments in both season.

Examining interaction effect between storage period and the tested treatments, data presented in Table (14.b) show that irrespective of the initial readings, the interactions of seven days storage period registered the highest values of fruit firmness, especially 4% $CaCl_2$- treated fruits in the first season (6.17 lb/inch^2) and 2% yeast-treated fruits in the second one (5.30 lb/inch^2), followed descendingly by the interactions of fourteen days storage periods, particularly 4% $CaCl_2$- treated fruits in the first season and 2% NaOCl-treated fruits in the second one.

On contrary, the lowest values of fruit firmness were recorded by the interactions of forty two days storage period, especially 1% yeast-treated fruits (1.53 & 1.73 lb/inch^2) in both seasons. The other values came inbetween. The differences between the different storage period interactions were significant and within each specific storage period were in most cases insignificant.

Table (14.b)

c. Cold storage at 0°C

Referring to specific effect of storage period, Table (14.c) demonstrates that fruit firmness decreased as storage period prolonged. The disclosed data indicate this result, hence the initial readings of fruit firmness scored (6.80 & 6.10 lb/inch^2) against (5.59 & 5.21 lb/inch^2) for those kept for seven days under cold storage (0°C) in the first and second seasons, respectively. The lowest fruit firmness (1.78 & 1.93 lb/inch^2) were produced by cold stored fruits for forty two days during 2003 and 2004 seasons, respectively. The differences between the aforementioned storage periods were so high to be significant.

Looking at specific effect of some post harvest treatments, Table (14.c) declares that 2% NaOCl and 4% $CaCl_2$-treated fruits induced statistically the highest values in comparison with other tested treatments. On reverse, 1% yeast suspension treatment in 2003 season and 2% $CaCl_2$ treatment in 2004 season induced the lowest fruit firmness. The other tested treatments came inbetween the previously mentioned two categories.

As for the interaction effect between the tested treatment and storage period, it is easy to realize that the freshly harvested fruits i.e. before subjecting to cold storage were more firm than those kept under cold storage for forty two days or lesser up to seven days. Generally, irrespective of the initial readings, the highest values of fruit firmness were gained by the interactions of seven days storage period especially, 4% $CaCl_2$-treated fruits (6.03 & 5.47 lb/inch^2) in both seasons. On the opposite, the lowest fruit firmness were produced the interactions of forty two days storage period, particularly 2% yeast suspension-treated fruits in the first season, and tap water-treated fruits “control” in the second one. The other interactions came inbetween the abovementioned treatments.

Conclusively, fruit firmness decreased gradually with storage period, as the rate of degradation of insoluble protopectins to more soluble pectins increased with the progress of storage period. Also, pectin estrase activity is expected to increase progressively during storage and as a result peel and pulp hardness decreased during storage. Besides the reduction in fruit firmness during storage was time and temperature dependent. Negative correlation between fruit firmness and both storage temperature and storage period (Ponomarer, 1968).

Table (14.c)

The role of calcium chloride in enhancing fruit firmness during storage may be attributed to the fact that the exogenous Ca^{++} was incorporated into protopectin molecule in the middle membrane and retarded hydrolysis during post-harvest ripening, inhibited fruit softening and extended storability (Bantch and Arasimovich, 1993). The recorded results of $CaCl_2$ dealing with their prospective affect on reducing the rate of loss of fruit firmness are in harmony with earlier studies of Mir *et al.* (1993) on apple fruits cv. Red Delicious, Souty *et al.* (1995) on apricot fruits, Ait-Oubahou *et al.* (1995) on five apple cultivars, Pirmoradian and Babalar (1995) on apple fruits cv. Red Delicious, Suntharalingam (1996) on mango fruits cv. Willard, Farooq *et al.* (1999) on pear fruits cv. Bartlett, Nickhah *et al.* (1999) on pear fruits, Tajinder *et al.* (2003) on pear fruits cv. Patharnakh and Ali (2005) on persimmon fruits cv. Costata.

The results of active yeast suspension are in harmony with those mentioned by Sugar (1992) and Mehaisen (1999). They declared that active yeast suspension as a post harvest treatment failed to induce a promising affect on fruit firmness.

Furthermore, Sandhu and Randhawa (1992) and Mehaisen (1999) emphasized the obtained result of NaOCl in this concern mentioned sodium hypochlorite at 1.5-2 % as a post harvest treatment was effective in improving fruit firmness.

4.1.2.5. Pulp carotenoids content

a. Storage under ambient room conditions

Looking at specific effect of storage period, data presented in Table (15.a) illustrate that out of all tested storage periods the initial storage period (zero day storage) scored the lowest values of fruit carotenoids content (2.34 & 2.45 mg/100 g fresh weight). Results of the storage period show that fruit pulp carotenoids content (mg/100 g fresh weight) increased as the storage period prolonged, thereupon the highest fruit pulp carotenoids content (2.83 mg/100 g fresh weight) were recorded by twenty one days stored fruits in 2003 season and (2.74 mg/100 g fresh weight) by fourteen days stored fruit in 2004 season. On reverse, seven days stored fruits scored the lowest values of fruit pulp carotenoids content (2.63 & 2.63 mg/100 g fresh weight) in 2003 and 2004 seasons, respectively (irrespective of the initial reading).

(Table, 15.a)

Pointing to specific effect of the tested post harvest treatments, the statistical analysis (Table, 15.a) demonstrate that there was indistinctive trend regarding the response of fruit pulp carotenoids content to the studied post harvest treatments throughout the course of study. One can conclusively say that 2% NaOCl-treated fruit produced the richest fruits in pulp carotenoids content (2.81 mg/100 g fresh weight) in 2003 season, while 2% yeast-treated fruits showed its superiority (2.79 mg/100 g fresh weight) in this concern in 2004 season. On contrary, the lowest values of this parameter were gained by 2% yeast-treated fruits (2.70 mg/100 g fresh weight) in the first season and 2 & 4% $CaCl_2$-treated fruits (2.66 mg/100 g fresh weight) in the second one.

As for the interaction effect between the tested treatments and storage period, tabulated data indicate that the interactions of twenty one days storage period in the first season dominated the analogous ones of fourteen days storage period and the later ones in both season surpassed the corresponding ones of seven days storage period in enhancing fruit pulp carotenoids content. On the other hand, the freshly harvested fruits (zero day storage) registered the lowest values in this sphere. Generally, 2% NaOCl-treated fruits stored for twenty one days under ambient room conditions in 2003 season and 2% yeast-treated fruits kept for fourteen days under ambient room conditions in 2004 season, recorded the highest fruit pulp carotenoids content. Meanwhile, the lowest values of fruit carotenoids content were registered by 2% yeast-treated fruits kept under ambient room conditions for seven days in 2003 season and 2% $CaCl_2$-treated ones in 2004 season.

b. Cold storage at 5°C

Discussing specific effect of storage period, Table (15.b) indicates that evaluated storage periods could be arranged in ascendingly regarding their positive effect on pulp carotenoids content as follows: zero day storage period (2.34 & 2.45 mg/100 g fresh weight), seven days (2.43 & 2.48 mg/100 g fresh weight), fourteen days (2.52 & 2.53 mg/100 g fresh weight), twenty one days (2.60 & 2.58 mg/100 g fresh weight), twenty eight days (2.64 & 2.62 mg/100 g fresh weight), thirty five days (2.65 & 2.67 mg/100 g fresh weight) and forty two days (2.66 & 2.71 mg/100 g fresh weight) during 2003 and 2004 season, respectively. The differences between the most aforementioned storage periods were obvious to be significant.

TABLE (15b)

Referring to specific effect of tested post harvest treatments, the statistical analysis illustrate that the effect of these treatments changed from one season to another. In this field, in 2003 season, 1% yeast treatment dominated all tested treatments in exhibiting positive effect on pulp carotenoids content. Moreover, tap water, 2% $CaCl_2$ and 2% yeast treatments induced statistically similar values and higher positive effect on pulp carotenoids content than 4% $CaCl_2$ treatment. On reverse, in 2004 season 2% NaOCl and 1% yeast treatments scored the highest values of pulp carotenoids content, whereas the lowest value was noticed with 2% $CaCl_2$ treatment. Other treatments gave nearly similar values with non significant differences.

Examining the interaction effect between post harvest treatments and storage period, tabulated data demonstrate that the interactions of forty two days storage period surpassed the analogous ones of other studied storage periods in enhancing pulp carotenoids content. On the other hand, the interactions of seven days storage period registered the lowest values in this sphere. Briefly, tap water "control" and 4% $CaCl_2$-treated fruits in 2003 season and 2% $CaCl_2$-treated fruits in 2004 season stored for seven days scored the lowest values of pulp carotenoids, whereas untreated fruits in 2003 season and 1% yeast-treated fruits in 2004 season stored under 5°C for forty two days gave the highest values of pulp carotenoids content. Other interactions took an intermediate positions between the aforementioned two categories.

c. Cold storage at 0°C

As for specific effect of storage period, Table (15.c) shows that prolonging the storage period increased fruit pulp carotenoids content. In this respect, cold storage of Costata persimmon fruits at 0°C for forty two days induced the highest positive effect on pulp carotenoids content (2.75 & 2.79 mg/100 g fresh weight) compared with the analogous freshly harvested fruits (zero days storage) i.e. initial readings (2.34 & 2.45 mg/100 g fresh weight) in 2003 and 2004 seasons, respectively. The remained studied storage periods occupied intermediate place between aforesaid categories in both seasons of this study. The differences between the most storage period were significant.

Pointing to specific effect of tested treatments, it is worthily to observe that 2% $CaCl_2$, 1% yeast and 2% NaOCl-treated fruits were the richest ones regarding pulp carotenoids content in the first season and the second one, respectively. On contrary, 4% $CaCl_2$-treated fruits in both seasons showed to be the poorest ones of pulp carotenoids content. The rest treatments came inbetween in this concern without significant differences in most cases.

Focusing on the interaction effect between test post harvest treatment and storage period, Table (15.c) reveals that in most cases, the highest reading of fruit pulp carotenoids content were noticed in descending order with interactions of forty two days storage period, thirty five days, twenty eight days, twenty one days, fourteen days and finally the interactions of seven days storage period.

However, 2% $CaCl_2$ and 1% yeast suspension-treated fruits stored at 0°C for forty two days scored the highest values of fruit pulp carotenoids content. Besides, the lowest values were produced by the interactions of seven days storage period with 4% $CaCl_2$ in both seasons. Other interactions recorded inbetween values, but the differences within each specific column were in most cases insignificant.

The obtained results dealing with the reduction of fruit chlorophyll and appearance of fruit carotenoids during storage due to post harvest treatments with $CaCl_2$ at 2- up to 8% go in line with the findings of Suntharalingam (1996) on Willard mango fruits and Farooq *et al.* (1999) on Bartlett pear fruits. On contraty, Mahajan and Sharma (1995) reported that $CaCl_2$ at 6% as a post harvest treatment resulted in improving fruit colour of mango fruits cv. Dashehari.

Table (15.c)

4.1.2.6. Fruit total sugars content

a. Storage under ambient room conditions

Concerning specific effect of storage period, Table (16.a) show that fruit total sugars content was increased as the storage period advanced. The obtained data illustrate this result, hence the initial storage period (zero day storage) registered the lowest values of fruit total sugars content (14.53 & 14.37%), whereas seven days stored fruit recorded (16.08 & 16.10%) in 2003 and 2004 seasons, respectively. However, the greatest total sugars content was scored after twenty one days storage period (16.63%) in the first season and after fourteen days storage period (16.72%) in the second one.

With regard to specific effect of the tested post harvest treatments, it is clear from Table (16.a) that in both seasons, the highest fruit total sugars content was gained by active yeast suspension treatment at 2% as it gave 16.56 & 16.76% in both seasons.

On contrary, the lowest fruit sugars content was obtained by 2% NaOCl treatment as it (16.26 & 16.07%) in both seasons. The other tested treatments showed inbetween values in this respect.

Examining the interaction effect between treatments and storage period, it is obvious from Table (16.a) that freshly harvested fruits had lesser total sugars content than those stored under ambient room conditions for twenty one days, fourteen days or seven days storage duration. However, the highest values of fruit total sugars content were noticed with the interactions of twenty one days storage in the first season, especially the interaction of 2% yeast treatment, while in the second season the interactions of fourteen days storage showed superiority in this concern, particularly the combination of tap water “control”. On contrary, irrespective of zero day storage period, the lowest values of fruits total sugars content were producing by the interactions of seven days storage period especially 2% NaOCl-treated fruits in both seasons of this work. The other combinations occupied an intermediate position between the abovementioned combination categories.

Table (16.a)

b. Cold storage at 5°C

With respect to specific effect of storage period, data reported in Table (16.b) reveal that fruit total sugars content was gradually increased as the storage period prolonged. The initial fruit total sugars readings i.e. before storage period (zero day storage) were (14.53 & 14.37%). Generally, the richest fruits reading total sugars content were produced by cold stored fruits for forty two days. On the other hand, irrespective of initial readings, the poorest fruits in their content of total sugars were cold stored fruits for seven days in both seasons.

Considering specific effect of the tested treatments, tabulated data illustrate that 1% yeast treatment fruits showed to be the most effective one in enhancing fruit total sugars content (16.14%) in the first season and 2% yeast treatment (16.11%). On reverse, the lowest values (16.02 & 15.92%) of this parameter were scored by 4% $CaCl_2$ treatment in both seasons.

As for the interaction effect between the storage period and the studied post harvest treatments, tabulated data declare that as the storage period prolonged, the fruit total sugars content increased irrespective of the effect of the tested post harvest treatments. Thereupon, the interactions of seven days storage period (regardless of initial storage period) recorded the lowest fruit total sugars values especially, 2% yeast-treated fruits in 2003 season and 2% NaOCl-treated ones in 2004 season. On contrary, the highest fruit total sugars values were observed by the interactions of forty two days storage duration under 5°C cold storage, particularly 1% yeast-treated fruits and 2% yeast-treated fruits in the first and second seasons, respectively. The differences between the interactions were significant in both seasons of study.

Table (16.b)

c. Cold storage at 0°C

Concerning specific effect of storage period, it is clear from Table (16.c) that there is a positive correlation between fruit total sugars content and storage duration, hence fruit total sugars content showed a steadily increase as the storage period advanced. However, cold stored fruits for forty two days scored the highest fruit total sugars values (16.57 & 16.58%) when compared with the values of initial readings (14.53 & 14.37%) or seven days storage period (15.07 & 15.02%).

Besides, the storage periods could be descendingly arranged regarding their positive effect on fruit total sugar content as follows: forty two days, thirty five days, twenty eight days, twenty one days, fourteen days and seven days. The differences between all evaluated storage periods were significant in both seasons.

Referring to specific effect of tested treatments, it was obvious from Table (16-c) that 2% yeast and 2% NaOCl treatments were the most promising treatments for enhancing fruit total sugars content in both seasons. On reverse, the lowest values of this parameter were recorded by 1% yeast suspension treatment the first season and 4% $CaCl_2$ treatment in the second one. The rest post harvest treatments gave inbetween values in this respect.

As for the interaction effect between the tested treatments and storage period, Table (16.c) demonstrates that the highest fruit total sugars percentages were recorded by the interactions of forty two days storage period particularly, 2% NaOCl-treated fruits in 2003 season (16.70) and 2% yeast-treated fruits in 2004 season (16.73). On the other hand, the interactions of seven days storage period had the lowest fruit total sugars percentage especially, the combinations of control fruits (14.90) in the first season and 1% $CaCl_2$-treated fruits (14.70) in the second one. The rest interactions occupied inbetween position between the aforementioned two categories. Briefly, the differences between the interactions in most cases were significant from the statistical stand point in both seasons of study.

The increase in total sugars percentage of Costata persimmon fruits with the progress of storage duration could be due to the conversion of complex forms of carbohydrates like starch to simple forms of sugars due to the greater activity of starch splitting enzymes (McArthurt, 1956).

Table (16.c)

The obtained results dealing with fruit sugars content during storage due to $CaCl_2$ as a post harvest treatments are coincided with those mentioned earlier by Mahajan and Sharma (1995) on mango fruits cv. Dashehari, El-Zaabalawy (2001) on date palm cultivars (Zaghloul, Hayani and Samani) and Choudury *et al.* (2003) on sapota fruits cv. Pala. They revealed that $CaCl_2$ at 1 or 2% reduced augmented biochemical attributes such as total sugars.

The results of yeast are in accordance with those reported by Sugar (1992) and Mehaisen (1999) they mentioned that active yeast suspension as a post harvest treatment induced a slight effect on fruit total sugars content.

Furthermore, the obtained results concerning the effect of NaOCl on fruit total sugars content go in line with the findings of Sandhu and Randhawa (1992) and Mehaisen (1999). They reported that NaOCl at 1.5-2.0% as a post harvest treatment enhanced fruit total sugars content of Litchi fruits cv. seedless late and Le Conte pear fruits, respectively.

4.1.2.7. Fruit total soluble solids percentage (T.S.S.%)

a. Storage under ambient room conditions

With respect to specific effect of storage period, Table (17.a) reveal that the decrease in fruit total soluble solids content (%) is proportionated with the advancement of the storage period. The obtained data emphasize this result, hence the initial readings of fruit total soluble solids i.e. before storage were (22.20 & 21.60%), whereas when Costata persimmon fruits stored under ambient room conditions for seven days, the readings were (16.61 & 16.82%) and the values became much lower when storage period extended up to fourteen days to record (14.49 & 14.48%) during 2003 and 2004 seasons, respectively. Finally, the lowest value was recorded after twenty one days storage period in 2003 season.

Pointing to specific effect of the tested post harvest treatments, the statistical analysis indicate that there was indistinctive trend regarding the response of fruit total soluble solids percentage to the studied treatments throughout the course of this study. One can conclusively say that the highest fruit total soluble solids percentage were produced by 2% NaOCl treatment in the first season, and 4% $CaCl_2$ treatment in the second one, whereas 2% yeast treatment showed the other way around.

Table (17.a)

Considering the interaction effect between storage period and the tested treatments, Table (17.a) demonstrates that irrespective of the readings of zero day storage, the interactions of seven days storage surpassed the analogous ones of fourteen days storage period in both seasons and the later ones predominated the corresponding ones of twenty one days storage period in the first season. Abstractly, 4% $CaCl_2$-treated fruits stored for seven days under ambient room conditions recorded statistically the highest values (17.27 & 17.53%), meanwhile 2% yeast-treated fruits kept under ambient room conditions for fourteen days scored the lowest values (13.80 & 13.40%) in both seasons, but 2% $CaCl_2$-treated fruits registered the lowest values (12.80%), when stored for twenty one days under ambient room conditions in 2003 season.

b. Cold storage at 5°C

As for specific effect of storage period, data presented in Table (17.b) illustrate that prolonging cold storage period of Costata persimmon fruits resulted in decreasing fruit total soluble solids percentage. In this concern, the initial readings before cold storage at 5°C ere (22.20 & 21.60%), whereas prolonging cold storage period up to seven days recorded the highest values (20.42 & 20.39%), irrespective of the initial readings, followed descendingly by those stored for fourteen days (18.19 & 18.94%) in both season.

On contrary, prolonging the storage period up to forty two days registered the lowest values (13.93 & 14.78%), followed ascendingly by thirty five days storage period (14.42 & 15.13%) in the first and second season, respectively. Additionally, twenty eight days and twenty one days storage periods occupied an intermediate position, but twenty one days storage period surpassed twenty eight days storage period exerting more enhancing affect. The differences between the studied storage periods were so high to be significant.

Looking to specific effect of the tested treatments, data in Table (17.b) demonstrate that in 2003 season, 2% NaOCl-treated fruits and 1% yeast-treated fruits appeared to be the most effective treatments for inducing the highest fruit total soluble solids percentage as they gave (16.96 & 16.94%), respectively. While, in the second season 1 & 2% yeast-treated fruits showed superiority in this respect. On reverse, 2% yeast-treated fruits significantly produced the lowest fruit total soluble solids content (16.21 & 16.98%) in the first and second season, respectively.

Table (17.b)

Regarding interaction effect between storage period and tested post harvest treatments, data presented in Table (17.b) indicate that the combinations of seven days storage period, particularly 2 and 4% $CaCl_2$-treated fruits in 2003 season and tap water-treated fruits (control) and 2% NaOCl-treated ones in 2004 season were the richest ones in TSS values. On the opposite the lowest values of this parameter were produced by the combinations of fort-two days, especially tap water and 2% yeast-treated fruits in the first and second season, respectively. Other interactions took intermediate positions between the abovementioned values, but the differences within each specific column were in most cases insignificant.

c. Cold storage at 0°C

Referring to specific effect of storage period, Table (17.c) shows that fruit total soluble solids percentage decreased as the storage period increased. The gained data explain this result, where the initial storage (zero day storage) recorded (22.20 & 21.60%), while seven days cold stored fruits scored statistically the highest values (20.57 & 20.38%), followed descendingly by fourteen days-stored fruits (18.27 & 17.96%) in 2003 and 2004 seasons, respectively. On contrary, forty two days stored fruits scored statistically the lowest values (14.62 & 14.87%), followed ascendingly by those stored for thirty five days storage period (15.41 & 15.72%) in the first and second season, respectively. Additionally, twenty eight days and twenty one days occupied an intermediate position, but the positive effect was inside of twenty one days storage period.

Evaluating specific effect of the tested treatments, the obtained data demonstrate that in 2003 season, 1% yeast treatment produced the richest fruits in their total soluble solids content (17.51%), followed descendingly by 4% $CaCl_2$-treated fruits (17.41%), whereas 2% $CaCl_2$ treatment resulted in the lowest fruit total soluble solids content (16.98%). Besides, in the second one 4% $CaCl_2$ treatment showed to be the most effective treatment for producing the highest fruit total soluble solids content (17.72%), followed descendingly by 2% $CaCl_2$ treatment (17.58%) while, 2% yeast treatment produced the lowest fruit total soluble solids content (16.54%). The rest treatments gave inbetween values in this respect.

Table (17.c)

Regarding interaction effect between the storage period and the tested post harvest treatments, data in Table (17.c) indicate that the interactions of seven days storage period, especially tap water-treated fruits scored the highest values (20.80 & 20.93%) in both season, followed descendingly by the interactions of fourteen days storage period and they surpassed the interactions of the other storage periods. Therefore, the lowest fruit total soluble solids content were observed with cold stored Costata persimmon fruits for forty two days, especially those treated with 2% yeast (13.80 & 14.20%) in both season. The rest interactions came in between.

The obtained results of calcium as a post harvest treatment in retaining and inducing higher total solids percentage of persimmon fruits cv. Costata during storage go in line with the analogous ones mentioned by Abdul *et al.* (1997) on two mango cultivars (Fazli and Ashwina), Babalar *et al.* (1999)on two grape cultivars namely Keshmeshy Bidaneh and Shahroudy, Farooq *et al.* (1999)on pear cv. Bartlett (Williams' Bon Chretien) and Ali (2005) on persimmon fruits cv. Costata as they stated that $CaCl_2$ treatments improved fruit T.S.S content.

The obtained results of yeast in this concern are in accordance with those mentioned by Sugar (1992) and Mehaisen (1999). Furthermore, the gained results of NaOCl in this respect are in harmony with the findings of Sandhu and Randhawa (1992) and Mehaisen (1999). They pointed out that NaOCl treatment induced insignificant effect on fruit total soluble solids.

4.1.2.8. Fruit total acidity content

a. Storage under ambient room conditions

Referring to specific effect of storage period, it is quite evident that the decrease in fruit total acidity content is proportionated with the advancement of storage period (Table, 18.a). The scored data indicate this result, hence the initial readings of fruit total acidity i.e., before cold storage were (0.36 & 0.39%). Generally, the highest values of fruit total acidity content (irrespective of initial readings) were recorded with seven days stored fruits under ambient room conditions (0.24 & 0.22%) in both season, whereas the lowest values of this parameter were scored when the fruits stored under ambient room conditions for

twenty one days (0.12%) during 2003 season or for fourteen days under ambient room conditions (0.17 & 0.13%) during 2003 and 2004 seasons.

Looking at specific effect of the tested post harvest treatments, the statistical analysis show that 2% NaOCl-treated fruits had the highest fruit total acidity percentages in both seasons. On contrary, the lowest values of fruit total acidity were observed with 1% yeast suspension-treated fruits in the first season. The rest tested treatments induced similar effect in this respect.

Considering interaction effect between the tested post harvest treatments and storage period, the resulted interactions show that the interactions of seven days storage period surpassed the analogous ones of fourteen days storage period and the later ones predominated the corresponding ones of twenty one days storage period in 2003 season in increasing fruit total acidity percentage.

Briefly, 4% $CaCl_2$-treated fruits and 2% NaOCl-treated fruits stored under ambient room conditions for seven days recorded the highest values of fruit total acidity content in the first season, while in the second season, 2% NaOCl treated fruits and 1% yeast-treated ones stored for seven days showed higher values in this respect, whereas 2% $CaCl_2$-treated fruits and 2% yeast-treated fruits kept under ambient room conditions for fourteen days scored the lowest values during 2003 and 2004 seasons, respectively. On the other hand, in the second season 4% $CaCl_2$ and 1% yeast treated fruits, stored for twenty one days storage period under ambient room conditions recorded the lowest values of fruit total acidity content. The other interactions took an intermediate position between the aforesaid combination categories in both seasons.

Table (18.a)

b. Cold storage at 5°C

Discussing specific effect of storage period, Table (18.b) illustrates that prolonging cold storage period resulted in decreasing total acidity content of Costata persimmon fruits. In this concern, the initial reading before storage were the highest value (0.36 & 0.39%), whereas, prolonging cold storage up to forty two days registered the lowest values (0.11 & 0.11%) in the first and second seasons, respectively. The other storage periods occupied an intermediate positions in this respect, but seven days storage period scored the highest values in this concern. The differences between the tested storage periods were so high to be significant in both seasons.

With respect to specific effect of the tested post harvest treatments, Table (18.b) demonstrates that most tested treatments induced statistically similar effect on fruit total acidity, particularly in 2004 season except for 4% $CaCl_2$-treated fruits and 2% NaOCl-treated ones which produced significantly the highest values in the first season.

On reverse, 2% $CaCl_2$ and 1 & 2% yeast-treated fruits exerted statistically the lowest values in this respect in both season. This trend was true only in the first season, while in the second one 2% yeast-treated fruits scored the lowest values in this concern.

Focusing on the interaction effect between the tested treatment and storage period, Table (18.b) illustrates that the interactions of seven days storage period surpassed the analogous ones of fourteen days storage period or the other storage periods regarding fruit content of total acidity. Generally, the highest fruit total acidity percentages were scored by persimmon fruits stored for seven days (regardless of the initial) especially 2% NaOCl-treated fruits (0.33 & 0.35) during 2003 and 2004 seasons, respectively. On the opposite, the lowest values of fruit total acidity content were recorded by persimmon fruits stored for forty two days. The treatments under such storage period (42 days) exerted statistically similar values in both seasons of study.

Table (18.b)

c. Cold storage at 0°C

As for specific effect of storage period, Table (18.c) demonstrates that prolonging the storage period induced a remarkable reductive effect on fruit total acidity content, where the initial storage readings (Zero day storage) recorded higher fruit total acidity content (0.36 & 0.39%), followed descendingly by seven days storage period (0.31 & 0.32%) in comparison with (0.26 & 0.28%) for those stored for fourteen days, (0.21 & 0.22%) for the corresponding ones stored for twenty one days, (0.17 0.18%) for those stored for twenty eight days, (0.15 & 0.15%) for those stored for thirty five days and finally, (0.12 & 0.12%) for those stored for forty two days during 2003 and 2004 seasons, respectively. The differences between the studied storage periods in this respect were significant from the statistical standpoint.

Referring to specific effect of the tested post harvest treatments, tabulated data show that in 2003 season 2 & 4% $CaCl_2$ and 2% NaOCl-treated fruits scored the highest values of fruit total acidity content (0.21%), while the lowest value was gained by usingthe treatment of yeast at 2%. On the other hand, in 2004 seasonthe statistical analysis emphasize that total acidity of persimmon fruits showed no significant response to the studied post-harvest treatments.

Concerning the interaction effect between the tested treatments and storage period, it is quite clear from Table (18.c) that the interactions of seven days storage period scored the highest values of fruit total acidity content especially 4% $CaCl_2$-treated fruits in the first season and 1% yeast treated fruits in the second one. On reverse, the lowest values of this parameter were registered by the combinations of forty two days storage duration as the treatment under such storage period exhibited similar values without significant differences in both seasons.

The decrease in total acidity during storage at different temperatures could be due to its consumption in respiratory activities with the progress of storage time and the increase in storage temperature, as citric acid could be used as an organic substrate in the respiration process.

The obtained results of $CaCl_2$ dealing with their reducing fruit acidity are in harmony with earlier reports of Mahajan and Sharma (1995) on mango fruits cv. Dashehari, Abdul *et al.* (1997) on mango fruits and Choudury *et al.* (2003) on sapota fruits cv. Pala. On reverse Nickhah *et al.* (1999) reported that treating pear fruits with $CaCl_2$ solutions increased acidity levels, but Pirmoradian and Babalar (1995) on apple fruits, El-Zaabalawy (2001) on date fruits and Shaaban (2006) on guava fruits mentioned that $CaCl_2$ treatments were not affected on fruit acidity.

Table (18.c)

The obtained result of yeast in this respect are in harmony with the findings of Sugar (1992) and Mehaisen (1999). Furthermore, Sandhu and Randhawa (1992) and Mehaisen (1999) reported similar results to that obtained by sodium hypochlorite.

4.1.2.9. Fruit tannins content

a. Storage under ambient room conditions

Examining specific effect of storage period, Table (19.a) demonstrates that fruit tannins content (g tannic acid/100 g fruit fresh weight) of persimmon fruits cv. Costata was decreased as the storage duration prolonged. The presented data show this result, hence the initial storage period (zero day storage) scored the highest fruit tannins values (1.35 & 1.40 g tannic acid/100 g fresh weight), whereas seven days storage under ambient room conditions registered (1.13 & 1.16 g tannic acid / 100 g fresh weight) in both season. Moreover, the lowest fruits in their tannins content were recorded by those stored under ambient room conditions for twenty one days storage period (0.95 g tannic acid/100 g fresh weight) in 2003 season and under fourteen days storage period (1.00 g/tannic acid/100 g fresh weight) in 2004 season. The differences between the tested storage periods in this concern were obvious to be significant in both seasons.

Evaluating specific effect of post harvest treatments, it is obvious from Table (19.a) that the lowest value of fruit tannins content was produced by 2% yeast suspension treatment (0.96 & 0.99 g tannic acid/100 g fresh weight) while, the highest value of fruit tannins content was gained by 4% $CaCl_2$ treatment (1.08 & 1.17 g tannic acid/100 g fresh weight) in the first and second season respectively.

Other tested treatments gave inbetween values in this respect. Besides, the statistical analysis indicates that other treatments in the second season gave similar effect on fruit tannins content.

Regarding interaction effect between the storage period and the tested post harvest treatments, tabulated data illustrate that as the storage period prolonged, the fruit tannins content decreased. Thereupon, the interactions of seven days storage periods recorded higher values of fruit tannins content (irrespective of initially readings) than the analogous ones of fourteen days storage period in both season and the later ones surpassed the corresponding ones of twenty one days storage period in the first season. The higher values of fruit

Table (19.a)

tannins content were scored with seven days storage period interactions, especially those combined with $CaCl_2$ at 4% and yeast at 1% in the first and second seasons, respectively. On contrary, the lowest values of tannins content were recorded by twenty one days storage period interactions during 2003 season or fourteen days storage period interactions during 2004 season, particularly 2% yeast suspension. Other interactions recorded inbetween values in this respect.

b. Cold storage at 5°C

In regard to specific effect of storage period, Table (19.b) shows that the reduction in tannins content of Costata persimmon fruits is in proportionate with the advancement of storage period. In this respect, forty two days cold stored fruits recorded the lowest values of fruit tannins content (0.91 & 0.95 g tannic acid/100 g fresh weight) against (1.35 & 1.40 g tannic acid/100 g fresh weight) for the freshly harvested fruits (zero day storage) in the first and second season, respectively. Other values of cold storage period at 5°C occupied an intermediate position between the previously mentioned two categories, the differences between the most tested cold storage periods pronounced to be significant.

Considering specific effect of the tested post harvest treatments, enclosed data reveal that there was a fluctuated trend regarding the response of fruit tannins content to the tested treatments from one season to another. However, in 2003 season, 2% NaOCl-treated fruits had statistically higher tannins content than the corresponding ones of 2% yeast suspension-treated ones. The significant differences between the remained treatments including 2% NaOCl and 2% yeast suspension were insignificant from the statistical standpoint. Moreover, in 2004 season, 2% NaOCl treatment succeeded in reducing fruit tannins content in comparison with tap water "control" and 2 & 4% $CaCl_2$ treatments. The rest treatments involving the aforementioned treatments exert statistically similar effect in this sphere.

Concerning interaction effect between storage period and tested post harvest treatments, it is easy to realize that fruit tannins content responded to the interaction between the two studied factors. As shown in Table (19.b), all interactions of seven days storage period recorded the highest values of fruit tannins content (irrespective of the initial readings), followed by those of fourteen

Table (19.b)

days storage period. The combinations of twenty one days storage period, surpassed the corresponding ones of twenty eight days storage period and those of thirty five days storage period. On reverse, the interactions of forty two days storage period scored the lowest fruit tannins content values. Generally, all interactions of seven days storage period scored statistically and similarly higher tannins content. On reverse, 2% NaOCl-treated fruits, cold stored (5°C) for forty two days surpassed the other combinations regarding their positive effect on reducing fruit tannins content.

c. Cold storage at 0°C

With respect to specific effect of storage period, Table (19.c) shows that tannins content of Costata persimmon fruits decreased as the storage period advanced, in both season. In this respect, the average initial fruit tannins content i.e. before cold storage (Zero day storage) recorded (1.35 & 1.40 g tannic acid / 100 g fresh weight) against (1.28 & 1.27 g tannic acid/100 g fresh weight) cold stored fruits for those of seven days, (1.22 & 1.19 g tannic acid/100 g fresh weight) for the analogous ones of fourteen days storage period, (1.13 & 1.13 g tannic acid / 100 g fresh weight) for those of twenty one days storage duration, (1.05 & 1.06 g tannic acid/100 g fresh weight) for those of twenty eight days storage period, (0.98 & 1.03 g tannic acid/100 g fresh weight) for the corresponding ones of thirty five days storage period and lastly (0.95 & 0.94 g tannic acid/100 g fresh weight) during the first and second season, respectively. The differences between the studied periods (7, 14, 21, 28, 35 and 42 days) were obvious to be significant.

Referring to specific effect of post harvest treatments, tabulated data reveal that in the first season the studied treatments induced similar significant effect on fruit tannins content. On contrary significant differences were shown between the tested treatments in the second season, hence 2% $CaCl_2$-treated fruits, followed by those treated by the higher $CaCl_2$ concentration (4%) recorded the highest fruit tannins content throughout the storage periods in comparison with other tested treatments. On reverse, 1% and 2% yeast-treated fruits had comparatively the lowest values of tannins content. Other tested treatments gave inbetween values in this concern.

Table (19.c)

Focusing on the interaction effect between the treatments and storage period, it is quite clear that in both seasons all interactions of seven days storage period at 0°C recorded higher values of fruit tannins content, followed descendingly by the analogous ones of the interactions of fourteen days storage duration, twenty one days, twenty eight days, thirty five days and finally forty two days cold storage duration. Shortly, 4% $CaCl_2$-treated fruits, stored for seven days at 0°C had the highest values of tannins content. On contrary, 2% yeast-treated fruits stored for forty two days at 0°C proved to be the best combination in reducing tannins content from the statistical standpoint. Besides, other interactions recorded inbetween values, but the differences within each specific storage period were in most cases so small to reach the significance level.

The decrease in fruit tannins content during maturation and storage may be attributed to the fact that soluble leucocyandin tannins are converted during maturation into insoluble tannins, which take part in a non enzymic oxidative browning. These insoluble leucoanthocyandin decreased during storage (Maier and Metzer, 1965).

The obtained results of $CaCl_2$ affects on reducing fruit tannins content go in line with those mentioned by Mahayan and Sharma (1995) on mango fruits cv. Dashehari, Zaabalawy (2001) on date palm cvs Zaghloul, Hayani and Samani, Tajinder *et al.* (2003) on pear cv. Patharakhi and Ali (2005) on persimmon fruits cv. Costata. They reported that calcium chloride as a post harvest treatment was effective in maintaining the highest fruit quality and reducing fruit tannins content. Moreover, the result of NaOCl in reducing fruit tannins content was mentioned earlier by Sandhu and Randhawa who stated that NaOCl is effective post harvest treatment in maintaining fruit quality of litchi fruits cv. Seedless late.

4.1.2.10. Fruit ascorbic acid content (Vitamin C)

a. Storage under ambient room conditions

As for specific effect of storage period, it is clear from Table (20.a) that fruit ascorbic acid content (mg/100 ml juice) was decreased with the extension of storage period. The initial values of fruit ascorbic acid content i.e. before storage (zero day storage) registered (10.31 & 9.64 mg/100 ml juice) compared with (4.61 & 4.38 mg/100 ml juice) for those stored under ambient room for seven days and (2.72 & 2.67 mg/100 ml juice) for the analogous ones kept at ambient room

conditions for fourteen days during 2003 and 2004 seasons, respectively. However, the lowest fruit ascorbic acid values were observed with those kept under ambient room conditions for fourteen days (2.72 & 2.67 mg/100 ml juice) during 2003 and 2004 seasons or for twenty one days storage period (2.11 mg/100 ml juice) during 2003 season. The differences between the studied storage periods in this respect were pronounced to be significant.

Concerning specific effect of the tested post harvest treatments, tabulated data show that the richest fruits in ascorbic acid were those treated with 2% NaOCl (3.51 & 3.72 mg/100 ml juice) in the first and second seasons, respectively. On contrary, the lowest values of fruit ascorbic acid content were produced by 2% yeast suspensions-treated fruits in 2003 season, followed ascendingly by those treated by the lower concentration of yeast suspension (1%) in 2004 season. Such negative effect of yeast suspension concentrations was changed to the reverse in the second season, as they induced positive effect in this concern. Besides, control and 2% $CaCl_2$ treatments induced statistically similar and inbetween values in this sphere.

Referring to the interaction effect between the storage period and the tested post harvest treatments, tabulated data show that as he storage period prolonged, the fruit ascorbic acid content decreased. Thus, the interactions of seven days storage period (irrespective of initial storage period) registered higher values of fruit ascorbic acid content than the analogous ones of fourteen days storage period and the later ones surpassed the corresponding ones of twenty one days storage period in 2003 season. Anyway, the differences within the storage period interactions were so high to be significant. So, the highest values of fruit ascorbic acid content were obtained by the interactions of the seven days storage period, particularly those combined with 2% CaCl2 in the first season and 2% NaOCl in the second one. On reverse, the lowest values of fruit ascorbic acid content were observed with the interactions of twenty one days storage period, especially those interacted with 2 & 4% CaCl2 and 2% yeast treatments in 2003 season and the interactions of fourteen days storage period, particularly those combined with 2% yeast suspension treatment in 2004 season. Other interactions occupied an intermediate position between the previously mentioned two categories.

Table (20.a)

b. Storage at 5°C

Concerning specific effect of storage period, data in Table (20.b) illustrate that prolonging the storage period induced a remarkable decrease effect on fruit ascorbic acid content of Costata persimmon fruits, where the initial value of fresh fruit (Zero day storage) recorded the highest readings of ascorbic acid content (10.31 & 9.64 mg/100 ml juice) in comparison with (2.26 & 1.85 mg/100 ml juice) for those cold stored at 5°C for forty two days or the other tested storage periods. Consequently, the lowest values of this parameter were recorded by those cold stored at 5°C for forty two days.

Thereupon, the storage periods could be descendingly arranged regarding their positive effect as follows: 42 days, 35 days, 21 days, 14 days and 7 days. The differences between the studied storage periods and with in each column in this respect were significant from the standpoint in both seasons.

Considering specific effect of the tested post harvest treatments, 4% $CaCl_2$ was the superior treatment in maintaining fruit ascorbic acid content during storage than most tested treatments in both season, whereas control fruits (tap water treatment) in the first season and 2% $CaCl_2$-treated fruits in the second one failed to do similar effect. Other tested treatments occupied an intermediate position between the abovementioned treatments.

With regard to the interaction effect between storage period and the tested post harvest treatments, tabulated data show that there was a reversible correlation between storage duration and ascorbic acid content of Costata persimmon fruits, irrespective of the effect of the tested post harvest treatments. Thereupon, all interactions of seven days storage period scored higher values of fruit ascorbic acid content than the analogous ones of fourteen days storage period, twenty one days, twenty eight days, thirty five days and forty two days storage periods. Anyhow, the differences between the six storage periods interactions were so high to be significant. The highest values of fruit ascorbic acid content were recorded with seven days storage period interactions, particularly 4% $CaCl_2$-treated fruits (8.41 and 8.13 mg/100 ml juice) in the first and second seasons, respectively. Meanwhile, the lowest values of fruit ascorbic acid content were observed with the interactions of forty two days storage period, especially the combinations of control fruits in the first season and 2% yeast-treated fruits in the second one. Generally, in most cases the differences between the resulted interactions within each specific storage period were significant in both season of study.

Table (20.b)

c- Cold storage at 0°C

Looking at specific effect of storage period, Table (20.c) illustrates that the initial readings of Costata persimmon ascorbic acid content i.e. before subjecting to cold storage (10.31 & 9.64 mg/100 ml juice). Such values were more than four folds the corresponding ones stored for forty two days (2.28 & 2.15 mg/100 ml juice) in 2003 and 2004 seasons, respectively. Besides, ascorbic acid content of cold stored fruits for seven days (8.22 & 8.08 mg/100 ml juice) was about three folds that of thirty five days cold stored fruits (2.78 & 2.88 mg/100 ml juice) and about two and half folds that of twenty eight days cold storage in the first and second season, respectively. Moreover, the values of ascorbic acid content for cold stored fruits for fourteen days (6.92 & 6.36 mg/100 ml juice) was statistically higher than those recorded by twenty one days cold stored fruits (5.47 & 4.42 mg/100 ml juice) during the first and second seasons, respectively. The differences between the studied storage periods were obviously significant from the statistical standpoint in both seasons of this study.

With respect to specific effect of tested post harvest treatments, tabulated data show that 2% yeast suspension treatment in 2003 season and 4% $CaCl_2$ treatment in 2004 season proved to be the most effective treatments in maintaining fruit ascorbic acid content during storage duration, followed descendingly by 4% $CaCl_2$ and 2% NaOCl treatments in 2003 season and 2% yeast suspension in 2004 season. Moreover, control, 2% $CaCl_2$ and 1% yeast suspension treatments induced statistically similar and the lowest positive effect on fruit ascorbic acid content.

As for the interaction effect between storage periods and tested treatments, data in Table (20.c) demonstrate that fruit ascorbic acid content reverberated with the advancement of storage period, regardless of the effect of the studied post harvest treatments. So, the interactions of seven days storage period recorded absolutely higher values of fruit ascorbic acid content than the other interactions of other tested storage periods, particularly when seven days cold storage period combined with 4% $CaCl_2$ in both seasons and 2% yeast suspension in the first season. On contrary, the lowest values of this parameter were recorded with those stored forty two days and combined with 2% NaOCl treatment in 2003 season and the control treatment in 2004 season. The

Table (20.c)

interactions of storage periods could be descendingly arranged regarding their positive effect on fruit ascorbic acid content as follows: 7, 14, 21, 28, 35 and 42 days. The differences between the different storage period interactions were significant and within each specific storage period were in most cases insignificant.

The gained results of calcium chloride regarding its affect on improving fruit quality traits, maintaining eating quality during storage and decreasing the rate of reduction in ascorbic acid are similar to earlier reports of Mahajan and Sharma (1995), Tajinder *et al.*(2003) and Shaaban (2006). They mentioned that $CaCl_2$ treatments succeeded in maintaining fruit ascorbic acid content during storage.

Furthermore, Sandhu and Randhawa (1992) mentioned similar results to that obtained by NaOCl on fruit ascorbic acid content.

Part II Effect of some pre-harvest treatments on enhancing storage ability of Zebda mango fruits

4.2.1. The initial effect of some pre-harvest treatments on some pomological characteristics of Zebda mango fruits

Tables (21.a & b) and Photo (10) illustrate the initial response of some physical properties of mango fruits cv. Zebda i.e. fruit dimensions (length, breadth and thickness), fruit weight, pulp (weight, percentage and dry weight percentage) peel (weight and percentage) and seed (weight and percentage) to some pre-harvest treatments namely gibberellin (GA_3) at 25, 50 and 75 ppm, calcium chloride ($CaCl_2$) at 1 and 2% and active yeast suspension at 1 and 2% during 2003 and 2004 seasons.

4.2.1.1. Fruit length

It is obvious from Tables (21.a & b) and Photo (10) that 75 ppm GA_3 sprays followed descendingly by 50 ppm GA3 sprays and yeast suspension at 2% produced the longest fruits (15.54 & 15.13 cm), (14.49 & 13.83 cm) and (14.23 & 13.60 cm) as compared with all tested treatments including the control (11.93 & 11.50 cm) in 2003 and 2004 seasons, respectively. Furthermore, 25 ppm GA_3 sprays and yeast suspension at 1% induced similarly high positive effect on fruit length from statistical standpoint. Finally, $CaCl_2$ treatments (1 & 2%) induced nearly insignificant effect in this respect.

Table (21.a)

Table (21. b)

4.2.1.2. Fruit breadth

Tables (21.a & b) and Photo (10) demonstrate that 75 ppm GA_3 sprays, followed by 50 ppm GA_3 sprays produced the widest fruits (9.28 & 9.27 cm) and (8.78 & 9.00 cm) in comparison with all tested treatments in 2003 and 2004 seasons, respectively. On contrary, $CaCl_2$ treatments (1 & 2%) induced negative effect on fruit breadth as compared with the control. Other tested treatments produced inbetween values in this respect but still higher than those produced by control treatment.

Photo (10): The initial effect of some pre–harvest treatments on some physical properties of Zebda mango fruits.

4.2.1.3. Fruit thickness

Data enclosed in Tables (21.a & b) show that the thickest mango fruits were produced by 75 ppm GA_3, 50 ppm GA_3 and yeast suspension sprays at 2% in descending order. Other tested treatments showed a fluctuated trend in this concern from one season to another.

4.2.1.4. Fruit weight

It is quite evident from Tables (21.a & b) that all tested treatments succeeded in enhancing weight of Zebda mango fruits during the two seasons of study as compared with the control. Generally, this enhancing effect was significant for all studied treatments except for $CaCl_2$ treatments (1 & 2%). Briefly, the high GA_3 concentration (75 ppm) was the superior in this concern, hence this treatment recorded (457.1 & 454.4 g) against (327.6 & 325.8 g) fruit weight for tap water-sprayed trees "control" in 2003 and 2004 seasons, respectively. Besides, 50 ppm GA_3 treatment exerted high stimulative effect in this respect and followed descendingly by 2% yeast treatment. Moreover, GA_3 at 25 ppm and yeast at 1% induced similarly the lowest positive effect in this sphere from the statistical standpoint.

4.2.1.5. Pulp weight

It is clear from Tables (21.a & b) that the high concentration of GA_3 sprays (75 ppm) produced the heaviest pulp fruits (356.4 & 356.3 g) as compared with other tested treatments including the control (251.1 & 250.3g) in 2003 and 2004 seasons, respectively. Other tested treatments could be descendingly arranged regarding their stimulative effect on pulp weight as follows: 50 ppm GA_3, yeast at 2%, 25 ppm GA_3 and yeast at 1%. Besides, $CaCl_2$ treatments (1 & 2%) failed to induce a remarkable effect in this concern.

4.2.1.6. Pulp percentage

Tables (21.a & b) demonstrate that in both seasons out of all tested treatments 50 and 75 ppm GA_3 treatments produced similarly the richest fruits in their pulp content from the statistical standpoint. Other studied treatments induced nearly more or less similar effect in this respect.

4.2.1.7. Pulp dry weight percentage

Data reported in Tables (21.a & b) show that all tested treatments failed to exert an obvious trend regarding pulp dry weight percentage in 2003 season and insignificant effect in this concern in 2004 season.

4.2.1.8. Peel weight

Tables (21.a & b) illustrate that in both seasons peel weight trait followed nearly the same pattern of response of fruit weight to the tested treatments. However, all tested treatments except for $CaCl_2$ at 1% exerted positive effect on peel weight as compared with the control. The highest values of peel weight (50.97 & 50.67 g) were recorded by 75 ppm GA_3 treatment against (37.40 & 37.00 g) for tap water-treated fruits "control" during 2003 and 2004 seasons, respectively. Moreover, GA_3 at 50 ppm, yeast suspension at 2% and GA_3 at 25 ppm induced statistically high positive effect in this concern. The differences between the aforementioned treatments in this concern were significant. Lastly, both $CaCl_2$ concentrations (1 & 2%) gave similarly the lowest peel weight values in both seasons.

4.2.1.9. Peel percentage

Tables (21.a & b) illustrate that in both seasons, out of all studied treatments, fruits of 2% $CaCl_2$-sprayed trees had the highest peel percentage values. Other tested treatments showed nearly similar values in this respect from statistical standpoint.

2.4.1.10. Seed weight

Tables (21.a & b) show that in both seasons fruits of 75 ppm GA_3, 2% yeast and 50 ppm GA_3-sprayed trees had heavier seeds than the corresponding ones of other tested treatments including the control. Moreover, the lower concentration of GA_3 (25 ppm) in the first season and both $CaCl_2$ concentrations in both seasons induced insignificant effect in this concern. Besides, yeast suspension sprays at 1% in both seasons and GA_3 at 25 ppm in the second season induced positive effect on seed weight from the statistical standpoint.

4.2.1.11. Seed percentage

It is clear from Tables (21.a & b) that in 2003 and 2004 seasons, 50 and 75 ppm GA_3 treatments succeeded in producing the favourable effect through reducing seed percentage of the fruit in comparison with other tested treatments. On contrary, both yeast concentrations (1 & 2%) significantly increased seed percentage of the fruit. Other tested treatments failed to induce an obvious trend in this respect during the two studied seasons.

4.2.1.12. Pulp firmness

It is obvious $CaCl_2$-sprayed trees produced firmer fruits as compared with all tested treatments including the control. Anyhow, the differences between both $CaCl_2$ concentrations were insignificant in both seasons and when compared with untreated fruits "control" and 50 ppm GA_3-sprayed ones in 2004 season (Tables, 21.a & b). On contrary, 2 and 1% yeast-treated trees produced more soft fruits in comparison with those produced by other tested treatments. Other treatments recorded inbetween values in this concern.

Conclusively, 75 and 50 ppm GA_3 sprays in general and 75 ppm GA_3 treatment in particular were the superior treatments in enhancing fruit length, diameter and thickness, fruit weight, pulp weight, pulp percentage, peel weight, seed weight and seed percentage. Such treatments induced insignificant effect on pulp dry weight, peel percentage and pulp firmness. Moreover, 2% yeast suspension treatment came next to the aforementioned GA_3 treatments (75 & 50 ppm) regarding their positive effect on the aforementioned traits, except its negative effect on pulp firmness. Furthermore, $CaCl_2$ treatments (1 &2%) induced the highest positive effect on peel percentage and pulp firmness, besides they exerted the highest reductive effect on fruit diameter and failed to affect or to induce a pronounced effect on other studied parameters.

4.2.2. Initial effect of some pre-harvest treatments on some chemical characteristics of Zebda mango fruits

The initial response of Zebda mango fruits to some pre-harvest treatments i.e., gibberellin (GA_3) at 25, 50 and 75 ppm, calcium chloride ($CaCl_2$) at 1 and 2% and active yeast suspension at 1 and 2% in comparison with the control on some chemical traits expressed as pulp total soluble solids (T.S.S.) as (%), ascorbic acid content (Vitamin C) as mg/100 ml juice, total acidity (%), sugars (%) as (reducing, non reducing and total) and carotenoids content (mg/100 g fresh weight) as well as peel chlorophyll content (a & b) and carotenoids content (mg/100 g fresh weight) during 2003 and 2004 seasons is reported in Tables (22.a & b).

4.2.2.1. Pulp total soluble solids percentage (T.S.S. %)

Tables (22.a & b) demonstrate that all tested treatments induced nearly similar effect on pulp total soluble solids percentage from the statistical standpoint except for the control, 75 ppm GA_3 and 2% $CaCl_2$ treatments in 2003 season and 50 ppm GA_3 treatment which exhibited lower values of T.S.S., but still statistically similar to those of most tested treatments. On the other hand, 2% yeast treatment recorded the highest T.S.S. values, but remained insignificant in comparison with most studied treatments.

4.2.2.2. Pulp ascorbic acid content "Vitamin C"

It is clear from Tables (22.a & b) that in both seasons fruits of 2% yeast suspension-sprayed trees showed to be the richest ones in ascorbic acid content (Vitamin C), followed descendingly by those sprayed with 1% yeast and 1 & 2% $CaCl_2$ treatments. Besides, GA_3 treatments (25, 50 and 75 ppm) recorded the lowest values in this respect.

4.2.2.3. Pulp acidity (%)

Table (22.a) demonstrates that in 2003 season all tested treatments produced statistically similar effect on pulp acidity percentage. On the other hand, in 2004 season, 2% yeast suspension treatment followed descendingly by 50 and 75 ppm GA_3 treatments succeeded in reducing pulp acidity percentage (Table, 22.b).

Table (22.a)

Table (22.b)

4.2.2.4. Pulp reducing sugars (%)

It is obvious that in 2003 season, most tested treatments induced similar effect on pulp reducing sugar content of Zebda mango fruits except for 50 ppm GA_3 and 2% $CaCl_2$ treatments which recorded the lowest values in this respect, (Table, 22.a). Such affect of the aforementioned treatments disappeared in 2004 season (Table, 22.b).

4.2.2.5. Pulp non reducing sugars (%)

Tables (22.a & b) show that in both seasons pulp non reducing sugars percentage of Zebda mango fruits showed no significant response to the affect of the studied treatments.

4.2.2.6. Pulp total sugars (%)

Table (22.a) shows that all tested treatments induced similar affect on pulp total sugars percentage of Zebda mango fruits in 2003 season from statistical standpoint. Besides, in 2004 season 1 and 2% $CaCl_2$ treatments recorded the lowest values of pulp total sugars percentage, but still similar to those produced by most of the tested treatments (Table, 22.b).

4.2.2.7. Pulp carotenoids content

It is quite evident that in 2003 season, fruit pulp of 1 and 2% yeast suspension-sprayed trees had the highest values of carotenoids, (Table, 22.a). On the contrary, 25 ppm GA_3 and 1 & 2% $CaCl_2$ treatments showed the lowest values of pulp carotenoids in an ascending order. Other tested treatments recorded inbetween values in this concern. On the other hand, in 2004 season all tested treatments exerted similar effect on pulp carotenoids content except $CaCl_2$ treatments (1 & 2%) which produced statistically less positive effect in this concern when compared with 2% yeast treatment, (Table, 22.b).

4.2.2.8. Peel chlorophyll (a) content

In the first season, all tested treatments showed similar effect on peel chlorophyll (a) content (Table, 22.a). Furthermore, in the second season, 2% $CaCl_2$

treatment produced significantly higher positive effect on peel chlorophyll (a) content as compared with 2% yeast treatment. Other studied treatments gave inbetween values in this sphere (Table, 22.b).

4.2.2.9. Peel chlorophyll (b) content

Table (22.a) illustrates that fruit peel of 75 ppm GA_3 sprayed trees proved to be the richest ones in chlorophyll (b) content in 2003 season from the statistical standpoint. Other treatments induced statistically similar values in this respect. Moreover, in 2004 season (Table, 22.b) all studied treatments gave more or less similar values in this concern except 1% yeast treatment which exerted statistically higher positive effect than did 25 ppm GA_3 treatment.

4.2.2.10. Peel carotenoids content

It is clear from Table (22.a) that in 2003 season, fruits of 1% $CaCl_2$-sprayed trees had higher peel carotenoids content than the analogous ones of 25 ppm GA_3, 2% $CaCl_2$, 75 ppm GA_3 and the control. The rest treatments gave statistically similar values in this respect. Moreover, in 2004 season, 1 & 2% yeast and 1% $CaCl_2$ treatments recorded statistically higher peel carotenoids values than those produced by 75 ppm GA_3 and 2% $CaCl_2$ treatments. The remained treatments came inbetween in this concern (Table, 22.b).

Abstractly, 2% yeast sprays proved to be the most efficient treatment in enhancing pulp ascorbic acid content (Vitamin C) and pulp and peel carotenoids content as well as reducing pulp acidity percentage. Moreover, 2% $CaCl_2$ sprays produced the highest positive effect on peel chlorophyll (a) content, but reduced pulp carotenoids content, whereas 1% $CaCl_2$ sprays improved peel carotenoids content. Furthermore, 75 ppm GA_3 sprays exerted the most positive effect on peel chlorophyll (b) content, whereas nearly all GA_3 sprays showed to be the most efficient treatment in reducing fruit acidity percentage. Finally, all tested treatments failed to induce a remarkable and distinctive effect on pulp total soluble solids, pulp reducing sugars, non reducing sugars and total sugars.

4.2.3. Fruit physiochemical attributes in response to some pre-harvest treatments (GA_3, $CaCl_2$ and yeast) during storage under (ambient room, 15 and 10°C) and fruit keeping on shelf (3 & 6 days).

The effect of some pre-harvest treatments i.e., gibberellin (GA_3) at 25, 50 and 75 ppm, calcium chloride ($CaCl_2$) at 1 & 2% and yeast suspension at 1 & 2% and fruit storage at ambient room conditions (28±2°C & 75-80% R.H.) as well as keeping the cold stored fruits on shelf (3 & 6 days) on some physiochemical attributes of Zebda mango fruits during 2003 and 2004 seasons is reported in Tables (23.a, b, c, d and e - 35 a, b, c, d and e), exhibited in Photos (11-19) and illustrated in Figures (15-24). The evaluated physiochemical attributes of Zebda mango fruits in response to the aforementioned factors of study (pre-harvest treatments, storage periods and days on shelf as well as their interactions) were: weight loss percentage, decay percentage, fruit firmness (lb/inch^2), peel chlorophyll a & b content (mg/100 g F.W.), peel carotenoids content (mg/100 g F.W.), pulp carotenoids content (mg/100 g F.W.), reducing sugars percentage, non reducing sugars percentage, total sugars percentage, total soluble solids percentage, total acidity percentage and ascorbic acid content (mg/100 ml juice).

4.2.2.1. Weight loss percentage

a. Storage under ambient room conditions

Referring to specific effect of storage period, it is obvious from Table (23.a) that in both seasons the loss in fruit weight percentage is proportionally increased with the progress of storage period. The tabulated data emphasize this result, hence loss in fruit weight percentage recorded (18.01 & 16.08) after fourteen days storage period compared with (8.97 & 8.15) for the analogous ones kept under ambient room conditions for seven days during 2003 and 2004 seasons, respectively. This means that Zebda mango fruits lost about one sixth of its weight when kept under ambient room conditions for fourteen days and lost about one twelfth of its weight when stored under ambient room conditions for seven days. The differences between the aforementioned two storage periods (7 and 14 days) or the initial reading at zero day storage (freshly harvested fruits) were pronounced to be significant.

Table (23.a)

Concerning specific effect of the tested pre-harvest treatments, Table (23.a) demonstrates that all evaluated pre-harvest treatments (except for 1% yeast suspension treatment in 2004 season) succeeded in reducing weight loss percentage of Zebda mango fruits during storage duration in comparison with tap water-sprayed fruits "control" in both seasons. Generally, 1% $CaCl_2$ proved to be the most efficient treatment in this concern, followed descendingly by 2% $CaCl_2$ treatment. Anyhow, in 2004 season, the difference between the two concentrations of $CaCl_2$ was so small to reach the significance level. Moreover, GA_3 at 25 ppm treatment came next in this descending order. The remained treatments exerted in most cases similar effect in this concern.

As for the interaction between the storage period and the tested pre-harvest treatments, it is clear from Table (23.a) and Fig (15) that the combinations of seven days storage under ambient room conditions recorded statistically the lowest percentages of weight particularly 1 & 2% $CaCl_2$ treatments in comparison with the interactions of fourteen days ambient room storage. The highest percentage of weight loss was observed with ambient room stored fruits for fourteen days and treated with tap water "control" in 2003 season and 2% yeast suspension treatment in the 2004 season. Other combinations of both seven and fourteen days storage period recorded inbetween values within its limit.

Conclusively, it is important to notice that the storability of Zebda mango fruits under ambient room conditions reach to fourteen days, only, whereas when storage was conducted under cold storage (15 or 10°C), the storage period extended up to twenty eight days.

Fig (15)

b. Cold storage at 15°C

Regarding specific effect of storage period, Tables (23.b & c) illustrate that weight loss percentages were steadily increased as the storage period advanced. Consequently, twenty eight days cold storage duration recorded significantly the highest weight loss percentages (11.94 & 12.12), followed descendingly by twenty one days cold storage period (9.50 & 9.47), fourteen days cold storage duration (7.20 & 7.54) and seven days cold storage period (4.91 & 5.24) during 2003 and 2004 seasons, respectively. The differences between the aforementioned cold storage periods were so high that they reached the significance level.

Looking at specific effect of the tested pre-harvest treatments, tabulated data show that all studied treatments succeeded in reducing the loss in fruit weight during the storage periods in comparison with the control. Shortly, 2% $CaCl_2$ treatment produced the most reductive effect on weight loss percentage, followed descendingly by 1% $CaCl_2$ treatment. The difference between the two concentrations of $CaCl_2$ was significant in 2004 season, only. Besides, 1% yeast suspension and 50 ppm GA_3 treatments induced a prospective effect in this concern. Furthermore, in 2004 season 50 ppm GA_3 treatment surpassed both 1% yeast suspension and 25 ppm GA_3 treatments in reducing weight loss percentages. The rest treatments gave inbetween values in this respect.

Discussing specific effect of days on shelf, it is easy to notice that keeping the cold stored fruits at 15°C on shelf for longer period (six days) caused a marked increment in weight loss percentages (10.94 & 11.04) against (5.65 & 5.96) for the analogous ones freshy removed from cold stores (zero day on shelf), whereas those kept on shelf for three days after cold stores removal scored an intermediate values (8.58 & 8.78) during the first and second seasons, respectively.

The differences between the three periods on shelf were obvious to be significant.

Focusing on the interaction effect between treatments, storage period and days on shelf, it is clear from Tables (23.b & c) and Figures (16 & 17) that the combinations of seven days cold stored fruits, kept on shelf for zero day (just removed from cold stores), particularly those treated with 1 & 2% $CaCl_2$, 2% yeast suspension and 25 & 50 ppm GA_3 treatments were the superior

Tables (23.b)

Tables (23. c)

Figures (16)

Figures (17)

combinations in reducing weight loss percentage, followed ascendingly by the analogous ones stored for seven days and kept on shelf for three days. Moreover, the combinations of seven days storage period x three days on shelf and fourteen days storage period with zero day on shelf exerted statistically similar and prospective reductive affect on weight loss percentages. Furthermore, the interactions of seven days cold storage duration with six days on shelf induced statistically a marked reductive effect than did the combinations of twenty one cold storage period with zero day on shelf and fourteen days cold storage with three days on shelf and the corresponding ones of twenty eight cold storage duration with zero day on shelf. However, the differences between the aforementioned different storage period combinations as well as within each days on shelf category were in most cases obvious to be significant. On reverse, the highest loss in weight loss percentages were produced by the combinations of twenty-eight cold storage period with six days on shelf, particularly those treated with tap water "control", followed descendingly by the analogous ones of twenty one days cold storage duration with six days on shelf and twenty-eight days cold storage period with three days on shelf. Besides, the combinations of fourteen days cold storage period with six days on shelf and the corresponding ones of twenty-one days cold storage period with three days on shelf gave statistically similar and higher values in this respect.

c. Cold storage at 10°C

With respect to specific effect of storage period, Tables (23.d & e) illustrate that the loss in fruit weight percentage was positively proportionated with 10°C cold storage duration. The statistical analysis emphasizes this result, hence the longer the duration of cold storage (28 days), the higher was the loss in fruit weight percentages (9.88 & 9.40) against (3.99 & 4.40) for the analogous ones subjected to shorter duration of cold storage during 2003 and 2004 seasons, respectively. Moreover, twenty one cold stored fruits lost higher percentage of their weight (8.02 & 7.41) in comparison with the corresponding ones cold stored for fourteen days (5.68 & 5.41) during the first and second seasons, respectively. The statistical analysis emphasizes that the differences between the aforementioned cold storage durations were high to be significant.

Examining specific effect of the tested preharvest treatments, it is easy to realize that 2% $CaCl_2$ treatment predominated all evaluated treatments in

exerting a high prospective reductive affect on weight loss percentage, followed descendingly by both 50 ppm GA_3 and 1% $CaCl_2$ treatments, hence 50 ppm GA_3 surpassed 1% $CaCl_2$ in this respect in 2003 season and the reverse was true in 2004 season. Also, both 25 ppm GA_3 and 1% yeast suspension treatments came next in this descending order and took similar trend to that of aforementioned two treatments. On contrary, tap water-treated fruits "control" in both seasons and 2% yeast suspension treated fruits particularly in 2003 season lost higher percentages of their weight during storage period.

Considering specific effect of days on shelf, Tables (23.d & e) demonstrate that keeping 10°C cold stored fruits on shelf for longer period (six days) markedly increased their weight loss (9.40 & 9.10%) compared with the analogous ones just removed from cold stores (zero day on shelf) which recorded about one half of that lost by six days on shelf (4.14 & 4.40%) in 2003 and 2004 seasons, respectively. Furthermore, cold stored fruits, left on shelf for three days scored an intermediate values in this respect (7.13 & 6.88%) in comparison with the previously two mentioned categories during the first and second seasons, respectively.

Focusing on the interaction effect between pre-harvest treatments, storage period and days on shelf, Tables (23.d & e) and Figures (18 & 19) illustrate that the combinations of seven days cold storage with zero day on shelf showed to be the most efficient combinations in reducing weight loss, followed ascendingly by the analogous ones of fourteen days cold storage duration with zero day on shelf, seven days cold storage period with three days on shelf, twenty one days cold storage period with zero day on shelf, seven days cold storage duration with six days on shelf and twenty-eight days cold storage period with zero day on shelf. However, the differences between the aforementioned combinations of different cold storage durations and even within each days on shelf category in most cases were so high to be significant. On contrary, the combinations of twenty-eight days storage period with six days on shelf, particularly those treated with tap water "control" and 2% yeast suspension lost the highest percentages of their weight during the cold storage duration, followed ascendingly by the corresponding ones of twenty one days storage period with six days on shelf and twenty-eight days cold storage duration with three days on shelf.

Tables (23.d)

Tables (23. e)

Figures (18)

Figures (19)

The differences between the aforementioned combinations and within each combination categories were in most cases obvious to reach the significance level. Other combinations occupied an intermediate position between the aforementioned two limits of weight loss. Shortly, seven days cold stored fruits, just removed from cold stores and treated with 50 ppm GA_3 in both seasons and 1 & 2% yeast suspension in 2003 season and 1 & 2% $CaCl_2$ in 2004 scored the lowest values of weight loss percentages.

Weight loss of harvested horticultural crops is mainly due to the water loss, which is known as transpiration, while some weight loss is attributed to loss of carbon in respiration process, but this is only a minor part of the total. High storage temperature causes a high respiration rate which leads to a fruit weight loss (Hardenburg *et al.*, 1990). On the other hand, (Dietz *et al.,* 1988), during their studies on Mallika, Totapuri, Pain, Dashehari and Alphonso mango fruits, found that the weight loss of mango fruits is significantly correlated with the total number of lenticels per fruit but not significantly correlated with the cuticular thickness.

The obtained results of GA_3 are coincided with earlier reports of Al-Juboory *et al.* (1990), Bhanja and Lenka (1994), El-Kassas *et al.* (1995), Choudhury *et al.* (2003), Mohd-Amir *et al.* (2003) and Shaaban (2006). They reported that pre-harvest sprays with GA_3 at 20-200 ppm produced a pronounced prospective affect on reducing physiological loss in weight of grape, sapota, pomegranate, mandarin and guava fruits, respectively.

The effect of $CaCl_2$ on fruit weight loss percentage go in line with earlier studies of Singh *et al.* (1993), Kluge *et al.* (1999) and Chitarra *et al.* (2001). They sprayed mango trees (cvs. Dashehari, Tommy Atkins and Tommy Atkins, respectively) with calcium compounds ($Ca(NO_3)_2$ or $CaCl_2$ at 0.6-5.0%) as a pre-harvest application. They concluded that pre-harvest sprays with calcium reduced the rate of physiological weight loss during storage. Moreover, Subburamu *et al.* (1990), Raychaudharyi *et al.* (1992), Bhanja and Lenka (1994), Chandra *et al.* (1994), Ali *et al.* (1995), Brar (1997), Yadav and Singh (1999), Choudhury *et al.* (2003), Mod-Amir *et al.* (2003) and Shaaban (2006) realized that the loss in fruit weight during storage of grape cv. Muscat, guava cv. L. 49, Sapota, guava cv. Allahabad Safeda, Red raspberry cv. Sceptar, peach fruits cv. Shan-1- Punjab, aonla fruits, sapota cv. Pala, Kinnow mandarin fruits and guava fruits cv. Maamoura, respectively was greatly reduced due to pre-harvest sprays of calcium in the form of calcium chloride at 0.3-5.0% or calcium nitrate at 1.0-2.5%.

4.2.2.2. Fruit decay percentage

a. Storage under ambient room conditions

Referring to specific effect of storage period, it is quite evident that keeping Zebda mango fruits under ambient room conditions for fourteen day increased fruit decay percentages (56.57 & 58.04) against (6.37 & 7.78) for the analogous ones stored for seven days during 2003 and 2004 seasons, respectively, (Table, 24.a).

Analyzing specific effect of the tested pre-harvest treatments, the statistical analysis illustrate that the effect of the studied pre-harvest treatments changed from one season to another. In this respect, 1% $CaCl_2$ treatment showed to be the superior one in reducing fruit decay percentage particularly when compared with control and 2% yeast suspension treatments which induced statistically the highest fruit decay percentage in a descending order. Moreover, 50 ppm GA_3, 75 ppm GA_3 and 1% yeast suspension treatments exerted similar and higher prospective effect in reducing fruit decay percentage.

Finally, 25 ppm GA_3 and 2% $CaCl_2$ treatments produced similar and the lowest efficient affect on reducing fruit decay percentage. On the other hand, in 2004 season, 25 ppm GA_3, 2% $CaCl_2$ and 1% yeast suspension treatments gave statistically similar and the lowest values of fruit decay percentage in comparison with the rest treatments including the control. On the contrary, control and 2% yeast suspension treatments scored statistically similar and the highest percentages of fruit decay percentages. Besides, 25 ppm GA_3, 2% $CaCl_2$ and 1% yeast suspension treatments registered statistically similar and an intermediate values in comparison with the previously two mentioned categories.

Evaluating the interaction effect between the tested pre-harvest treatments and storage periods, it is obvious from Table (24.a), Photo (11) and Fig (20) that the combinations of fourteen days storage duration, irrespective of the tested pre-harvest treatments scored a pronounced higher fruit decay percentage in comparison with the corresponding ones of seven days storage duration.

(Table, 24.a).

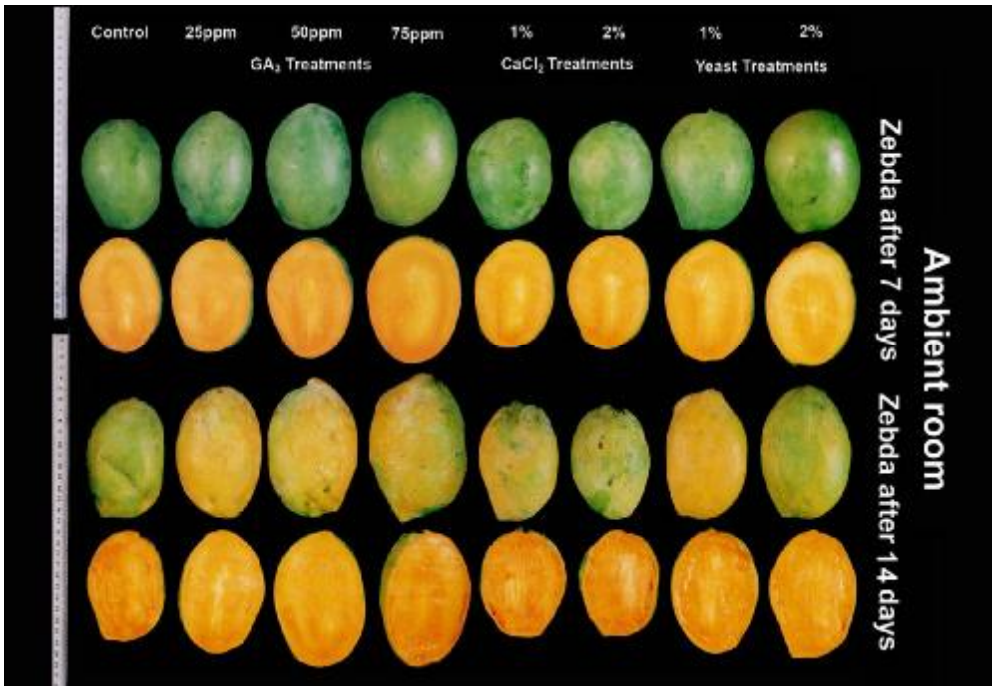

Photo (11): Physical changes in pre –harvest treated Zebda mango fruits during storage under ambient room.

The differences within each storage duration combinations in most cases were significant. Briefly, all combinations of seven days storage duration, particularly 1% $CaCl_2$ in 2003 season and 1 & 2% yeast suspension treatments in 2004 season produced a remarkable efficiency in reducing fruit decay percentage. On reverse, all combinations of fourteen days cold storage duration, particularly the control treatment in 2003 & 2004 seasons and 2% yeast suspension treatment in 2004 season scored statistically the highest values of fruit decay percentages. Other combinations recorded inbetween values within its storage duration category.

Fig (20)

b. Cold storage at 15°C

Firstly, it is important to say that there was a steadily increment in decay percentage with increasing the storage temperature. Such observation disappeared with the beginning of the third week of cold storage, hence decay percentage of Zebda mango fruits at 10°C may surpassed the analogous ones subjected to cold storage at 15°C. This may attributed to the effect of low temperature (cold injury) which a marked darkness in pulp and finally led to the failure of fruit to continue in ripening process on one hand an exert unexpected affects on some fruit physiochemical characters on the other one.

Thereupon, it is preferable when cold storage of Zebda mango fruits is conducted at 10°C, the storage period did not exceed two weeks to avoid fruit internal injury.

Evaluating specific effect of storage duration, Tables (24.b & c) demonstrate that the storage ability of Zebda mango fruits was reduced (i.e., fruit decay percentage was increased) with the extension of the storage period.

In this concept, cold storage for twenty eight days reduced the storability of Zebda mango fruits, hence it recorded the highest values of fruit decay percentages (33.82 & 37.17) against (1.86 & 2.3) for the corresponding ones cold stored for seven days in 2003 and 2004 seasons, respectively. Besides, the storability of fourteen days cold stored fruits surpassed the analogous ones cold stored for twenty one days. In this concern, fourteen days cold stored fruits scored (9.87 & 9.73) decay percentages against (21.53 & 23.71) for the analogous ones cold stored for twenty one days. However, the differences between the four cold storage durations were remarkable and pronounced to be significant.

Examining specific effect of the tested pre-harvest treatments, it is clear from Tables (24.b & c) that the most efficient treatments in enhancing storability of Zebda mango fruits and reducing the fruit decay percentages could be descendingly arranged as follows: 1% $CaCl_2$, (2% $CaCl_2$ and 50 ppm GA_3), 25 ppm GA_3 and 1% yeast suspension treatments. Besides, control treatment scored the highest percentage of fruit decay in 2003 season and 75 ppm exerted the same action in 2004 season. Other treatments came inbetween in this sphere.

Tables (24.b)

Tables (24. c)

As for specific effect of days on shelf, Tables (24.b & c) illustrate that lefting the cold stored fruit for longer period on shelf (six days) decreased the storability of fruits through increasing the decay percentages (29.04 & 31.33) compared with those did not subject to keeping on shelf (2.61 & 2.76), whereas keeping cold stored fruits on shelf for three days scored (18.66 & 20.62) during 2003 and 2004 seasons, respectively. The differences between the effect of days on shelf durations were obvious and pronounced to be significant.

Focusing on the interaction effect between the tested pre-harvest treatments, storage period and days on shelf, it is quite evident from Tables (24.b & c), Photos (12, 13, 14 and 15) and Figures (21 & 22) that, extending the storage period up to twenty-one or twenty-eight days with keeping cold stored fruit on shelf for six days or even three days for 28 days cold storage induced a remarkable negative effect on storability of Zebda mango fruits, irrespective of the tested treatments.

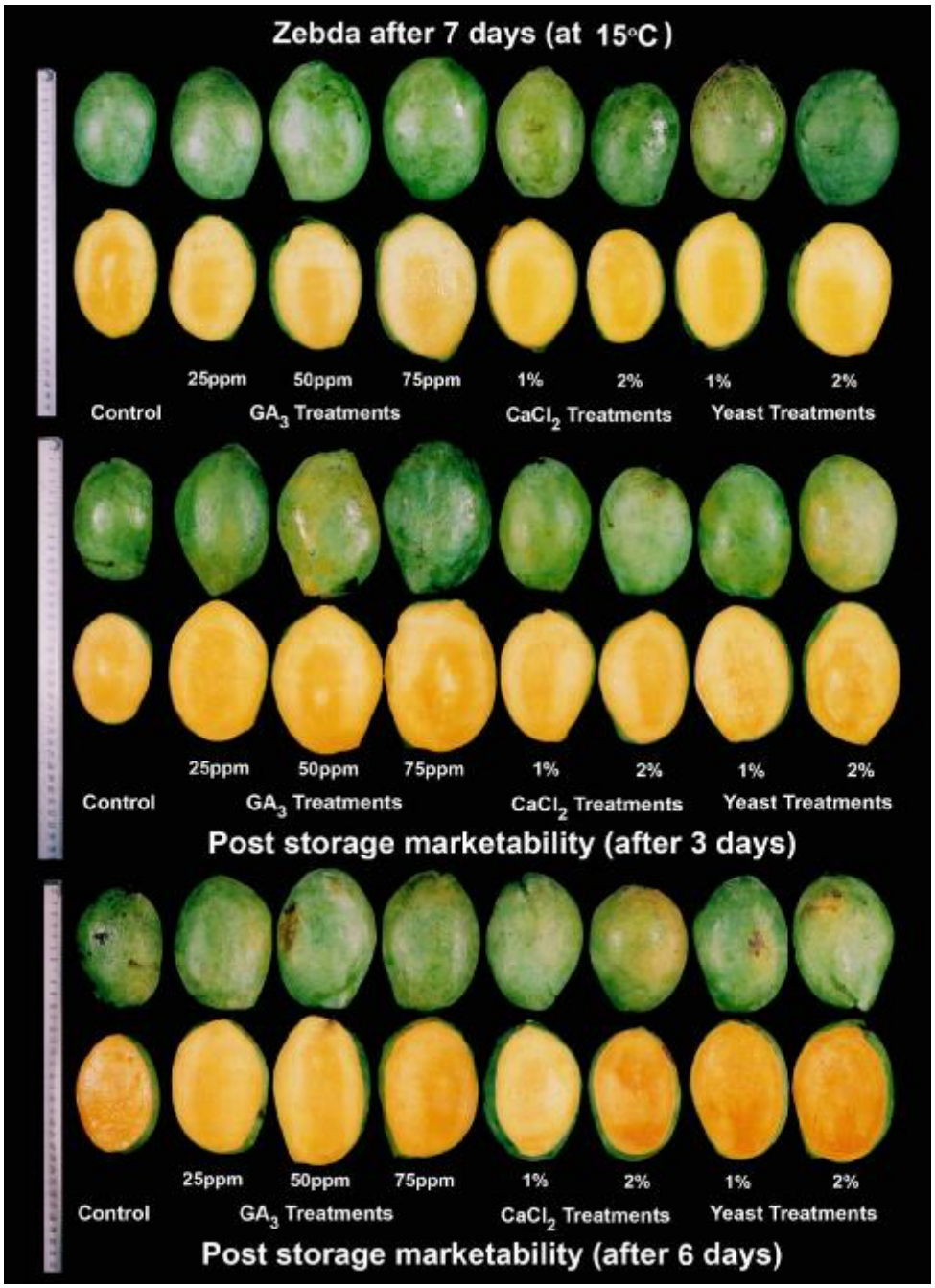

Photo (12): Physical changes in pre–harvest treated Zebda mango fruits during storage (7 days) at 15 ºC and post storage marketability (3 & 6 days on shelf).

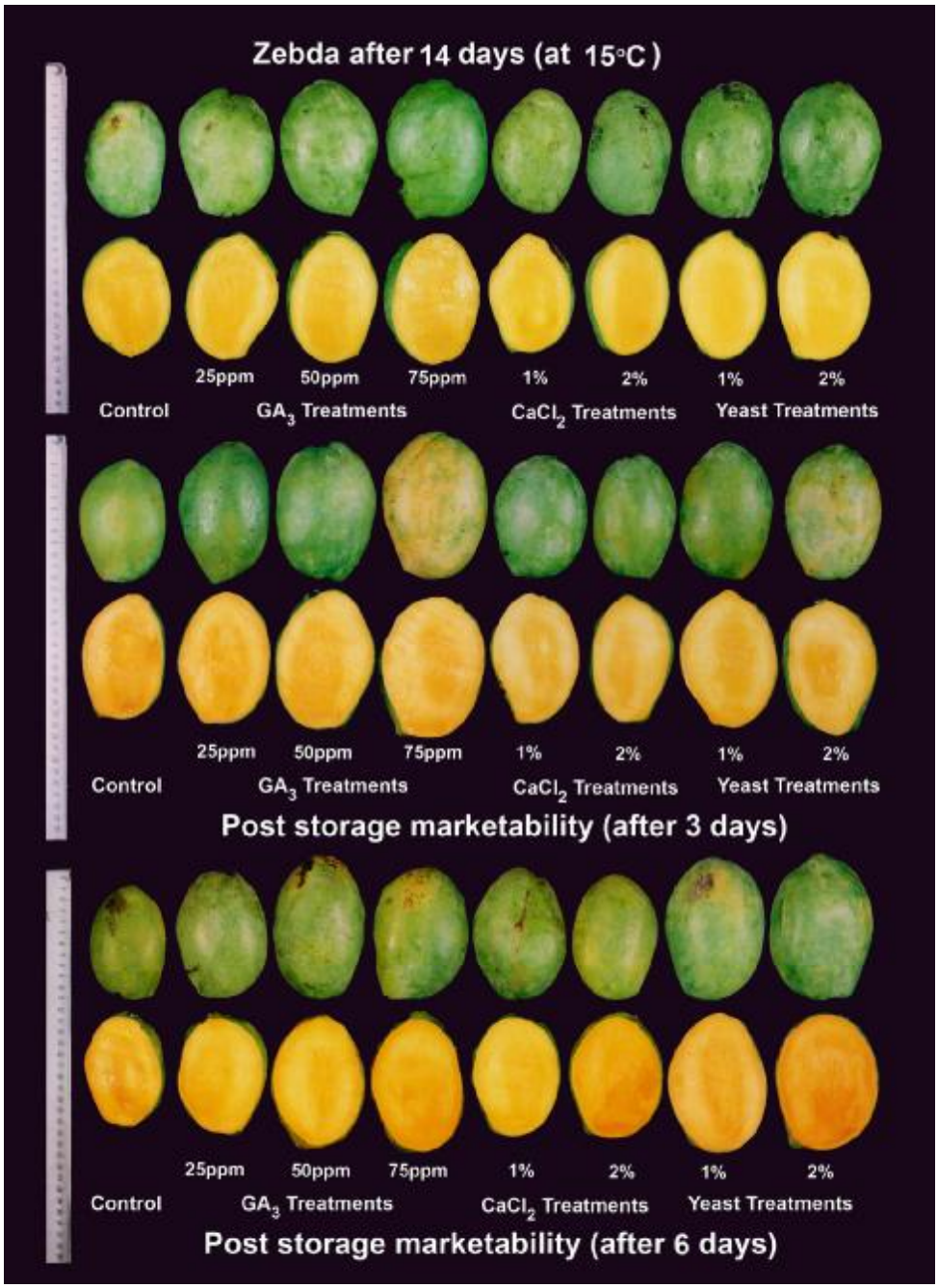

Photo (13): Physical changes in pre–harvest treated Zebda mango fruits during storage (14 days) at 15 ºC and post storage marketability (3 & 6 days on shelf).

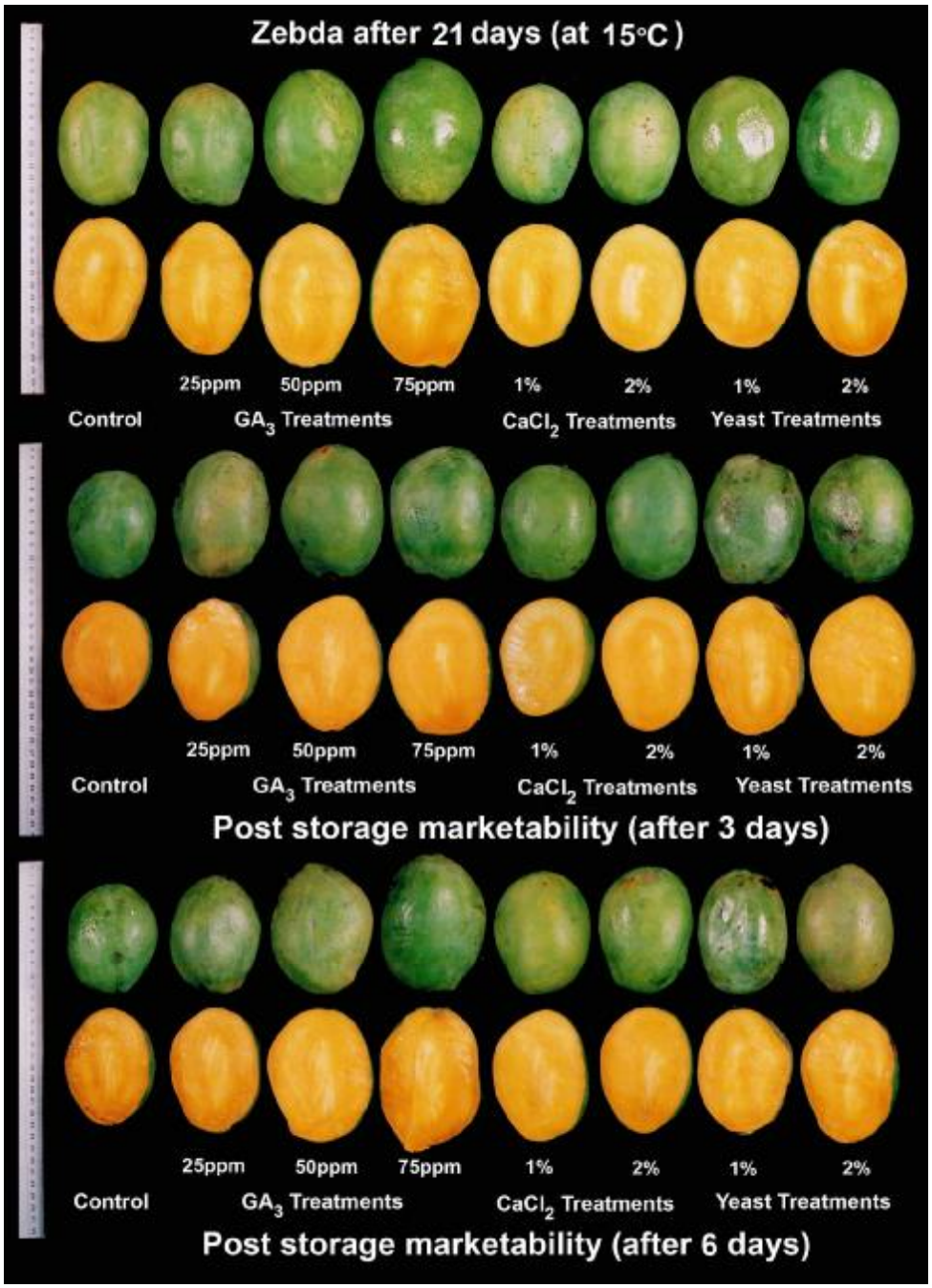

Photo (14): Physical changes in pre –harvest treated Zebda mango fruits during storage (21 days) at 15ºC and post storage marketability (3 & 6 days on shelf).

Photo (15): Physical changes in pre –harvest treated Zebda mango fruits during storage (28 days) at 15ºC and post storage marketability (3 & 6 days on shelf).

Figures (21)

Figures (22)

This means that days on shelf was more effective than the storage period. The combinations of twenty eight storage period with zero day on shelf emphasize the previously mentioned information, hence they recorded lower values of decay percentage in comparison with the analogous ones stored for the same period but kept on shelf for six or even three days.

Briefly, seven days storage period with zero or three days on shelf, fourteen days storage duration with zero day on shelf recorded zero decay percentage in 2003 and 2004 seasons. Besides, the combination of seven, fourteen and twenty one days storage period in both seasons or even twenty-eight days storage period in 2003 season with zero day on shelf and 25 or 50 ppm GA_3 treatments scored zero decay percentage. Besides, the combinations of seven days storage period with six days on shelf, fourteen days storage duration with three days on shelf and twenty eight days storage period with zero day on shelf recorded less decay percentage than the analogous ones of fourteen days storage period with three days on shelf. On contrary, the interactions of twenty one days storage period with three days on shelf registered relatively higher decay percentage than the corresponding ones of fourteen days storage period with six days on shelf. However, the differences between the different storage periods and within each specific days on shelf were high to be significant.

c. Cold storage at 10°C

Concerning specific effect of storage period, Tables (24.d & e) demonstrate that the storage ability decreased with the extension of storage duration even though the storage was conducted at low temperature (10°C).

In this concept, the highest percentages of fruit decay was found after twenty-eight days storage duration (36.90 & 40.80), meanwhile the cold storage at 10°C succeeded to reduce fruit decay percentage to be (1.44 & 0.84) after seven days storage duration during 2003 and 2004 seasons, respectively. Besides, fourteen days storage period exerted more positive effect on reducing fruit decay percentage (7.27 & 9.11) than did twenty-one days storage period (25.70 & 25.31) during the first and second seasons, respectively. The differences between the previously mentioned storage durations were so high to be significant.

Tables (24.d)

Tables (24. e)

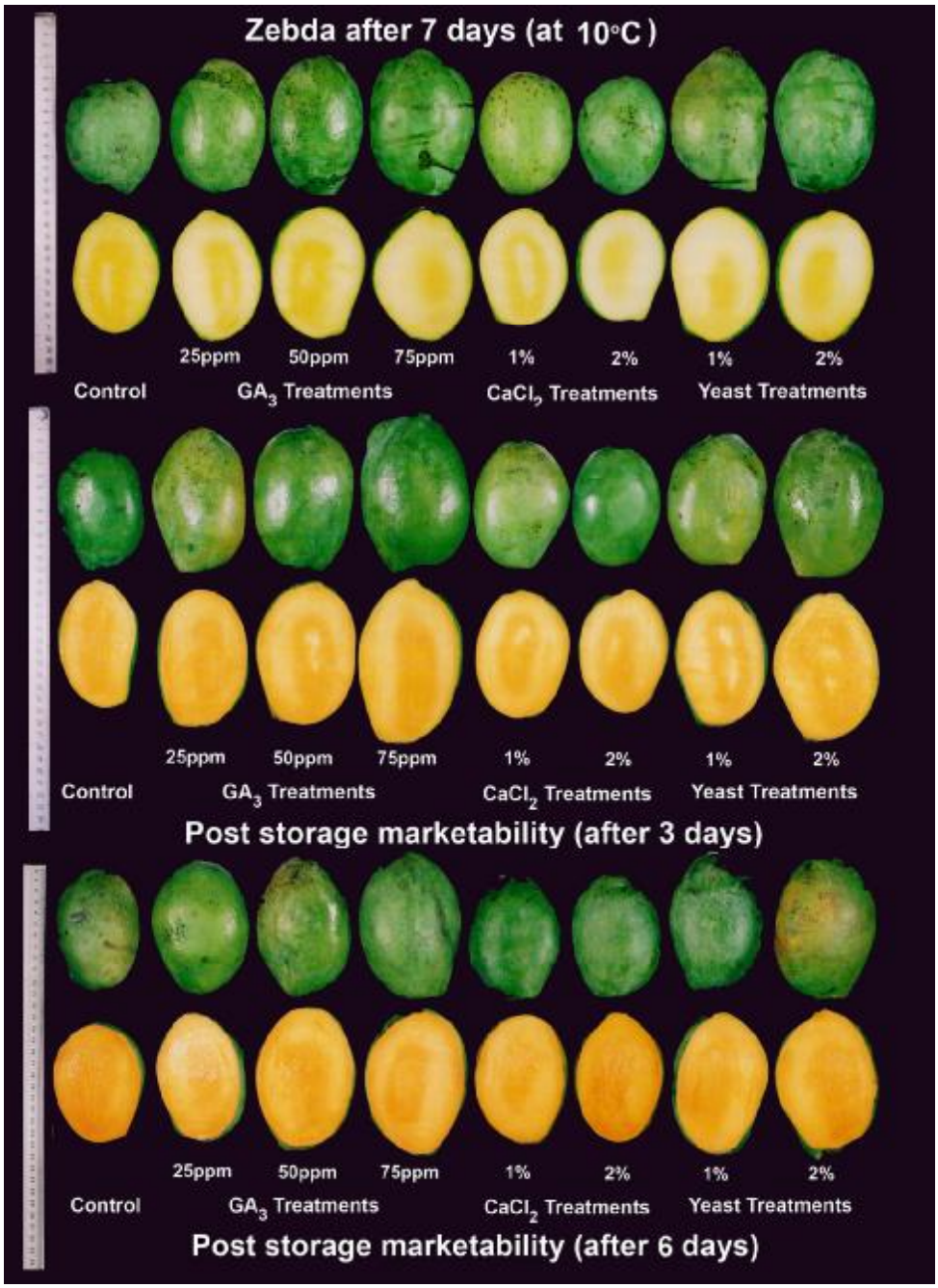

Photo (16): Physical changes in pre–harvest treated Zebda mango fruits during storage (7 days) at 10 ºC and post storage marketability (3 & 6 days on shelf).

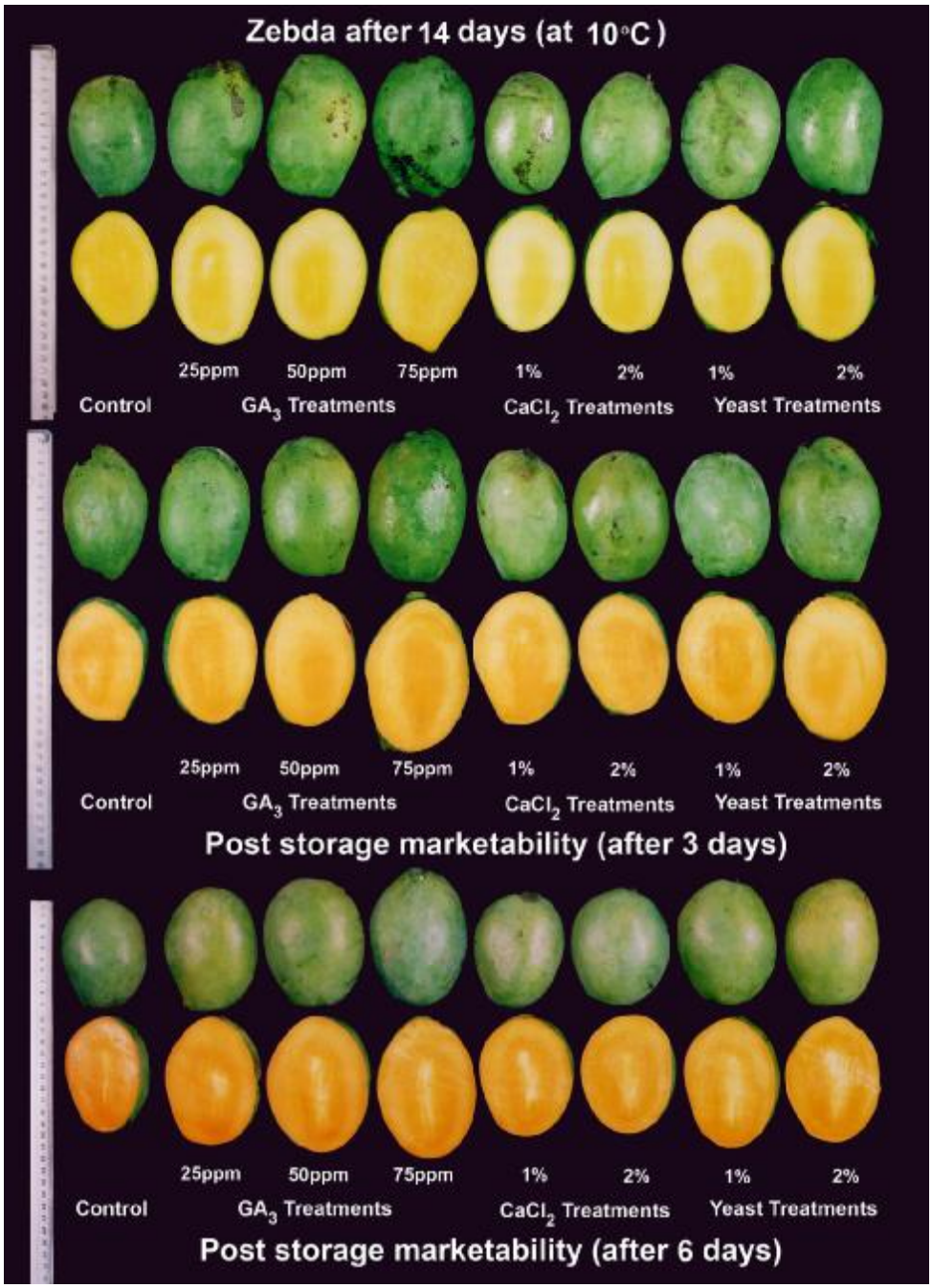

Photo (17): Physical changes in pre –harvest treated Zebda mango fruits during storage (14 days) at 10ºC and post storage marketability (3 & 6 days on shelf).

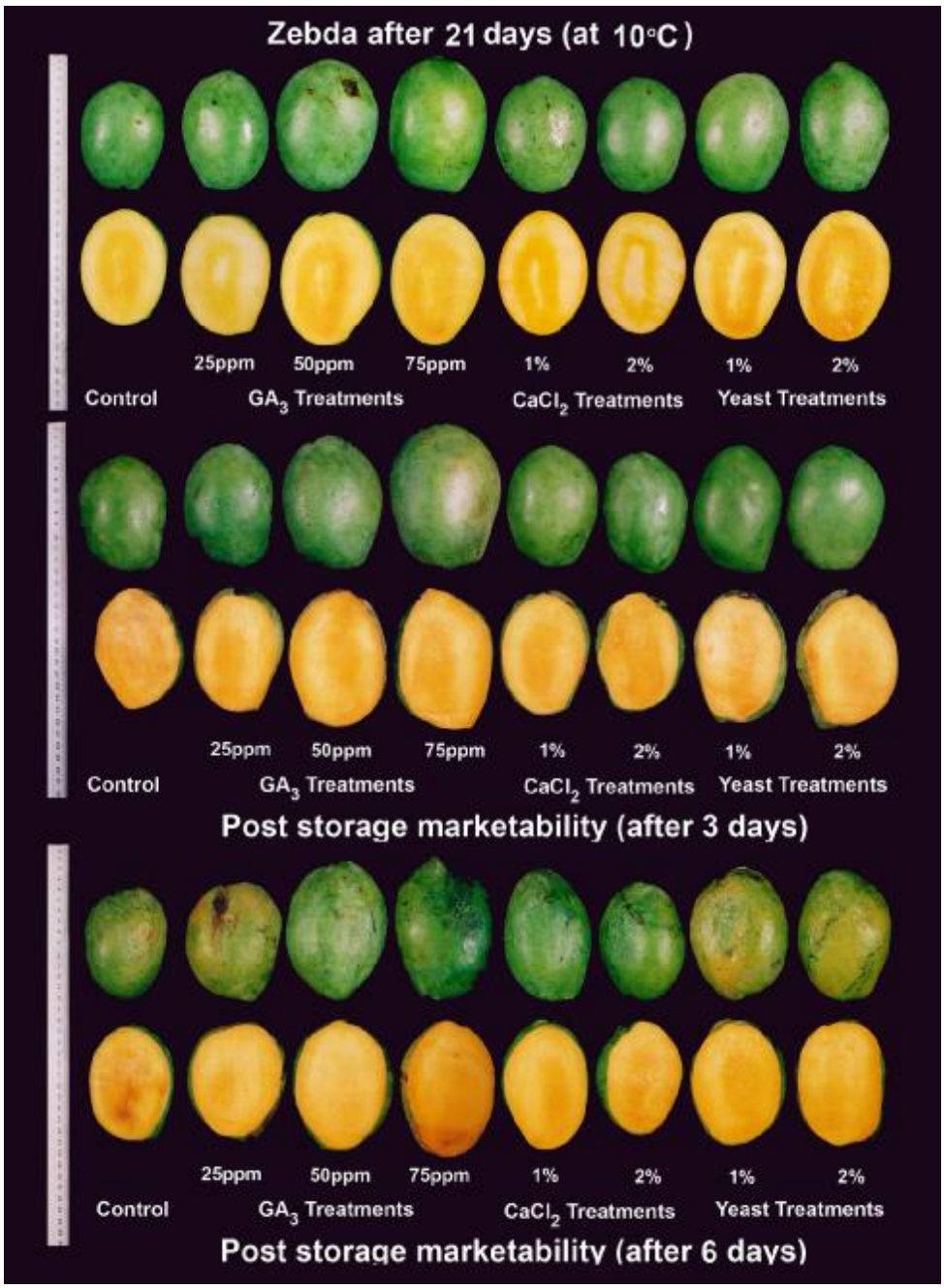

Photo (18): Physical changes in pre –harvest treated Zebda mango fruits during storage (21 days) at 10ºC and post storage marketability (3 & 6 days on shelf).

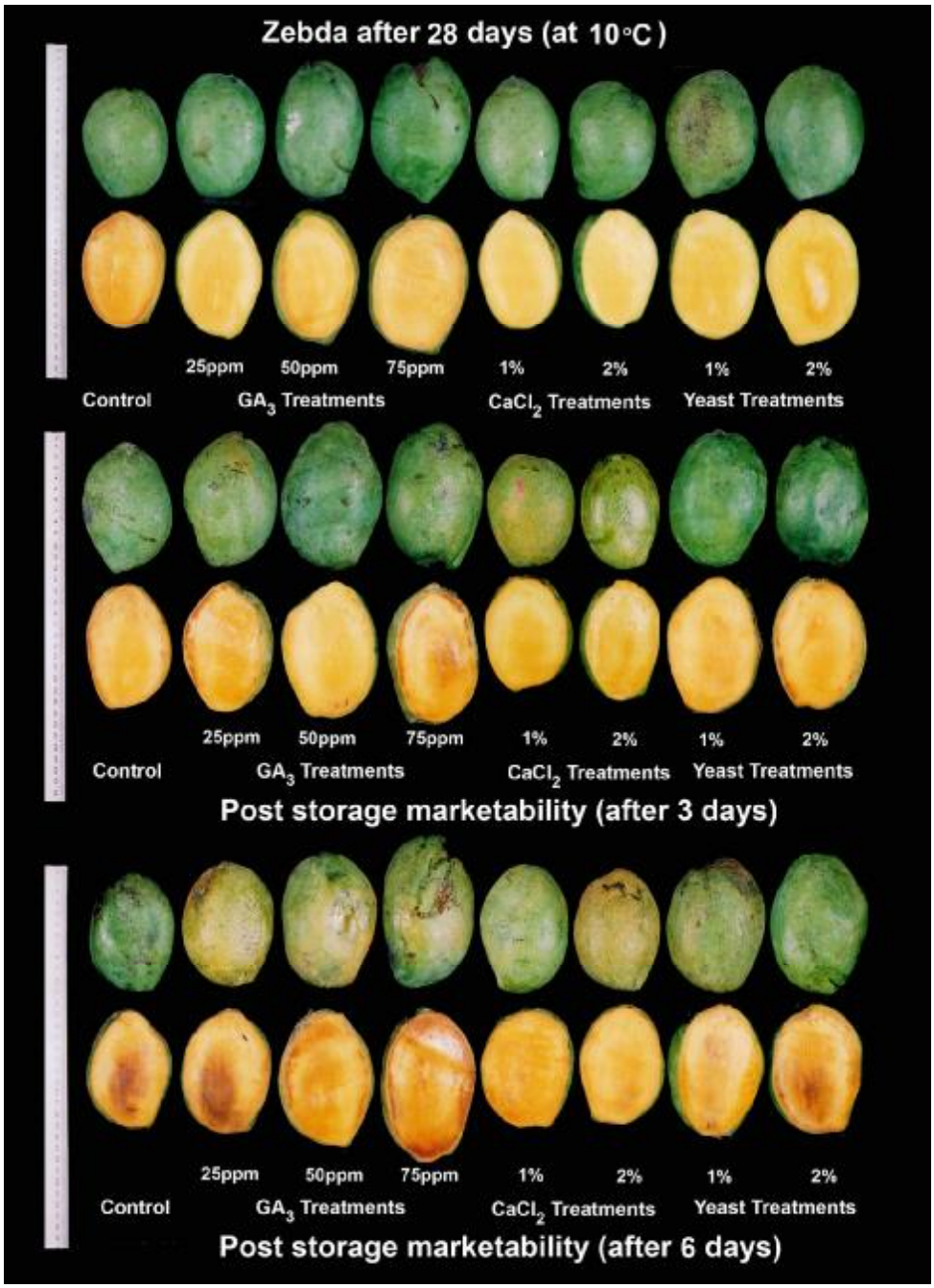

Photo (19): Physical changes in pre –harvest treated Zebda mango fruits during storage (28 days) at 10ºC and post storage marketability (3 & 6 days on shelf).

Figures (23)

Figures (24)

As for specific effect of the tested pre-harvest treatments, the statistical analysis demonstrates that 50 ppm GA_3 and 2% $CaCl_2$ treatments were the superior treatments in reducing fruit decay percentage, followed descendingly by 1% $CaCl_2$, 25 ppm GA_3 and 1% yeast suspension treatments. The differences between the aforementioned treatments were remarkable and pronounced to be significant, except for 50 ppm GA_3 and 2% $CaCl_2$ treatments. Besides, the control "tap water", 75 ppm GA_3 and 2% yeast suspension treatments induced nearly similar values and the lowest enhancing effect on reducing fruit decay percentage throughout the course of study.

Evaluating specific effect of days on shelf, it is quite clear that lefting the cold stored fruits on shelf for longer period (six days) reduced the storage ability of Zebda mango fruits through increasing fruit decay percentage (30.87 & 32.45) compared with the analogous ones freshy removed from cold stores and did not subject to shelf keeping (3.05 & 3.06) in 2003 and 2004 seasons, respectively. Moreover, cold stored fruits kept on shelf for three days scored (19.56 & 21.55) fruit decay percentage in the first and second seasons, respectively. The differences between the three periods on shelf were obvious to be significant.

Handling the interaction effect between treatments, storage period and days on shelf, it is quite clear from Tables (24.d & e), Photos (16, 17, 18 and 19) and Figures (23 & 24) that cold storage at 10C for seven days and keeping the fruits on shelf for zero or three days and fourteen days storage period received no shelf treatment succeeded in maintaining Zebda fruits without deterioration i.e. zero decay percentage. Generally, 50 ppm GA_3 and 2% $CaCl_2$-treated fruits, cold stored for even twenty-eight days and did not subject to keeping on shelf showed no mark of deterioration (zero decay percentage). On contrary, the combinations of twenty-eight days storage period with six days on shelf particularly, 2% yeast suspension and the control treatments in both seasons and 75 ppm GA_3 in the second season scored the highest percentages of fruit decay, followed descendingly by the analogous ones of the same storage period (28 days) but with three days on shelf, twenty-one days storage period with six days followed by three days on shelf. The differences between the previously mentioned combinations within each storage period or even within each days on shelf category were in most cases remarkable to be significant. Moreover, cold storage for fourteen days with three days on shelf

combinations produced nearly similar and prospective effect on fruit decay percentage to that of twenty-one days storage period with zero day on shelf. On the other hand, in spite of storing Zebda mango fruits at 10°C for longer period (28 days), without lefting the cold stored fruits on shelf, the decay percentages still remained lower than the analogous ones cold stored for shorter period (14 days) with six days on shelf and twenty-one days cold storage period with three days on shelf in an ascending order. The differences between the aforementioned storage period combinations and within each days on shelf combinations were pronounced in most cases to reach the significance level.

The susceptibility of mangoes to chilling injuries when stored at low temperatures could be due to the physical changes in membrane lipids (Chaplin, 1989). while Zauberman *et al.* (1988) recorded that the development of chilling injury on the peel of Kiett fruits stored at 5°C and illustrated that peroxidase and cellulase activities in the peel of such fruits rose during the development of CI to much higher levels than in non-chilled fruits. It is suggested that the increase in activity of the two enzymes is part of the CI syndrome that develops during storage of mango fruits at chilling temperatures. In addition, Graham (1990) illustrated that there are two likely causals of chilling sensitivity which lead to chilling injury. The first involves physical changes in certain membrane lipids, particularly phosphatidylglycerols, which result in changes in membrane properties and eventual disorganization of cellular compartmentation. The second causal is due to the impairment of the catalytic function of certain key enzymes of metabolism, of which phosphoenol pyruvate carboxylase is an example. On the other hand, Wang *et al.* (1995) worked on Zhihua mango and illustrated that the fruits which developed chilling injury showed slightly increase in fuperoxide dismutase (FOD) activity and a decline in catalase (CAT) activity under these conditions, indicating that membrane-lipid peroxidation was enhanced. In Alphanso mango, Chhatpar *et al.* (1971) illustrated that the development of chilling injury in fruit peel, as in the pulp is marked by a significant decrease in the soluble sugars content (mainly sucrose). No significant change in total hexose content and less starch breakdown was noticed; In addition, invertase activity is increased, whereas that of amylase is decreased. Furthermore, Hulme (1971) mentioned that K^+ and Ca^{2+} inhibit amylase activity and stimulate invertase activity. Also, the accumulation of K^+ and Ca^{2+} ions

in injured tissue might contribute to the difference in the activity of the two enzymes in chilled tissue. So, low temperature injury in stored mango fruits may be a result of the impairment of cellular permeability resulting in an unbalance between various ions affecting the activity of the key enzyme in carbohydrate metabolism.

The results of GA_3 are in harmony with the findings of Khader (1991) and Kumar and Singh (1993). They mentioned that spraying mango trees cvs. Dashehari and Amrapali, respectively with GA_3 as a pre-harvest treatment decreased the fruit decay percentage during storage. Also, Coggins and Henning (1985), Ranjit and Gupta (1987), Bhanja and Lenka (1994), Durate *et al.* (1965), Wang *et al.* (1985), Massignan *et al.* (2001), Choudhury *et al.* (2003), Mohd-Amir *et al.* (2003) and recently Jayachandran *et al.* (2005) concluded that GA_3 sprays as a pre-harvest treatment induced a remarkable reduction in fruit decay percentage, fruit rotting and spoilage of Valencia oranges, grapes, sapota, mandarin, peaches, oranges, kinnow mandarin and guava, respectively.

The obtained results of $CaCl_2$ in this concept go in line with findings of Singh *et al.* (1987a), Singh *et al.* (1993), Sanjay *et al.* (1998) and Chitarra *et al.* (2001). They sprayed mango trees cvs. Amrapali, Dashehari, Amrapali and Tommy Atkins, respectively with calcium nitrate or calcium chloride at 0.5-5.0%. They reported that Ca treatments decreased the fruit decay percentage and increased the storage life of fruits. Besides, Ranjit *et al.* (1990) on grape cv. Delight, Subburamu *et al.* (1990) on grape cv. Muscat, Bhanja and Lenka (1994) on Sapota, Mir *et al.* (1995) on Chery, Mir *et al.* (1996) on apple cv. Red Delicicus, Brar *et al.* (1997) on peach cv. Shan-1-Punjab, Yadav and Singh (1999) on anola fruits, Choudhury *et al.* (2003) on Sapota cv. Pala, Mohd-Amir *et al.* (2003) on kinnow mandarin and Recasens *et al.* (2004) on apple cv. Golden Smoothee. They sprayed the trees of these fruit species with calcium as a pre harvest treatment in the form of calcium chloride at 0.3-5% or calcium nitrate at 1.0-2.5% to enhance fruit storage life. They mentioned that calcium treated fruits showed the lowest decay percentage and the longest life as compared with untreated ones “control”. On contrast, Ray *et al.* (1993) mentioned that pre-harvest spray with calcium nitrate and calcium chloride at 2500 and 5000 ppm significantly increased the incidence of disease on mango fruits cv. Bombay. They added that disease incidence increased with increasing

rates of the calcium compounds and spraying twice was more effective than a single spray.

The results of yeast in this respect are in agreement with earlier reports of reported by Lima *et al.* (1997) on grape and El-Neshawy *et al.* (2003) on grape.

4.2.3.3. Fruit Firmness (lb/ inch^2)

a. Storage under ambient room conditions

Regarding specific effect of storage period, it is easy to notice from Table (25.a) that Zebda mango lost its firmness with the advancement of storage period. The recorded data emphasize this result hence, the initial readings of fruit firmness i.e. before storage under ambient room conditions were (18.81 & 16.98 lb/inch^2) whereas, at fourteen days room storage, the readings subjected to a marked reduction to score (0.68 & 0.68 lb/inch^2) in 2003 and 2004 seasons, respectively. Besides, seven days room storage period registered also lower values (0.94 & 1.12 lb/inch^2) in the first and second season, respectively. The differences between the three storage periods were pronounced to be significant.

Referring to specific effect of the tested treatments, Table (25.a) illustrates that 1 & 2% $CaCl_2$ treatments induced statistically similar and higher values in comparison with the tested treatments.

On the contrary, 1 & 2% yeast suspension treatments and 75 ppm GA_3 treatment induced the lowest values in this concern. Other tested treatments came inbetween the previously two mentioned categories.

Examining the interaction effect between treatments and storage period, it is easy to realize that the freshy harvested fruits i.e. did not subject to room storage were more firm than those kept under ambient room conditions for fourteen or seven days. Besides, the lowest values were observed with the combinations of fourteen days storage period. Briefly, Zebda mango fruits room stored for fourteen days and treated with 50 ppm GA_3 in 2003 season or 75 ppm GA_3 in 2004 season were the least firm fruits (0.50 & 0.57 lb/inch^2) respectively. The firm fruits were those freshy harvested and received no room storage and treated with 1 & 2% $CaCl_2$.

Table (25.a)

b. Cold storage at 15 ºC

Looking at specific effect of storage period, Tables (25.b & c) illustrate that Zebda mango fruits became softy with the advancement of storage period. In this respect, twenty-eight days cold stored fruits recorded the lowest values of fruit firmness (1.16 & 1.25 lb/inch^2) against (18.81 & 16.98 lb/inch^2) for the freshy picked fruits in 2003 and 2004 seasons, respectively. Besides, twenty one days cold stored fruits were more softy (1.79 & 2.10 lb/inch^2) than fourteen days cold stored fruits (3.00 & 2.88 lb/inch^2) and seven days cold stored fruits (4.46 & 4.67 lb/inch^2) in 2003 and 2004 seasons. The differences were obvious to be significant.

Evaluating specific effect of the tested treatments, Tables (25.b & c) show that 1 & 2% $CaCl_2$ treatments surpassed all tested treatments in increasing fruit firmness. On contrary, 2% yeast suspension treatment induced significant reduction in fruit firmness. The rest treatments scored inbetween values in this concern.

With respect to specific effect of days on shelf, it is easy to realize that keeping the cold stored fruits on shelf for six days resulted in reduction of fruit firmness (1.15 & 1.10 lb/inch^2) compared with those received no shelf treatment (4.77 & 4.92 lb/inch^2), whereas those kept on shelf for three days scored inbetween values (1.90 & 2.10 lb/inch^2) for the first and second seasons, respectively. The differences between these periods were high to be significant.

Focusing on the interaction effect between treatments, storage period and days on shelf, out of these interactions, the combinations of seven day cold storage period with zero day on shelf scored absolutely higher values, followed descendingly by the analogous ones of fourteen days cold storage period with zero day on shelf and twenty-one days cold storage duration with zero day on shelf. The differences were pronounced to be significant. On the other hand, the combinations of twenty eight cold storage period x three days on shelf or zero day on shelf, combinations of twenty one cold storage duration x three days on shelf, fourteen days cold storage period x six days on shelf and seven days cold storage period x six days on shelf and seven days cold storage duration x six days on shelf produced in most cases similar values in this respect.

Moreover, the combinations of twenty-eight days cold storage duration with six days on shelf registered the lowest values. Shortly, twenty-eight cold stored fruits, kept on shelf for six days and treated with 50 ppm GA_3 or 1% yeast suspension in the first season and 25 ppm GA_3 or 2% yeast suspension in the second one were the most softy fruits. On reverse, seven days cold stored fruits, kept on shelf for zero day and treated with 1% $CaCl_2$ were the most firm fruits.

Tables (25.b)

Tables (25. c)

c. Cold storage at 10°C

Concerning specific effect of storage period, Tables (25.d & e) reveal that prolonging the storage period at 10°C, increased softness of Zebda mango fruits. The longer the storage period (28 days), the more was the softness of mango fruits (2.21 & 2.74 lb/inch^2) against (18.81 & 16.98 lb/inch^2) for freshy harvested Zebda fruits in the first and second seasons, respectively. Besides, seven days cold stored fruits were more firm (5.44 & 5.90 lb/inch^2) than those cold stored for fourteen days (3.76 & 4.23 lb/inch^2) and twenty-one cold stored fruits (2.61 & 3.19 lb/inch^2) during 2003 and 2004 seasons, respectively. The differences between the studied cold storage periods were pronounced to be significant.

In regard to specific effect of the tested pre-harvest treatments, Tables (25.d & e) indicate that 1 & 2% $CaCl_2$ treatments induced high positive effect on fruit firmness in a descending order. On reverse, 2 & 1% yeast suspension treatments scored the lowest values of fruit firmness. The rest treatments came inbetween in this respect.

Pointing to specific effect of days on shelf, the statistical analysis illustrates that Zebda mango fruits became more softy when left on shelf for six days (1.40 & 1.50 lb/inch^2) compared with those just removed from cold stores and did not subject to shelf treatment (6.98 & 7.90 lb/inch^2), whereas those left on shelf for three days after removal from cold stores scored (2.14 & 2.65 lb/inch^2) during the first and second seasons, respectively. The differences between the recorded data were pronounced to be significant.

Discussing the interaction effect between treatments storage period and days on shelf, statistical analysis demonstrates that the combinations of seven days cold storage with zero day on shelf produced absolutely the highest values of fruit firmness, followed descendingly by the analogous ones cold stored at 10°C for fourteen and twenty one days with zero day on shelf. On reverse, the most softy fruits were produced by the following combinations twenty-eight, twenty one, fourteen and seven days storage periods with six days on shelf. The differences between the aforementioned combinations in most cases were lacking from the statistical standpoint. The remained combinations scored inbetween values in this concern. The most softy fruits were produced by the combinations of twenty cold storage periods x three days on shelf x 500 ppm GA_3 treatment in 2003 season and the control “tap water” in 2004 season. On contrary, the most firm fruits were observed with the combinations of seven days cold storage x zero day on shelf x 1% $CaCl_2$ treatments in both seasons.

Tables (25.d)

Tables (25. e)

Mango softening is considered one of the several problems associated" with the marketing of mango fruit. Mangoes soften very quickly and extensively. Loss of fruit firmness increased susceptibility to bruising and decay during shipping and storage. The decrease in fruit firmness with the progress of storage period is due mainly to decomposition of enzymatic degradation in insoluble protopectins to more simple soluble pectins, solubilization of cell and cell wall contents as a result of the increasing in pectin esterase activity (Deshpande and Salunkhe, 1964). Roe and Bruemmer (1981) followed the changes in pectic substances and enzymes during ripening and storage of "Keitt" mangoes. The relationship between the distribution of pectic substances and tissue softening was examined in harvested mangoes ripened at 21°C to reach four stages of ripeness. They found that water-soluble and alkali-soluble pectin declined and ammonium-oxalate-soluble pectin increased as the mango lost its firmness. Polygalacturonase and cellulase activities of cell wall preparations increased markedly during ripening. The decline in alkali-soluble pectin and the increase in polygalacturonase activity were well correlated with the loss of firmness. When ripe mangoes were stored at 4°C alkali-soluble pectin declined slowly, and this decline was again correlated with loss of firmness. The cellulase activity of cell wall preparations also increased during storage at 4°C and the increase was correlated with the loss in firmness. Generally, softening in fleshy fruits is primarily due to cell wall modification during ripening (Mitcham and McDonald, 1992).

The enhancement and positive affect of the tested pre-harvest GA_3 sprays on fruit firmness is in agreement with the earlier reports of Coggins and Henning (1985) on Valencia orange and Fidelibus *et al.* (2002) on orange fruits.

$CaCl_2$ treatment applied on Zebda mango fruits showed higher significant flesh firmness for refrigerated fruits at 10, 15°C or those held at ambient temperature (28±2°C). This result can explained with the effect of Ca on fruit softening where it is an essential part of the cell wall structure and it also influences cell membrane integrity (Fallahi *et al.,* 1997). $CaCl_2$ treatment may delay glactolipid breakdown, increase the rate of sterol conjugation and they affect membrane organization and function during the postharvest life of fruits (Picchioni *et al.*, 1995).

The decrease in reduction rate of flesh firmness during storage due to the tested pre-harvest sprays of $CaCl_2$ is in agreement with earlier reports of Evangelista *et al.* (2000), Silva and Menezes (2000) and Chitarra *et al.* (2001) on mango fruits cv. Tommy Atkins. They realized that Ca treatments succeeded in reducing the less of firmness fruits during storage. This result was also supported by Gupta *et al.* (1987b) on jack fruit, Gupta and Neena (1988) on ber fruits, Raychaudharyi *et al.* (1992) on guava fruits cv. L. 49, Tripathi and Bhatgava (1993) on Red Delicious apple fruits, Ali *et al.* (1995) on Red raspberries cv. Sceptar, Siddiqui and Bangerth (1995) on Golden Delcious apple fruits and Brar *et al.* (1997) on peach fruits cv. Shan-1-Punjab.

4.2.3.4. Pulp carotenoids content

a. Storage under ambient room conditions

As for specific effect of storage period, Table (26.a) demonstrate that keeping Zebda mango fruits under ambient room conditions for fourteen days induced a remarkable increment in fruit pulp carotenoids content (2.05 & 1.87 mg/100 g F.W.) against (0.57 & 0.53 mg/100 g F.W.) for the freshy harvested fruits in 2003 and 2004 seasons, respectively. Besides, room stored fruits for seven days scored (1.23 & 1.25 mg/100 g F.W.) in the first and second seasons, respectively. Generally, the differences between the aforementioned storage periods were pronounced to be significant.

Referring to specific effect of the tested pre-harvest treatments, it is quite clear from Table (26.a) that 2 & 1% yeast suspension-treated fruits were the richest ones, regarding pulp carotenoids content. On contrary, control and 2% $CaCl_2$ treatments in 2003 season and 50 & 75 ppm GA_3 treated fruits in 2004 season showed the lowest values of pulp carotenoids content. The rest treatments came inbetween in this respect without significant differences in most cases.

Examining the interaction effect between treatments and storage period, tabulated data illustrate that the combinations of fourteen days storage period dominated the analogous ones of seven days storage period in enhancing pulp carotenoids content.

Table (26.a)

On the other hand, the combinations of freshy harvested fruits (zero day storage) registered the lowest values in this sphere. Briefly, fresh harvested fruits treated with 25 ppm GA_3 in 2003 season and 2% $CaCl_2$ in 2004 season scored the lowest values, whereas 2% yeast suspension treated fruits stored under ambient room conditions for fourteen days gave the highest values of pulp carotenoids content. Other combinations took an intermediate positions between the aforementioned two categories.

b. Cold storage at 15°C

Pointing to specific effect of storage period, Tables (26.b & c) show that there was a steadily increment in pulp carotenoids content with the advancement of storage period. In this respect, cold storage of Zebda mango fruits at 15°C for twenty-eight days induced the highest positive effect on pulp carotenoids content (1.37 & 1.32 mg/100 g F.W.) compared with the analogous ones did not subject to cold storage treatment (0.58 & 0.53 mg/100 g F.W.) in 2003 and 2004 seasons, respectively. Moreover, twenty one days storage period surpassed the corresponding ones of fourteen and seven days storage periods. The differences between the five storage periods were so high to be significant.

Focusing on specific effect of tested pre-harvest treatments, the statistical analysis proves that the response of pulp carotenoids content to the studied treatments change from one season to another. In 2003 season, all tested treatments failed to induce a positive effect on pulp carotenoids content in comparison with the control. However, 2% yeast suspension treatment surpassed the rest treatments in enhancing pulp carotenoids content. On contrary, 25 ppm GA_3 and 2% $CaCl_2$ treatments showed to be the least efficient treatments in this concern.

The rest treatments produced an intermediate values in this sphere. On the other hand, in 2004 season 75 ppm GA_3 and 2% yeast suspension treatments exerted significantly higher positive effect on pulp carotenoids content in comparison with 25 ppm GA_3 and 1 & 2% $CaCl_2$ treatments. The remained treatments gave statistically similar values to those of aforementioned treatments.

Tables (26.b)

Tables (26. c)

Concerning specific effect of days on shelf, it is easy to notice that keeping the cold stored fruits on shelf for longer period (six days) increased pulp carotenoids content (1.51 & 1.53 mg/100 g F.W.) compared with (0.91 & 0.91 mg/100 g F.W.) for the those just removed from cold stores and did not subject to shelf treatment in 2003 and 2004 seasons, respectively. Besides, lefting cold stored fruits on shelf for three days occupied an intermediate position and recorded (1.14 & 1.12 mg/100 g F.W.) in the first and second seasons, respectively. The statistical analysis declares that the differences between the three tested periods on shelf were significant.

Evaluating the interaction effect between the tested treatments, storage period and days on shelf, the resulted combinations indicate that the combinations of twenty-eight days storage period with six days on shelf had the highest values of pulp carotenoids content, followed descendingly by the corresponding ones of twenty-one days, fourteen days and seven days storage period with six days on shelf. The combinations of different storage periods (28, 21, 14 and 7 days) with three days on shelf took the same trend of those with six days on shelf. Moreover, the combinations of different storage periods (7, 14, 21 and 28 days) with zero day on shelf recorded statistically the lowest values in this respect in an ascending order. However, the lowest values were produced by the combinations of seven days storage period x 50 ppm GA_3 treatment x zero day on shelf in both seasons. On contrary, the highest values in this concern were shown with the combinations of twenty eight days storage period x six days on shelf x 75 ppm GA_3 treatment in 2003 season and 2% $CaCl_2$ treatments in 2004 season.

c. Cold storage at 10°C

As for specific effect of storage period, Tables (26.d & e) reveal that cold storage at 10°C of Zebda mango fruits for twenty-one days induced the highest values of pulp carotenoids in comparison with both twenty-eight days and fourteen days storage period. Besides, the last two mentioned storage periods (21 & 14 days) surpassed those stored for seven days or those did not subject to cold storage. Moreover, twenty-eight days storage period dominated fourteen days storage period in enhancing pulp carotenoids content in 2003 season, whereas the reverse was true in 2004 season. On contrary, freshy harvested fruits (did not subject to cold storage) scored statistically the lowest values in both seasons.

Referring to specific effect of the tested treatments, the statistical analysis demonstrates that the response of pulp carotenoids content to the tested

treatments changed from one season to another. In this concern, Table (26.d) shows that 2% yeast suspension-treated fruits were the richest ones regarding pulp carotenoids contents in 2003 season, followed descendingly by the analogous ones treated with 1% yeast and 75 ppm GA_3 sprays. The remained treatments exerted not only similar but also the lowest values in this respect. On the other side, Table (26.e) illustrates that in 2004 season, only 50 ppm GA_3 treatment surpassed 1% $CaCl_2$ treatment in this sphere. The rest treatments produced similar values even so the aforementioned treatments from the statistical standpoint.

Looking at specific effect of days on shelf, tabulated data indicate that the longer the period on which the cold stored fruit kept on shelf the higher was the values of pulp carotenoids content. Thereupon, cold stored Zebda mango fruits, kept on shelf for six days scored the highest values (1.36 & 1.33 mg/100 g F.W.) against (0.75 & 0.75 mg/100 g F.W.) for those just removed from cold stores during the first and second seasons, respectively. Besides, lefting cold stored fruits on shelf for three days occupied an intermediate position (1.04 & 1.12 mg/100 g F.W.) between the aforementioned two shelf periods. The differences were obvious to be significant.

Examining the interaction effect between treatments, storage period and days on shelf, the statistical analysis declares that the interaction between three factors produced combinations with new trend. This could be showed with the combinations of twenty one days and fourteen days storage period with six days on shelf which produced the highest values in this concern, followed descendingly by the corresponding ones of twenty-one days storage period with three days on shelf and twenty-eight days storage period with six days on shelf. On reverse, the combinations of different storage periods (7, 14, 21 and 28 days) with zero day on shelf registered the lowest values in this sphere, particularly those of seven days storage period. The remained combinations came inbetween the previously two mentioned categories. Shortly, the combinations of seven days cold storage period x zero day on shelf x 25 & 75 ppm GA_3 and 1% $CaCl_2$ in 2003 season and 1 & 2% $CaCl_2$ and 75 ppm GA_3 treatments in 2004 season showed to be the least efficient combinations in this concern. On the other hand, the combinations of twenty one day cold storage period x six days on shelf x 25 ppm GA_3 or 2% yeast suspension treatments in 2003 season and those of fourteen days cold storage period x six days on shelf x 75 ppm GA_3 treatment, were the most efficient combinations in enhancing pulp carotenoids content.

Table (26.d)

Table (26.e)

4.2.3.5. Peel chlorophyll “a” content

a. Storage under ambient room conditions

Pointing to specific effect of storage period, Table (27.a) reveals that the decrease in fruit chlorophyll “a” content is proportionally with the advancement of the storage period. The recorded data emphasize this result, hence the initial readings of fruit chlorophyll “a” content i.e. before storage were (6.68 & 5.97 mg/100 g F.W.), whereas when Zebda mango fruits kept under ambient room conditions for seven days, the readings were (3.42 & 2.63 mg/100 g F.W.) and the values became much lower when storage period extended up to fourteen days to record (2.32 & 2.15 mg/100 g F.W.) during 2003 and 2004 seasons, respectively.

Referring to specific effect of the tested pre-harvest treatments, the statistical analysis demonstrates that there was indistinctive trend regarding the response of fruit chlorophyll “a” content to the studied treatments throughout the course of study. One can conclusively say that the highest values of fruit chlorophyll “a” content were produced by 2 & 1% $CaCl_2$ treatments, whereas, 2 & 1% yeast suspension treatments took the other way around.

Examining the interaction effect between treatments and storage period, Table (27.a) illustrates that the combinations of zero day storage (initial readings), regardless of the tested treatments surpassed the analogous ones of seven days storage period and the later ones predominated the corresponding ones of fourteen days storage period, irrespective of the tested treatments.

Briefly, 2% $CaCl_2$ treated fruits, received no storage period scored the highest values (7.15 & 6.46 mg/ 100 g F.W.), meanwhile, (1 & 2%) $CaCl_2$-treated fruits, kept under ambient room conditions for fourteen days registered the lowest values (2.10 & 1.98 mg/100 g F.W.) during the first and second seasons, respectively.

b. Cold storage at 15°C

Looking to specific effect of storage period, Tables (27.b & c) demonstrate that prolonging the cold storage period of Zebda mango fruits resulted in decreasing fruit chlorophyll “a” content. In this respect, the initial readings before cold storage at 15°C were the highest (6.68 & 5.97 mg/100 g F.W.), whereas prolong cold storage period up to twenty eight days registered the lowest values (3.06 & 2.90 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. Besides,

Table (27.a)

twenty one days and fourteen days storage period occupied an intermediate position in this respect, but fourteen days storage period surpassed twenty-one days storage period in this concern. The differences between the studied storage periods were so high to be significant.

Considering specific effect of the tested pre-harvest treatments, Tables (27.b & c) illustrate that in 2003 season, all tested treatments induced statistically similar effect on fruit chlorophyll "a" content, except for 2% yeast suspension treatment which produced significantly the lowest value. On the other hand, in 2004 season, 1 & 2% $CaCl_2$ treatments dominated all tested treatments in increasing fruit content of chlorophyll "a". On reverse, 2% yeast suspension treatment exerted statistically the lowest positive effect in this concern. Besides, the control treatment and 25 & 50 ppm GA_3 treatments induced statistically similar effect in this respect, but still lower than that of 75 ppm GA_3 treatment.

As for specific effect of days on shelf, it is quite evident from Tables (27.b & c) that keeping Zebda mango fruits on shelf for longer period (six days) after removal from cold stores resulted in reducing fruit content of chlorophyll "a" (3.07 & 2.70 mg/100 g F.W.), whereas the initial readings of those already removed from cold stores were (4.48 & 4.09 mg/100 g F.W.), meanwhile those kept on shelf for three days after removal from cold stores scored (3.66 & 3.14 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. The differences between the periods on shelf were pronounced to be significant.

Regarding the interaction effect between tested treatments, storage period and days on shelf, it is easy to notice that the combinations of seven days storage period with zero day on shelf registered remarkably higher values in comparison with all resulted combinations. Moreover, the combinations of fourteen days storage period with zero day on shelf, seven days storage period with three days on shelf and fourteen days storage period with three days on shelf induced similar and higher positive effect in this respect from the statistical standpoint. On contrary, the lowest values of fruit chlorophyll "a" were observed with the combinations of twenty-eight days storage period with six days on shelf, followed ascendingly by the corresponding ones of twenty-one days storage period with six days on shelf. Other combination recorded intermediate values in this sphere. Shortly, the lowest values of fruit chlorophyll "a" were observed with the

Tables (27.b)

Tables (27. c)

combinations of (twenty-eight days storage period x control treatment x six days on shelf) and (twenty-one days storage period x 1% yeast suspension treatment x six days on shelf) in 2003 season as well as the combinations of control treatment, 1 & 2% yeast suspension treatments x twenty-eight days storage period x six days on shelf). On reverse, the highest values of fruit chlorophyll "a" content were produced by tap water treated fruits "control" or 25 ppm GA_3-treated ones, stored at 15°C for seven days and did not subject to shelf treatment in 2003 season, besides the combinations of (1 & 2% $CaCl_2$ treatments x seven days cold storage x zero day on shelf) in 2004 season.

c. Cold storage at 10°C

Concerning specific effect of storage period, Tables (27.d & e) explain that fruit chlorophyll "a" content decreased with the advancement of storage period. The statistical analysis emphasizes this statement, hence, the initial readings of fruit chlorophyll "a" content before cold storage at 10°C were (6.68 & 5.97 mg/100 g F.W.), whereas, these readings after twenty-eight days cold storage period scored (3.36 & 2.99 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. Moreover, seven days-cold stored fruits registered (4.76 & 4.45 mg/100 g F.W.) against (4.31 & 3.71 mg/100 g F.W.) for those cold stored for fourteen days and (3.60 & 3.42 mg/100 g F.W.) for the analogous ones cold stored fro twenty-one days during the first and second seasons, respectively. The differences between storage periods were so high to be significant.

Focusing on specific effect of the tested pre-harvest treatments, the statistical analysis demonstrates that the trend of fruit chlorophyll "a" content in response to the studied pre-harvest treatments changes from one season to another. In this respect, in 2003 season 1% calcium chloride treatment was the superior treatment in increasing fruit chlorophyll "a" content, whereas 1 & 2% yeast suspension treatments were the least efficient treatments in this concern. Besides, 50 & 75 ppm GA_3 treatments induced statistically similar and higher positive effect in this sphere than did control and 25 ppm GA_3 treatments. On the other hand, in 2004 seasons 2% $CaCl_2$ treatment surpassed all tested treatments in increasing fruit chlorophyll "a" content, meanwhile 2% yeast suspension treatment took the other way around, followed ascendingly by both the control and 1% yeast suspension treatments. Besides, 75 ppm GA_3 and 1% $CaCl_2$ treatments predominated both 25 ppm GA_3 and 50 ppm GA_3 in an ascending order.

Tables (27.d)

Tables (27. e)

Referring to specific effect of days on shelf, Tables (27.d & e) illustrate that lefting cold stored Zebda mango fruits for longer period (six days) resulted in reducing fruit chlorophyll "a" content (3.28 & 3.03 mg/100 g F.W.) compared with the initial readings of those just removed from cold stored (5.04 & 4.49 mg/100 g F.W.) and (3.70 & 3.41 mg/100 g F.W.) for those kept on shelf for three days during 2003 and 2004 seasons, respectively. The differences were so high to be significant.

Discussing the interaction effect between treatments, storage period and days on shelf, Tables (27.d & e) demonstrate that the combinations of seven days storage period with zero day on shelf proved to be the superior interaction in enhancing fruit chlorophyll "a" content, followed descendingly by those of fourteen days cold storage period with zero day on shelf, twenty one days storage period with zero day on shelf and seven days cold storage duration with three days on shelf. Moreover, the combinations of three days on shelf with different tested treatments and storage periods (14 and 21 days) induced statistically similar values in this respect and higher the analogous ones of the combinations of different tested treatments x six days on shelf x storage periods (14, 21 and 28 days). Briefly, the lowest values of fruit chlorophyll "a" content were observed with 50 ppm GA_3 treated fruits in 2003 season and 1% yeast-treated fruits in 2004 season, cold stored for twenty eight days and kept on shelf for six days. On reverse, the highest values were produced by the combinations of 50 ppm GA_3-treated fruits in 2003 season and 2% $CaCl_2$-treated fruits in 2004 season, cold stored for seven days and did not subject to shelf treatments.

4.2.3.6. Peel chlorophyll "b" content

a. Storage under ambient room conditions

Looking at specific effect of storage period, Table (28.a) demonstrates that fruit chlorophyll "b" disappeared as storage period advanced. The disclosed data emphasize this result, hence the initial readings o fruit chlorophyll "b" scored (3.66 & 3.78 mg/100 g F.W.) against (1.90 & 1.89 mg/100 g F.W.) for those stored for seven days, whereas the lowest values of fruit chlorophyll "b" (0.8 & 0.81 mg/100 g F.W.) were produced by those stored for fourteen days during 2003 and

2004 seasons, respectively. The differences between the aforementioned storage periods were so high enough to be significant.

Concerning specific effect of the tested pre-harvest treatments, fruit chlorophyll "b" failed to show a distinctive trend in response to the tested treatments throughout the two studied seasons. In 2003 season, 75 ppm GA_3-treated fruits had the highest values of chlorophyll "b" whereas, 25 & 50 ppm GA_3 and 1 & 2% yeast suspension-treated fruits had statistically similar and the lowest values in this concern. The rest treatments occupied an intermediate position between the aforementioned two categories. On the other hand, all tested treatments exerted statistically similar effect in this sphere, except 1% yeast suspension treatment which recorded statistically the lowest values in this sphere.

Looking at the interaction effect between the tested treatments and storage period, it is clear that the combinations of zero day storage period recorded higher values of mango fruit content of chlorophyll "b" when compared with the analogous ones of seven days storage period and in turn the later mentioned combinations surpassed the corresponding ones of fourteen days storage period. The differences between the three mentioned combinations categories were remarkable to be significant. Briefly, 50 ppm GA3 and 1% yeast suspension treated fruits in 2003 season as well as 1 & 2% yeast-treated fruits, stored for fourteen days had the lowest values in this concern. On the contrary, the initial readings (Zero day storage) of 75 ppm GA3-treated fruits in both seasons and 2% yeast suspension-treated fruits in 2004 season were the highest from the statistical standpoint.

b. Cold storage at 15°C

Regarding specific effect of storage period, it is obvious from Tables (28.b & c) that the initial readings of mango fruit content of chlorophyll "b" i.e. before cold storage were the highest (3.66 & 3.78 mg/100 g F.W.) against (2.42 & 2.40 mg/100 g F.W.) for the analogous ones cold stored at 15°C for seven days, (2.02 & 1.95 mg/100 g F.W.) for the corresponding ones, cold stored for fourteen days, (1.70 & 1.76 mg/100 g F.W.) for those cold stored for twenty one days and finally, the lowest values (1.45 & 1.47 mg/100 g F.W.) were produced by those stored for longer period (28 days) during 2003 and 2004 seasons, respectively. The differences between the five tested storage periods were pronounced to be significant.

Table (28.a)

Tables (28.b)

Tables (28. c)

As for specific effect of tested pre-harvest treatments, statistical analysis demonstrates that the tested treatments failed to producea distinctive effect in this respect, throughout the two studied seasons. The obtained data emphasize this result, hence in 2003 season all tested treatments induced statistically similar effect in this respect, except for 2% yeast suspension treatment which produced significantly lower value. On the other hand, in 2004 season 2% yeast suspension treatment dominated all studied treatments in increasing fruit content of chlorophyll "b" followed descendingly by the lower concentration of $CaCl_2$ (1%). Moreover, GA_3 treatments (25, 50 and 75 ppm) exerted statistically similar and higher positive effect than $CaCl_2$ treatments (1 & 2%) and the control.

With respect to specific effect of days on shelf, tabulated data declare that prolonging the period on shelf resulted in poverty of fruit content of chlorophyll "b". This result was clear when the readings of fruit content of chlorophyll "b" of those just removed from cold stores and did not subject to shelf treatment, were the highest (2.39 & 2.39 mg/100 g F.W.) against (1.85 & 1.86 mg/100 g F.W.) and (1.45 & 1.44 mg/100 g F.W.) for those kept for three and six days on shelf during 2003 and 2004 seasons, respectively. The differences between the three periods on shelf were significant from statistical standpoint.

Regarding the interaction effect between treatments, storage period and days on shelf, Tables (28.b & c) illustrate that this interaction introduced a new combinations with distinctive effect, hence the combinations of seven days storage period and zero day on shelf surpassed all other combinations in increasing fruit content of chlorophyll "b" followed descendingly by the analogous ones of fourteen days storage period with zero day on shelf, seven days storage period with three days on shelf, twenty one storage period with zero day on shelf, seven days storage period with six days on shelf and lastly, twenty eight storage period with zero day on shelf. On reverse, the combinations of longer storage period (28 days) with longer period on shelf (6 days) the lower was fruit content of chlorophyll "b", followed ascendingly by the corresponding ones of twenty one storage period with six days on shelf and fourteen days storage period with six days on shelf. Other resulted combinations came inbetween in this sphere. Shortly, 2% yeast suspension in the first season and 1% $CaCl_2$-treated fruits in both seasons, cold stored for twenty eight days and kept on shelf for six days gave the

lowest values in this respect. On contrary, 25 ppm GA_3-treated fruits in the first season and 75 ppm GA_3-treated ones in the second season, cold stored at 15°C for seven days and received no shelf treatment showed to be the superior combination regarding fruit content of chlorophyll "b" values.

c. Cold storage at 10°C

Referring to the specific effect of storage period, Tables (28.d & e) reveal that prolonging the storage period induced a significant reduction in fruit content of chlorophyll "b". In this respect, the initial readings of fruit chlorophyll "b" content i.e. before cold storage at 10°C were the highest (3.66 & 3.78 mg/100 g F.W.), then reduced to record (2.38 & 2.46 mg/100 g F.W.) after seven days cold storage, (2.09 & 2.20 mg/100 g F.W.) after fourteen days cold storage period, (1.77 & 1.94 mg/100 g F.W.) after twenty one days cold storage period and the lowest values (1.58 & 1.64 mg/100 g F.W.) after twenty eight days cold storage period during 2003 and 2004 seasons, respectively. The reduction in fruit chlorophyll "b" content with advancement of storage period was pronounced to reach the significant level.

Concerning specific effect of tested pre harvest treatments, statistical analysis reveals that the studied treatments failed to induce a distinctive effect on fruit chlorophyll "b" throughout the two seasons.

As for specific effect of days on shelf, keeping the cold stored fruits on shelf for longer period (six days) resulted in decreasing fruit content of chlorophyll "b", followed ascendingly by those kept on shelf for three days. On the other hand, the initial readings of fruit content of chlorophyll "b" of those removed from cold stores and received no shelf treatment were the highest.

Considering the interaction effect between treatments, storage period and days on shelf, Tables (28.d & e) show that the combinations of seven days storage period with zero day on shelf scored statistically the highest values of fruit chlorophyll "b" content, followed descendingly by the analogous ones stored for fourteen days and kept zero day on shelf as well as those of twenty one days storage period and received no shelf treatment (zero day on shelf), seven days storage period and kept on shelf for three days, fourteen days and twenty one days storage period and kept on shelf for three days, besides, the corresponding ones

Tables (28.d)

Tables (28. e)

cold stored for twenty-eight days and did not subject to keeping on shelf nearly in the similar level of significance. On reverse, the combinations of twenty-eight days storage period, twenty-one days and fourteen days storage period with six days on shelf as well as twenty-eight storage period with three days on shelf scored nearly and in most cases similar and lower values of fruit chlorophyll "b" content. Other combinations came inbetween the previously two mentioned categories. Briefly, the highest values of fruit chlorophyll "b" content were produced by those treated with 1% $CaCl_2$, stored for seven days and kept zero day on shelf in 2003 season and those treated with 1% yeast suspension, cold stored for seven days and received no shelf treatment in 2004 season. Moreover, the lowest values were observed with the interactions of 1 & 2% yeast suspension-treated fruits in 2003 seasons and 25 ppm GA_3 as well as 2% yeast suspension treated fruits, cold stored for twenty-eight days and kept on shelf for six days in 2004 season.

4.2.3.7. Peel carotenoids content

a. Storage under ambient room conditions

As for specific effect of storage period, it is clear from Table (29.a) that in both seasons, the longer the storage period (14 days) the higher was the peel content of carotenoids (5.09 & 4.99 mg/100 g F.W.) in 2003 and 2004 seasons, respectively. Besides, seven days storage of Zebda mango fruits under ambient room conditions resulted in enhancing peel carotenoids content (4.78 & 4.77 mg/100 g F.W.) in comparison with the initial, readings of peel carotenoids content i.e. zero storage period (2.96 & 2.98 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. The differences between the aforementioned three storage periods were pronounced to reach the significance level.

Referring to specific effect of the tested pre harvest treatments, statistical analysis declares that peel carotenoids content showed a fluctuated trend from season to another. In this concern, in 2003 season tap water "control" treatment and 1% yeast treatment induced significantly similar and higher positive effect on peel carotenoids content in comparison with 25 ppm GA_3, 2% $CaCl_2$ and (50 & 75 ppm) GA_3 treatments in an ascending order. The differences between the previously mentioned treatments and the rest treatments were so small to be considered.

Table (29.a)

Moreover, in 2004 season, the picture was completely changed, hence all tested treatments exerted statistically similar and higher positive effect on peel carotenoids content in comparison with 75 ppm GA_3 and 2% $CaCl_2$ treatments. The differences between the aforementioned two treatments were significant on side of 2% $CaCl_2$

With respect to the interaction effect between treatments and storage period, it is quite clear that the interactions of fourteen days storage period surpassed the analogous ones of seven days storage period and the later combinations predominated in their positive effect the corresponding ones did not subject to storage. However, the differences between the corresponding combinations were remarkable to be significant. Generally, untreated fruits "control" in 2003 season and 25 ppm GA_3-treated fruits stored for fourteen days proved to be the richest ones regarding their peel carotenoids content. On contrary, the initial readings of 25 ppm GA_3-treated fruits in 2003 season and 75 ppm GA_3-treated fruits in 2004 season were the lowest from the statistical standpoint.

b. Cold storage at 15°C

Discussing specific effect of storage period, Tables (29.b & c) illustrate that evaluated storage periods could be arranged in descending order regarding their positive effect on peel carotenoids content as follows: twenty eight days (4.10 & 4.12 mg/100 g F.W.), twenty one days (3.97 & 4.06 mg/100 g F.W.), fourteen days (3.82 & 3.90 mg/100 g F.W.), seven days (3.71 & 3.72 mg/100 g F.W.) and initial readings i.e. zero day storage (2.96 & 2.98 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. The differences between the aforementioned storage periods were obvious to be significant.

Looking at specific effect of the tested pre-harvest treatments, the statistical analysis demonstrates that the effect of these treatments changed from one season to another. In this respect, in 2003 season, 2% yeast treatment surpassed all studied treatments in exerting positive effect on peel carotenoids content. Moreover, tap water "control", 25 ppm GA_3 and 1% yeast treatments induced statistically similar and higher positive effect on peel carotenoids content than did (50 & 75 ppm) GA_3 and (1 & 2%) $CaCl_2$ treatments. However, the significant differences between the members of the last category were lacking.

Tables (29.b)

Tables (29. c)

As for specific effect of days on shelf, it is easy to notice from the statistical analysis that the longer the storage period at 15°C, kept on shelf, the higher was the peel carotenoids content. Thereupon, cold stored fruits, kept for six days on shelf recorded the highest values of peel carotenoids content (4.38 & 4.31 mg/100 g F.W.), followed descendingly by the analogous ones, kept on shelf for three days (3.98 & 4.66 mg/100 g F.W.), whereas the initial readings of cold stored fruit (did not subject to shelf conditions) recorded the lowest values (3.35 & 3.49 mg/100 g F.W.) in 2003 and 2004 seasons, respectively. The differences between the aforementioned periods on shelf were so high to be significant.

Examining the interaction effect between treatments, storage period and days on shelf, Tables (29.b & c) declare that the interactions of twenty eight days, twenty one days and fourteen days storage period with six days on shelf recorded similar and higher values of peel carotenoids content in comparison with most studied combinations. Besides, the combinations of twenty eight days and twenty one days with three days on shelf as well as the analogous ones of fourteen days and seven days storage period with six days on shelf came next in this descending order and induced statistically similar effect in this concern. On contrary, the lowest values of peel carotenoids content in an ascending order were produced by the combinations of seven days (in particular), fourteen days, twenty one days and twenty eight days storage periods with zero day on shelf, as well as the corresponding ones of seven days storage period with three days on shelf. However, the differences between the aforementioned combination categories in most cases were significant. Briefly, the least efficient combinations in this sphere were GA_3 treatments (25, 50 and 75 ppm) and 1% yeast treatment, whereas the most prospective combination in this concern was 2% yeast suspension-treated fruits, cold stored at 15°C and kept on shelf for six days.

c. Cold storage at 10°C

As for specific effect of storage period, (Table 29.d & e) show that prolonging the cold storage period at 10°C for twenty one days gave statistically higher values of peel carotenoids content in comparison with fourteen days, seven days and the initial readings. Extending the storage period up to twenty-eight days failed to induce an additional positive effect on peel carotenoids content. The initial

readings of peel carotenoids content (fruit did not subject to cold storage) were the lowest from the statistical standpoint. Moreover, twenty one days storage period exerted more positive effect in this concern than did seven days storage period in 2003 season. Such superiority disappeared in 2004 season.

Analyzing specific effect of the tested pre-harvest treatments, in 2003 season 2% yeast suspension treatment predominated all studied treatments in enhancing peel carotenoids content. Besides, tap water treatment "control", (25 & 50 ppm) GA_3 and the lower concentration (1%) of both $CaCl_2$ and yeast suspension treatments induced statistically similar effect and surpassed 75 ppm GA_3 and 2% $CaCl_2$ treatments.

On the other hand, in 2004 season the trend was changed, hence 1% yeast suspension treatment was the superior treatment in enhancing peel carotenoids content. On reverse, 2% $CaCl_2$ showed to be the least efficient treatments in producing positive effect in this respect. Other tested treatments gave statistically similar values and came inbetween the previously two mentioned categories.

Reading specific effect of days on shelf, Tables (29.d & e) illustrate that the longer the period of keeping the cold stored fruits on shelf, the higher were the values of peel carotenoids. Consequently, cold stored fruits, kept on shelf for six days scored the highest values (4.15 & 4.16 mg/100 g F.W.) against (4.01 & 3.94 mg/100 g F.W.) for the analogous ones kept on shelf for three days, whereas the readings of fresh cold stored fruit (did not receive shelf treatment) recorded the lowest values in this concern (3.30 & 3.32 mg/100 g F.W.) during 2003 and 2004 seasons, respectively. The differences between the three periods were high enough to be significant.

Pointing to the interaction effect between treatments, storage period and days on shelf, Tables (29.d & e) illustrate that the combinations of different storage periods (28, 21, 14 and 7 days) with six and three days on shelf induced statistically similar and higher positive effect on peel carotenoids content. On contrary, the interactions of different evaluated storage periods (7, 14, 21 and 28 days) with zero day on shelf exerted in an ascending order the least significant prospective effect in this sphere. The differences were significant on positive prospective side of twenty eight storage period when compared with seven days storage period. In summary, 25 and 75 ppm GA_3 as well as 2% $CaCl_2$-treated

fruits, stored for seven days at 10C and kept for zero day on shelf showed to be the least efficient combination in stimulating carotenoids formation in Zebda mango fruit peel, whereas 1% yeast suspension-treated fruits stored for twenty one days at 10°C and kept for six days on shelf and 1% yeast-suspension-treated fruits, stored for twenty-eight days and kept for six days on shelf proved to be the most prominent combinations in enhancing carotenoids formation in peel of Zebda mango fruit in the first and second seasons, respectively.

The synthesis of carotenoids in the pulp is accompanied by changes in the ultrastructure of plastids. So, as ripening proceeds, tubular structures visible in the plastids of unripe fruit are lost, while osmiophilic globules increase in size and number (Parikh *et al.,* 1990 on Alphonso mango). In a series of studies Modi *et al.* (1965) and Mattoo *et al.* (1968) illustrated that the synthesis of carotenoids in mango fruits involves mevalonic acid and geraniol as precursors via the same bio synthetic pathway of carotenogenesis established in other species.

During ripening of Tommy Atkins mangoes, Medlicott *et al.* (1986) observed a rapid destruction of chlorophyll, with chlorophyll "a" preferentially degraded relative to chlorophyll "b", while the carotenoids level increases. A more rapid loss in chlorophyll "a" is typically observed in senescence (Simpson *et al.,* 1976). Furthermore, the plastid thylakoid membrane systems in the peel are gradually broken down during ripening, while osmiophilic globules enlarge and increase in number. This loss of granal membrane integrity is associated with chlorophyll degradation, while the appearance of osmiophilic globules accompanies increases in carotenoid levels, indicating the transformation of the chloroplast to a chromoplast containing red or yellow carotenoid pigments (Medlicott *et al.*, 1986 on Tommy Atkins mangoes and Parikh *et al.,* 1990 on Alphonso mangoes). On the other hand, the synthesis of carotenoids in mangoes involves mevalonic acid and geraniol as precursors via the same synthetic pathway of carotenogenesis established in other species (Modi *et al.*, 1965 and Mattoo *et al.*, 1968). In addition, Mattoo *et al.* (1967 & 1968) observed an increase in the mevalonic acid and geraniol content during ripening in Alphonso mangoes, and revealed that phosphatase enzyme is a key factor in regulating the carotenogenesis in ripe mangoes.

(Table 29.d)

(Table 29. e)

The obtained results dealing with GA_3 affect on improving beta-carotene concentrations, delaying pigmentation and enhancing the intensity of juice colour are in accordance with the findings of Kumar and Singh (1993) on Amrapali mango fruits, Duarte *et al.* (1995) on mandarin fruits and El-Kassas *et al.* (1995) on Manfalouty pomegranate fruits.

The recorded results dealing with $CaCl_2$ pre-harvest sprays affect on maintaining fruit quality, enhancing fruit quality infinitely or improving juice colour intensity during storage are in harmony with earlier reports of Gupta and Neena (1988) on ber fruits, Ranjit *et al.* (1990) on grape cv. Delight, Raychaudharyi *et al.* (1992) on guava fruits cv. L. 49, Singh *et al.* (1993) on mango fruits cv. Dashehari, Ali *et al.* (1995) on raspberries cv. Sceptar and Enl-Kassas *et al.* (1995) on pomegranate fruits cv. Manfalouty. Such prospective affects were achieved when calcium was sprayed as a pre-harvest treatment in the form of calcium chloride at 0.6-2.0% or calcium nitrate at 0.75-2.50%.

4.2.2.8. Fruit Total Soluble Solids Percentage (T.S.S.%)

a. Storage under ambient room conditions

Referring to specific effect of storage period, Table (30.a) illustrates that fruit total soluble solids percentage accumulates as the storage period advanced.

The obtained data explain this result, hence the initial storage (zero day storage) recorded statistically the lowest fruit total soluble solids percentages (10.62 & 11.55), whereas seven days-stored fruits scored (16.07 & 16.53) and fourteen days-stored fruits gave (17.58 & 17.90) during 2003 and 2004 seasons, respectively.

Concerning specific effect of the tested pre-harvest treatments, out of all studied treatments only, 1% yeast suspension treatment scored statistically higher fruit total soluble solids percentage in comparison with the control. The rest treatments in addition to the control recorded similar values of fruit total soluble solids from the statistical standpoint.

Evaluating the interaction effect between the tested treatments and storage period, the resulted combinations indicate that the interactions of fourteen days storage period surpassed the analogous ones of seven days storage period in enhancing fruit total soluble solids percentage. On the other hand, the

combinations of fresh harvested fruits (zero day storage) registered the lowest values in this sphere. Briefly, fresh harvested fruits treated with 75 ppm GA_3 and 2% $CaCl_2$ in 2003 season and 50 ppm GA_3 in 2004 season scored the lowest values, whereas, 1% yeast suspension treated fruits in 2003 season and 50 ppm GA_3 treated fruits in 2004 season, stored under ambient room conditions for fourteen days gave the highest values of fruit total soluble solids percentage. Other combinations recorded inbetween values its storage duration.

b. Cold storage at 15°C

As for specific effect of storage period, it is quite clear from Tables (30.b & c) that prolonging the storage period increased the accumulation of total soluble solids in Zebda mango fruits.

The reported data emphasized this result, where the initial reading of fruit total soluble solids scored (10.62 & 11.55%) against (13.96 & 14.33%) for seven days stored fruits, (14.83 & 14.96%) for fourteen days stored fruits, (15.42 & 15.46%) for twenty one stored fruits and finally (15.96 & 15.91%) for twenty eight stored fruits during 2003 and 2004 seasons, respectively. Generally, the differences between the aforementioned storage periods were obvious to reach the significance level.

With respect to specific effect of the pre-harvest treatments, statistical analysis declares that the tested treatments failed to induce a distinctive and remarkable effect in this concern throughout the two seasons of study.

Regarding specific effect of days on shelf, it is easy to notice that lefting fruits on shelf after removal from cold stores resulted in increasing fruit total soluble solids percentage. This was more obvious with prolonging the duration on shelf. In this concern, fruits kept zero day on shelf i.e. reading immediately after removal from cold storage scored (14.10 & 14.23%) against (14.93 & 15.12%) for those kept on shelf for three days and (16.10 & 16.14%) for those kept six days on shelf. The differences between the studied number of days durations on shelf were so high to be significant.

Referring to the effect of interaction between the tested treatments, storage period and number of days on shelf, it is obvious that this interaction induced a new combinations, in spite of the result that the combinations of six days

Table (30.a)

Tables (30.b)

Tables (30. c)

on shelf recorded the highest values of fruit total soluble solids. In this sphere, the combinations of twenty eight storage period and six days on shelf, followed descendingly by those stored for twenty-one days and kept on shelf for six days, the analogous ones stored for fourteen days and kept on shelf for six days and those stored for twenty eight days and kept on shelf for three days. On contrary, the combinations of zero day on shelf, particularly those stored seven days and those stored for fourteen days scored ascendingly the lowest values of fruit total soluble solids. Briefly, 2% $CaCl_2$-treated fruits stored for twenty eight days and kept on shelf for six days showed to be the efficient combination in enhancing fruit total soluble solids, whereas 2% $CaCl_2$-treated fruits, stored for seven days and kept on shelf for zero day showed to be the lowest ones in their total soluble solids content.

c. Cold storage at 10°C

Regarding the specific effect of storage period, Tables (30.d & e) demonstrate that prolonging storage period up to three weeks induced a pronounced positive effect on fruit total soluble solids content. The differences between the aforementioned three storage periods i.e. one week, two weeks and three weeks were obvious to be significant. Besides, extending the storage period to four weeks (28 days) failed to exert an additional positive effect on fruit total soluble solids content during the two seasons of study.

Considering specific effect of tested pre-harvest treatments, obtained data reveal that there was a fluctuated trend regarding the response of fruit total soluble solids to the tested treatments. However, in 2003 season 25 GA_3-treated fruits had statistically higher total soluble solids than the corresponding ones of 1 & 2% $CaCl_2$ treated fruits. The significant differences between the remained treatments including $CaCl_2$ treatments and 25 ppm GA_3 were insignificant from the statistical standpoint.

Moreover, in 2004 season, 2% yeast suspension treatment enhanced fruit total soluble solids percentage in comparison with 50 ppm GA_3 and 1 & 2% $CaCl_2$ treatments. The rest treatments involving the aforementioned treatments exert statistically similar effect in this sphere.

Referring to specific effect of days on shelf, it is clear that in both seasons, the increment in fruit total soluble content in early proportionated with the number of days on shelf. In this concern, cold stored fruits, kept on shelf for six days recorded the

highest total soluble solids values (15.26 & 15.60%) against (14.42 & 14.78%) for the analogous ones cold stored and kept on shelf for three days, whereas those cold stored and kept zero day on shelf scored the lowest values of total soluble solids percentage (13.87 & 13.81%) during 2003 and 2004 seasons, respectively.

Considering interaction effect between storage period, tested pre-harvest treatments and days on shelf, Tables (30.d & e) illustrate that this interaction exert combinations with high efficiency on fruit total soluble solids percentage. Briefly, these combinations could be descendingly arranged as follows: (twenty one days storage period x six days on shelf), (twenty eight days storage period x six days on shelf), (fourteen days storage period x six days on shelf) and lastly, (seven days storage period x six days on shelf). The combinations of three days on shelf took the same trend of six days on shelf combinations. On reverse, the combinations of zero day on shelf scored the lowest values of fruit total soluble solids, particularly those of seven days storage period. However, Zebda mango fruits cold stored for twenty one days, treated with 1% $CaCl_2$ and kept on shelf for six days proved to be the most effective combination in enhancing fruit total soluble solids content, whereas cold stored fruits for seven days treated with 2% $CaCl_2$, and kept on shelf for zero day recorded the lowest values of total soluble solids.

The gradual increase in T.S.S. percentage with the raise of temperature, and storage period could be due to the degradation of complex insoluble compounds, like starch to simple soluble compounds like sugars ((Morga *et al.,* 1979 worked on Caraboa mangoes; Fuchs *et al*., 1980; Lam *et al,* 1985 on Golek Mangoes; Joshi and Roy, 1988 on Alphonso mangoes and Selvaraj *et al.* 1989) and also other complex insoluble components which degrade to soluble forms (Brinson *et al*., 1988 working on Ngowe mangoes). Furthermore, sugars are considered the major component of soluble solids in mango fruits (Kulkarni and Rameshwar, 1981 on Totapari and Dashehari mangoes and Brinson *et al*., 1988 on Ngowe mangoes). Such changes may increase with the increase in storage temperature as a catalytic factor. Also, those changes increased with the progress of storage time, which allow the accumulation of soluble solids in the fruit tissues, so, soluble solids percentage was a resultant of temperature and storage period.

Tables (30.d)

Tables (30. e)

The obtained results concerning the enhancing affect of GA_3 as a pre-harvest treatment at 5-100 ppm on fruit quality in term of soluble solids are in harmony with the findings of Kumar and Singh (1993) on Amrapali mango fruits, El-Kassas *et al.* (1995) on Manfalouty pomegranate, Mir *et al.* (1995) on cherry fruits and Jayachandran *et al.* (2005) on guava. On contrast, Modesto *et al.* (1999) and Choudhury *et al.* (2003) mentioned an opposite affect on T.S.S. of mandarin and sapota fruits.

The tabulated results of calcium as a pre-harvest treatment in the form of $Ca(OH)_2$, $Ca(NO_3)_2$ and $CaCl_2$ which illustrate its affect on retaining and inducing higher total soluble solids percentage of Zebda mango fruits during storage are in harmony with the analogous ones mentioned by Callan (1986) on cherry fruits cv. Lambert, Gupta *et al.* (1987a), Gupta and Neena (1988) on ber fruits, Branjit *et al.* (1990) on grape cv. Delight, Raychaudharyi *et al.* (1992) on guava fruits cv. Lucknow 49, El-Kassas *et al.* (1995) on Manfalouty pomegranate fruits, Siddiqui and Bangerth (1995) on peach fruits cv. Shan-1-Punjab and Kluge *et al.* (1999) on fruits cv. Tommy Atkins. On reverse, Choudhury *et al.* (2003) mentioned an opposite trend in this respect, when they worked on Sapota fruits cv. Pala.

4.2.3.9. Fruit Reducing Sugars percentage

a. Storage under ambient room conditions

With respect to specific effect of storage period, Table (31.a) shows that the increment in reducing sugars content of Zebda mango fruits is in proportional with the advancement of storage period. The recorded data emphasize this result, hence the fresh fruits (zero day storage) scored (4.64 & 4.86%) against (7.14 & 7.24%) for the corresponding ones stored for seven days and (7.50 & 7.76%) for the analogous ones kept under room ambient conditions for fourteen days during 2003 and 2004 seasons, respectively. The differences between the storage periods were pronounced to be significant.

Regarding specific effect of tested pre-harvest treatments, statistical analysis demonstrates that fruit reducing sugars content showed a fluctuated and indiscriminate response to the studied treatments, hence in the first season 2% yeast suspension treatment recorded the highest values of fruit reducing sugars content, but still insignificant when compared with other tested treatments, except for 2% $CaCl_2$ and 25 & 50 ppm GA_3 treatments where the differences were so high to be significant.

Table (31.a)

Moreover, in the second season, tap water-sprayed fruits "control" scored the highest values of reducing sugars content, but still similar to those of other tested treatments from the statistical standpoint except for 1% yeast and 2% $CaCl_2$ treatments where the differences were significant.

Referring to the interaction effect between the tested treatments and storage period, the resulted interactions illustrate that the combinations of fourteen days storage period predominated the analogous ones of seven days storage period in enhancing fruit reducing sugars content and the later ones surpassed the corresponding ones of unstored fruits (Zero day storage). The differences in most cases were significant when comparison with conducted under the same pre-harvest treatments. Briefly, 2% $CaCl_2$ sprayed fruits and unstored recorded the lowest values of reducing sugars content (4.57 & 4.84%), whereas, those sprayed with 1% $CaCl_2$ in 2003 season and sprayed ones with tap water "control" in 2004 season and stored for fourteen days scored the highest values of reducing sugars (7.58 & 7.65%), respectively.

b. Cold storage at 15°C

Considering specific effect of storage period, Tables (31.b & c) reveal that the highest fruit reducing sugars percentage according to the storage periods at 15°C could be descendingly arranged as follows: twenty-eight days storage period, twenty one days storage period, fourteen days storage period, seven days storage period and lastly unstored fruits (fresh ones). However, the differences between the storage periods were obvious to be significant.

Referring to specific effect of tested pre-harvest treatments, statistical analysis indicates that these studied treatments failed to induce a distinctive and remarkable effect on fruit reducing sugars content, except 2% $CaCl_2$ treatment which exerted the lowest values in this respect in comparison with most treatments in 2003 season. Such negative effect of 2% $CaCl_2$ treatment disappeared in 2004 season.

Concerning specific effect of number of days on shelf, it is quite evident that as the period at which cold stored fruits kept on shelf extended, the fruit reducing sugars content increased. In this field, cold stored fruits kept for six days on shelf recorded (7.10 & 7.20%) whereas the analogous ones kept for three days on shelf scored (6.50 & 6.59%), meanwhile, the readings for those immediately removed from cold stores (15°C) were (5.65 & 5.64%) for the first and second seasons, respectively. The differences were significant from the statistical standpoint.

Tables (31.b)

Tables (31. c)

Regarding the interaction effect between treatments, storage period and days on shelf, it is clear from Tables (31.b & c) that the highest readings of fruit reducing sugars content were noticed in descending order with the combinations of twenty eight days storage period and six days on shelf, twenty-one days storage period and six days on shelf, fourteen days storage period with six days on shelf, seven days storage period with six days on shelf. The differences were significant when a specific combination of storage period and days on shelf was compared with the analogous one of a shorter storage period and the same days on shelf. On contrary, the lowest values of fruit reducing sugars content were observed in an ascending order as follows: the combinations of zero days on shelf and seven days, fourteen days, twenty one days and lastly twenty eight days storage period. The interactions of three days on shelf and twenty eight, twenty one, fourteen and seven days storage period occupied an intermediate position between the previously two mentioned categories. Briefly, 2% $CaCl_2$-treated fruits, cold stored for seven days and kept zero day on shelf scored the lowest values of reducing sugars, meanwhile, 25 ppm GA_3 and 2% $CaCl_2$-treated fruits, stored for twenty-eight days and kept for six days on shelf proved to be the richest one in reducing sugars content in 2003 and 2004 seasons, respectively.

c- Cold storage at 10°C

Concerning specific effect of storage period, it is obvious from Tables (31.d & e) that cold storage periods at 10°C took a different pattern effect, hence fourteen days storage period predominated all studied storage periods in enhancing fruit reducing sugars content, followed descendingly by twenty eight days storage periods, twenty one days storage period and lastly seven days storage period. The significant differences were lacking between twenty one days storage period and twenty-eight days storage period on one hand in 2003 season and between twenty one days storage period and seven days storage period on the other one in 2004 season.

As for effect of tested treatments, in 2003 season only 2% yeast suspension treatment induced a pronounced effect on fruit reducing sugars in comparison with 50 ppm GA3 and 2% $CaCl_2$-treatments. The remained treatments exerted statistically similar effect to those aforementioned treatments. Moreover, in

2004 season, 2% yeast suspension treatment showed to be the most efficient treatment in increasing fruit reducing sugars content. On reverse, (50 & 75 ppm) GA3 treatments and (1 & 2%) $CaCl_2$ produced statistically similar and the lowest fruit reducing sugars content. The rest treatments produced inbetween values in this sphere.

Regarding specific effect of number of days at which kept on shelf, it is clear that prolonging the period of keeping cold stored fruits on shelf resulted in increasing fruit reducing sugars content. In this respect, cold stored fruits, kept on shelf for six days recorded the highest values of fruit reducing sugars (6.73 & 6.83%), whereas those kept for three days on shelf scored (6.21 & 6.34%), meanwhile readings of the corresponding ones after removal from cold store directly were (5.43 & 5.47%). However, the differences between the periods on shelf were significant from the statistical standpoint.

Referring to the interaction effect between treatments, storage period and days on shelf, the disclosed data demonstrate that the combinations of fourteen days storage period and six days on shelf recorded the highest values of fruit reducing sugars content, followed descendingly by those of seven days storage period and six days on shelf, twenty eight days storage period and six days on shelf and finally the corresponding ones of twenty-eight days storage period and kept on shelf for six days. On reverse, the combinations of seven days storage period and kept zero day on shelf recorded the lowest values in this sphere, followed ascendingly by the analogous ones of those removed directly from fourteen days storage period, twenty one days cold stored fruits and twenty-eight days stored fruits and kept zero day on shelf. The rest combinations took an intermediate position between the previously two mentioned categories. Shortly, 1% yeast suspension-sprayed fruits, stored for fourteen days and kept on shelf for six days were the richest ones in reducing sugars content, whereas (1 & 2%) $CaCl_2$-treated fruits, stored for seven days at 10°C and kept zero day on shelf were the poorest ones in this sphere.

Tables (31.d)

Tables (31. e)

4.2.3.10. Fruit Non Reducing Sugars percentage

a. Storage under ambient room conditions

As for specific effect of storage period, Table (32.a) illustrates that storage period induced a pronounced positive effect on fruit non reducing sugars content up to seven days only. In this concern, Zebda mango fruits kept under ambient room conditions for seven days scored higher values of non reducing sugars (5.88 & 5.91%) against (1.86 & 1.91%) for the analogous ones received no storage during 2003 and 2004 seasons, respectively. Prolonging the storage period up to fourteen days failed to induce an additional positive effect in this respect.

Regarding specific effect of tested pre-harvest treatments, statistical analysis emphasizes that Zebda mango fruits showed no significant response to the studied treatments.

Concerning the interaction effect between treatments and storage period, it is quite clear from Table (32.a) that the combinations of both seven and fourteen days storage periods induced statistically similar and higher positive effect on fruit non reducing sugars percentage as compared with the analogous ones of non stored fruits. Shortly, 75 ppm GA_3-treated fruits and (1 & 2%) $CaCl_2$ treated fruits and received no storage scored the lowest values of non reducing sugars percentage. On contrary, 1% yeast suspension-treated fruits and 2% $CaCl_2$ pre-harvest sprayed ones and subjected to fourteen days storage under ambient room conditions proved to be the richest ones regarding non reducing sugars content.

b. Cold storage at 15°C

Considering specific effect of storage period, Tables (32.b & c) demonstrate that in both seasons extending the storage period up to twenty one days succeeded in inducing a pronounced positive effect on fruit non reducing sugars content (5.13 & 4.91%) in 2003 and 2004 seasons, respectively. Moreover, extra storage period i.e. twenty eight days storage period failed to produce an additional positive effect on fruit non reducing sugars. Thereupon, the storage periods could be descendingly arranged according to their positive effect on fruit non reducing sugars content as follows: (28 & 21 days), (14 days) and (7 days). The initial readings of fruit non reducing sugars (before cold storage) were (1.86 & 1.91%), whereas it recorded (3.96 & 3.82%) for the analogous ones cold stored for seven days (4.51 & 4.19%) for the corresponding ones cold stored for fourteen days. The differences between the aforementioned storage periods were remarkable to be significant.

Table (32.a)

In regard to specific effect of tested pre-harvest treatments, statistical analysis reveals that in 2003 season, most of studied treatments induced similar effect in this respect, except 1% yeast suspension treatment which produced higher positive effect in this concern than did both 50 ppm GA_3 and 2% $CaCl_2$ treatments. Such exception disappeared in 2004 season.

As for specific effect of days on shelf, it is clear that there was a positive correlation between number of days on shelf and fruit non reducing sugars content. In this concern, cold stored fruits kept on shelf for six days scored the highest values of non reducing sugars (5.65 & 5.47%), whereas the analogous ones kept on shelf for three days read (4.57 & 4.52%) and lastly the initial readings after removal from cold stores directly were (3.90 & 3.43%) for 2003 and 2004, respectively.

The differences between the three evaluated periods were obvious to be significant.

Referring to the interaction effect between the tested treatments, storage period and days on shelf, Tables (32.b & c) illustrate that the combinations of twenty-eight days, twenty-one days, fourteen days and seven days storage period and six days on shelf produced statistically similar and higher positive effect on fruit non reducing sugars content in comparison with the corresponding ones of 28, 21, 14 and 7 days storage periods and three days on shelf. However, the differences between the combinations of different storage periods and six days on shelf on one hand and the corresponding ones of different storage periods and three days on shelf on the other one were significant from the statistical standpoint and insignificant within each combination of storage period and days on shelf. Besides, the combinations of different studied storage periods and zero days on shelf produced the lowest values of fruit non reducing sugars content, particularly those cold stored at 15°C for seven days and did not subject to keeping on shelf. Briefly, 2% $CaCl_2$ treated fruits, cold stored for seven days and kept for zero day on shelf scored the lowest values of non reducing sugars content. On contrary, the richest fruits in non reducing sugars content were produced by 50 ppm GA_3 treatment, twenty one days storage period and six days keeping on shelf.

Tables (32.b)

Tables (32c)

c. Cold storage at 10°C

Referring to specific effect of storage period, disclosed data in Tables (32.d & e) demonstrate that extending the storage period resulted in increasing Zebda mango fruits of non reducing sugars content. The longer storage period (28 days), the higher was the fruit content of non reducing sugars (4.91 & 4.46%) in 2003 and 2004 seasons, respectively.

On reverse, the initial readings of non reducing sugars were (1.86 & 1.91%) in the first and second seasons, respectively. Besides, twenty one days-stored fruits had higher percentages of non reducing sugars (4.73 & 4.53%) than those of fourteen days storage period (4.40 & 4.13%) and seven days storage period (3.86 & 3.70%) during 2003 and 2004 seasons, respectively. Moreover, the differences between twenty one days and twenty eight days storage period in this concern in the second season were so small to reach the significant level. Lastly, seven days storage period showed to be the least efficient storage period in increasing fruit non reducing sugars content.

With respect to specific effect of the tested pre-harvest treatments, the obtained data declare that fruit non reducing sugars content showed a fluctuated trend in response to the tested treatments, hence in 2003 season, most tested treatments exerted similar effect in this concern, except 50 ppm GA_3 and 2% yeast suspension treatments induced similar significant positive effect when compared with 1% $CaCl_2$. The picture was changed in 2004 season, where most studied treatments produced similar effect in this respect except 75 ppm GA_3, 2% $CaCl_2$ and 1% yeast suspension treatments which gave statistically higher values in comparison with those of 1% $CaCl_2$ treatment, only.

Concerning specific effect of days on shelf, it is obvious that increasing the number of days, at which cold stored mango fruits kept on shelf resulted in increasing fruit content of non reducing sugars. In this field, cold stored fruits at 10°C, kept on shelf for six days recorded statistically higher values of non reducing sugars (5.62 & 5.48%) against (4.27 & 4.02%) for the analogous ones kept on shelf for three days and finally (3.53 & 3.10%) for the corresponding one did not subject to days on shelf treatment. The differences between the aforementioned periods on shelf were high to be significant.

Tables (32.d)

Tables (32. e)

As for interaction effect between the tested treatments, storage period and days on shelf, Tables (32.d & e) illustrate that the combinations of twenty eight days, twenty one days and fourteen days storage period and six days on shelf induced statistically similar and higher values of fruit non reducing sugars. On reverse, the combinations of fourteen days, twenty one days storage period and zero day on shelf gave lower values in this respect. The lowest values of fruit non reducing sugars content were shown with the combinations of seven days storage period and did not receive the day on shelf treatment, particularly those treated with 1% yeast suspension. Other combinations occupied an intermediate position between the aforementioned categories. Briefly, the combinations of 2% yeast suspension treatment, twenty one storage period and six days on shelf in 2003 season and 75 ppm GA_3 treatment, twenty one storage period and six days on shelf in 2004 season surpassed all resulted combinations in enhancing fruit non reducing sugars content.

4.2.3.11. Fruit Total Sugars percentage

a. Storage under ambient room conditions

With respect to specific effect of storage period, Table (33.a) demonstrates that keeping Zebda mango fruits for fourteen days under ambient room conditions resulted in producing the highest values of fruit total sugars content (13.54 & 13.39%) against (13.02 & 13.15%) for the analogous ones stored for seven days under room conditions, whereas the initial readings of fruit total sugars content were (6.50 & 6.77%) during 2003 and 2004 seasons, respectively. The differences between the aforementioned three storage periods were remarkable to be significant.

Referring to specific effect of the tested pre-harvest treatments, statistical analysis emphasizes that fruit total sugars content showed no significant response to all studied treatments.

In regard to the interaction effect between the tested treatments and storage period, the analyzed data show that the interactions of fourteen days storage period and the analogous ones of seven day storage period produced statistically similar and higher values even within each storage period in comparison with the corresponding ones received no storage. Briefly, the initial readings of fruit total sugars content scored the lowest values with 2% $CaCl_2$ treatment in 2003 season and 1% $CaCl_2$ treatment in 2004 season.

Table (33.a)

b. Cold storage at 15°C

With respect to the specific effect of storage period, Tables (33.b & c) reveal that the sweetness of Zebda mango fruits enhanced as the storage period advanced. In this concern, twenty eight days stored fruits at 15°C were the most sweety fruits (11.99 & 11.71%), followed descendingly by those stored for twenty one days (11.62 & 11.50%), fourteen days storage period (10.83 & 10.63%) and finally those stored for seven days (10.05 & 9.93%) during 2003 and 2004 seasons, respectively. The differences between the aforementioned storage periods were so high to be significant.

Regarding specific effect of the tested pre-harvest treatments, statistical analysis declares that in 2003 season most tested treatments induced similar effect on fruit total sugars content, except 1 & 2% yeast suspension treatments produced higher positive effect in this respect than did 2% $CaCl_2$ and 50 ppm GA_3 treatments. On the other hand, in 2004 season, the tested treatments exerted statistically similar effect in this sphere.

Concerning specific effect of days on shelf, it is clear that the longer the period at which cold stored Zebda mango fruits kept on shelf, the higher was total sugars content. In this sphere, cold stored fruits kept on shelf for six days recorded the highest fruit total sugars percentages (12.75 & 12.67) against (11.07 & 11.10) for the analogous ones, kept on shelf for three days, whereas, the initial readings of total sugars of cold stored fruits were (9.55 & 9.06) during 2003 and 2004 seasons, respectively. The differences between the aforementioned periods were pronounced to be significant.

As for the interaction effect between treatments, storage period and days on shelf, Tables (33.b & c) show that the combinations of twenty eight days storage period, twenty one days storage period, fourteen days storage period and seven days storage period with six days on shelf achieved statistically the highest and similar values in comparison with all resulted combinations. The differences between the different mentioned combinations were lacking from statistical standpoint. Also, the differences between each combination members were significant. The combinations of seven days storage period and fourteen days storage period with zero day on shelf recorded similarly the lowest values of fruit total sugars percentage. The combinations of the different storage periods (7, 14, 21 and 28 days) with three days on shelf occupied an intermediate position between the aforementioned two categories. Shortly,

Tables (33.b)

Tables (33. c)

50 ppm GA_3-treated fruits, cold stored for seven days at 15°C and did not subject to shelf treatment had the lowest values of total sugars percentages (7.68 & 7.25) during the first and second season, respectively. On the other side, the highest values of total sugars percentage were produced by 1% yeast suspension treated fruits cold stored for twenty eight days and kept on shelf for six day in 2003 season and 2% yeast suspension treated fruits cold stored for twenty eight days and kept on shelf for six days in 2004 season.

c. Cold storage at 10°C

Considering specific effect of storage period, Tables (33.d & e) indicate that the longer the storage period (28 days) at 10°C, the higher was the fruit total sugars content. There were significant differences in this concern between twenty eight days storage period and other studied storage periods, except for twenty one days storage period in 2004 season, hence the differences was lacking from statistical standpoint. Besides, seven days storage period induced the least positive effect on fruit total sugars percentage. Furthermore, both fourteen days and twenty one days storage period induced statistically similar effect in this concern in 2003 season, but the difference of positive effect was on side of twenty one days storage period in 2004 season.

Regarding specific effect of tested treatments, statistical analysis illustrates that all tested treatments exerted similar effect on fruit total sugars percentages, except 25 ppm GA_3 treatment produced lower value in this respect, besides, 2% yeast suspension treatment produced significant positive effect in this sphere in comparison with 50 ppm GA_3 treatment in 2004 season.

Concerning specific effect of days on shelf, it is quite clear that keeping cold stored fruits on shelf for six days scored higher values of fruit total sugars (12.33 & 12.31%) against (10.47 & 10.3%) for the corresponding ones kept on shelf for three days, whereas those just removed from cold stores recorded the lowest readings of total sugars (8.96 & 8.55%) during 2003 and 2004 seasons, respectively. The differences between the three evaluated periods were remarkable to be significant.

Tables (33.d)

Tables (33. e)

With respect to the interaction effect between the treatments, storage period and days on shelf, it is obvious from Tables (33.d & e) that the highest values of fruit total sugars percentages were observed in the combinations of twenty eight days storage period with six days on shelf, twenty-one days storage period with six days on shelf and fourteen days storage period with six days on shelf. The differences between the aforementioned combinations were lacking from the statistical standpoint. Moreover, the combinations of seven days, fourteen days and twenty-one days storage period with zero days on shelf had the lowest values of fruit total sugars percentages particularly, those of seven days storage period. The rest interactions came inbetween the aforementioned two categories. Briefly 1% $CaCl_2$ x seven days storage period x zero day on shelf in 2003 season and 50 ppm GA_3 treatment x seven days storage period x zero day on shelf in 2004 season showed to be the least efficient combinations in enhancing fruit total sugars percentage. On reverse, the combinations of 25 ppm GA_3 x fourteen days storage period x six days on shelf in 2003 season and 2% yeast suspension treatment x fourteen days storage period x six days on shelf proved to be the superior combinations in improving fruit total sugars percentages.

During ripening process of mango fruit starch hydrolysis resulted in increasing total sugars with glucose, fructose and sucrose constituting most of the monosaccharides (Selvaraj *et al.*, 1989). Furthermore. Abou-Aziz *et al.* (1975) worked on Pairi mangoes and Medlicott and Thompson (1985) worked on Keitt mangoes, They arranged the principal sugars in mango fruits, in descending order to: sucrose, fructose and glucose. On the other hand, Shashirekha and Patwardhan (1976), worked on Badami mangoes and found that sucrose, fructose and glucose constitute most of the monosaccharides, and reported to be in similar concentrations in ripe mangoes.

The tabulated results dealing with the enhancement of fruit sugars content during storage due to pre-harvest sprays with GA_3 at 5-100 ppm go in line with the findings of Kumar and Singh (1993) on Amrapali mango fruits, El-Kassas *et al.* (1995) on Manfalouty pomegranate fruits, Mir *et al.* (1995) on cherry fruits and Jayachandran *et al.* (2005) on guava fruits. On reverse, Choudhury *et al.* (2003) reported that pre-harvest treatment with GA_3 resulted in decreasing augmented biochemical attributes such as sugars of sapota fruits.

The positive and prospective obtained results of calcium as a pre-harvest treatment in the form of calcium nitrate at 0.70-2.50% or calcium chloride at 0.6-2.0% on fruit on fruit sugar parameters are coincided with those mentioned earlier by Gupta *et al.* (1987-b) on jack fruits, Raychaudharyi *et al.* (1992) on guava fruits cv. Lucknow 49, Chandra *et al.* (1994) on guava fruits cv. Allahabad Safeda, El-Kassas *et al.* (1995) on Manfalouty pomegranate, Brar *et al.* (1997) on peach fruits cv. Shan-1-Punjab and Silva and Menezes (2001) on mango fruits cv. Tommy Atkins. On contrary, Choudhury *et al.* (2003) mentioned that pre-harvest spray with calcium chloride at 2.0% decreased the augmented biochemical attributes such as sugars of Sapota fruits cv. Pala.

4.2.3.12. Fruit total acidity percentage

a. Storage under ambient room conditions

Considering specific effect of storage period, it is obvious from Table (34.a) that fruit total acidity content decreased as the storage period prolonged. The initial fruit acidity content before storage period (zero day storage) recorded (1.30 & 1.21%) compared with (0.28 & 0.25%) for those stored under ambient room for seven days and (0.20 & 0.20%) for the analogous ones kept at ambient room conditions for fourteen days during 2003 and 2004 seasons, respectively. However, the differences between the studied periods in this respect were pronounced to be significant.

As for specific effect of the tested pre-harvest treatments, tabulated data reveal that the studied treatments failed to induce a remarkable effect on fruit total acidity content, hence significant differences were lacking between the tested treatments except for 1% $CaCl_2$ treated fruits which had significantly higher total acidity content than 75 ppm GA_3-treated ones in 2003 season and yeast treatments (1 & 2%) which scored statistically lower values of fruit total acidity content in comparison with the rest tested treatments in 2004 season.

Regarding the effect of interaction between the storage period and the tested pre-harvest treatments, tabulated data illustrate that as the storage period prolonged, the fruit total acidity decreased irrespective of the effect of the tested pre-harvest treatments. Thereupon, the combinations of zero day storage period (initial storage period) recorded higher values of fruit total acidity content than the

Table (34.a)

analogous ones of seven days storage period and the later ones surpassed the corresponding ones of fourteen days storage period. Anyhow, the differences between the three storage period combinations were so high to be significant. The higher values of fruit total acidity content were observed with the initial storage period (zero day storage) particularly $CaCl_2$ at 1 & 2% and control "untreated fruits", whereas the lowest values of fruit total acidity content were noticed with those stored for fourteen days storage period particularly $CaCl_2$ at 2 & 1%. Generally, in most cases the differences between interactions within each specific storage period were so small to reach significant level.

b. Cold storage at 15°C

Referring to specific effect of storage period, Tables (34.b & c) demonstrate that prolonging the storage period induced a remarkable reductive effect on fruit total acidity content, where the initial storage reading (zero day storage) recorded statistically higher fruit total acidity content (1.29 & 1.21%) in comparison with (0.64 & 0.56%) for those stored for seven days at 15°C, (0.46 & 0.40%) for the analogous ones stored for fourteen days, (0.35 & 0.31%) for the corresponding ones stored for twenty one days and finally, (0.32 & 0.29%) for those stored for twenty eight days during 2003 and 2004 seasons, respectively. However, the differences between the studied storage periods in this concern were significant from the statistical standpoint.

Concerning specific effect of the tested pre-harvest treatments, 2% $CaCl_2$-treated fruits had higher total acidity content than most tested treatments especially in the first season, whereas 75 ppm GA_3-treated fruits recorded lower values of total acidity than most studied treatments, particularly in the second season. Other tested treatments failed to induce a remarkable effect during the two studied seasons.

As for specific effect of days on shelf, the recorded data indicate that the initial readings of fruit acidity content after removal from cold stores (zero day on shelf) recorded (0.70 & 0.54%) against (0.35 & 0.32%) for those kept on shelf for three days after removing from cold stores and (0.27 & 0.26%) for the analogous ones kept on shelf for six days after removal from cold stores. The differences between the periods at which fruits were kept on shelf were so high enough to be significant.

Tables (34.b)

Tables (34. c)

With respect to effect of interaction between tested pre-harvest treatments, storage period and number of days on shelf, it is clear that fruit total acidity content responded greatly to the interaction between the aforementioned three factors and a new trend appeared as shown in Table (34.b & c), hence all combinations of seven days storage period and zero day on shelf recorded statistically the highest values of fruit acidity content, followed by fourteen days storage period and zero day on shelf, the analogous ones of seven days storage period and three days on shelf, the corresponding ones of twenty one storage period and zero day on shelf, those of fourteen days storage period and three days on shelf and the corresponding ones of twenty eight storage period and zero day on shelf. On reverse, the combinations of twenty eight storage period and six days on shelf recorded the lowest fruit acidity values. The rest combinations came inbetween the previously two mentioned extremes.

Generally, 1 & 2% $CaCl_2$-treated fruits, cold stored at 15°C for seven days and kept on shelf for zero day surpassed the other studied combinations regarding their positive effect on fruit total acidity content. On reverse, all combinations of twenty eight storage period and kept on shelf for six days scored statistically and similarly lower acidity content.

c. Cold storage at 10°C

In regard to specific effect of storage period, Tables (34.d & e) declare that Zebda mango fruits at the initial storage period (Zero day storage) recorded nearly two folds total acidity content (1.29 & 1.21%) in comparison with those stored for seven days at 10°C (0.66 & 0.61%), whereas those stored for fourteen days scored (0.53 & 0.53%), the analogous ones stored for twenty one days recorded (0.50 & 0.50%) and lastly, the corresponding ones stored for twenty-eight days gave (0.49 & 0.48%) during 2003 and 2004 seasons, respectively.

The differences between the studied storage periods were significant from the statistical standpoint.

With respect to specific effect of the tested pre-harvest treatments, $CaCl_2$ treatments (1 & 2%) and 50 ppm GA_3 induced statistically similar and higher fruit total acidity content in comparison with other tested treatments. On reverse, 75 ppm GA_3 and yeast at 2% treatments produced less acidic fruits. The rest treatments came inbetween the previously mentioned two extremes.

Tables (34.d)

Tables (34. e)

Concerning specific effect of days on shelf, the fruits kept for three days scored nearly one half acidity values that of zero day on shelf, whereas those kept on shelf for six days scored the lowest values of total acidity. This illustrates that there was a reversible correlation between days on shelf and fruit total acidity content.

As for the effect of interaction between tested pre-harvest treatments, storage periods and days on shelf, it is clear from the tabulated data that the studied factor days on shelf exerted the highest effect of the tested interactions, hence, the combinations of seven days storage period and kept on shelf for zero day recorded significantly higher fruit acidity content followed descendingly by those stored for fourteen, twenty one and lastly twenty eight days and kept on zero day shelf. Moreover, fruit stored for seven days and kept on shelf for three days scored higher fruit acidity values than those stored for fourteen, twenty one and twenty eight days and kept on shelf for three days. However, the differences between the previously three mentioned combinations were nearly lacking. Furthermore, the combinations of seven, fourteen, twenty-one and twenty-eight days storage and kept on shelf for six days recorded nearly similar fruit acidity values from the statistical standpoint. Briefly, seven days stored fruits, treated with 1 & 2% $CaCl_2$ and kept on shelf for zero day recorded the highest values of total acidity. On contrary, fruits stored for fourteen days, treated with 25 ppm GA_3 or yeast at 2% and kept on shelf for six days scored the lowest values of fruit acidity. The obtained results indicate a reductive affect of GA_3 as a pre-harvest treatment at 5-100 ppm on total acidity of Zebda mango fruits towards the end of storage period which came in accordance with those outlines by El-Kassas *et al.* (1995) on Manfalouty pomegranate, Choudhury *et al.* (2003) on Sapota fruits and Jayachandran *et al.* (2005) on guava fruits.

The recorded results of $CaCl_2$ dealing with their prospective affect on improving fruit flavour, enhancing fruit quality infinitely or reducing fruit organic acid content are in harmony with earlier works of Gupta *et al.* (1987-b) on jack fruit, Ranjit *et al.* (1990) on grape cv. Delight, Brar *et al.* (1997) on peach fruits cv. Shan-1-Punjab, Kluge *et al.* (1999) on mango fruits cv. Tommy Atkins and Choudhury *et al.* (2003) on sapota fruits cv. Pala.

4.2.2.13. Fruit ascorbic acid content (Vitamin C)

a. Storage under ambient room

Referring to specific effect of storage period, it is obvious from Table (35.a) that there was a reversible correlation between fruit ascorbic acid content (mg/ml juice) and storage period, hence fruit ascorbic acid content showed a remarkable decrease as the storage period advanced. In this concern, the initial fruit ascorbic acid value for those kept zero day under ambient room conditions recorded (50.03 & 50.25 mg/100 ml juice) against (35.25 & 34.00 mg/100 ml juice) for those stored for seven days and (22.72 & 26.42 mg/100 ml juice) for those stored for fourteen days under ambient room conditions during 2003 and 2004 seasons, respectively.

As for specific effect of pre-harvest treatments, 2% $CaCl_2$-treated fruits, followed by those treated by the lower $CaCl_2$ concentration (1%) showed to be the richest ones in their ascorbic acid content throughout the storage periods in comparison with other tested treatments. On reverse, 25 ppm GA_3-treated fruits in 2003 seasons and 75 ppm GA_3-treated fruits in 2004 season had comparatively the lowest values of ascorbic acid. Other tested treatments gave inbetween values in this concern.

Concerning effect of interaction between the storage period and the tested pre-harvest treatments, tabulated data show that fruit ascorbic acid content decreased as the storage period advanced, irrespective of the effect of tested treatments. Consequently, the combinations of initial (zero day) storage period recorded higher values of fruit ascorbic acid content than the corresponding ones of seven days storage period and their later ones surpassed the analogous ones of fourteen days storage period. However, the higher values of fruit ascorbic acid after fourteen days storage period were observed with those treated with 2% $CaCl_2$ and kept for seven days under ambient room conditions (41.37 & 37.79 mg/100 ml juice) for 2003 and 2004 seasons, respectively. On contrary, the lowest values of fruit ascorbic acid content were noticed with those treated with 25 ppm GA_3 and kept for fourteen days under ambient room conditions (18.93 & 24.61 mg/100 ml juice) for 2003 and 2004 seasons. Other studied interactions scored inbetween values in this concern within each storage period and significant differences between these combinations were present even within each storage period.

Table (35.a)

b. Cold storage at 15°C

With respect to specific effect of storage period, data reported in Tables (35.b & c) illustrate that ascorbic acid content of Zebda mango fruits decreased as the storage period prolonged regardless of the effect of the tested treatments and number of days at which the stored were kept on shelves in both seasons. In this respect, the average initial fruit ascorbic acid content i.e. before cold storage (zero initial day storage) recorded (50.03 & 50.25 mg/100 ml juice) against (39.06 & 38.67 mg/100 ml juice) for those of seven days cold storage at 15°C, (31.05 & 36.43 mg/100 ml juice) for the analogous ones of fourteen days cold storage (15°C), (27.63 & 31.96 mg/100 ml juice) for the corresponding ones of twenty one cold-storage period and lastly (26.23 & 29.69) for those of twenty eight cold storage period during 2003 and 2004, respectively, irrespective of number of days in which the cold stored fruits were kept on shelves. The differences between the studied storage periods (0, 7, 14, 21 and 28 days) were obvious to be significant.

Regarding specific effect of pre-harvest treatments, 2% $CaCl_2$ treated fruits recorded the highest values of ascorbic acid content, followed descendingly by the analogous ones treated with 1% $CaCl_2$ treatment and 2 & 1% yeast suspension treatments. On reverse, GA_3 treatments induced a marked reduction in fruit ascorbic acid content in comparison with the control. In this concern, GA_3 at 50 ppm recorded the lowest values of fruit ascorbic acid content, followed ascendingly by 75 ppm GA_3 and 25 ppm GA_3 treatments in both season.

Concerning the specific effect of days on shelf, after cold stored fruits kept zero day on shelf had the highest ascorbic acid values (35.57 & 39.00 mg/100 ml juice) against (30.07 & 32.89 mg/100 ml juice) for those after cold storage, kept on shelves for three days and (27.18 & 30.66 mg/100 juice) for the fruits removed from cold storage and kept for six days on shelves during 2003 and 2004 seasons, respectively. However, the differences were so high to reach the significant level.

Referring to effect of interaction between the tested treatments, storage period and number of days on shelf, it is quite clear that in both seasons all combinations of seven days cold storage and zero day on shelf recorded higher values of fruit ascorbic acid content than the analogous ones of the interactions of fourteen days, twenty one days and twenty eight days storage period and zero day on shelf, respectively. Moreover, the rest combinations of days

Tables (35.b)

Tables (35. c)

on shelf (3 and 6 days), storage periods (7, 14, 21 and 28 days) and tested pre-harvest treatments took the same trend of the previously interactions (zero day on shelf x storage periods x the tested treatments). Consequently, each specific treatment under seven days storage period and specific number of days on shelf recorded higher fruit ascorbic acid value when compared with the same treatments under the same number of days on shelf and fourteen days, twenty one days and twenty-eight days storage period, respectively. Shortly, 2% $CaCl_2$-treated fruits, stored for seven days at 15°C and kept on shelf for zero day proved the best combination in enhancing fruit ascorbic acid content. On contrary 75 and 50 ppm GA_3-treated fruits stored for twenty-eight days at 15 days and kept on shelf for six days had comparatively the lowest ascorbic acid content from the statistical standpoint. Besides, all combinations within each storage period and days on shelf recorded inbetween values, but the differences within each specific column (storage period x days on shelf x tested treatments) were in most cases pronounced to reach the significance level.

c. Cold storage at 10°C

As for specific effect of storage period, it is obvious from Tables (35.d & e) that in both seasons Zebda mango fruits showed a gradual loss in their ascorbic acid content as the storage period advanced.

In this respect, initial ascorbic acid values of fruits before storage recorded (50.03 & 50.25 mg/100 ml juice) against (40.02 & 40.50 mg/100 ml juice) for those stored for seven days, (36.24 & 38.29 mg/100 ml juice) for the analogous ones stored for fourteen days, (29.95 & 33.73 mg/100 ml juice) for the corresponding ones stored for twenty one days and finally (26.74 & 30.57 mg/100 ml juice) for those stored for twenty-eight days during 2003 and 2004 seasons, respectively. However, the differences between the storage periods regarding fruit ascorbic acid content were obvious enough to be significant.

Referring to specific effect of the tested pre-harvest treatments, enclosed data reveal that 2% $CaCl_2$ proved to be the most efficient treatment in reducing the loss in fruit ascorbic acid content throughout the storage periods, followed descendingly by lower concentration of $CaCl_2$ (1%) and (2 & 1%) yeast suspension treatments. The differences between the previously mentioned treatments (except, 2% $CaCl_2$) were so

small to reach the significant level in most cases. On reverse, gibberellin treatments induced a negative effect on fruit ascorbic acid content as compared with the control. In this concern, the higher GA_3 concentration (75 ppm) exerted higher reductive effect on fruit ascorbic acid content, followed ascendingly by 50 ppm GA_3 and finally 25 ppm GA_3 treatment. Anyhow, the differences between either GA_3 treatments or the control were insignificant.

With respect to specific effect of days on shelf, it is clear from obtained data that Zebda mango fruits kept zero day on shelf after removal from cold stored recorded the higher values of ascorbic acid (37.98 & 40.53 mg/100 ml juice), whereas those kept on shelves three days after removal from cold stores (32.17 & 35.21 mg/100 ml juice), meanwhile those remained for six days on shelves after cold storage scored (29.66 & 31.59 mg/100 ml juice) during 2003 and 2004 seasons, respectively. However, the differences between the three tested periods on shelf in this concern were so great to be significant.

Concerning interaction effect between storage period, the tested pre-harvest treatments and days on shelf on fruit ascorbic acid content, tabulated data illustrate that the interaction between the three studied factors induced a new trend with a different pattern of values. The resulted combinations could be descendingly regarding fruit ascorbic acid content as follows: (seven days storage period x zero day on shelf), (fourteen days storage period x zero day on shelf), (seven days storage period x three days on shelf), (twenty one days storage period x zero day on shelf), (fourteen days storage period x three days on shelf), and (seven days storage period x six days on shelf). Besides the combinations of fourteen days storage period x six days on shelf scored nearly similar values to those of (twenty-eight days storage period x zero day on shelf). Meanwhile, the combinations of twenty-one days storage period x three days on shelf surpassed those of twenty-eight storage period x three days on shelf). Lastly, the combinations of twenty-eight days storage period and kept six days on shelf. Shortly, 2% $CaCl_2$-treated fruits, stored for seven days at 10°C and kept zero day on shelf recorded significantly the highest values (48.29 & 48.09 mg/100 ml juice), whereas untreated fruits “control” stored for twenty-eight days at 10°C and kept on shelves for six days scored significantly the lowest values (23.81 & 24.14 mg/100 ml juice) during 2003 and 2004 seasons, respectively.

Tables (35. d)

Tables (35. e)

The loss in ascorbic acid content during storage could be attributed to the increase in ascorbate oxidase activity (Cardello and Cardello, 1998 on Haden mangoes).

The enhancement of ascorbic acid content of Zebda mango fruits due to GA_3 sprays is in harmony with those mentioned earlier by Kumar and Singh (1993) on mango fruits cv. Amrapali and Mohd-Amir *et al.* (2003) on mandarin cv. Kinnow.

The obtained results of calcium chloride regarding its affect on improving fruit quality traits, maintaining eating quality during storage and decreasing the rate of reduction in ascorbic acid are similar to earlier reports of Raychoudharyi *et al.* (1992) on guava fruits cv. Lucknow 49, Chandra *et al.* (1994) on guava fruits cv. Allahabad Safeda and Mohd-Amir *et al.* (2003) on mandarin fruits cv. Kinnow.

5- SUMMARY and CONCLUSION

This study included two main parts as follows:-

Part I: Trials to improve some marketing characteristics (ripening) and enhancing storage ability of Costata persimmon fruits.

This part of study was in turn subdivided into two parts as follows:-

5.1.1. Effect of some chemical substances on some marketing characteristics (ripening) of Costata persimmon fruits.

5.1.2. Effect of some post harvest treatments on storage ability of Costata persimmon fruits.

Part II: Trials to enhance storability of Zebda mango fruits through some pre harvest treatment.

Thereupon, this study was handled as follows:-

Part I: Trials to improve some marketing characteristics (ripening) and enhancing storage ability of Costata persimmon fruits.

This part of study was conducted at Fruit Handling and Storage Unit, Horticulture Department, Faculty of Agriculture, Benha Univ. Kalubia Governorate.

5.1.1. Effect of some chemical substances on some marketing characteristics "ripening" of Costata Persimmon fruits.

In 2003 and 2004 seasons, persimmon fruits (*Diospyros kaki,* L.) cv. Costata were harvested at mature stage i.e., mid-October. The productive Costata persimmon trees were 15-year-old grown in a clay-loamy soil in the farm of Barrage Research Station of the Horticulture Research Institute, Kalubia Governorate. The productive trees were similar in growth vigour had a good physical condition and received similarly the recommended horticultural practices. Harvested fruits were brought as soon as possible to Fruit Handling and Storage Unit, Horticulture Department, Faculty of Agriculture, Benha Univ. Kalubia Governorate.

Tested fruits were sorted (all malformed, crushed and diseased fruits were discarded) and the uniform fruits were chosen, quickly washed with tap water and then dipped in borax solution at 5% as a fungicide, then rewashed with tap water and dried

through the exposure to air from an electric ventilator. A second sorting was done to recheck the fruits for any defects.

Thereafter, these fruits were divided into two main groups, the first one was subjected to ripening treatments study as a trial to evaluate the efficiency of some chemical treatments in accelerating ripening process and producing an early and uniform ripened fruits with good quality meanwhile, the second groups of prepared fruits were subjected to investigate the efficiency of some post harvest treatments on prolonging the storage life of persimmon fruits.

The first group of selected and uniform persimmon fruits cv. Costata was divided into five subgroups to receive one of the following ripening treatments:-

(1) Ethephon (CEPA): The effect of ethephon (2-chloroethyl phosphonic acid) on ripening of "Costata" persimmon fruits was investigated; hence mature and uniform fruits were dipped for five minutes in 500 or 1000 ppm ethephon (ethrel) solution, (2) Calcium carbide (CaC_2): Calcium carbide was added at 2.5 or 5.0 g/box fruits (about 4 kg fruits) to bring up acetylene and ethylene (ripening gases) and (3) Control treatment: persimmon fruits were dipped in water for five minutes as a control to be compared with treated fruits (ethephon and calcium carbide).

All treatments of this study were held at ambient room conditions (30±2°C and 65-70% R.H.). The initial values of the studied fruit parameters were determined before treatments application and periodically at two days intervals throughout the ripening period.

All treated fruits in this study were packed carefully after receiving the tested treatments in plastic boxes "42 x 28 x 12 cm" wrapped with polyethylene film, previously treated with Cifadex as a fungicide and each box contained thirty five fruits.

Consequently, this investigation included five ripening treatments namely; 500 & 1000 ppm ethephon and 2.5 & 5.0 g calcium carbide as well as the control treatment. The tested treatments were arranged in a completely randomized block design and each treatment was replicated three times and each replicate was represented with two boxes, one of these two boxes was employed to determine the changes in fruit physical properties i.e. ripening percentage, weight loss percentage, decay percentage and fruit firmness, whereas the second one was devoted for fruit chemical properties determination i.e. carotenoids, total sugars content, total soluble solids, titratable acidity, ascorbic acid (V.C) and tannins content.

The obtained results could be summarized as follows:-

5.1.1.1. Ripening percentage of persimmon fruits

It was found that fruit ripening percentages of Costata persimmon fruit were linearly increased with advancement of the ripening period. Consequently, the longer the ripening period, the higher was fruit ripening percentage and vice versa. However, the highest fruit ripening percentages were recorded after eight days of ripening treatments application, whereas the lowest fruit ripening percentages were scored after two days of ripening treatments performance. In addition, all the tested ripening treatments succeeded in enhancing fruit ripening percentages, especially 1000 ppm ethephon-treated fruits. As for the interaction effect between ripening period, ripening chemical substances and their concentration, it was noticed that the combinations of eight days ripening period recorded the highest of fruit ripening percentages (except for the control treatment), while two days ripening duration combinations registered the lowest fruit ripening percentages, especially untreated fruits (control).

5.1.1.2. Fruit weight loss percentage

Weight loss percentage of Costata persimmon fruits is progressively increased with the advancement of ripening duration. Hence, the highest fruit weight loss percentage was gained after eight days of ripening treatments application, whereas the lowest fruit loss percentage was recorded after two days of ripening incubation. Also, all tested ripening treatments had a promising affect in increasing fruit ripening percentage, especially 1000 ppm ethephon treatment. Moreover, the resulted combinations of eight days ripening duration resulted in the highest fruit weight loss percentages. On contrary, the combinations of two days ripening period induced the lowest values in this respect.

5.1.1.3. Fruit decay percentage

It could be observed that an increment in fruit decay percentages were in parallel with the ripening duration, consequently eight days after ripening treatments application induced the highest fruit decay percentage, whereas two days ripening duration scored the lowest values in this concern. Moreover, all tested ripening treatments induced progressive increases in fruit decay percentage, particularly ethephon treatments when compared with control. Furthermore, the resulted combinations of eight days ripening period statistically induced the highest fruit decay

percentage, especially 1000 ppm ethephon-treated fruits, while two days ripening period produced the lowest fruit decay percentage, particularly untreated fruits.

5.1.1.4. Fruit firmness (lb/inch^2)

Fruit firmness was decreased proportionally with prolonging ripening period. Thus, two days ripening period scored the highest fruit firmness values when compared with the other ripening periods, especially eight days ripening period, which recorded the lowest values in this concern. Moreover, all the studied ripening treatments resulted in decreasing fruit firmness particularly, 1000 ppm ethephon treatment as compared with the control. Additionally, the obtained combinations of two days ripening duration scored the highest fruit firmness values, especially untreated fruits, while the lowest values of this parameter were recorded by the combinations of eight days ripening period (except for the control treatment).

5.1.1.5. Fruit carotenoids content

It could be concluded that the increases in fruit carotenoids content was in parallel with ripening duration. Thereupon eight days after ripening treatments application gave the highest fruit carotenoids content, whereas two days ripening duration scored the lowest values in this concern.

Furthermore, all the tested ripening treatments induced progressive increments in fruit carotenoids content with superiority for ethephon treatments in most cases. Moreover, the resulted combinations of eight days ripening period statistically induced the richest fruit carotenoids content, while two days ripening period produced the lowest fruit carotenoids content, especially untreated fruits.

5.1.1.6. Fruit total sugars (%)

It was observed that the longer the ripening period, the higher was fruit total sugars content and vice versa. Therefore, eight days ripening period produced the richest fruits in total sugars content, but two days ripening period took the other way around in this sphere. Also, all tested ripening treatments succeeded in enhancing fruit total sugars content, especially 1000 ppm ethephon treatment. Moreover, the resulted combinations of eight days ripening duration produced the highest values of fruit total sugars content. On reverse, the combinations of the two ripening period induced the lowest values in this respect.

5.1.1.7. Fruit total soluble solids percentage (T.S.S.%)

It was realized that fruit TSS percentages of Costata persimmon fruits were linearly decreased with the increment of ripening period. So, the lowest fruit TSS percentages were scored after eight days of ripening treatments application, while the greatest fruit TSS percentages were registered after two days of ripening period. In addition, all studied ripening treatments statistically decreased the values of fruit TSS percentages particularly 1000 ppm ethephon treatment in comparison with other tested treatments including the control which recorded the highest values in this concern. Moreover, two days of ripening duration combinations induced the richest fruits in TSS percentage, especially untreated fruit "control". On the opposite, the combinations of eight days ripening duration produced the lowest values in this concept except for untreated fruits "control".

5.1.1.8. Fruit acidity percentage

The longer the ripening period, the lower was fruit acidity percentage. Hence, eight days ripening period scored the lowest values of fruit acidity percentage, while the highest values of fruit acidity percentage were recorded after two days of ripening treatments application. Moreover, all tested ripening treatments statistically succeeded in decreasing fruit acidity percentage, especially ethephon at 1000 or 500 ppm. Besides, the gained combinations of eight days ripening duration (except for untreated fruits) produced the lowest fruit acidity percentages, particularly 1000 ppm ethephon treatment (an average of two seasons).

5.1.1.9. Fruit ascorbic acid content

Fruit ascorbic acid content of Costata persimmon fruits is proportionally decreased with the progress of ripening period. However, two days ripening period showed superiority in inducing the highest values of fruit ascorbic acid, whereas after eight days ripening period, such values reduced to reach the minimum level.

Also, all tested ripening treatments significantly decreased fruit ascorbic acid content in comparison with untreated fruits "control". Moreover, the resulted combinations of two days ripening period, especially the control treatment produced the richest fruits in ascorbic acid content, whereas the combinations of eight days ripening period (regardless of the control) registered the lowest values in this concept.

5.1.1.10. Fruit tannins content

Fruit tannins content was decreased as the ripening period advanced. However, the highest fruit tannins content was recorded after two days of ripening period, whereas the lowest fruit tannins content was registered after eight days of ripening duration. Additionally, all tested ripening treatments significantly succeeded in decreasing fruit tannins content, especially 1000 ppm ethephon treatment when compared with the other tested treatments including the control. Besides, the resulted combinations of eight days ripening duration proved to be the most promising one for producing the lowest values of fruit tannins content particularly, that of 1000 ppm ethephon treated fruits.

Conclusively, it is preferable to treat costata persimmon fruits with 500 ppm ethephon or 2.5 g calcium carbide /box fruits (about 4 kg fruits) to accelerate ripening process and producing an early and uniform ripened fruits with good quality.

5.1.2. Effect of some post harvest treatments on storage ability of Costata persimmon fruits.

The second group of well selected uniform "Costata" persimmon fruits were immersed in 500 ppm ethephon solution for five minutes to bring the fruits to ripening stage, then the fruits were divided into six subgroups to receive one of the following storage treatments:-

(1) Calcium chloride ($CaCl_2$): Well sorted mature Costata persimmon fruits were dipped for five minutes in 2 or 4% calcium chloride ($CaCl_2$) solution, thereafter fruits of each treatment were air dried, (2) Yeast: Well sorted mature and uniform "Costata" persimmon fruits were dipped in active yeast suspension at 1 or 2% (*Saccharomyces cerevisiae*) for five minutes. The fruits were then air dried, (3) Sodium hypochlorite (NaOCl): Mature and well sorted fruits were dipped in sodium hypochlorite (NaOCl) at 2% for five minutes, then the treated fruits were air dried and (4) Control treatment: Mature, uniform and well selected fruits were dipped in tap water for five minutes as a control (untreated fruits) to be compared with $CaCl_2$, yeast and NaOCl - treated fruits

Consequently, this investigation included three storage temperatures i.e. ambient room, cold temperature at 5°C and cold temperature at 0°C. Besides, within each tested storage temperature six post harvest treatments were evaluated namely: 2 & 4% $CaCl_2$, 1 & 2% yeast suspension, 2% NaOCl and the control (untreated fruits).

The initial values of evaluated fruit parameters were determined before treatment application and periodically at weekly intervals throughout the storage period at the tested storage temperature (ambient room, 5°C and 0°C).

All treated fruits were packed carefully in plastic boxes "42 x 28 x 12 cm", previously treated with cifadex as a fungicide and each box contained thirty five fruits.

The tested post harvest treatments were arranged in a completely randomized block design and each treatment was replicated three times, with two boxes of fruits per replicate.

The obtained results could be summarized as follows:-

5.1.2.1. Weight loss percentage

It was found that Costata persimmon fruits showed loss in their weight with the advancement of storage period under the three tested temperatures. Thus, the longer the storage period, the higher was fruit loss weight percentage and vice versa. So, the lowest fruit weight loss percentages were recorded after seven days storage period under the three studied temperatures, whereas the highest fruit weight loss percentages were scored after twenty one days storage period in 2003 season, fourteen days in 2004 season under ambient room conditions, forty two days storage period under cold storage at 5 or 0°C.

Moreover, most tested post-harvest treatments succeeded in reducing fruit weight loss percentages. Therefore under ambient room condition, 2% $CaCl_2$-treated fruit, 2% $NaOCl_2$-treated fruits under cold storage at 5°C as an average of both seasons and 4% $CaCl_2$ & 2% NaOCl-treated fruits as an average of both seasons appeared to be the most effective treatments for producing the lowest values of fruit weight loss percentages.

The interaction between storage period and the studied post-harvest treatments, indicates that the combinations of seven days storage periods under the three studied storage temperatures resulted in the lowest fruit weight loss percentages, especially 2% NaOCl-treated fruits (an average of two seasons).

5.1.2.2. Fruit decay percentage

Fruit decay percentage of Costata persimmon fruits was increased as the storage period advanced. So, the longer the storage period, the higher was fruit decay percentage. This trend was true under the three studied storage temperatures. Hence, the lowest fruit decay percentages were recorded after seven days storage period

under the three tested storage temperatures. On contrary, the highest fruit decay percentages were registered after twenty one days in 2003 season, fourteen days storage period in 2004 season under ambient room condition, forty two days storage period under cold storage at 5 & 0°C.

Besides, most of the tested post-harvest treatments positively affected fruit decay percentage during storage with the exception of storage under ambient room conditions as the treatments failed to induce any significant differences in this concern. Anyhow, 2% NaOCl treated fruit, 4% $CaCl_2$-treated fruits under cold storage at 5 and 0°C, respectively recorded the lowest fruit decay percentages.

The interaction between storage period and the tested post-harvest treatments, demonstrates that the combinations of seven days storage period under the three storage temperatures recorded the lowest fruit decay percentages, especially cold storage at 5 & 0°C which did not score any decayed fruit in both seasons. On reverse, the highest fruit decay percentages were registered by the combinations of twenty one days storage period in 2003 season and fourteen days in 2004 season under ambient room condition and the combinations of forty two days storage period under cold storage at 5 and 0°C.

5.1.2.3. Fruit Firmness (lb/inch^2)

Costata persimmon fruits became less firm with the advancement of storage period under the three tested storage temperatures. Also, the longer the storage period, the lesser was fruit firmness and vice versa. Anyhow, the highest values of fruit firmness values were recorded after seven days storage period under the three studied storage temperatures. On reverse, the lowest values of fruit firmness were gained after twenty one days, fourteen days storage period in the first and second seasons, respectively under ambient room conditions, forty two days cold storage period at 5 and 0°C.

In addition, most post-harvest treatments under the three studied storage temperatures succeeded in enhancing fruit firmness with the superiority for 4% $CaCl_2$-treated fruits in most cases.

The interaction effect between the storage period and the tested post-harvest treatments, shows that the combinations of seven days storage period of the three tested storage temperatures recorded the highest values of fruit firmness with superiority for 2% NaOCl-treated fruit under ambient room conditions, 4% $CaCl_2$-

treated fruits under cold storage at 5 and 0 °C in most cases. On contrary, the lowest fruit firmness values were registered after twenty one days, fourteen days combination in the first and second seasons, respectively under ambient room condition, and the combinations of forty two days storage period under cold storage at 5 and 0°C.

5.1.2.4. Fruit shelf life

It was noticed that post harvest treatments positively enhanced fruit shelf life, so 2% NaOCl and 4% $CaCl_2$-treated fruits induced the lowest fruit decay percentage during 2003 season, whereas 2% NaOCl and 2 & 4% $CaCl_2$-treated fruits showed superiority in inducing the lowest fruit decay percentage during 2004 season.

5.1.2.5. Pulp carotenoids content

Pulp carotenoids content was increased as the storage period prolonged under the three studied storage temperatures. However, the longer the storage period, the higher was fruit pulp carotenoids content. Therefore, the richest fruit pulp carotenoids content was produced by twenty one days stored fruits in 2003 season & fourteen days stored fruits in 2004 season under ambient room conditions, forty two days stored fruit under cold storage at 5 & 0°C in both seasons of this study.

In addition, most tested post-harvest treatments succeeded in enhancing fruit pulp carotenoids content. Generally, 2% NaOCl-treated fruit under ambient room conditions, 1% yeast-treated fruits under cold storage at 5°C and 2% NaOCl-treated fruit under cold storage at 0°C showed to be the most pronounced treatments for producing the greatest fruit pulp carotenoids content (an average of both seasons).

The interaction between storage period and the tested post-harvest treatments, demonstrates that the resulted combinations under ambient room conditions show that twenty one days storage period combinations in 2003 season, fourteen day storage period combination in 2004, especially 2% yeast treated-fruits, the combinations of forty two days storage period, particularly 1% yeast-treated fruits for cold storage at 5°C and 2% NaOCl-treated fruits for cold storage at 0°C showed to be the most effective treatments in inducing the highest fruit pulp carotenoids values. On the opposite, the lowest fruit pulp carotenoids values were scored by the combinations of seven days storage period under the three studied storage temperatures.

5.1.2.6. Fruit total sugars content

Fruit total sugars content is proportionally increased with the extension of storage period under the three studied temperatures in both seasons. Thereupon, the

longer the storage period, the higher was fruit total sugars content. However, seven days stored fruits under the three tested temperatures recorded the lowest fruit total sugars values, whereas the highest fruit total sugars values were scored after twenty one days in 2003 season and fourteen days storage period in 2004 season under ambient room conditions and after forty two days storage period under cold storage (5 & 0°C) in both seasons.

Besides, there was a fluctuated trend regarding the response of fruit total sugars content to the tested post harvest treatments in both seasons. Generally, 2% yeast treated fruits stored under ambient room conditions, 1% yeast-treated fruits cold stored at 5°C and 2% yeast-treated fruits cold stored at 0°C showed to be the most effective treatments for inducing the highest fruit sugar content (an average of both seasons).

The interaction between storage period and the tested post harvest treatments the resulted combinations of twenty one days storage period in 2003 season, fourteen days storage period in 2004 season, particularly 2% yeast-treated fruits kept under ambient room conditions, the combinations of forty two days cold stored at 5°C, especially 1 & 2% yeast treated fruits and the combinations of forty two days cold stored at 0°C, particularly 2% NaOCl-treated fruits in 2003 season and 2% yeast-treated fruits in 2004 season produced the highest fruit total sugars percentage in comparison with the other combinations.

5.1.2.7. Fruit total soluble solids percentage (T.S.S.%)

Fruit total soluble solids content (%) was decreased in proportional with the advancement of the storage period. This trend was true under the three studied storage temperatures in both seasons of this work. Thereupon, the longer the storage period, the lower was fruit TSS content and vice versa. Consequently, the highest fruit TSS percentages were scored after seven days storage period under the three tested storage temperatures, while twenty one days storage period in 2003 & fourteen days storage period in 2004 season under ambient room conditions, forty two days storage period under cold storage at 5°C & 0°C registered the lowest fruit TSS percentage.

Moreover, most tested post-harvest treatments succeeded in affecting fruit TSS percentages in both seasons. Anyway, 4% $CaCl_2$-treated fruits proved to be the most effective treatment in inducing the highest fruit TSS percentage under the three studied storage temperatures (an average of both seasons).

The resulted combinations resulted from interaction between storage period and the post-harvest treatments, show that the combinations of seven days storage period, especially 4% $CaCl_2$-treated fruits under ambient room conditions, 2% NaOCl-treated fruits cold stored at 5°C and 4% $CaCl_2$-treated fruits cold stored at 0°C were the richest ones in TSS percentage (an average of both seasons).

5.1.2.8. Fruit total acidity percentage

Fruit acidity percentage of Costata persimmon is steadily decreased with the advancement of storage duration. The stored fruits under ambient room conditions (twenty one days in 2003 & fourteen days in 2004 seasons) or at 5 & 0°C cold storage (forty two days) recorded the lowest fruit acidity percentages. However, the rate of reduction of fruit acidity percentage during storage duration under ambient room conditions is remarkably higher than under cold storage (5 & 0°C). Besides, the longer the storage duration i.e. twenty one days in 2003 season and fourteen days in 2004 season under ambient room conditions or forty two days under cold storage (5 & 0°C) the lower was fruit acidity percentage and vice versa.

On the other hand, most tested post-harvest treatments remarkably increased fruit acidity percentage in comparison with the control. The highest fruit acidity percentages were scored by 2% NaOCl-treated fruits under the three studied storage temperatures in both seasons.

Furthermore, the interaction between storage period and the tested post-harvest treatments shows that the resulted combinations demonstrate that under ambient room conditions the combinations of twenty one days storage period in 2003 season and the combination of fourteen days storage period in 2004 season under ambient room conditions had comparatively the lowest fruit acidity percentages, while under cold storage at 5 & 0°C, the combinations of forty two days storage period statistically induced the lowest fruit acidity percentages.

5.1.2.9. Fruit tannins content

Fruit tannins content of Costata persimmon is proportionally decreased with the advancement of storage period. This trend was true under the three studied temperatures in both seasons. Consequently, the longer the storage duration i.e. twenty one days storage duration in 2003 season and fourteen days storage duration in 2004 season under ambient room conditions or forty two days storage duration under cold storage (5 & 0°C), the lower was the fruit tannins content and vice versa.

Moreover, most tested post-harvest treatments, succeeded in reducing fruit tannins content, hence 2% yeast-treated fruits showed to be the most pronounced treatment for inducing the lowest fruit tannins content under the three evaluated storage temperatures.

In addition, the interaction between storage period and the tested post-harvest treatments reveals that the resulted combinations under ambient room conditions show that the combinations of twenty one days storage duration in 2003 season and fourteen days storage duration in 2004 season, produced the lowest fruit tannins content, especially 2% yeast-treated fruits in both seasons, while under cold storage (5 & 0°C) the combinations of forty two days storage period scored the lowest fruit tannins content with superiority for 2% NaOCl-treated fruits cold stored at 5°C and 2% yeast-treated fruits cold stored at 0°C.

5.1.2.10. Fruit ascorbic acid content (Vitamin C)

Fruit ascorbic acid content of Costata persimmon is proportionally decreased with the advancement of storage duration. This was pronounced with fruits kept under room conditions for twenty one days in 2003 or fourteen days in 2004 seasons as well as at 5 & 0°C cold storage for forty two days storage period. However, the longer the storage duration i.e. twenty one days in 2003 or fourteen days in 2004 season or forty two days under cold storage (5 & 0°C), the lower was fruit ascorbic acid content and vice versa.

Moreover, most tested post-harvest treatments enhanced fruit ascorbic acid content, hence 2% NaOCl-treated fruits had significantly the highest values in this respect under ambient room conditions, 4% $CaCl_2$-treated fruits cold stored at 5°C, whereas 2% yeast-treated fruits cold stored at 0°C in 2003 season and 4% $CaCl_2$-treatred fruits cold stored at 0°C in 2004 season showed superiority in this concern.

Furthermore, the interaction between storage period and the tested post-harvest treatments illustrates that the resulted combinations show that the combinations of seven days storage period had comparatively higher values of fruit ascorbic acid content, especially 4% $CaCl_2$-treated fruits in 2003 season and 2% NaOCl treated fruits in 2004 season under ambient room conditions, 4% $CaCl_2$-treated fruits under cold storage at 5°C and 2% yeast-treated fruits in 2003 season and 4% $CaCl_2$-treated fruits in 2004 season. On contrary, the lowest fruit ascorbic acid values were scored by the combinations of twenty one days storage period in 2003 season, fourteen days storage

period in 2004 season under ambient room conditions and the combinations of forty two day storage period under cold storage at 5 or 0°C in both seasons of this study.

In summary, in order to prolonging storability of Costata persimmon fruits up to forty two days with the maintenance of good fruit marketable parameters, it is preferable to dip the fruits in 4% calcium chloride or 2% sodium hypochlorite solutions for five minutes and keeping the fruits in cold stores at 5 or 0°C .

Part II: Trials to enhance storability of Zebda mango fruits through some pre harvest treatments.

5.2.1. The initial effect of some pre harvest treatments on pomological and some chemical characteristics of Zebda mango fruits.

Zebda mango trees (*Mangifera indica,* L.) grown in a sandy loam soil at Arab-El-Ghadery Village, Kalubia Governorate were devoted for this study. The trees were 20-years-old, uniform in growth, had good physiological condition and receiving normal agricultural practices.

In 2003 and 2004 seasons, selected Zebda mango trees were sprayed with one of the following pre harvest treatments: (1) Gibberellic acid (GA) at 25, 50 and 75 ppm, (2) Calcium chloride ($CaCl_2$) at 1 and 2%, (3) Active yeast suspension at 1 and 2% and (4) Tap water as a control treatment. Tween 20 as a surfactant was added at 0.01 % to all spray solution treatments including the tap water "control". The spray of all tested treatments was repeated three times a year, i.e. the first spray was done after fruit setting stability, meanwhile the others two sprays were carried out thereafter at three weeks intervals. Each treatment was represented by three replicates (one tree / replicate). The treatments were arranged in a completely randomized block design.

Zebda fruits were picked at mature green stage i.e., mid August in both seasons. Selected fruits were free of obvious mechanical damage and defects and approximately homogenous in size and colour. Fruits were then brought as soon as possible to the Post-harvest Laboratory of Pomology Department (APHC), Faculty of Agriculture, Alexandria University "under the supervision of Prof. Dr. Awad Hussien".

The obtained results of the initial effect of the tested pre harvest treatments on some pomological and chemical characteristics of Zebda mango fruits could be summarized as follows:-

GA_3 treatments (25, 50 and 75 ppm) particularly the higher concentration proved to be the superior treatment in enhancing fruit weight, peel weight, seed weight, pulp fresh weight, fruit pulp percentage, length, breadth and fruit thickness as well as reducing sugars, particularly using the high rate of GA_3 (75 ppm). Furthermore, $CaCl_2$ treatments particularly the higher concentration (2%) induced high positive effect on fruit peel percentage, fruit pulp dry weight, fruit firmness, fruit acidity and fruit chlorophyll "a" content.

Lastly, yeast treatments induced highest values of seed weight, seed weight percentage, pulp dry weight, fruit length, fruit thickness, fruit total soluble solids, fruit ascorbic acid content, non reducing sugars, pulp carotenoids content, peel chlorophyll "a, b" and carotenoids content with superiority for the highest concentration of yeast suspension (2%).

5.2.2. Fruit physiochemical attributes in response to some pre harvest treatments (GA_3, $CaCl_2$ and yeast) during storage (ambient room, 15 and 10°C) and fruit keeping on shelf (3 & 6 days).

Zebda mango fruits resulted from the previously mentioned pre harvest treatments were well selected and devoted for this study. Fruits with any insect infestation or defects were discarded. Sorted fruits were quickly washed with regular tap water, then, air dried with the aid of an electric fan. A second sorting was done to recheck the fruits for any defects to be ready for storage study.

Therefore, this investigation included three storage temperatures i.e. ambient room conditions (28±2°C & 75-80%R.H.), cold storage at 15 and 10°C. Besides, within each storage temperature eight pre harvest treatments were evaluated namely 25, 50 and 75 ppm GA_3, 1 & 2% $CaCl_2$, 1 & 2% yeast suspension and the control. The treatments were arranged in a completely randomized block design with three replicates for each treatment and each replicate was represented with two boxes of fruits.

All selected and uniform fruits for each treatment were packed in plastic boxes "42 x 28 x 12 cm", previously treated with Cifadex as a fungicide, every box contained fifteen fruits. Each treatment included 36 boxes, which divided into three lots. The first one contained 6 boxes and kept at ambient conditions (28±2°C & 75-80%R.H.), the second one contained 15 boxes and held at 15°C and 90-95% RH and the last one also contained 15 boxes and stored at 10°C and 90-95% RH.

The obtained results could be summarized as follows:-

5.2.2.1. Weight loss percentage

Weight loss percentage of Zebda mango fruits is proportionally increased with the progress of storage period, whether the fruits were stored under ambient room conditions (fourteen days storage duration) or at 15 & 10°C cold-storage (twenty-eight days storage duration). Anyhow, the rate of loss in fruit weight during storage under ambient room conditions is remarkably higher than under cold storage (15 & 10°C). Besides, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage (15 & 10°C), the higher was the loss in fruit weight percentage and vice versa.

On the other hand, all tested pre-harvest treatments succeeded in reducing the rate of loss in fruit weight during storage durations in comparison with the control. This was true under all studied storage temperatures (ambient room, 15 and 10°C) with the superiority in reducing weight loss percentage for 2 & 1% $CaCl_2$ under the three tested storage temperatures, in addition to 50 ppm GA3 combined with10°C cold storage.

Furthermore, keeping cold stored fruits at 15 or 10°C on shelf for longer period (six days) resulted in increasing the rate of loss in fruit weight in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf.

Additionally, under ambient room storage, the resulted combinations from the interaction between the pre-harvest treatments and storage period indicate that the combinations of seven days storage period, regardless of the tested pre-harvest treatments had comparatively lower fruit weight loss percentages than the analogous ones of fourteen days storage duration. However, seven days ambient room stored fruits treated with 2 or 1% $CaCl_2$ lost comparatively the lowest percentage of their weight during storage.

The interaction between storage period, days on shelf and the tested pre-harvest treatments, shows that days on shelf had a strong hand in determining the rate of loss in fruit weight, followed in action by the storage period. Thereupon, the longer the period on shelf (six days) combined with longer storage duration (twenty-eight days), the higher was the rate of loss in fruit weight during storage and the reverse was true. Shortly, 15 or 10°C-cold stored fruits for seven days, treated with 2 & 1% $CaCl_2$, 2% yeast or 25 & 50 ppm GA_3 and freshy removed from cold stores (zero day on shelf) recorded the lowest fruit weight loss percentages in an ascending order.

5.2.2.2. Fruit decay percentage

Decay percentage of Zebda mango fruits is proportionally increased with the advancement of storage duration. This was more obvious when the fruits were kept under room conditions (fourteen days storage duration) as well as at 15 & 10°C cold storage (twenty eight days storage duration). Anyway, the rate of increasing fruit decay percentage during storage under ambient room conditions is remarkably higher than under cold storage (15 & 10°C). Also, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty eight days under cold storage (15 & 10°C) the higher was fruit decay percentage and vice versa.

Moreover, most tested pre-harvest treatments succeeded in reducing fruit decay percentage during storage durations as compared with control in both seasons. This was true under all evaluated storage temperature (ambient room, 15 and 10°C) with the superiority in reducing fruit decay percentage for 1% $CaCl_2$-treated fruits in the first season and 1% yeast-treated fruits in the second one under ambient room conditions, 1% $CaCl_2$-treated fruits cold stored at 15°C and finally 2% $CaCl_2$-treated fruits cold stored at 10°C in both seasons.

Furthermore, keeping cold stored fruits at 15 and 10°C on shelves for longer period (six days) induced higher fruit decay percentage as compared with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf.

Moreover, under ambient room storage the lowest fruit decay percentages were recorded by the combinations of seven days storage period, especially 1% $CaCl_2$-treated fruits in 2003 season and 2% yeast-treated ones in 2004 season.

The interaction between storage period, days on shelf and the tested pre harvest treatments, indicates that days on shelf had a strong decision in determining fruit decay percentage, followed in action by the storage period. Thereupon, the longer the period on shelf (six days) combined with longer storage duration (twenty eight days), the higher was the percentage of fruit decay during storage and the reverse was true. However, 15°C cold stored fruits during all the storage periods, treated with 25 & 50 ppm GA_3 and freshy removed from cold stores (zero day on shelf) scored the lowest fruit decay percentages. Besides, 10°C cold stored fruits during all the storage durations, treated with 50 ppm GA_3 or 2% $CaCl_2$ in 2003 season and 1 & 2% $CaCl_2$-treated fruits in 2004 season and freshy removed from cold stores (zero day on shelf) gave the lowest fruit decay percentages.

5.2.2.3. Fruit Firmness (lb/inch)

Zebda mango fruits showed loss in its firmness with the advancement of storage period whether the fruits were stored under room conditions (fourteen days storage duration) or cold stored at 15 & 10°C (twenty-eight days storage duration). However, the loss in fruit firmness under ambient room conditions is remarkably higher than that under cold storage (15 & 10°C). In addition, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty eight days under cold storage (15 & 10°C), the higher was the loss in fruit firmness and vice versa in both seasons.

On the other side, most tested pre-harvest treatments succeeded in reducing the loss in fruit firmness during storage durations as compared with the control. This trend was true under all studied storage temperature (ambient room, 15 and 10°C) with the superiority in reducing the loss of fruit firmness for 2 & 1% $CaCl_2$-treated fruits under the three studied storage temperatures.

Moreover, keeping cold stored fruits at 15 or 10°C on shelf for longer duration (six days) resulted in increasing the rate of loss in fruit firmness when compared with those freshy removed from cold stores (Zero day on shelf) or kept for three days on shelf.

The interaction between the pre-harvest treatments and the storage period demonstrates that the combinations of seven days storage period had comparatively higher values of fruit firmness ($lb/inch^2$) than the analogous ones of fourteen days storage duration. Meanwhile, seven days room stored fruits treated with 2 & 1% $CaCl_2$ had comparatively the highest values of fruit firmness during storage.

Considering the interaction between storage period, days on shelf and the tested pre-harvest treatments, the resulted combinations show that days on shelf had a strong role in determining the rate of loss in fruit firmness, followed in action by the storage period. Therefore, the longer the period on shelf (six days) joined with longer storage duration (twenty eight days), the lower was fruit firmness values during storage period and the reverse was true. Briefly, 15 or 10°C cold stored fruits for seven days, treated with 1% $CaCl_2$ and freshy removed from cold stores (zero days on shelf) registered the highest values of fruit firmness in both seasons.

5.2.2.4. Pulp carotenoids content

It was found that a steadily increment in pulp carotenoids content with the advancement of storage period under the three studied temperatures in both seasons.

However, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage (15°C), the higher was fruit pulp carotenoids content and vice versa. Meanwhile, under cold storage at 10°C, extending the storage period up to three weeks increased fruit pulp carotenoids content, but prolonging the storage period up to four weeks failed to exert an additional positive effect on fruit pulp carotenoids content.

Furthermore, most tested pre-harvest treatments succeeded in increasing fruit pulp carotenoids content during storage duration in comparison with the control. This trend was true under all the studied storage temperatures with the superiority for 2% yeast-treated fruit in most cases in both seasons.

Moreover, keeping cold stored fruits at 15 and 10°C on shelf for longer period (six days) proved to be the most effective treatment for inducing higher fruit pulp carotenoids content in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf. In addition, under ambient room storage the resulted combinations indicate that the combinations of fourteen days storage period, especially 2% yeast-treated fruits had comparatively the greatest fruit pulp carotenoids content than the analogous ones of seven days storage period. Considering the interaction between storage period, days on shelf and the tested pre-harvest treatments, the resulted combinations demonstrate that days on shelf had a strong hand in determining the content of fruit pulp carotenoids, followed in action by the storage period. Therefore, the longer the period on shelf (six days) combined with longer storage duration (twenty-eight days for 15°C and twenty-one days for 10°C), the higher was fruit pulp carotenoids content and the reverse was true in most cases.

5.2.2.5. Fruit chlorophyll “a” content

Chlorophyll (a) content of Zebda mango fruits was proportionally decreased with the advancement of storage duration whether the fruit were stored under ambient room conditions (fourteen days storage period) or at 15 & 10°C cold storage (twenty-eight days storage duration). Anyhow, the rate of disappearance of fruit chlorophyll (a) content during storage under ambient room conditions was remarkably higher than under cold storage (15 & 10°C).

Moreover, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage (15 & 10°C) the higher was the decrease in fruit chlorophyll (a) content and vice versa.

In addition, most pre-harvest treatments succeeded in maintaining fruit chlorophyll (a) content during storage durations as compared with control in both seasons. This trend was true under all studied storage temperatures (ambient room, 51 and 10°C).

On the other hand, keeping cold stored fruits at 15 or 10°C on shelf for longer period (six days) resulted in increasing the decomposition of fruit chlorophyll (a) content in comparison with those freshy removed from cold stores (Zero day on shelf) or kept for three days on shelf.

Besides, under ambient room storage, the resulted combinations from the interaction between storage period and the studied pre-harvest treatments show that the combinations of seven days storage period, especially 2% $CaCl_2$-treated fruits had comparatively higher values of fruit chlorophyll (a) than the analogous ones of fourteen days storage period. As for the interaction between storage periods, days on shelf and the tested pre-harvest treatments, the obtained results indicate that days on shelf had a strong effect in determining the rate of degradation in fruit chlorophyll (a) content, followed in action by the storage period. Therefore, the longer the period on shelf (six days) combined with longer storage duration (twenty-eight days), the higher was the rate of disappearance in fruit chlorophyll (a) content during storage period and the reverse was true.

5.2.2.6. Fruit chlorophyll “b” content

Chlorophyll (b) content of Zebda mango fruits disappeared with the advancement of storage duration. Such trend was true under the three storage temperatures (ambient room, 15 and 10°C). However, the rate of disappearance in fruit chlorophyll (b) content during storage under ambient room conditions is remarkably higher than that under cold storage (15 & 10°C). Also, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage (15 & 10°C), the lower was fruit chlorophyll (b) content and vice versa.

On the other side, most tested pre-harvest treatments succeeded in reducing the decomposition rate of fruit chlorophyll (b) content under all the studied storage temperatures when compared with the control. Moreover, keeping cold stored fruits at

15 and 10°C on shelf for longer period (six days) induced the lowest fruit chlorophyll (b) content in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf. Furthermore, under ambient room conditions the highest fruit chlorophyll (b) values were recorded by the combinations of seven days storage period particularly, 75 ppm GA_3 or 2% yeast-treated fruits when compared with the analogous ones of fourteen days storage period combinations.

As for the interaction between storage period, days on shelf and the tested pre-harvest treatments, the gained results demonstrate that days on shelf had a strong role in determining the rate of loss in fruit chlorophyll (b) content followed in action by the storage period. Thereafter, the longer the period on shelf (six days) joined with longer storage period (twenty-eight days), the higher was the rate of loss in fruit chlorophyll (b) content during storage and the reverse was true. However, the combinations of 15 or 10°C-cold storage for seven days and freshy removed from cold stores (Zero day on shelf) recorded the highest fruit chlorophyll (b) values in both seasons.

5.2.2.7. Peel carotenoids content

The longer the storage period (fourteen days for ambient room conditions or twenty-eight days storage period for 15 & 10°C) the higher was peel carotenoids content in both seasons. However, the greatest fruit peel carotenoids content was scored after fourteen days under ambient room conditions, and after twenty-eight days under cold storage at 15 and 10°C. On contrary the lowest fruit peel content was recorded after seven days storage period at all the three studied temperatures.

Furthermore, fruit peel carotenoids content showed a fluctuated trend in response to tested pre-harvest treatments from one season to another. This was true under all studied storage temperatures.

Additionally, keeping cold stored fruits at 15 and 10°C on shelf for longer period (six days) resulted in increasing fruit peel carotenoids content in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf.

Besides, under ambient room storage, the resulted combinations from the interaction between the pre-harvest treatments and storage period demonstrate that the combinations of fourteen days storage period had statistically the richest fruit peel carotenoids content during storage.

Looking at the interaction between storage period, days on shelf and the tested pre-harvest treatments, the resulted combinations show that days on shelf had a strong

hand in determining the content of fruit peel carotenoids followed in action by the storage period. Consequently, the longer the period on shelf (six day) combined with longer storage duration (twenty-eight days), the highest was peel carotenoids content during storage period and the reverse was true.

Briefly, 15 or 10°C cold stored fruits for twenty-eight days, treated with 2% yeast suspension and kept for six days on shelf recorded in most cases the highest fruit peel carotenoids values.

5.2.2.8. Fruit Total Soluble Solids Percentage (T.S.S.%)

TSS percentage of Zebda mango fruits was proportionally increased with the advancement of storage period whether the fruits were stored under ambient room conditions (fourteen days storage duration) or at 15°C (twenty-eight days), while cold storage at 10°C prolonged the storage period up to three weeks with a pronounced positive effect in this respect, but extending the storage period to four weeks failed to exert an additional positive effect on fruit TSS percentage.

Besides, most tested pre-harvest treatments failed to induce an obvious trend of fruit TSS percentage under the three tested temperatures in both seasons.

Moreover, keeping cold stored fruits (15 & 10°C) on shelf for longer period (six days) induced the lowest values of fruit TSS percentage when compared with those freshy removed from cold stores (Zero day on shelf) or kept for three days on shelf.

Furthermore, under ambient room conditions, the resulted combinations show that the combination of fourteen days storage period, comparatively produced the highest values of fruit TSS percentage in comparison with seven days storage period combinations.

The interaction between storage period, days on shelf and the tested pre-harvest treatments, indicates that 15°C cold stored fruits for twenty-eight days and kept for six days on shelf recorded the highest fruit TSS values, while 10°C cold stored fruits for twenty-one days and kept for six days on shelf showed superiority in this concern.

5.2.2.9. Fruit Reducing Sugars Percentage

The increment in reducing sugars percentage of Zebda mango fruits was in proportional with the advancement of storage period. Therefore, the longer the storage duration i.e. fourteen days under ambient room conditions, the higher was fruit reducing sugar percentage and vice versa. Such trend was true only under ambient room conditions, while cold storage at 15 or 10°C took a different pattern effect, hence

fourteen days storage period predominated all studied storage period in enhancing fruit reducing sugars percentage, followed descendingly by twenty-eight days storage period, twenty-one days storage period and lastly seven days storage period.

Additionally, most tested pre-harvest treatments failed to induce an obvious trend of fruit reducing sugars percentage under the three studied temperatures in both seasons.

On the other hand, keeping cold stored fruits (15 & 10°C) on shelf for longer period (six days) resulted in increasing fruit reducing sugars percentage in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf.

Moreover, under ambient room conditions, the resulted combinations demonstrate that the interactions of fourteen days storage period showed to be the most effective combinations in producing the highest fruit reducing sugars percentages, especially when combined with $CaCl_2$ at 1% in 2003 season and tap water-treated fruits in 2004 season. The interaction between storage period, days on shelf and the tested pre-harvest treatments, indicates that days on shelf had a strong effect in determining fruit reducing sugars percentage, followed in action by the storage period. Thus, the longer the period on shelf (six days) joined with twenty-eight days storage period, the higher was fruit reducing sugars percentage.

5.2.2.10. Fruit Non Reducing Sugars Percentage

Under ambient room conditions, storage period induced a pronounced positive effect on fruit non reducing sugars percentage up to seven days only, whereas prolonging the storage period up to fourteen days failed to induce an additional positive effect in this concern. While, under cold storage at 15°C and 10°C, the increment in fruit non reducing sugars percentage was proportionally increased with the progress of storage period, hence the longer the storage period the higher was fruit non-reducing sugars percentage.

Moreover, most tested pre-harvest treatments failed to induce an obvious trend of fruit non reducing sugar percentage under the three studied temperatures in most cases.

Furthermore, keeping cold stored fruits (15 or 10°C) on shelf for longer period (six days) had significantly the highest fruit non-reducing sugars values in comparison with those freshy removed from cold stores (zero day on shelf) or kept for three days

on shelf. In addition, under ambient room conditions the resulted combinations show that the combinations of fourteen day storage period had comparatively the highest values of fruit non-reducing sugars, especially 1% yeast treated fruits in 2003 season, while in the second season the combinations of the same days storage period showed superiority in this concern particularly, 2% $CaCl_2$ treatment.

The interaction between storage period, days on shelf and the tested pre-harvest treatments, indicates that the longer the period on shelf (six days) joined with longer storage duration (twenty eight days), the higher was fruit non-reducing sugars percentage in both seasons.

5.2.2.11. Fruit Total Sugars Percentage

Fruit total sugar percentage of Zebda mango fruits was proportionally increased with the progress of storage period under the three studied temperatures. Anyhow, the highest fruit total sugars percentage was registered at the end of every storage periods under the three storage temperatures. Besides, keeping Zebda mango fruits under ambient room conditions for fourteen days or twenty-eight days under cold storage (15 & 10°C) scored the highest fruit total sugars percentage in both seasons. Furthermore, most tested pre-harvest treatments failed to induce a significant increases in fruit total sugars percentage, especially under ambient room conditions in comparison with the control.

Moreover, keeping cold stored fruits at 15 or 10°C on shelf for longer period (six days) showed to be the most effective factor for inducing the greatest fruit total sugars percentage as compared with those freshy removed from cold stores (Zero day on shelf) or kept for three days on shelf.

Besides, under ambient room storage, the resulted combinations indicate that the combinations of fourteen days storage period had comparatively higher fruit total sugars values than the analogous ones of seven days storage duration in both seasons.

Moreover, the interaction between storage period, days on shelf and the tested pre-harvest treatments, shows that days on shelf had a strong hand in determining fruit total sugars percentage, followed in action by the storage period. So, the longer the period on shelf (six days) joined with longer storage period (twenty-eight days), the higher was fruit total sugar percentage and the opposite was true. Thus, 15 or 10°C

cold stored fruits for twenty-eight days, treated with yeast at 2% and kept on shelf for six days recorded the highest fruit total sugar percentage in most cases.

5.2.2.12. Fruit total acidity Percentage

Fruit total acidity percentage was decreased as the storage period advanced. This was true under the three studied temperatures in both seasons. Besides, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage at 15 and 10°C, the higher was the decrease in fruit total acidity percentage and vice versa.

In addition, most treatments of the tested pre-harvest treatments failed to produce a distinctive effect in this respect throughout the two studied seasons under the three tested storage temperatures.

Moreover, keeping cold stored fruits (15 & 10°C) on shelf for longer period (six days) induced the highest reduction in fruit total acidity percentage when compared with those freshy removed from cold stores (zero day on shelf) or kept for three days on shelf.

Furthermore, under ambient room conditions, the resulted combinations demonstrate that the interactions of fourteen days storage period statistically induced the lowest fruit total acidity values in comparison with the analogous one of seven days storage period combinations.

The interaction between storage period, days on shelf and the tested pre-harvest treatments, indicates that the days on shelf had a strong hand in determining the content of fruit acidity, followed in action by the storage period. Thus, the longer the period storage on shelf (six days) coupled with longer duration (twenty-eight days), the lower was fruit acidity percentage in most cases and the reverse was true. Therefore, cold stored fruits at 15°C for twenty-eight days or cold stored ones at 10°C for twenty one days and kept on shelf for six days recorded the lowest values in this respect.

5.2.2.13. Fruit ascorbic acid content (Vitamin C)

Fruit ascorbic acid content of Zebda mango fruits was proportionally decreased with the advancement of storage period. This trend was true under the three studied temperatures in both seasons. However, the longer the storage duration i.e. fourteen days under ambient room conditions or twenty-eight days under cold storage (15 & 10°C), the lower was fruit ascorbic acid content and vice versa. Additionally, most tested pre-harvest treatments succeeded in maintaining fruit ascorbic acid content

under the three studied storage temperatures, with superiority for 2% $CaCl_2$ treatment in both seasons.

Furthermore, freshy fruits removed from cold stores (zero day on shelf) appeared to be the most effective one for producing the richest fruit ascorbic acid content in comparison with those kept for longer period on shelf (six days) or three days on shelf.

Moreover, under ambient room conditions, the resulted combinations demonstrate that the interactions of seven days storage period had significantly the highest values of fruit ascorbic acid content as compared with the analogous ones of fourteen days storage period. So, seven days room stored fruits treated with 2% $CaCl_2$ statistically recorded the highest values in this respect.

The interaction between storage period, days on shelf and the tested pre-harvest treatments, the resulted combinations illustrate that the shorter the period on shelf (zero day) combined with shorter storage duration (seven days), the higher was fruit ascorbic acid content and the reverse was true.

Conclusively, to enhance storability and marketability of Zebda mango fruits, it is advisable to pre-harvest spray Zebda mango fruits three times a year (The first spray was done after fruit setting stability, meanwhile the others two sprays were carried out thereafter at three weeks intervals) with 2% calcium chloride or 50 ppm gibberellin and keeping treated fruits after harvesting under storage at 15°C and 90-95% R.H.

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محاولات لتحسين الصفات التسويقية وإطالة العمر التخزينى لثمار الكاكى والمانجو

تشتمل هذه الدراسة على جزئين رئيسيين هما :-

الجزء الأول **محاولات لتحسين بعض الصفات التسويقية "الإنضاج" والمقدرة التخزينية لثمار الكاكى كوستاتا.**

ويحتوى الجزء الأول من الدراسة على تجربتين هما :-

التجربة الأولى **تأثير بعض المواد الكيماوية على بعض الصفات التسويقية "الإنضاج" لثمار الكاكى كوستاتا.**

التجربة الثانية **تأثير بعض معاملات ما بعد الحصاد على المقدرة التخزينية لثمار الكاكى كوستاتا.**

الجزء الثاني **محاولات لتحسين المقدرة التخزينية لثمار المانجو زبده من خلال إستخدام بعض معاملات ما قبل الحصاد.**

ومن ثم فإن هذه الدراسة قد تم تناولها كالآتى :-

الجزء الأول **محاولات لتحسين بعض الصفات التسويقية "الإنضاج" والمقدرة التخزينية لثمار الكاكى كوستاتا.**

هذا الجزء من الدراسة قد تم إجراءه فى معمل تداول وتخزين الثمار بقسم البساتين بكلية الزراعة – جامعة بنها – محافظة القليوبية.

التجربة الأولى: تأثير بعض المواد الكيماوية على بعض الصفات التسويقية "الإنضاج" لثمار الكاكى كوستاتا.

جمعت ثمار الكاكي صنف كوستاتا المكتملة النمو فى منتصف شهر أكتوبر خلال موسمى ٢٠٠٣ و٢٠٠٤م من أشجار عمرهما ١٥ سنة منزرعة فى تربة طينية طميية بمزرعة محطة البحوث بالقناطر والتابعة لمعهد بحوث البساتين بمحافظة القليوبية ، الأشجار المثمرة المنتخبة متماثلة تقريبا في نموها وإثمارها وتلاقي العمليات البستانية الموصى بها فى المنطقة، وتم نقل الثمار المجموعة مباشرة إلى معمل تداول وتخزين الثمار بقسم البساتين بكلية الزراعة - جامعة بنها. حيث تم فرز الثمار بعد حصادها بإستبعاد الثمار المشوهة والمجروحة والمصابة وأختيرت الثمار السليمة والمتماثلة وغسلت بماء الصنبور ثم غمست فى محلول البوراكس (٥%) كمطهر

فطرى ثم تم غسلها بماء الصنبور وبعد ذلك جففت الثمار باستخدام مراوح كهربائية وأجرى لها فرز آخر لإستبعاد أي ثمار قد عرضت للإصابة أثناء إجراء هذه العمليات.

هذا وقد تم تقسيم هذه الثمار إلى مجموعتين رئيسيتين حيث خضعت ثمار المجموعة الأولى لمعاملات الإنضاج كمحاولة لدراسة كفاءة بعض المعاملات الكيماوية في الإسراع من عمليات النضج والحصول على ثمار متماثلة النضج (ناضجة) فى وقت قصير وذات صفات تسويقية جيدة، بينما خضعت ثمار المجموعة الثانية لدراسة كفاءة بعض معاملات ما بعد الحصاد على إطالة العمر التخزيني لثمار الكاكى.

المجموعة الأولى من ثمار الكاكى "كوستاتا" المختارة والمتماثلة تقريبا تم تقسيمها إلى خمس مجموعات لإجراء إحدى معاملات النضج عليها كالأتى:-

١- الإيثيفون : تم نقع ثمار الكاكي "كوستاتا" المكتملة النمو والمتماثلة في محاليل الإيثيفون بتركيز ٥٠٠ ، ١٠٠٠ جزء فى المليون لمدة خمس دقائق.

٢- كربيد الكالسيوم : تم معاملة ثمار الكاكي "كوستاتا" بكربيد الكالسيوم بمعدل ٢,٥ ، ٥ جم/صندوق ثمار(حوالي٤ كجم ثمار).

٣- المقارنة : تم غمس ثمار الكاكي في الماء لمدة خمس دقائق لمقارنتها بالثمار المعاملة بالإيثيفون و كربيد الكالسيوم.

بعد إجراء المعاملات، تم وضع الثمار المعاملة تحت ظروف الغرفة (٣٠±٣ مْ و ٦٥-٧٠ % رطوبة نسبية). وقد تم تقدير القراءات الأولية للصفات المدروسة قبل إجراء المعاملات وعلى فترات دورية كل يومين خلال فترة النضج.

تم تعبئة جميع الثمار المعاملة بعد إجراء المعاملة مباشرة فى صناديق بلاستيك مقاس ٤٢ × ٢٨ × ١٢سم والتى سبق معاملتها بسيفادكس (Cifadex) كمطهر فطرى، وتم تغليف الصناديق بالبولى إيثيلين بحيث يحتوى كل صندوق على ٣٥ ثمرة. صممت التجربة بنظام القطاعات كاملة العشوائية وتحتوى كل معاملة على ثلاث مكررات وكل مكررة ممثلة بصندوقين ، أحدهما خصص لتقدير الصفات الطبيعية (نسبة النضج ، الفقد فى الوزن ، التالف ، صلابة الثمار) بينما خصص الصندوق الثاني لتقدير الصفات الكيماوية (كاروتين ، سكريات كلية ، مواد صلبة ذائبة كلية ، حموضة ، أسكوربيك أسيد ، تانينات).

ويمكن تلخيص أهم النتائج المتحصل عليها كالآتى:-

١ - النسبة المئوية لثمار الكاكى الناضجة

إزدادت النسبة المئوية لإنضاج ثمار الكاكي كوستاتا تزايداً تصاعدياً مع طول فترة الإنضاج، فكلما إمتدت فترة النضج كلما زادت النسبة المئوية للإنضاج والعكس صحيح، وتم الوصول إلى أكبر نسبة إنضاج بعد ثمانية أيام من إجراء معاملات النضج في حين كانت أقل نسبة إنضاج بعد يومين من إجراء معاملات النضج. كما وجد أن جميع معاملات النضج المستخدمة قد نجحت فى زيادة النسبة المئوية للنضج خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء فى المليون.

وإزداد تأثير فترة النضج بتدعيمها بمواد النضج الكيماوية وتركيزاتها ، فقد وجد أنه بعد ثمانية أيام من إجراء المعاملات قد سجلت أعلى نسبة إنضاج (ما عدا معاملة المقارنة) بينما بعد يومين من إجراء المعاملات كانت أقل نسبة إنضاج خاصة معاملة المقارنة.

٢ - النسبة المئوية للفقد فى الوزن

إزداد الفقد في وزن ثمار الكاكى بدرجة واضحة بتقدم فترة النضج، حيث سجلت أعلي نسبة مئوية للفقد فى الوزن بعد ثمانية أيام من إجراء معاملات الإنضاج بينما كانت أقل نسبة مئوية للفقد فى الوزن بعد يومين من إجراء المعاملات. وأدت جميع معاملات النضج المستخدمة إلى زيادة نسبة الفقد فى الوزن خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء فى المليون ، علاوة على ذلك فقد لوحظ أعلي نسبة للفقد فى الوزن بعد ثمانية أيام من إجراء معاملات النضج وعلى العكس سجلت أقل نسبة للفقد فى الوزن بعد يومين من إجراء معاملات النضج.

٣ - النسبة المئوية للثمار التالفة

أوضحت النتائج المتحصل عليها أن النسبة المئوية للثمار التالفة تزداد بزيادة فترة النضج، حيث وجد أنه كلما طالت فترة النضج كلما زادت نسبة التالف والعكس صحيح ، وسجلت أعلى نسبة تالف بعد ثمانية أيام من إجراء معاملات النضج بينما كانت أقل نسبة تالف بعد يومين من إجراء المعاملات. بالإضافة إلى ذلك فقد أدت جميع معاملات الإنضاج إلى زيادة النسبة المئوية للثمار التالفة خاصة معاملتي الأيثيفون.

وأعطت تفاعلات الثمانية أيام من إجراء معاملات النضج أعلى نسبة تالف خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء في المليون بينما سجلت أقل نسبة تالف بعد يومين من إجراء معاملات النضج خاصة معاملة المقارنة.

٤ - صلابة الثمار

وجد أن ثمار الكاكى تفقد صلابتها مع طول فترة النضج حيث كانت الثمار أكثر صلابة بعد يومين من إجراء معاملات الإنضاج بينما كانت الثمار أقل صلابة بعد ثمانية أيام من إجراء

معاملات النضج. وقد أدت جميع معاملات الإنضاج المستخدمة إلى نقص فى صلابة الثمار خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء فى المليون إذا ما قورنت بمعاملة المقارنة، بالإضافة إلى ذلك فقد لوحظت أكبر قيم لصلابة الثمار بعد يومين من إجراء المعاملات خاصة معاملة المقارنة بينما سجلت أقل قيم لصلابة الثمار بعد ثمانية أيام من إجراء معاملات النضج (ماعدا ثمار المقارنة).

٥ - محتوى الثمار من الكاروتين

وجد أن الزيادة فى محتوى الثمار من الكاروتين متوازية مع إمتداد فترة الإنضاج ولوحظ أن أعلى محتوى للثمار من الكاروتين بعد ثمانية أيام من إجراء معاملات الإنضاج بينما كان أقل محتوى للثمار من الكاروتين بعد يومين من إجراء معاملات النضج.وأدت جميع معاملات النضج المستخدمة إلى زيادة واضحة فى محتوى الثمار من الكاروتين وقد أظهرت معاملات الإيثيفون تفوقها فى ذلك فى معظم الحالات. كذلك وجد أن تفاعلات الثمانية أيام من إجراء معاملات النضج قد أعطت أعلى محتوى للثمار من الكاروتين بينما كانت أقل القيم لمحتوى الثمار من الكاروتين قد ظهر مع تفاعلات ما بعد يومين من إجراء المعاملات.

٦ - محتوى الثمار من السكريات الكلية

إزداد محتوى ثمار الكاكى من السكريات الكلية كلما طالت فترة النضج والعكس صحيح لذلك أنتجت فترة ثمانية أيام من إجراء المعاملات أغنى الثمار فى محتواها من السكريات الكلية بينما أنتجت فترة يومين من إجراء الإنضاج أقل محتوى من السكريات الكلية. وقد نجحت جميع معاملات الإنضاج المستخدمة فى زيادة محتوى الثمار من السكريات الكلية خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء فى المليون. كما وجد أن تفاعلات الثمانية أيام من إجراء معاملات النضج قد أعطت أكبر محتوى للثمار من السكريات الكلية وعلى العكس فقد أعطت تفاعلات ما بعد يومين من إجراء المعاملات أقل القيم فى المحتوى من السكريات الكلية.

٧ - المواد الصلبة الذائبة الكلية

إنخفض محتوى ثمار الكاكي "كوستاتا" من المواد الصلبة الذائبة الكلية بطول فترة النضج حيث سجل أقل محتوى للثمار من المواد الصلبة الذائبة الكلية بعد ثمانية أيام من إجراء معاملات الإنضاج بينما سجل أعلي محتوى للثمار من المواد الصلبة الذائبة الكلية بعد يومين من إجراء المعاملات ، بالإضافة إلى ذلك فقد أدت جميع معاملات النضج المستخدمة إلى تقليل محتوى الثمار من المواد الصلبة الذائبة الكلية خاصة معاملة الإيثيفون بتركيز ١٠٠٠ جزء فى المليون مقارنة بباقي المعاملات شاملة معاملة المقارنة التي سجلت أعلى محتوى للثمار من المواد الصلبة الذائبة الكلية. وبالنسبة لتأثير التفاعل ما بين فترة النضج ومواد الإنضاج المستخدمة وتركيزاتها فقد أعطت تفاعلات يومين من إجراء معاملات الإنضاج أعلى القيم فى محتوى الثمار من المواد

الصلبة الذائبة الكلية خاصة معاملة المقارنة وعلى العكس سجلت تفاعلات الثمانية أيام من إجراء معاملات النضج أقل محتوى للثمار من المواد الصلبة الذائبة الكلية.

٨ - النسبة المئوية للحموضة

إنخفض النسبة المئوية لحموضة الثمار بطول فترة النضج حيث سجلت أقل نسبة حموضة بعد ثمانية أيام من إجراء معاملات الإنضاج بينما كانت أعلى نسبة حموضة في الثمار بعد يومين من إجراء معاملات الإنضاج ، علاوة على ذلك فقد نجحت جميع معاملات الإنضاج المستخدمة فى خفض النسبة المئوية للحموضة خاصة معاملة الثمار بالإيثيفون بكلا تركيزيه (٥٠٠ ، ١٠٠٠ جزء فى المليون)، بجانب ذلك فقد أعطت تفاعلات الثمانية أيام من إجراء المعاملات (ما عدا معاملة المقارنة) أقل قيم لحموضة الثمار خاصة المعاملة بالإيثيفون تركيز ١٠٠٠ جزء فى المليون (متوسط الموسمين).

٩ - محتوي الثمار من حمض الإسكوربيك (فيتامين ج)

إنخفض محتوى الثمار من حمض الإسكوربيك(فيتامين ج) مع طول فترة التخزين حيث سجل أعلى محتوى للثمار من فيتامين (ج) بعد يومين من إجراء معاملات النضج بينما كان أقل محتوى بعد ثمانية أيام من إجراء المعاملات ، كما أدت جميع المعاملات المستخدمة إلى نقص معنوى فى محتوى الثمار من حمض الإسكوربيك إذا ما قورنت بمعاملة المقارنة .وأدت تفاعلات اليومين من إجراء المعاملات خاصة الثمار غير المعاملة (المقارنة) إلي زيادة قيم حمض الإسكوربيك ، بينما سجلت تفاعلات الثمانية أيام من إجراء معاملات الإنضاج (ما عدا معاملة المقارنة) أقل القيم فى محتوى الثمار من حمض الإسكوربيك .

١٠ - محتوى الثمار من التانينات

نقص محتوى ثمار الكاكي "كوستاتا" من التانينات بزيادة فترة النضج فقد كانت أعلى قيم لمحتوي الثمار من التانينات بعد مرور يومين من إجراء معاملات الإنضاج ، بينما سجلت أقل القيم بعد مرور ثمانية أيام من إجراء معاملات الإنضاج ، كما حققت جميع معاملات الإنضاج المختبرة إنخفاضاً في محتوى الثمار من التانينات خاصة المعاملة بالإيثيفون بتركيز ١٠٠٠ جزء فى المليون مقارنة بباقى المعاملات شاملة معاملة المقارنة ، وكانت نتائج تفاعلات الثمانية أيام بعد إجراء معاملات النضج أقل القيم فى محتوى الثمار من التانينات خاصة فى الثمار المعاملة بالإيثيفون تركيز ١٠٠٠ جزء فى المليون.

وبناء على نتائج هذه التجربة ، فإنه للحصول على ثمار مبكرة النضج ، ومتماثلة في نضجها ، مع الحد من نسبة الثمار التالفة بدرجة ملحوظة وتحسين الصفات الأكلية لثمار الكاكى صنف كوستاتا ، فإن أفضل المعاملات هى غمس الثمار في محلول الإثيفون بتركيز ٥٠٠

جزء/المليون لمدة خمس دقائق أو معاملة الثمار بكربيد الكالسيوم بمعدل ٢,٥ جم / صندوق ثمار (حوالي ٤ كجم ثمار).

التجربة الثانية: تأثير بعض معاملات ما بعد الحصاد على المقدرة التخزينية لثمار الكاكى كوستاتا

نقعت المجموعة الثانية من ثمار الكاكى المنتخبة والمتماثلة في محلول الإيثيفون تركيز ٥٠٠ جزء فى المليون لمدة خمس دقائق لتحفيز الثمار على النضج ثم قسمت الثمار بعد ذلك إلى ست مجموعات لإجراء المعاملات الآتية :-

(١) كلوريد الكالسيوم : نقعت ثمار الكاكي المكتملة النمو لمدة خمس دقائق فى محاليل كلوريد الكالسيوم تركيز ٢ ، ٤% ثم جففت الثمار هوائياً.

(٢) الخميرة : نقعت ثمار الكاكي "كوستاتا" المكتملة النمو والمتماثلة فى مستخلص الخميرة تركيز ١ ، ٢% لمدة خمس دقائق ثم جففت الثمار فى هوائياً.

(٣) هيبوكلوريت الصوديوم : نقعت ثمار الكاكي المكتملة النمو والمنتخبة فى محلول هيبوكلوريت الصوديوم تركيز ٢% لمدة خمس دقائق ثم جففت الثمار هوائياً.

(٤) معاملة المقارنة : نقعت ثمار الكاكي المنتخبة والكاملة النمو والمتماثلة فى ماء الصنبور لمدة خمس دقائق لمقارنتها بمعاملات كلوريد الكالسيوم والخميرة و هيبوكلوريت الصوديوم.

واشتملت هذه التجربة على ثلاث درجات حرارة هى: الغرفة العادية (٣٠±٣ ْم، ٦٥-٧٠% رطوبة نسبية) ، درجة حرارة تبريد ٥ ْم و ٨٥ ± ٢% رطوبة نسبية ودرجة حرارة تبريد صفر ْم و ٨٥ ± ٢% رطوبة نسبية بالإضافة إلي ست معاملات ما بعد الحصاد تحت كل درجة حرارة مستخدمة. هذا وقد تم تقدير القيم الأولية (المبدئية) لجميع الصفات المدروسة قبل إجراء المعاملات وكذلك على فترات دورية كل أسبوع خلال فترة التخزين على درجات الحرارة المستخدمة (الغرفة العادية، ٥ ْم، صفر ْم).

تم تعبئة جميع الثمار المعاملة بحرص فى صناديق بلاستيك مفتوحة مقاس (٤٢ × ٢٨ × ١٢سم) والتى سبق تعقيمها بالسيفادكس (Cifadex) كمطهر فطرى ، وقد تم وضع ٣٥ ثمرة كاكى فى كل صندوق (حوالي ٤ كجم ثمار).ورتبت معاملات ما بعد الحصاد المختبرة فى قطاعات كاملة العشوائية وكررت كل معاملة ثلاث مرات بحيث تحتوى كل مكررة على صندوقين أحدهما خصص لتقدير الصفات الطبيعية للثمار(النسبة المئوية للفقد فى الوزن – النسبة المئوية للتالف – صلابة الثمار – مدة بقاء الثمار تحت ظروف الغرفة العادية days on shelf) بينما خصص

الصندوق الثانى لتقدير صفات الثمار الكيماوية (الكاروتين – السكريات الكلية – المـواد الـصلبة الذائبة الكلية – الحموضة – التانينات – حمض الإسكوربيك).

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى :-

١ - النسبة المئوية للفقد فى الوزن

حدث نقص فى ثمار الكاكي "كوستاتا" بتقدم فترة التخزين تحت درجات الحـرارة الثلاثـة المستخدمة ، وجد أن أقل فقد فى الوزن بعد ٧ أيام من التخزين تحت درجات الحـرارة الثلاثـة المستخدمة بينما كان أكبر فقد فى الوزن بعد ٢١ يوم من التخزين فى موسم ٢٠٠٣م وبعـد ١٤ يوم فى موسم ٢٠٠٤م وذلك تحت ظروف تخزين الغرفة العادية أو بعد ٤٢ يوم من التخزين تحت التخزين المبرد على درجات حرارة ٥ أو صفر ْ مئوي. كما وجد أن معظم معاملات ما بعد الحصاد قد حققت إنخفاضاً فى النسبة المئوية للفقد فى وزن الثمار ، وأظهرت الثمار المعاملـة بكلوريـد الكالسيوم تركيز ٢% تحت ظروف الغرفة العادية والمعاملة بهيبوكلوريت الصوديوم تركيـز ٢% (متوسط الموسمين) تحت التخزين المبـرد علـى درجـة ٥ ْم والمعاملـة بكلوريـد الكالـسيوم تركيز ٤% والمعاملة بهيبوكلوريت الصوديوم تركيز ٢% (متوسط الموسـمين) تحـت التخـزين المبرد على درجة صفر ْم أقل القيم للفقد فى الوزن. أما بالنسبة لتأثير التفاعل بين فترة التخـزين ومعاملات ما بعد الحصاد المستخدمة) فقد أوضحت النتائج أن تفاعلات السبعة أيام تخـزين قـد أعطت أقل نسب للفقد فى وزن الثمار تحت درجات حرارة التخزين المختلفة خاصـة فـى الثمـار المعاملة بهيبوكلوريت الصوديوم ٢% (متوسط الموسمين).

٢ - النسبة المئوية للثمار التالفة

أوضحت النتائج أن النسبة المئوية للثمار التالفة تزداد بزيادة فترة التخزين تحت درجـات الحرارة المختلفة ، حيث سجلت أقل نسبة ثمار تالفة بعد سبعة أيام من التخزين تحـت درجـات الحرارة الثلاثة المستخدمة ، بينما كانت أعلي نسبة ثمار تالفة بعد ٢١ يوم تخزين خلال موسـم ٢٠٠٣م ، ١٤ يوم خلال موسم ٢٠٠٤م تحت ظروف تخزين الغرفة أو بعد ٤٢ يوم تخزين مبرد على درجة حرارة ٥ أو صفر ْمئوى. وقللت معظم معاملات ما بعد الحصاد نسبة الثمـار التالفـة وذلك تحت التخزين المبرد (٥، صفر ْم)، فقد أعطت المعاملة بهيبوكلوريـت الـصوديوم ٢% أو بكلوريد الكالسيوم ٤% تحت ظروف التخزين المبرد (٥، صفر ْم) أقل نسبة ثمار تالفة بينما لـم تحقق فى إظهار أى فروق معنوية تحت ظروف تخزين الغرفة العادية.

وبالنسبة لتأثير التفاعل بين مدة التخزين ومعاملات ما بعد الحصاد فقد أعطـت تفـاعلات السبعة أيام تخزين تحت درجات حرارة التخزين المختلفة أقل نسبة مئوية للثمار التالفة وخاصـة عند التخزين على درجات حرارة التبريد (٥، صفر ْم) حيث لوحظ عدم وجود أى ثمار تالفـة فـى

كلا الموسمين، وعلى العكس فقد سجلت تفاعلات ٢١ يوم فترة تخزين فى موسم ٢٠٠٣م و ١٤ يوم فترة تخزين فى موسم ٢٠٠٤م تحت ظروف تخزين الغرفة ، أو بعد ٤٢ يوم من التخزين المبرد (٥، صفر ْم) أعلي نسبة مئوية للثمار التالفة .

٣ - صلابة الثمار

انخفضت صلابة ثمار الكاكى "صنف كوستاتا" مع تقدم فترة التخزين تحت درجات حرارة التخزين المختلفة (الغرفة، ٥، صفر ْم). وعموماً فقد سجلت أعلي قيم لصلابة الثمار قد سجلت بعد سبعة أيام من التخزين تحت درجات الحرارة الثلاثة المستخدمة، بينما لوحظت أقل قيم لصلابة الثمار بعد ٢١ يوم تخزين فى موسم ٢٠٠٣م و١٤ يوم فى موسم ٢٠٠٤م تحت ظروف تخزين الغرفة أو بعد ٤٢ يوم تخزين مبرد (٥، صفر ْم). وحسنت معظم معاملات ما بعد الحصاد من صلابة الثمار تحت درجات حرارة التخزين الثلاث المختبرة خاصة معاملة كلوريد الكالسيوم بتركيز ٤% التى أظهرت تفوقها فى المحافظة على صلابة الثمار فى معظم الحالات.

وأحدثت تفاعلات سبعة أيام تخزين تحت درجات حرارة التخزين المختلفة أعلى قيم لصلابة الثمار خاصة فى الثمار المعاملة بهيبوكلوريت الصوديوم تركيز ٢% تحت ظروف تخزين الغرفة، في حين تفوقت فى ذلك معاملة كلوريد الكالسيوم بتركيز ٤% فى معظم حالات التخزين المبرد (٥، صفر ْم). وعلى العكس من ذلك وجد أن أقل الثمار صلابة الناتجة من تفاعلات ٢١ يوم تخزين في موسم ٢٠٠٣ م و ١٤ يوم مدة تخزين فى موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة أو تفاعلات ٤٢ يوم تخزين تحت درجات حرارة التخزين المبرد (٥، صفر ْم).

٤ - المقدرة التسويقية للثمار بعد إخراجها من التخزين المبرد Fruit shelf life (مدة بقاء الثمار تحت ظروف الغرفة بعد إخراجها من التخزين المبرد)

حسنت معظم معاملات ما بعد الحصاد المختبرة من المقدرة التسويقية للثمار بعد إخراجها من المخازن المبردة خاصة الثمار المعاملة بهيبوكلوريت الصوديوم بتركيز ٢% و كلوريد الكالسيوم بتركيز ٤% حيث أعطت أقل نسبة تالف للثمار فى موسم ٢٠٠٣ م. بينما تفوقت معاملات هيبوكلوريت الصوديوم ٢% و كلوريد الكالسيوم ٢ ، ٤% عن باقى المعاملات فى إعطاء أقل نسبة تالف فى موسم ٢٠٠٤م خلال فترة التسويق ما بعد التخزين المبرد.

٥ - محتوى الثمرة من الكاروتين

إزداد محتوى الثمار من الكاروتين بإطالة فترة التخزين تحت درجات حرارة التخزين المستخدمة (الغرفة ، ٥ ، صفر ْم) ، فكلما طالت فترة التخزين إزداد محتوى الثمرة من الكاروتين، وسجل أعلى محتوى للكاروتين فى الثمار بعد ٢١ يوم تخزين في موسم ٢٠٠٣ م وبعد ١٤ يوم فى موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة أو بعد ٤٢ يوم تخزين مبرد (٥ ،

صفر ْم). كذلك حققت معظم معاملات ما بعد الحصاد المستخدمة تحسناً في محتوى الثمار من الكاروتين. وعموماً فقد أعطت معاملات ٢% هيبوكلوريت الصوديوم تحت ظروف التخزين في الغرفة العادية، ١% مستخلص الخميرة تحت درجة حرارة تخزين مبرد ٥ ْم و٢% هيبوكلوريت الصوديوم تحت ظروف التخزين المبرد (صفر ْم) أعلى محتوى للكاروتين فى الثمار (متوسط الموسمين).

أوضحت النتائج أن تفاعلات ٢١ يوم مدة تخزين فى موسم ٢٠٠٣م وتفاعلات ١٤ يوم فى موسم ٢٠٠٤ م تحت ظروف الغرفة العادية خاصة معاملة الثمار بمستخلص الخميرة تركيز ١%، وتفاعلات ٤٢ يوم تخزين مبرد (٥ ْم) خاصة معاملة مستخلص الخميرة ١% ومعاملة هيبوكلوريت الصوديوم على درجة حرارة تخزين صفر ْم قد سجلت أعلى محتوى للثمار من الكاروتين ، وعلى العكس أحدثت تفاعلات ٧ أيام تخزين تحت درجات حرارة التخزين المستخدمة أقل محتوى للثمار من الكاروتين.

٦ - محتوى الثمرة من السكريات الكلية

إزداد محتوى الثمرة من السكريات الكلية بزيادة فترة التخزين تحت درجات حرارة التخزين الثلاث المستخدمة في كلا الموسمين ، فقد سجلت ٧ أيام تخزين تحت درجات حرارة التخزين المختلفة (الغرفة، ٥، صفر ْم) أقل محتوى للثمرة من السكريات الكلية ، في حين سجل أعلى محتوى للثمار من السكريات الكلية بعد ٢١ يوم تخزين فى موسم ٢٠٠٣ م ، ١٤ يوم فى موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة العادية، وبعد ٤٢ يوم مدة تخزين مبرد (٥، صفر ْم) خلال موسمى الدراسة. كما أوضحت النتائج أن معاملات الخميرة بتركيز ٢% تحت ظروف الغرفة العادية ، الخميرة تركيز ١% للتخزين المبرد (٥ ْم) والخميرة بتركيز ٢% للتخزين المبرد (صفر ْم) كانت أفضل المعاملات فى زيادة محتوى الثمرة من السكريات الكلية كمتوسط للموسمين. أدت تفاعلات ٢١ يوم تخزين في موسم ٢٠٠٣م وتفاعلات ١٤ يوم تخزين في موسم ٢٠٠٤م خاصة معاملة الخميرة بتركيز ٢% تحت ظروف تخزين الغرفة العادية و تفاعلات ٤٢ يوم تخزين مبرد(٥ ْم) خاصة معاملات الخميرة ١ ، ٢% ومعاملات هيبوكلوريت الصوديوم ٢% فى موسم ٢٠٠٣ م والخميرة ٢% فى موسم ٢٠٠٤ م تحت درجة حرارة تبريد صفر ْم إلى زيادة واضحة في محتوى الثمار من السكريات الكلية مقارنة بباقى التفاعلات.

٧ - محتوى الثمرة من المواد الصلبة الذائبة الكلية

نقص محتوى الثمرة من المواد الصلبة الذائبة الكلية بتقدم فترة التخزين تحت درجات حرارة التخزين المختلفة فى كلا الموسمين. وسجل أعلى محتوى للثمرة من المواد الصلبة الذائبة الكلية بعد ٧ أيام تخزين تحت درجات حرارة التخزين المختلفة ، بينما لوحظ أقل محتوى للثمرة من المواد الصلبة الذائبة الكلية بعد ٢١ يوم تخزين فى موسم ٢٠٠٣ م ، ١٤ يوم فى موسم

٢٠٠٤م تحت ظروف تخزين الغرفة العادية ، وبعد ٤٢ يوم تحت التخزين المبرد (٥ ، صفر ْم). كما أثرت معظم معاملات ما بعد الحصاد إيجابياً على محتوى الثمرة من المواد الصلبة الذائبة الكلية فى كلا الموسمين خاصة المعاملة بكلوريد الكالسيوم ٤% التى أدت إلى زيادة واضحة في محتوى الثمار من المواد الصلبة الذائبة الكلية تحت درجات حرارة التخزين المختلفة (متوسط للموسمين) ، وأعطت تفاعلات ٧ أيام تخزين خاصة معاملة كلوريد الكالسيوم ٤% تحت ظروف تخزين الغرفة العادية والمعاملة بهيبوكلوريت الصوديوم ٢% تحت التخزين المبرد (٥ ْم) والمعاملة بكلوريد الكالسيوم ٤% تحت التخزين المبرد (صفر ْم) أعلى نسبة مئوية للمواد الصلبة الذائبة الكلية (متوسط الموسمين).

٨- محتوى الثمرة من الحموضة الكلية

نقص محتوى ثمار الكاكي كوستاتا من الحموضة بانتظام بتقدم فترة التخزين سواء كان تخزين الثمار تحت ظروف الغرفة العادية أو تحت درجات حرارة التخزين المبرد (٥، صفر ْم) ، كما وجد أن معدل نقص الحموضة خلال فترة التخزين تحت ظروف الغرفة العادية كان أعلى من معدل النقص تحت ظروف التخزين المبرد (٥، صفر ْم) ، ومن جهة أخرى فقد أدت معظم معاملات ما بعد الحصاد المستخدمة إلى زيادة ملحوظة فى محتوى الثمار من الحموضة مقارنة بالثمار الغير معاملة (المقارنة). وقد سجلت الثمار المعاملة بهيبوكلوريت الصوديوم ٢% اعلى القيم فى محتواها من الحموضة تحت درجات حرارة التخزين الثلاثة المستخدمة فى كلا موسمي الدراسة.

أما بالنسبة لتأثير التفاعل بين فترة التخزين ومعاملات ما بعد الحصاد المستخدمة فقد أعطت تفاعلات ٢١ يوم تخزين في موسم ٢٠٠٣ م، ١٤ يوم تخزين في موسم ٢٠٠٤م تحت ظروف تخزين الغرفة العادية ، وتفاعلات ٤٢ يوم تخزين تحت درجات حرارة التبريد (٥، صفر ْم) أقل محتوى للثمار من الحموضة.

٩- محتوى الثمرة من التانينات

توجد علاقة عكسية بين محتوى ثمار الكاكي كوستاتا من التانينات و فترة التخزين تحت درجات حرارة التخزين المختلفة فى كلا الموسمين فإطالة فترة التخزين إلى ٢١ يوم في موسم ٢٠٠٣ م، ١٤ يوم فى موسم ٢٠٠٤ م تحت ظروف الغرفة العادية أو ٤٢ يوم تحت التخزين المبرد على درجات حرارة ٥، صفر ْم أدى إلى تقليل محتوى الثمار من التانينات والعكس. كما حققت معظم معاملات ما بعد الحصاد المختبرة انخفاضا واضحاً في محتوى الثمار من التانينات خاصة معاملة الخميرة بتركيز ٢% وذلك تحت درجات حرارة التخزين المختلفة (الغرفة العادية،

٥،

صفر ْم). وسجلت تفاعلات ٢١ يوم تخزين في موسم ٢٠٠٣ م و تفاعلات ١٤ يوم فى موسم ٢٠٠٤ م أقل محتوى للثمار من التانينات تحت ظروف تخزين الغرفة العادية خاصة الثمار المعاملة بالخميرة ٢% فى كلا الموسمين ، بينما سجلت تفاعلات ٤٢ يوم تخزين خاصة الثمار المعاملة بهيبوكلوريت الصوديوم ٢% تحت التخزين المبرد (٥ ْم) والثمار المعاملة بالخميرة ٢% تحت التخزين المبرد (صفر ْم) أقل محتوى للثمار من التانينات.

١٠- محتوى الثمرة من حمض الإسكوربيك

انخفض محتوى ثمار الكاكي كوستاتا من حمض الإسكوربيك بإطالة فترة التخزين تحت درجات حرارة التخزين المختلفة (الغرفة العادية ، ٥ ْم ، صفر ْم) فإطالة فترة التخزين لمدة ٢١ يوم فى موسم ٢٠٠٣م و ١٤ يوم في موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة العادية أو لمدة ٤٢ يوم تحت درجات حرارة التخزين المبرد (٥، صفر ْم) أدى إلى إنخفاض محتوى الثمرة من حمض الإسكوربيك. حسنت معظم معاملات ما بعد الحصاد من محتوى ثمار الكاكي كوستاتا من حمض الإسكوربيك خلال التخزين خاصة المعاملة بهيبوكلوريت الصوديوم ٢% تحت ظروف تخزين الغرفة العادية ، ومعاملة كلوريد الكالسيوم ٤ % تحت درجة حرارة تخزين ٥ ْم ، ومعاملة الخميرة ٢% تحت درجة حرارة تخزين(صفر ْم) في موسم ٢٠٠٣ م ومعاملة كلوريد الكالسيوم ٤% فى موسم ٢٠٠٤م.

أعطت تفاعلات ٧ أيام تخزين خاصة معاملة كلوريد الكالسيوم ٤% فى موسم ٢٠٠٣ م ومعاملة هيبوكلوريت الصوديوم ٢% فى موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة العادية ومعاملة كلوريد الكالسيوم ٤% تحت درجة حرارة تخزين (٥ ْم) ومعاملة الخميرة ٢% تحت درجة حرارة تخزين (صفر ْم) لموسم ٢٠٠٣م ومعاملة كلوريد الكالسيوم فى موسم ٢٠٠٤ م أعلى محتوى للثمار من حمض الإسكوربيك، وعلى العكس سجل أقل محتوى للثمار من حمض الإسكوربيك مع تفاعلات ٢١ يوم تخزين في موسم ٢٠٠٣م وتفاعلات ١٤ يوم فى موسم ٢٠٠٤ م تحت ظروف تخزين الغرفة العادية ، وتفاعلات ٤٢ يوم تخزين تحت درجات حرارة التخزين المبرد (٥ ْم ، صفر ْم) خلال موسمى الدراسة.

ومن ثم، فإنه لزيادة المقدرة التخزينية والتسويقية مع المحافظة على الصفات الأكلية لثمار الكاكي كوستاتا، تعتبر معاملة نقع الثمار في محلول كلوريد الكالسيوم بتركيز ٤% أو هيبوكلوريت الصوديوم بتركيز ٢% لمدة خمس دقائق وتخزين الثمار المعاملة على درجة صفر أو ٥ درجة مئوى لمدة ٤٢ يوم من أفضل المعاملات فى هذا الصدد.

الجزء الثاني **محاولات لتحسين المقدرة التخزينية لثمار المانجو صنف زبده ببعض معاملات ما قبل الحصاد .**

(١) التأثير الأولى (المبدئي) لبعض معاملات ما قبل الحصاد على بعض الصفات التسويقية لثمار المانجو زبده.

في هذه التجربة اختيرت أشجار مانجو صنف زبده عمرها ٢٠ عام ومتماثلة في النمو والإثمار ومنزرعة في تربة رملية طميية بقرية عرب الغديري بمحافظة القليوبية. لإجراء هذه الدراسة.

رشت الأشجار المنتخبة خلال موسمي٢٠٠٣م ، ٢٠٠٤م بمعاملات ما قبل الحصاد الآتية : الجبريللين بتركيزات ٢٥ ، ٥٠ ، ٧٥ جزء / المليون ، كلوريد الكالسيوم بتركيز ١ ، ٢% والخميرة بتركيزات ١ ، ٢% بالإضافة إلى معاملة المقارنة وهى الرش بماء الصنبور و تم إضافة مادة Tween 20 كمادة ناشرة بتركيز ٠,٠١% لجميع المعاملات بما فيها معاملة المقارنة.

رشت محاليل هذه المعاملات ثلاث مرات سنوياً خلال موسمي الدراسة وأجريت الرشة الأولى بعد ثبات عملية العقد وبين الرشة الثانية والثالثة ثلاثة أسابيع، ومثلت كل معاملة بثلاث مكررات بحيث تحتوى كل مكررة على شجرة واحدة ورتبت معاملات هذه التجربة فى قطاعات كاملة العشوائية.

جمعت ثمار المانجو المكتملة النمو في منتصف أغسطس فى كلا الموسمين، وانتخبت الثمار المتشابهة في الحجم واللون والخالية من الإصابات الميكانيكية والخالية من أى عيوب واضحة، ثم أحضرت الثمار مباشرة إلى معمل تخزين الحاصلات البستانية بقسم الفاكهة بكلية الزراعة – جامعة الإسكندرية وذلك تحت إشراف أ.د/ عواد محمد حسين.

ويمكن تلخيص أهم النتائج المتحصل عليها نتيجة استخدام بعض معاملات ما قبل الحصاد كالآتي :-

أعطت معاملتي الجبريللين (٥٠ ، ٧٥ جزء فى المليون) وخاصة التركيز المرتفع أفضل النتائج بالنسبة لوزن الثمار، وزن القشرة، وزن البذرة، الوزن الطازج للب، نسبة اللب بالنسبة للثمار، طول وعرض وسمك الثمار، السكريات المختزلة، كذلك أعطت معاملات الكالسيوم وخاصة التركيز المرتفع (٢%) أعلى القيم بالنسبة لصفة نسبة القشرة للثمرة، الوزن الجاف للب، صلابة الثمار، حموضة الثمار، محتوى الثمار من كلوروفيل أ. في حين أعطت معاملات الخميرة وخاصة التركيز المرتفع ٢% أعلى القيم بالنسبة لوزن البذرة، ونسبة البذرة بالنسبة للثمرة، والوزن الجاف للب، طول الثمرة، سمك الثمرة، محتوى الثمار من المواد الصلبة الذائبة، محتوى الثمار

من حمض الإسكوربيك، السكريات الغير مختزلة، محتوى الثمار من الكاروتينات، محتوى قشرة الثمار من كلوروفيل أ، ب، والكاروتينات.

(٢) تأثير بعض معاملات ما قبل الحصاد (الجبريللين – كلوريد الكالسيوم – الخميرة) على بعض الصفات التسويقية لثمار المانجو زبده والمخزنة تحت درجات حرارة الغرفة ، ١٠ ، ١٥ ْم بالإضافة إلى وضع الثمار فى الـ Shelf life لمدة ٣ ، ٦ أيام .

في هذه التجربة تم استخدام ثمار المانجو والسابق معاملاتها بمعاملات ما قبل الحصاد السابق ذكرها حيث تم انتخاب واختيار الثمار السليمة والخالية من الإصابات والأمراض وتم غسلها بماء الصنبور وتجفيفها بالمراوح الكهربية ثم أجرى فرز آخر للثمار حيث تم استبعاد أي ثمار مصابة.

تحتوى هذه الدراسة على ثلاث درجات حرارة تخزين هى حرارة الغرفة العادية (٢٨±٢ م° و ٧٥ -٨٠% رطوبة نسبية) ، التخزين المبرد على١٠ ْم و٩٠ -٩٥% رطوبة نسبية و١٥ ْم و٩٠ -٩٥% رطوبة نسبية وتحت كل درجة حرارة تم دراسة تأثير معاملات ما قبل الحصاد الثماني وهى الجبريللين بتركيزات ٢٥ ، ٥٠ ، ٧٥ جزء فى المليون ، كلوريد الكالسيوم بتركيزات ١ ، ٢% والخميرة بتركيزات ١ ، ٢% بالإضافة إلى معاملة المقارنة. وقد تم ترتيب المعاملات فى قطاعات كاملة العشوائية وكررت كل معاملة ثلاث مرات ومثلت كل مكررة بصندوقين من الثمار.

تمت تعبئة الثمار المتماثلة لكل معاملة فى صناديق بلاستيك (٤٢ × ٢٨ × ١٢ سم) والتى سبق معاملتها بمبيد فطرى Cifadex وتحتوي كل معاملة على ٣٦ صندوق و يحتوى كل صندوق على ١٥ ثمرة وقسمت الصناديق إلى ثلاثة أقسام: القسم الأول يحتوى على ٦ صناديق ويستخدم للتخزين تحت ظروف حرارة الغرفة العادية (٢٨ ±٢ ْم و ٧٥ -٨٠ % رطوبة نسبية) والقسم الثاني يحتوى على ١٥ صندوق ويستخدم للتخزين على حرارة ١٥ ْم ورطوبة نسبية٩٠ -٩٥%

و القسم الثالث يحتوى على ١٥ صندوق ويخزن على حرارة ١٠ ْم ورطوبة نسبية ٩٠ -٩٥%.

ويمكن تلخيص النتائج المتحصل عليها كالآتى:-

(١) النسبة المئوية للفقد فى الوزن

ازدادت النسبة المئوية للفقد فى الوزن لثمار المانجو صنف زبده بإطالة فترة التخزين سواء تحت ظروف الغرفة العادية (لمدة ١٤ يوم) أو تحت التخزين المبرد على درجة حرارة ١٠ ، ١٥ ْم (لمدة ٢٨ يوم). كما وجد أن نسبة الفقد فى الوزن تحت ظروف الغرفة العادية أعلى بالمقارنة بالتخزين المبرد (١٠ ، ١٥ ْم).

وحققت جميع معاملات ما قبل الحصاد المستخدمة إنخفاضاً في النسبة المئوية للفقد فى الوزن خلال فترات التخزين تحت ظروف درجات حرارة التخزين المختلفة مقارنة بمعاملة المقارنة، و تفوقت في ذلك معاملة كلوريد الكالسيوم بتركيز ١ ، ٢% تحت جميع درجات الحرارة المستخدمة بالإضافة إلى معاملة الجبريللين بتركيز ٥٠ جزء فى المليون تحت درجة حرارة ١٠ ْم. كما وجد أن وضع ثمار المانجو تحت ظروف الغرفة العادية بعد التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم لمدة ٦ أيام أدى إلى زيادة الفقد فى الوزن عند المقارنة بمثيلتها التى تم إخراجها مباشرة من جو التبريد ولم توضع تحت ظروف الغرفة العادية أو التي وضعت لمدة ٣ أيام. سجلت تفاعلات ٧ أيام تخزين أقل نسب للفقد فى وزن الثمار خاصة معاملة كلوريد الكالسيوم ١ ، ٢% مقارنة بتفاعلات ١٤ يوم تخزين. وجد أن عامل ترك الثمار المبردة تحت ظروف الغرفة العادية (shelf life) هو العامل الأقوى فى تحديد معدل الفقد فى الوزن يليه فى الفعل عامل فترة التخزين لذلك كلما طالت فترة Shelf life (٦ أيام) مع طول فترة التخزين (٢٨ يوم) كلما زادت نسبة الفقد فى وزن ثمار المانجو والعكس صحيح. وعموماً وجد أنه تحت ظروف التخزين المبرد (١٠ ، ١٥ ْم) فإن ثمار المانجو المعاملة بكلوريد الكالسيوم تركيز ١ ، ٢% أو بالخميرة تركيز ٢% أو بالجبريللين تركيز ٥٠ جزء فى المليون والتى أخرجت بعد ٧ أيام من التخزين المبرد ولم توضع تحت ظروف الغرفة العادية (zero day on shelf) قد سجلت أقل القيم فى نسبة الفقد فى الوزن.

(٢) النسبة المئوية للثمار التالفة

إزدادت النسبة المئوية للثمار التالفة بامتداد فترة التخزين وكان ذلك أكثر وضوحاً عند التخزين تحت ظروف الغرفة العادية (لمدة ١٤ يوم) عن التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم (لمدة ٢٨ يوم)، وعلى أية حال فإن الزيادة فى نسبة الثمار التالفة تحت ظروف الغرفة العادية كانت أعلى منها تحت ظروف التخزين المبرد (١٥ ، ١٠ ْم). وجد أن إطالة فترة التخزين (لمدة ١٤ يوم عند التخزين تحت ظروف الغرفة العادية أو ٢٨ يوم عند التخزين المبرد (١٥، ١٠ ْم) أدى إلى إرتفاع نسبة التالف والعكس صحيح ، بجانب ذلك حققت معظم معاملات ما قبل الحصاد إنخفاض فى النسبة المئوية للثمار التالفة خلال فترات التخزين مقارنة بالثمار الغير معاملة (المقارنة) تحت درجات الحرارة المختلفة (الغرفة ، ١٥ ، ١٠ ْم) و أظهرت الثمار المعاملة بكلوريد الكالسيوم بتركيز ١% خلال الموسم الأول، والثمار المعاملة بمستخلص الخميرة ١% فى الموسم الثانى تفوقها فى ذلك عند التخزين تحت ظروف الغرفة العادية بينما كانت أقل نسبة تالف عند التخزين المبرد على درجة ١٥ ْم فى الثمار المعاملة بكلوريد الكالسيوم بتركيز

٢% فى حين كانت فى الثمار المعاملة بكلوريد الكالسيوم بتركيز ١% عند التخزين المبرد على درجة ١٠ ْم فى كلا الموسمين.

بالإضافة إلى ذلك فإن وضع ثمار المانجو بعد إخراجها من المخازن المبردة (١٥، ١٠ ْم) تحت ظروف الغرفة العادية (shelf life) لمدة (٦ أيام) يؤدى إلى زيادة النسبة المئوية للثمار التالفة مقارنة بتلك التى لم توضع (صفر يوم) أو التى وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية. وسجلت تفاعلات سبعة أيام تخزين تحت ظروف حرارة الغرفة العادية أقل القيم فى نسبة التالف خاصة الثمار المعاملة بكلوريد الكالسيوم بتركيز ١% في الموسم الأول والثمار المعاملة بمستخلص الخميرة بتركيز١% في الموسم الثاني ، و أوضحت نتائج التفاعلات ما بين فترات التخزين ومدة بقاء الثمار بعد التخزين المبرد ومعاملات ما قبل الحصاد أن طول الفترة التي تترك فيها الثمار بعد إخراجها من التخزين المبرد تحت ظروف الغرفة العادية كان له التأثير الأقوى فى تحديد النسبة المئوية للثمار التالفة يتبعه فى الفعل عامل فترة التخزين ، كذلك كلما طالت فترة Shelf life (٦ أيام) مع طول فترة التخزين كلما زادت النسبة المئوية للثمار التالفة والعكس صحيح. وعموماً فإن الثمار المعاملة بالجبريللين تركيز ٢٥ أو ٥٠ جزء فى المليون والمخزنة على درجة ١٥ ْم خلال جميع فترات التخزين والتى لم توضع تحت ظروف الغرفة العادية بعد التخزين المبرد. سجلت أقل القيم فى نسبة التالف ، بجانب ذلك فإن الثمار المعاملة بالجبريللين بتركيز ٥٠ جزء فى المليون أو المعاملة بكلوريد الكالسيوم بتركيز ٢% في الموسم ٢٠٠٣م والمعاملة بكلوريد الكالسيوم بتركيز ١، ٢% فى موسم ٢٠٠٤ م والمخزنة على درجة حرارة ١٠ ْم خلال جميع فترات التخزين والتى لم توضع تحت ظروف الغرفة العادية بعد التخزين المبرد سجلت أقل القيم فى النسبة المئوية للثمار التالفة.

(٣) صلابة الثمار

انخفضت صلابة ثمار المانجو "صنف زبده" مع تقدم فترة التخزين سواء المخزنة تحت ظروف الغرفة العادية (لمدة ١٤ يوم) أو التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم (لمدة ٢٨ يوم). وكان معدل فقد الثمار لصلابتها عالياً تحت ظروف تخزين الغرفة العادية عنه فى التخزين المبرد (١٥ ، ١٠ ْم). بالإضافة إلى ذلك فإن إطالة فترة التخزين (لمدة ١٤ يوم تحت ظروف الغرفة العادية ولمدة ٢٨ يوم تحت ظروف التخزين المبرد "١٥ ، ١٠ ْم") أدى إلى زيادة في فقد الثمار لصلابتها والعكس صحيح في كلا الموسمين ، ومن جهة أخرى فقد نجحت معظم معاملات ما قبل الحصاد في تقليل فقد الثمار لصلابتها خلال فترات التخزين إذا ما قورنت بمعاملة المقارنة تحت جميع درجات حرارة التخزين (ظروف الغرفة العادية ، ١٥ ، ١٠ ْم) وقد تفوقت فى ذلك الثمار المعاملة بكلوريد الكالسيوم بتركيز ١ ، ٢% تحت درجات حرارة التخزين الثلاث ، علاوة

على ذلك فإنه كلما طالت فترة وضع الثمار بعد التخزين المبرد تحت ظروف الغرفة العادية (٦ أيام) كلما زادت نسبة فقد الثمار لصلابتها مقارنة بتلك التى لم توضع أو التى وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية بعد التخزين المبرد. و أعطت تفاعلات ٧ أيام تخزين تحت ظروف التخزين فى الغرفة العادية أعلى قيم لصلابة الثمار مقارنة بتفاعلات ١٤ يوم تخزين.

أعطت ثمار المانجو المعاملة بكلوريد الكالسيوم بتركيز ٢ ، ١% والمخزنة لمدة ٧ أيام أعلى القيم لصلابة الثمار خلال مدة التخزين تحت ظروف الغرفة العادية. ومن خلال التفاعل ما بين فترة التخزين ومعاملات ما قبل الحصاد وعدد الأيام ما بعد التخزين المبرد تحت ظروف الغرفة العادية أوضحت نتائج التفاعلات أن ترك الثمار المبردة تحت ظروف الغرفة العادية يلعب الدور الأقوى فى تحديد نسبة الفقد فى صلابة الثمار يتبعه فى الفعل عامل فترة التخزين ، فكلما طالت مدة بقاء الثمار بعد التخزين المبرد تحت ظروف الغرفة العادية (٦ أيام) مع طول فترة التخزين (٢٨ يوم) كلما قلت صلابة الثمار والعكس صحيح ، فقد أظهرت الثمار المخزنة لمدة ٧ أيام على درجة حرارة ١٥ ْم أو ١٠ ْم والمعاملة بكلوريد الكالسيوم بتركيز ١% والتي لم توضع تحت ظروف الغرفة العادية بعد التخزين المبرد أعلى قيم لصلابة الثمار خلال موسمى الدراسة.

(٤) محتوى اللب من الكاروتين

إزداد محتوى لب ثمار المانجو من الكاروتين تدريجياً بتقدم فترة التخزين تحت ظروف درجات حرارة التخزين المستخدمة. أدى إطالة فترة التخزين (لمدة ١٤ يوم تحت ظروف الغرفة العادية أو مدة ٢٨ يوم تحت التخزين المبرد على درجة حرارة ١٥ ْم إلى زيادة محتوى اللب من الكاروتين والعكس صحيح ، و تحت ظروف التخزين المبرد على درجة حرارة ١٠ ْم فإن امتداد فترة التخزين لمدة ثلاثة أسابيع يصاحبه زيادة فى محتوى اللب من الكاروتين،ولم يكن لزيادة فترة التخزين لمدة أربعة أسابيع تأثيرإيجابى على محتوى اللب من الكاروتين.

علاوة على ذلك فقد حققت معظم معاملات ما قبل الحصاد المختبرة زيادة في محتوى اللب من الكاروتين خلال فترات التخزين إذا ما قورنت بمعاملة المقارنة تحت ظروف جميع درجات الحرارة المستخدمة، وأظهرت الثمار المعاملة بمستخلص الخميرة تفوقها فى ذلك فى أغلب الحالات خلال الموسمين. بالإضافة لذلك فإن وضع الثمار بعد التخزين المبرد (١٥ ، ١٠ ْم) لمدة طويلة تحت ظروف الغرفة العادية (٦ أيام) كان أكثر المعاملات كفاءة في زيادة محتوى اللب من الكاروتين مقارنة بتلك الثمار التى لم توضع تحت ظروف الغرفة العادية بعد التخزين المبرد أو التي وضعت لمدة ٣ أيام. وأعطت تفاعلات ١٤ يوم تخزين تحت ظروف التخزين فى الغرفة العادية خاصة الثمار المعاملة بالخميرة بتركيز ٢% أعلى محتوى الكاروتين في اللب مقارنة بتفاعلات ٧ أيام تخزين. أما عن التفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة

العادية بعد التخزين المبرد ومعاملات ما قبل الحصاد فقد أوضحت النتائج أن عامل تـرك الثمـار المبردة تحت ظروف الغرفة العادية هو القوى في تحديد محتوى اللب من الكاروتين يليه فى ذلـك عامل فترة التخزين. وعلى ذلك فإن أطول فترة بقاء للثمار تحت ظـروف الغرفـة العاديـة بعـد التخزين المبرد (٦ أيام) مع أطول فترة تخزين (٢٨ يوم على درجة ١٥ ْم أو ٢١ يوم على درجة ١٠ ْم) قد أعطت أعلى قيم لمحتوى اللب من الكاروتين والعكس صحيح في معظم الحالات.

(٥) محتوى قشرة الثمار من كلوروفيل " أ "

إنخفض محتوى ثمار المانجو "صنف زبده" من كلوروفيل " أ " بتقدم فترة تخزين الثمـار سواء فى الثمار المخزنة تحت ظروف الغرفة العادية (لمدة ١٤ يوم) أو تحت التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم (لمدة ٢٨ يوم). وإن معدل إنخفاض محتوى الثمار من كلوروفيل " أ " خلال التخزين تحت ظروف الغرفة العادية كان أكبر منه تحـت ظـروف التخـزين المبـرد (١٥، ١٠ ْم). و أنه كلما طالت فترة التخزين (١٤ يوم) تحت ظروف الغرفة العادية أو٢٨ يوم تحـت ظروف التخزين المبرد (١٥ ، ١٠ ْم) كلما زاد الانخفاض فى محتوى الثمار من كلوروفيل " أ " .

وأدت معظم معاملات ما قبل الحصاد إلى المحافظة على محتوى الثمار من كلوروفيل " أ " خلال فترات التخزين إذا ما قورنت بمعاملة المقارنة تحت جميع درجـات الحـرارة المـستخدمة (الغرفة العادية ، ١٥ ، ١٠ ْم). من جهة أخرى فإن وضع الثمار المخزنة على درجة حـرارة ١٥ أو ١٠ ْم لأطول مدة تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد (٦ أيام) قد أدى إلى زيادة في تحلل كلوروفيل " أ " مقارنة بالثمار التى لم توضع تحت ظروف الغرفة العادية بعـد خروجها من التخزين المبرد أو التى وضعت لمدة ٣ أيام تحت ظروف الغرفة العاديـة . وأعطـت تفاعلات ٧ أيام تخزين خاصة الثمار المعاملة بكلوريد الكالسيوم بتركيز ٢% تحت ظروف الغرفـة العادية أكبر القيم في محتوى الثمار من كلوروفيل " أ " مقارنة بمثيلاتها التي خزنت لمدة ١٤ يوم تخزين. أما بالنسبة للتفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة العادية بعـد إخراجها من التخزين المبرد وبين معاملات ما قبل الحصاد المختبرة فقـد أوضـحت النتـائج أن عامل طول فترة بقاء الثمار المخزنة بالتبريد تحت ظروف الغرفة العادية كان له التأثير الأقوى فى تحديد معدل الإنخفاض فى المحتوى من كلوروفيل " أ " يتبعه في ذلك عامل طول فترة التخزين ، فكلما طالت مدة بقاء الثمار تحت ظروف الغرفة العادية بعد التخزين المبرد مع طول فترة التخزين (٢٨ يوم) كما زاد معدل الإنخفاض فى محتوى قشرة الثمار من كلوروفيل " أ " والعكس صحيح.

(٦) محتوى الثمار من كلوروفيل " ب "

إنخفض محتوى ثمار المانجو "صنف زبده" من كلوروفيل " ب " بتقدم فتـرة التخـزين تحت جميع درجات الحرارة المستخدمة (الغرفة العاديـة ، ١٥ ، ١٠ ْم). كمـا وجـد أن معـدل الإنخفاض في المحتوى من كلوروفيل " ب " تحت ظروف الغرفة العادية كان أكبر منهـا تحـت

ظروف التخزين المبرد (١٥، ١٠ ْم). و أنه كلما طالت فترة التخزين لمدة ١٤ يوم تحت ظروف الغرفة العادية أو لمدة ٢٨ يوم تحت التخزين المبرد (١٥، ١٠ ْم) كلما قل محتوى الثمار من كلوروفيل " ب " والعكس صحيح.

ومن جهة أخرى فقد أدت معظم معاملات ما قبل الحصاد المدروسة إلى تقليل معدل الانخفاض فى محتوى الثمار من كلوروفيل " ب " إذا ما قورنت بمعاملة المقارنة. بينما أدى وضع الثمار المخزنة على درجات حرارة التبريد ١٥ ، ١٠ ْم لمدة طويلة(٦ أيام) بعد خروجها من التخزين المبرد تحت ظروف الغرفة العادية قد أدى إلى خفض محتوى الثمار من كلوروفيل " ب " مقارنة بتلك الثمار التى أخرجت مباشرة من التخزين المبرد ولم توضع تحت ظروف الغرفة العادية أو تلك التي وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية.

سجلت تفاعلات ٧ أيام تخزين تحت ظروف تخزين الغرفة العادية أعلى القيم في محتوى الثمار من كلوروفيل " ب " خاصة الثمار المعاملة بالجبريللين تركيز ٧٥ جزء فى المليون أو بالخميرة تركيز ٢% مقارنة بنظائرها التي خزنت لمدة ١٤ يوم. أما تحت ظروف التخزين المبرد فإن تأثير التفاعل بين فترات التخزين ومدة بقاء الثمار بعد إخراجها من التبريد وبين معاملات ما قبل الحصاد المستخدمة أظهرت نتائجه أن عامل طول فترة بقاء الثمار بعد إخراجها من المخازن المبردة تحت ظروف الغرفة العادية له الدور القوى فى تحديد معدل النقص فى كلوروفيل " ب " يليه في الفعل عامل طول فترة التخزين. فكلما طالت مدة بقاء الثمار تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد مع طول فترة التخزين المبرد (٢٨ يوم) كلما كان الإنخفاض أكبر فى محتوى الثمار من كلوروفيل " ب " والعكس صحيح. في حين سجلت تفاعلات الثمار المخزنة لمدة ٧ أيام والتى أخرجت مباشرة من التبريد ولم توضع تحت ظروف الغرفة العادية أعلى القيم في محتوى الثمار من كلوروفيل " ب " في كلا الموسمين.

(٧) محتوى القشرة من الكاروتين

وجد أنه كلما طالت فترة التخزين (١٤ يوم تحت ظروف الغرفة العادية أو ٢٨ يوم تحت التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم) كلما زاد محتوى قشرة الثمرة من الكاروتين فى كلا الموسمين ، حيث كان أكبر محتوى للقشرة من الكاروتين بعد ١٤ يوم من التخزين تحت ظروف الغرفة العادية أو بعد ٢٨ يوم من التخزين المبرد على درجة حرارة ١٥ ، ١٠ ْم. وعلى العكس فقد سجل أقل محتوى للقشرة من الكاروتين بعد ٧ أيام من التخزين على جميع درجات الحرارة المستخدمة. بالإضافة لذلك أظهر محتوى القشرة من الكاروتين تذبذب في الاتجاه من موسم إلى آخر تحت جميع درجات الحرارة المدروسة.ووجد أن وضع الثمار المخزنة على درجات حرارة التبريد تحت ظروف الغرفة العادية لمدة طويلة (٦ أيام) بعد خروجها من التخزين المبرد قد أدى إلى زيادة في محتوى القشرة من الكاروتين مقارنة بتلك الثمار المخزنة بالتبريد ولم توضع

أو وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد ، بجانب ذلك أوضحت التفاعلات بين فترة التخزين ومعاملات ما قبل الحصاد تحت ظروف تخزين الغرفة العادية أن تفاعلات ١٤ يوم تخزين هي الأغنى في محتوى القشرة من الكاروتين خلال فترة التخزين.

أما بالنسبة لتأثير التفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد وبين معاملات ما قبل الحصاد فقد دلت النتائج أن عامل طول فترة بقاء الثمار المبردة تحت ظروف الغرفة العادية هو الأقوى في تحديد محتوى قشرة الثمرة من الكاروتين يتبعه فى الفعل عامل فترة التخزين ، ونتيجة لذلك فكلما طالت مدة بقاء الثمار(٦ أيام) تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد مع طول فترة التخزين (٢٨ يوم) كلما زاد محتوى قشرة الثمرة من الكاروتين والعكس صحيح. وعموماً فإن الثمار المخزنة على درجات حرارة التبريد ١٥ ، ١٠ ْم والمعاملة بمستخلص الخميرة بتركيز ٢% والتي وضعت لمدة ٦ أيام تحت ظروف الغرفة العادية بعد التبريد قد سجلت فى معظم الحالات أعلى القيم فى محتوى قشرة الثمرة من الكاروتين.

(٨) محتوى الثمرة من المواد الصلبة الذائبة الكلية

إزداد محتوى ثمار المانجو "صنف زبده" بتقدم فترة التخزين سواء كان ذلك فى الثمار المخزنة تحت ظروف الغرفة العادية (لمدة ١٤ يوم) أو تحت درجة حرارة تبريد ١٥ ْم (لمدة ٢٨ يوم) ، بينما تحت ظروف التخزين المبرد على درجة حرارة ١٠ ْم فإن إمتداد فترة التخزين لمدة ثلاثة أسابيع يصاحبه بوضوح هذا التأثير الإيجابى ولكن زيادة فترة التخزين إلى أربعة أسابيع لم يحقق استمرار هذا التأثير الإيجابى لمحتوى الثمرة من المواد الصلبة الذائبة الكلية. بجانب ذلك لم يكن هناك إتجاه واضح لتأثير معظم معاملات ما قبل الحصاد المستخدمة على محتوى الثمرة من المواد الصلبة الذائبة الكلية تحت درجات حرارة التخزين المستخدمة خلال موسمى الدراسة. بينما أعطت الثمار المتروكة لمدة طويلة (٦ أيام) تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد (١٥ ، ١٠ ْم) أعلى القيم فى المحتوى من المواد الصلبة الذائبة الكلية مقارنة بنظائرها التى أخرجت مباشرة من المخازن المبردة ولم توضع تحت ظروف الغرفة العادية أو التي وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية.

وتحت ظروف تخزين الغرفة العادية أظهرت نتائج التفاعلات أن تفاعلات ما بعد ١٤ يوم من التخزين أعلى القيم فى محتوى الثمار من المواد الصلبة الذائبة الكلية مقارنة بتفاعلات ما بعد ٧ أيام من التخزين. وأوضحت نتائج التفاعلات أن الثمار المخزنة على درجة حرارة ١٥ ْم لمدة ٢٨ يوم والتى تم وضعها لمدة ٦ أيام تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد قد سجلت أعلى القيم فى محتوى الثمرة من المواد الصلبة الذائبة الكلية ، بينما أظهرت الثمار

الموضوعة لمدة ٦ أيام تحت ظروف الغرفة العادية بعد تخزينها لمدة ٢١ يوم على درجة حـــرارة ١٠ ْم تفوقها فى هذا الشأن.

(٩) محتوى الثمرة من السكريات المختزلة

إزداد محتوى ثمار المانجو "صنف زبده" من السكريات المختزلة مع تقدم فترة التخـــزين. لذلك كلما طالت فترة التخزين لمدة ١٤ يوم تحت ظروف الغرفة العادية إزداد محتوى الثمرة مـــن السكريات المختزلة ، وذلك تحت ظروف تخزين الغرفة العادية ، بينما تحـــت ظـــروف التخـــزين المبرد على درجات حرارة ١٥ ، ١٠ ْم فقد أثر ذلك بشكل معاكس ، حيث تفوقت فتـــرة ١٤ يـــوم تخزين على جميع فترات التخزين فى تحسين محتوى الثمار من الـــسكريات المختزلـــة متبوعـــة تنازلياً بفترة ٢٨ يوم ، ٢١ يوم ثم أخيراً فترة ٧ أيام تخزين. بالإضافة إلى ذلك لم تحقق معظـــم معاملات ما قبل الحصاد المستخدمة تأثير واضح على محتوى الثمرة من السكريات المختزلة تحت درجات حرارة التخزين المدروسة خلال الموسمين.

من جهة أخرى فقد أعطت الثمار الموضوعة تحت ظروف الغرفة العاديـــة لمـــدة طويلـــة (٦ أيام) بعد خروجها من التخزين المبرد (١٥ ، ١٠ ْم) أعلى القيم فـــي محتـــوى الثمـــرة مـــن السكريات المختزلة مقارنة بتلك التى لم توضع تحت ظروف الغرفة العادية أو التي وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية بعد خروجها من التخزين المبرد.

وأوضحت النتائج أن تفاعلات ١٤ يوم تخزين تحت ظروف تخزين الغرفة العاديـــة كانـــت أكثر تأثيراً فى إعطاء أعلى القيم فى محتوى الثمرة من السكريات المختزلة خاصة معاملة كلوريد الكالسيوم بتركيز ١% فى الموسم الأول ، ومعاملة المقارنة في الموسم الثاني ، وبالنسبة للتفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة العادية بعد التخزين المبرد وبين معاملات ما قبل الحصاد المستخدمة. أظهرت النتائج المتحصل عليها أن عامل مدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد هو العامل الأقوى فى تحديد كمية محتوى الثمـــرة من السكريات المختزلة يليه عامل فترة التخزين ، فكلما طالت مدة بقاء الثمار تحت ظروف الغرفة العادية بعد التخزين المبرد (٦ أيام) مع طول مدة التخزين لمدة ٢٨ يوم كلما زاد محتوى الثمـــرة من السكريات المختزلة.

(١٠) محتوى الثمرة من السكريات غير المختزلة

أحدث التخزين لمدة ٧ أيام فقط تحت ظروف تخزين الغرفة العادية تـــأثيراً إيجابيـــاً علـــى محتوى الثمرة من السكريات غير المختزلة بينما لم يسبب طول الفترة إلـــى ١٤ يـــوم أي تـــأثير إضافي على محتوى الثمرة من السكريات الغير مختزلة ، بينما تحت ظروف التخزين المبرد علـــى درجات حرارة ١٥ ، ١٠ ْم لوحظ زيادة محتوى الثمرة من السكريات غير المختزلة متناسباً مـــع

زيادة فترة التخزين ، حيث كلما طالت فترة التخزين كلما زاد محتوى الثمار من السكريات الغير مختزلة.

لم تحقق معظم معاملات ما قبل الحصاد المستخدمة في معظم الحالات تأثير واضح على محتوى الثمرة من السكريات غير المختزلة تحت درجات الحرارة المستخدمة. كذلك أعطت ثمار المانجو "صنف زبده" المتروكة لمدة طويلة(٦ أيام) تحت ظروف الغرفة العادية بعد التخزين المبرد (١٥ ، ١٠ ْم) أعلى القيم في السكريات غير المختزلة مقارنة بتلك التى لم توضع تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد أو تلك التي وضعت لمدة ٣ أيام تحت ظروف تخزين الغرفة العادية. وأوضحت نتائج التفاعلات أن تفاعلات ١٤ يوم تخزين أعطت أعلى القيم فى محتوى الثمار من السكريات غير المختزلة خاصة الثمار المعاملة بمستخلص الخميرة بتركيز ١% فى الموسم الأول بينما تفوقت فى ذلك معاملة كلوريد الكالسيوم بتركيز ٢% فى الموسم الثانى تحت نفس فترة التخزين (١٤ يوم). أما عن تأثير التفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة بعد التخزين المبرد وبين معاملات ما قبل الحصاد المختبرة فقد أظهرت التفاعلات أنه كلما طالت مدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد ومع طول فترة التخزين كلما زاد محتوى الثمرة من السكريات غير المختزلة.

(١١) محتوى الثمرة من السكريات الكلية

تتراكم (تتزايد) السكريات الكلية فى ثمار المانجو "زبده" مع زيادة فترة التخزين تحت درجات الحرارة المستخدمة ، وسجل أعلى محتوى للسكريات الكلية في نهاية فترة التخزين فى جميع درجات الحرارة المدروسة ، حيث وجد أن تخزين ثمار المانجو لمدة ١٤ يوم تحت ظروف الغرفة العادية أو لمدة ٢٨ يوم عند التخزين المبرد (١٥ ، ١٠ ْم) قد أعطى أعلى محتوى للسكريات الكلية فى كلا الموسمين. فى حين لم تحقق معظم معاملات ما قبل الحصاد زيادة معنوية في محتوى الثمرة من السكريات الكلية إذا ما قورنت بمعاملة المقارنة خاصة تحت ظروف تخزين الغرفة العادية.

كذلك وجد أن وضع الثمار تحت ظروف الغرفة العادية لمدة طويلة (٦ أيام) بعد إخراجها من التخزين المبرد على درجات حرارة ١٥ ، ١٠ ْم كان العامل الأكثر تأثيراً فى زيادة محتوى الثمرة من السكريات الكلية مقارنة بتلك التى لم توضع أو التى وضعت لمدة ٣ أيام تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد.

بجانب ذلك وتحت ظروف تخزين الغرفة العادية فقد أعطت تفاعلات ١٤ يوم تخزين أعلى القيم فى محتوى الثمرة من السكريات الكلية مقارنة بنظائرها ٧ أيام تخزين خلال موسمي الدراسة. أما بالنسبة لتأثير التفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة

العادية بعد التخزين المبرد وبين معاملات ما قبل الحصاد المستخدم ، أظهرت النتائج المتحصل عليها أن العامل الأساسي في تحديد محتوى الثمرة من السكريات الكلية هو عامل مدة بقاء الثمار تحت ظروف الغرفة العادية بعد التخزين المبرد يتبعه في الفعل عامل فترة التخزين ، لذلك كلما طالت مدة بقاء الثمار(٦ أيام) تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد مع طول فترة التخزين المبرد (٢٨ يوم) كلما زاد محتوى الثمرة من السكريات الكلية والعكس صحيح. كما وجد أن ثمار المانجو المخزنة على درجات حرارة ١٥ ، ١٠ ْم لمدة ٢٨ يوم والمعاملة بمستخلص الخميرة تركيز ٢% والتى تم وضعها لمدة ٦ أيام تحت ظروف الغرفة العادية بعد إخراجها من التبريد قد سجلت فى معظم الحالات أعلى محتوى للسكريات الكلية.

(١٢) محتوى الثمرة من الحموضة

تناقصت الحموضة الكلية للثمار بتقدم فترة التخزين تحت درجات حرارة التخزين المختلفة في كلا الموسمين ، فكلما طالت فترة التخزين (١٤ يوم) تحت ظروف الغرفة أو (٢٨ يوم) تحت التخزين المبرد على درجات حرارة ١٥ ، ١٠ ْم كلما كان النقص واضحاً في محتوى الثمرة من الحموضة الكلية . بالإضافة إلى ذلك وجد أن معظم معاملات ما قبل الحصاد المستخدمة لم تحقق أي تأثير مميز على محتوى الثمار من الحموضة تحت درجات الحرارة المستخدمة خلال موسمي الدراسة. كما وجد أن وضع الثمار المخزنة على درجات حرارة التبريد ١٥ ، ١٠ ْم لمدة طويلة (٦ أيام) تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد قد أحدث أعلى إنخفاض في حموضة الثمرة مقارنة بالثمار التي وضعت لمدة ٣ أيام أو التى لم توضع تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد .

وتحت ظروف التخزين فى الغرفة العادية أوضحت نتائج التفاعلات أن تفاعلات تخزين ١٤ يوم تخزين قد أعطت أقل قيم الحموضة مقارنة بمثيلاتها ٧ أيام. أما بالنسبة للتفاعل بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد وبين معاملات ما قبل الحصاد المختبرة ، فقد أوضحت نتائج التفاعلات أن عامل مدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد هو الأقوى فى تحديد محتوى الثمرة من الحموضة يليه فى الفعل عامل فترة التخزين فكلما طالت مدة بقاء الثمرة تحت ظروف الغرفة بعد إخراجها من التخزين المبرد مقترناً مع طول فترة التخزين (٢٨ يوم) كلما قلت حموضة الثمرة ، لذلك سجلت الثمار المخزنة لمدة ٢٨ يوم على درجة حرارة ١٥ ْم أو المخزنة لمدة ٢١ يوم على درجة حرارة ١٠ ْم والموضوعة لمدة ٦ أيام تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد أقل قيم الحموضة.

(١٣) محتوى الثمرة من حمض الإسكوربيك " فيتامين ج "

إنخفض محتوى ثمار المانجو "زبده" من حامض الإسكوربيك مع تقدم فترة التخزين تحت درجات حرارة التخزين المختلفة (الغرفة العادية ، ١٥ ، ١٠ ْم) فى كلا موسمى الدراسة ، فكلما طالت فترة التخزين لمدة ١٤ يوم تحت ظروف الغرفة العادية أو ٢٨ يوم فى التخزين المبرد (١٥ ، ١٠ ْم) كلما قل محتوى الثمرة من حمض الإسكوربيك ، بالإضافة إلى ذلك فقد وجد أن غالبية معاملات ما قبل الحصاد المستخدمة قد حققت زيادة في محتوى الثمرة من حمض الإسكوربيك تحت درجات الحرارة المستخدمة مع تفوق معاملة كلوريد الكالسيوم فى كلا الموسمين ، كما أظهرت الثمار التى أخرجت من التبريد ولم توضع تحت ظروف الغرفة العادية فاعلية كبيرة في زيادة محتواها من حمض الإسكوربيك مقارنة بتلك الموضوعة لفترة طويلة (٦ أيام) تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد.

أوضحت نتائج التفاعلات تحت ظروف التخزين فى الغرفة العادية أن تفاعلات ٧ أيام تخزين قد سجلت أعلى القيم لمحتوى الثمرة من حمض الإسكوربيك مقارنة بمثيلاتها التي خزنت لمدة ١٤ يوم. كما أعطت الثمار المعاملة بكلوريد الكالسيوم تركيز ٢% والمخزنة لمدة ٧ أيام أعلى القيم إحصائياً فى محتواها من حمض الإسكوربيك.

وبالنسبة لتأثير التفاعل ما بين فترة التخزين ومدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد وبين معاملات ما قبل الحصاد المختبرة فقد أوضحت نتائج التفاعلات أنه كلما قصرت مدة بقاء الثمار تحت ظروف الغرفة العادية بعد إخراجها من التخزين المبرد مع قصر فترة التخزين (٧ أيام) كلما زاد محتوى الثمرة من حامض الإسكوربيك.

وبناء على نتائج هذه الدراسة، فإنه لزيادة المقدرة التخزينية والتسويقية ، والمحافظة على الصفات الأكلية لثمار المانجو صنف زبده ، فإن رش الأشجار بكلوريد الكالسيوم بتركيز ٢% أو الجبريللين بتركيز ٥٠ جزء / المليون ثلاث مرات سنوياً (الرشة الأولى بعد ثبات عقد الثمار، والرشة الثانية والثالثة بين كل منهما ثلاثة أسابيع) ثم تخزين الثمار المعاملة تحت درجة حرارة ١٥° م لمدة ٢٨ يوم أو تحت درجة حرارة ١٠° م لمدة ١٤ يوم كانت نتائج أكثر المعاملات كفاءة فى إحداث هذه التأثيرات.

محاولات لتحسين الصفات التسويقية وإطالة العمر التخزيني لثمار الكاكي والمانجو

رسالة مقدمة

حامد الزعبلاوى محمود البدوى

بكالوريوس زراعة (شعبة بساتين) كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (١٩٩٧)
ماجستير في العلوم الزراعية (بساتين – فاكهة) – كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (٢٠٠١)

للحصول علي
درجة دكتوراه الفلسفة في العلوم الزراعية
بساتين (فاكهة)

لجنة الإشراف :

(١) أ.د/ بهجت محمود هليل .....
أستاذ الفاكهة ــ كلية الزراعة– جامعة بنها
(٢) أ.د/ حسن السيد منصور جندية .....
أستاذ الفاكهة ــ كلية الزراعة– جامعة بنها
(٣) أ.د/ أحمد أحمد رزق السيد عطوية .....
أستاذ الفاكهة ــ كلية الزراعة– جامعة بنها

محاولات لتحسين الصفات التسويقية وإطالة العمر التخزيني لثمار الكاكي والمانجو

رسالة مقدمة

حامد الزعبلاوى محمود البدوى

بكالوريوس زراعة (شعبة بساتين) كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (١٩٩٧)

ماجستير في العلوم الزراعية (بساتين – فاكهة) – كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (٢٠٠١)

للحصول علي

درجة دكتوراه الفلسفة في العلوم الزراعية

بساتين (فاكهة)

وقد تمت مناقشة الرسالة قبل اللجنة المشكلة من السادة الأساتذة:

(١) أ.د/ عواد محمد حسين .....

أستاذ علم الفاكهة – كلية الزراعة بالشاطبي– جامعة الإسكندرية "ممتحناً ورئيسا"

(٢) أ.د/ فاروق عبد الحميد المرشدي .....

أستاذ علم الفاكهة – كلية الزراعة– جامعة كفر الشيخ "ممتحناً"

(٣) أ.د/ بهجت محمود هليل .....

أستاذ علم الفاكهة – كلية الزراعة– جامعة بنها "عضوا من لجنة الإشراف"

(٤) أ.د/ حسن السيد منصور جندية .....

أستاذ علم الفاكهة – كلية الزراعة– جامعة بنها "عضوا من لجنة الإشراف"

(٥) أ.د/ أحمد أحمد رزق السيد عطوية .....

أستاذ علم الفاكهة – كلية الزراعة– جامعة بنها "عضوا من لجنة الإشراف"

تاريخ المناقشة : ١٣ / ٨ / ٢٠٠٧ م

محاولات لتحسين الصفات التسويقية وإطالة العمر التخزيني لثمار الكاكي والمانجو

رسالة مقدمة

حامد الزعبلاوي محمود البدوي

بكالوريوس زراعة (شعبة بساتين) كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (١٩٩٧)
ماجستير في العلوم الزراعية (بساتين – فاكهة) – كلية الزراعة بمشتهر– جامعة الزقازيق فرع بنها (٢٠٠١)

للحصـــــول على

درجة دكتوراه الفلسفة في العلوم الزراعية

بساتين (فاكهة)

قسم البساتين

كلية الزراعة

جامعة بنها

٢٠٠٧