J. Product. & Dev., 15(2): 201-222 (2010)

REDUCING CHILLING INJURIES OF PONKAN TANGARINE FRUITS DURING DISINFESTATION WITH COLD QUARANTINE TREATMENT BY USING SOME HEAT WATER TREATMENTS AND IMAZYLIL

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ABSTRACT

Two experiments were conducted during 2009 and 2010 seasons at the Post-harvest Laboratory of Horticulture Department, Faculty of Agriculture, Zagazig University to assess the effectiveness of imazylil (IMZ) and hot water treatments (HWT) , as follow : 1- Fruits were dipped in water (20^{o}C) for 5min., 2- Fruits were dipped in IMZ 1000 ppm (20^{o}C) for 5 min., 3- Fruits were dipped in hot water (52^{o}C) for 2 min., 4- Fruits were dipped in hot water (60^{o}C) for 20 Sec. and 5- Fruits were dipped in hot water (70^{o}C) for 10 Sec. as well as three cold storage periods under 2^{o}C (as a cold quarantine disinfestation) and 90 – 95% relative humidity as follow : 10, 20 and 30 days on Ponkan tangarine fruits and shelf life period after 3 and 6 days.

Advancing storage period caused progressive increment in chilling injury (CI), fruit decay (FD), heat injury % (HI), fresh weight loss (FWL %) and acidity % of samples taken during cold storage as well as FWL %, Pulp % juice %, juice volume/kg fruits, peel firmness, acidity %, TSS %, and technological index (TI) during shelf life periods. On the contrary, increasing cold storage period decreased pulp firmness, peel firmness, TSS/acid ratio and vitamin C. In addition, peel percentage, pulp firmness, TSS/acid ratio and vitamin C depressed with increasing cold storage during after shelf life periods.

The tested hot water (HW) and fungicide (IMZ) treatments decreased CI and FD percentage of fruits during either cold storage or shelf life periods. In addition, there is no effect of tested treatments on fruit quality attributes *during cold storage or during shelf life periods.*

Key words: Cold storage, hot water treatments, Ponkan tangarine fruits, chilling injury, panel test index, decay, disinfestations.

INTRODUCTION

Citrus fruits are among the most important and popular fruit crops all over the world. In Egypt, citrus ranks the first among all other fruits regarding both area and production. The area of mandarin is 110267feddans producing about 758105 tons (Anonymous, 2008). Ponkan tangerine cv.*(Citrus reticulata,* Blanco) in Egypt called Chineese mandarin.

Several postharvest heat treatments have reported to induce fruit tolerance to cold temperature and to reduce the development of CI symptoms during cold storage and cold quarantine treatments (Porat *et al*., 2000 and 2003).

Hot water is preferred for most applications since water is a more efficient heat transfer medium than air. In addition to hot water immersion, a new technology based on a brief hot water rinse and brush to clean and disinfect freshly harvested produce has been developed (Fallik, 2004). Postharvest heat treatments can also used to induce fruit tolerance to cold temperatures and to reduce the development of chilling injury symptoms during cold storage and cold quarantine (Schirra *et al*., 2004). Postharvest hot water dipping inhibited or reduced pathogen development (Rodov *et al*., 2000) and greatly increased the efficacy of fungicides applied in post harvest treatments (Schirra and Mulas, 1995). However, information is scarce regarding the beneficial effects of postharvest heat treatments on “Ponkan tangarine” as an efficient pretreatment to improve its storage stability and its resistance to CI.

Certain citrus fruit cultivars are susceptible to low storage temperature (Paull, 1990) and quarantine conditions may cause chilling injury (CI), especially when fruit returned to warm temperature, predisposing them to decay (Edwards *et al*., 1994 and Underhill *et al*., 1995). Therefore, fruit resistance to low temperature during quarantine improved. Since it has be shown that postharvest heat treatments alleviate CI in sensitive cultivars and reduce storage decay (Schirra *et al*., 2000). It might be applied to overcome the risk of CI and decay of quarantined fruit (Schirra *et al*., 2002 a & b). Pratella *et al*., (1968) Study of provided evidence for the potential of hot water dipping (HWD) on the keeping quality of quarantined “Ponkan tangarine" that, among orange cultivars, are the most susceptible to CI. Fruit condition in terms of CI, decay, quality attributes, and various physical and chemical changes assessed following treatment, after quarantine, subsequent storage and simulated marketing conditions.

Cold treatment protocol for Mediterranean fruit fly (*Ceratitis capitata*) is 1.7^{o}C for 14 days or 2.2^{o}C for 16 days exposure period (USDA-APHIS website). For citrus fruit De Lima *et al*. (2007) reported that Queensland fruit flay (QFF) is susceptible to cold treatment temperatures up to 3 degrees, total insect mortality achieved in 14 days for lemons and 16 days for oranges and mandarins at both 2 and 3 degrees, in additions, for Medfly larvae were susceptible on citrus fruit to cold treatment with total insect mortality achieved in 18 days for lemons and 20 days for oranges and mandarins at 3 degrees (2 degrees lower).

Therefore, the aim of this work was to reduce chilling injury of Ponkan tangarine fruits during disinfestations with cold quarantine by dipping in different hot water temperature and imazylil.

MATERIALS AND METHODS

This work was carried out during 2009 and 2010 seasons at the Post-harvest Laboratory of Horticulture Department, Faculty of Agriculture, Zagazig University, to reduce chilling injury and evaluate the effectiveness of imazylil (IMZ) and some hot water treatments at different cold storage periods under 2^{o}C as a cold quarantine treatment to increase its resistance to CI and during shelf life periods of tangarine fruits Ponkan cultivar.

Tangarine fruits used in this study were obtained from a Private Orchard at Menia El-Kamh, Sharkia Governorate, Egypt. All used fruits were harvested at ripe stage from similar trees aged 20 years old, grown in loamy soil at 5 x 5 meters apart. Fruits were picked using small clippers at 1st January, packed in carton boxes, and directly transferred to the laboratory. Then, they washed, air dried and rechecked for any defects.

This work designed as factorial experiment including cold storage periods (three) and heat treatments (five) in completely randomized design, in three replicate, each replicate contained 60 uniform fruits. Therefore, the experiment implicated 15 interaction treatments. The cold storage periods were 10, 20 and 30 days at 2^{o}C (as a quarantine degree) and 90-95% RH, while the treatments were as follows:

1. Fruits were dipped in water (20^{o}C) for 5min. (referred to as: F+W+20^{o}Cx5min.).
2. Fruits were dipped in IMZ 1000 ppm (20^{o}C) for 5min. (referred to as: F+IMZ+20^{o}Cx5min.).
3. Fruits were dipped in hot water (52^{o}C) for 2 min. (referred to as: F+HW+52^{o}Cx2min.).
4. Fruits were dipped in hot water (60^{o}C) for 20 Sec. (referred to as: F+HW+60^{o}Cx20 Sec.).

5. Fruits were dipped in hot water (70^{o}C) for 10 Sec. (referred to as: F+HW+70^{o}Cx10 Sec.).

The hot water treatments were applied by submerging naked fruits in stirred hot water bath at 52^{o}C, 60^{o}C and 70^{o}C for 2 Min., 20 and 10 Sec., respectively, and then transferred immediately to cold water. All fruits of these treatments bagged in perforated (0.06% of area) low density polyethylene 20-micron thickness.

Samples of each treatment were randomly taken after 10, 20 and 30 days of cold period to evaluate the effect of storage periods, the tested treatments, and their interaction. After 10, 20 and 30 days of cold storage , 30 fruits for each treatment were kept for 3 and 6 days in an incubator at 20^{o}C and 60-70 % RH (similar to supermarket conditions) to detect the effects on fruits shelf life.

Table1: Characteristics of Ponkan tangarine fruits before cold storage.

Parameters	1st Season	2nd Season	Parameters	1st Season	2nd Season
Pulp firmness(g/cm^2)	162	156	**TSS %**	10.8	10.8
Peel firmness(kg/cm^2)	2.28	2.20	**Acidity %**	0.92	0.88
Pulp %	69.8	70.5	**Vit.C(ml/100ml Juice)**	39.8	41.6
Peel %	30.2	29.5	**TSS/Acid. ratio**	11.9	12.1
Juice %	27.3	28.6	**Tech. Index**	2.95	3.09
Juice volume/kg	281	290			

Data recorded:

Evaluation of treatment effects was implicated the following parameters:

I. Fruit Exclusion Attributes:

They were included:

1- Chilling injury (CI): Chilling injury expressed as pitting, staining and necrotic areas in the peel (Sanchez-Ballesta *et al*., 2003). Chilling injury was determined by the percentage of affected fruit.

2-Fruit decay percentage**:** It was determined by the percentage of affected fruit as rots caused by various fungi.

3- Heat injury: It was determined by the percentage of affected fruit (more than 25% red spots on fruit skin).

II. Other fruit quality parameters:

They were included fruit taste and physical and chemical properties of peel, pulp and juice of fruits as follows:

1- ***Fresh weight losses percentage (FWL %):*** Fruits were weighed just before cold storage treatments, then weighed after each cold storage period. Then, FWL percentage was calculated**.**

2- ***Panel test index (PTI):*** Each replicate was judged by 5 persons to give PTI score according to the following index: 4= excellent taste; 3= very good taste; 2 = good taste; 1= acceptable taste and 0= bad taste.

3- ***Pulp percentage*****:** It was expressed as percent of fruit weight (w/w).

4- ***Peel percentage:*** Percentage of peel was calculated (100-Pulp %).

5- ***Juice percentage*****:** Juice was extracted from randomly taken fruits per replicate. Juice content expressed as percent of fruit weight (w/w).

6- ***Volume of juice*** : Milliliter was expressed as volume of juice extracted from one kg fruits

7- ***Pulp firmness and peel firmness*****:** Five fruits for each replicate were used to determine for each of the pulp firmness (g/cm^2) and Peel firmness kg/cm^2. Pull Dynamometer (Model FD 101) used in this concern. The rind oil rupture pressure, the amount of pressure required to cause rupture of the oil cells on the surface of a rind was determined.

8- ***Juice total acidity:*** It was calculated by titration against 0.1 N sodium hydroxide in presence of phenolphthalein dye according to the method described by AOAC (1990)

9- ***Juice activated acidity (pH value):*** It was determined using a digital pH meter (Style Hanna 8514).

10- ***Juice total soluble solids percentage (TSS %):*** It was determined using a hand refractometer as Brix.

11- ***TSS / acid ratio****:* It was calculated by dividing TSS / acidity.

12- ***Ascorbic acid (Vit. C) content***: It was determined according to the procedures which described by Lucass (1944). Then it was calculated as milligrams ascorbic acid/ 100 ml. fruit juice.

13- ***Technological index (TI)****:* It was determined through the equation: TI= (SSC X juice %) /100. TI is an important variable to the citrus industry. Higher values of TI mean bet quality for juice manufacture (Chitarra and Chitarra, 1990).

Statistical Analysis:

The collected data were subjected to statistical analysis according to the methods described by Snedecor and Cochran (1980). Mean separation was done using Duncan Multiple Range Test at 5 % level (Duncan, 1958).

RESULTS AND DISCUSSION

1. Fruit excluded attributes

Data in Tables (2 and 3) represent the effect of storage periods, tested treatments and their interaction on chilling injury % (CI), fruit decay % (FD) and heat injury % (HI) during cold quarantine disinfestation. Also, cold storage and the following shelf life after 3 and 6 days of the Ponkan tangarine.

1.1. Effect of storage period

1.1.1. During cold storage

Presented data in Tables (2 and 3) show that percentage of CI, FD and HI of Ponkan tangarine fruits were significantly increased with increasing cold storage period. In this respect, cold storage period after 30 days recorded the maximum values (15.88 & 17.0 %) for CI ; (7.92 & 6.91 %) for FD and (16.54 & 16.76 %) for HI in the two seasons of study, respectively.

1.1.2. During shelf life

After cold storage, fruit samples which taken after 10, 20 and 30 days of cold storage and examined after 3 and 6 days of shelf life periods showed similar trend for CI, FD and HI percentages (Tables, 2 and 3). This trend was the gradual increments of percentages of the CI, FD and HI with increasing shelf life periods in both seasons.

The obtained results are in line with those obtained by Habashy (2002) on Ponkan tangarine; Ghasemnezhad *et al*.,(2008) on Satsuma mandarins and Mirdehghan *et al*., (2007) on pomegranate.

1.2. Effect of tested treatments

1.2.1. During cold storage

Data also in Tables (2 and 3) showed significant effect of IMZ and hot water treatments (HWT) on CI, FD and HI during cold storage in both seasons. The least values for the CI (3.05 & 4.44% in the two seasons) came from the treatment of (F+IMZ+20^{o}Cx5min.). The least FD value (0.0% in the two

Table 3. Effect of some heat treatments, cold storage period and their interaction on heat injury percentage of ponkan tangarine fruits during cold storage period and the following shelf life after 3 and 6 days (2009 and 2010 seasons).

Treatments		Heat injury % (HI)					
		After cold storage		Shelf life 3 days		Shelf life 6 days	
		1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Main effect of cold storage fruit period							
10 days		0.00c	0.00c	3.86c	4.93c	5.31c	6.60c
20 days		9.46b	9.20b	17.58b	17.13b	17.94b	17.72b
30 days		16.54a	16.76a	19.83a	19.86a	21.20a	20.0a
Main effect of treatments before storage at 2°C .							
Dipping in water 20°x 5 min.		0.00b	0.00c	0.00b	0.00b	0.00b	0.00b
D. in IMZ 1000 ppm 20°x 5 min.		0.00b	0.00c	0.00b	0.00b	0.00b	0.00b
D. in heat water 52°C x 2 min.		0.00b	0.00c	0.00b	0.00b	0.00b	0.00b
D. in heat water 60°C x 20 Sec.		1.38b	2.77b	0.80b	0.00b	2.00b	0.00b
D. in heat water 70°Cx 10 Sec.		41.96a	40.48a	68.0a	69.88a	72.10a	73.87a
Interaction (storage period X treatments).							
10 days X	**1**	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	2	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	3	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	4	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	5	0.00d	0.00d	19.3c	24.66c	26.56c	33.03c
20 days X	**1**	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	2	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	3	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	4	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	5	47.33b	46.00b	87.9b	85.66b	89.73b	88.6b
30 days X	**1**	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	2	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	3	0.00d	0.00d	0.00d	0.00d	0.00e	0.00d
	4	4.16c	8.33c	2.40d	0.00d	6.00d	0.00d
	5	78.56a	75.46a	96.7a	99.3a	100a	100a

Means within each column followed by the same letter (s) are not significantly different at 5% level.

seasons) came from the treatments of (F+IMZ+20°Cx5min. and F+HW+60°Cx20 Sec.) also, all used treatments significantly decreased FD. In addition, HI was to recorded 0.0% in the two seasons with (F+W+20°Cx5min.), (F+IMZ+20°Cx5min.), (F+HW+52°Cx2min.) treatments. The uppermost values for CI (12.20 &13.22% in both seasons resulted from treatment of (F+HW+70°Cx10 Sec.). As for FD (8.37 & 6.94% in the two seasons) came from (F+W+20°Cx5min.) treatment (control). So the highest values of HI (41.96 & 40.48 % in the two seasons) came from the treatment of (F+HW+70°Cx10 Sec.) then (1.38 & 2.77% in the two seasons) with treatment of

(F+HW+60^{o}Cx20 Sec.). On the other hand, hot water treatments (HWT) decreased FD. In addition, used fungicide (IMZ) decreased CI and FD % of fruits.

1.2.2. During shelf life

Data also in Tables (2 & 3) showed the effects of HWT and fungicide (IMZ) treatments on CI, FD percentage during shelf life. Hot water treatments significantly decreased CI and FD % compared with the control (F + W+ 20^{o}Cx5min.) treatment in both seasons. In addition, the effect of tested treatments on HI during shelf life revealed similar trend as discussed after cold storage in the tow seasons.

1.3. Effect of interaction (period x treatment)

1.3.1. During cold storage

The interaction respect cold storage periods (CSP) and hot water treatments (HWT) was recorded CI, FD and HI, percentage in the two seasons (Tables 2 and 3). In general, the minimum values of these parameters recorded from first cold storage period (10 days) with most treatments in both seasons. The highest values of CI and FD for fruits came always from 30 days cold storage x (F+W+20^{o}Cx5min.) in the two seasons. While, high values of HI percentage (78.56 & 75.46%) came from 30 days with (F+HW+70^{o}Cx10 Sec.) in both seasons.

1.3.2. During shelf life

The effect of interaction between CSP and HWT was statistically significant on CI and FD during shelf life and revealed similar trend as discussed after cold storage in both seasons (Tables 2 and 3).

The obtained results are in line with those obtained by Ghasemnezhad *et al.*, (2008) on Satsuma mandarins and Schirra *et al*., (2004) on blood oranges. Ghasemnezhad *et al*., (2008) reported that during storage at 2^{0}C for 8 weeks, a decline in catalase (CAT) activity observed, while peroxidase (POX) activity increased. This rapid increase in POX activity was associated with increased peel damage due to both chilling injury and heat damage. Decreasing chilling injury in (hot water dip) HWD correlated with decreased POX activity and maintenance of CAT activity during storage. Many investigators cleared that heat and fungicides treatments caused reductions in fruit decay by killing spores or delay in conidia germination, growth and sporulation (Dettori *et al*., 1996; Schirra *et al*., 2000 and Nafussi *et al*., 2001). HWT at high temperatures may cause that damage to sensitive citrus cultivars (Schirra and D' hallewin, 1997).

2-Other fruit quality attributes

2.1. Effect of storage period

2.1.1. During cold storage

Data in Tables (4-10) recorded the main effect of cold storage period on fruit fresh weight losses % (FWL %), panel test index (PTI), pulp and peel (percentage and firmness), juice (percentage and volume), total acidity %, TSS %, TSS/acid ratio, vitamin C and technological index (TI) were tabulated. The data showed gradual and significant increasing in FWL % and acidity % with the advance in cold storage period and reached its maximum values after 30 days of cold storage (0.70 & 0.84 % and 0.827& 0.866 % in the two tested seasons, respectively). On the contrary, the uppermost values for pulp firmness, peel firmness, TSS/acid ratio and vitamin C (162 & 161 g/cm^2; 3.04 & 2.84 kg/cm^2; 15.2 & 15.0 and 35.4 & 34.0 mg/100 ml juice in the two seasons, respectively) were obtained in the first sample (10 days). The following storage samples revealed gradually deceasing values for both parameters to reach minimum values at the last sample (30 days) in both seasons. While, data also showed insignificant effect of cold storage period on panel test index (PTI), pulp %, peel %, juice %, juice volume/kg fruits, TSS % and the technological index (TI) in both seasons.

2.1.2. During shelf life

Data showed that (Tables, 4-10) effect of cold storage period on FWL %, juice %, juice volume/kg fruits, acidity %, TSS % and the technological index (TI) after shelf life were significantly increased with increasing the cold storage period in both seasons. While, vitamin C significantly decreased with increasing the cold storage period. On the other hand, the effect of cold storage period after 6 days shelf life on pulp and peel (%) and peel firmness and after 3 and 6 days shelf life on PTI were insignificant in both seasons. These results are in line with Hong *et al*., (2007) on Satsuma mandarin who reported that with FWL% was increased with increasing cold storage period. Also, El-Hefnawi *et al*.,(2008) on Date palm reported that FWL % and TSS% increased, while, vitamin C were decreased with increasing the cold storage period, thus, Habashy (2002) on Ponkan Tangarine fruits reported that FWL%, acidity % & TSS % increased whereas pulp firmness & vitamin C decreased with storage periods in advanced.

Water loss can be one of the main causes of deterioration, since it not only resulted in direct quantative losses, but also causes losses in appearance (due to wilting and shriveling) and nutritional quality (Kader, 1986).

The loss in ascorbic acid content during storage, could be attributed to the rapid conversion of L- ascorbic acid into dihydrascobic acid in the presence of

Table10. Effect of some heat treatments, cold storage period and their interaction on technological index of ponkan tangarine fruits during cold storage period and the following shelf life after 3 and 6 days (2009- 2010 Seasons)

Treatments		Technological index (TI)					
		After cold storage		Shelf life 3 days		Shelf life 6 days	
		1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Main effect of cold storage fruit period							
10 days		2.84a	3.07a	2.93c	2.84b	2.95b	2.95b
20 days		2.84a	2.95a	3.28b	3.31a	2.91b	2.93b
30 days		3.08a	2.96a	3.45a	3.37a	3.72a	3.51a
Main effect of treatments before storage at 2°C .							
Dipping in water 20°x 5 min.		2.86a	2.92a	3.30a	3.17a	2.94a	2.99a
D. in IMZ 1000 ppm 20°x 5 min.		3.02ab	2.89a	3.19a	3.15a	3.22a	3.04a
D. in heat water 52°C x 2 min.		2.69b	2.82a	3.13a	3.26a	3.30a	3.26a
D. in heat water 60°C x 20 Sec.		3.21a	3.07a	3.12a	3.03a	3.13a	3.15a
D. in heat water 70°Cx 10 Sec.		2.81b	3..25a	3.36a	3.24a	3.37a	3.22a
Interaction (storage period X treatment)							
10 days X	**1**	2.41a	2.35a	2.94a	2.88a	3.04cde	2.92a
	2	2.83a	3.24a	2.69a	2.89a	2.88cde	2.78a
	3	2.71a	3.10a	2.94a	2.77a	2.68cde	3.37a
	4	3.16a	3.09a	2.99a	2.88a	2.81cde	2.54a
	5	3.07a	3.56a	3.09a	2.76a	3.35bc	3.17a
20 days X	**1**	3.09a	3.34a	3.35a	3.16a	2.46e	2.84a
	2	3.02a	2.95a	3.37a	3.24a	2.87cde	2.62a
	3	2.75a	2.51a	3.16a	3.49a	3.31bc	3.17a
	4	2.92a	2.97a	2.85a	2.94a	3.37bc	2.46a
	5	2.43a	2.96a	3.65a	3.69a	2.54de	2.57a
30 days X	**1**	3.09a	3.07a	3.61a	3.45a	3.33bc	3.21a
	2	3.23a	2.48a	3.50a	3.33a	3.90ab	3.73a
	3	2.60a	2.84a	3.29a	3.51a	3.91ab	3.25a
	4	3.54a	3.15a	3.51a	3.27a	3.22bcd	3.44a
	5	2.94a	3.24a	3.33a	3.28a	4.22a	3.91a

Means within each column followed by the same letter (s) are not significantly different at 5% level.

L- ascorbic acid oxidase (Hussein *et al.*,1998).

The gradual increase in the percentage of TSS with the increase of storage period could be attributed to the degradation of complex insoluble compounds, like, starch to simple soluble components, like sugars, which are the major TSS components. In addition, the increase in TSS might be due to water loss by transpiration through storage period (Hussein *et al.*, 1998).

2.2. Effect of tested treatments

2.2.1. During cold storage

The effect of tested treatments on FWL %, PTI, pulp and peel (percentage and firmness), juice (percentage and volume), acidity %, TSS %, TSS/acid ratio, vitamin

C and TI, generally, was insignificant during cold storage in both seasons except acidity % in the second season and vitamin C and technological index (TI) in first season (Tables 4-10).

2.2.2. During shelf life

The effects of tested treatments during shelf life after 3 days, generally, indicated that HW and fungicide (IMZ) treatments decreased values of peel firmness in the both seasons. While, HW and fungicide (IMZ) treatments increased of pulp firmness and TSS/acid ratio after 6 days of shelf life in both seasons. Acidity during shelf life after 6 days did not exhibited evident trend in both seasons. Whilst, FWL %, PTI, juice (percentage and volume) TSS%, TSS/acid ratio, vitamin C and (TI) values, generally, showed insignificant differences between treatments during shelf life after 3 and 6 days in both seasons (Tables 4-10).

2.3. Effect of interaction (period x treatment)

2.3.1. During cold storage

The effect of interaction between CSP x HWT (Tables 4-10) was, generally, statistically insignificant of FWL %, PTI, pulp and peel (% and firmness), juice (% and volume), acidity %, TSS%, TSS/acid ratio, vitamin C and TI during cold storage in both seasons**.** While, weight losses % of fruits were recorded the lowest values from the 10 days cold storage x (F+IMZ+20^{o}Cx5min.) treatment (0.10 and 0.04 in both seasons) and the highest values came from 30 days cold storage x (F+W+20^{o}Cx5min.) treatment (0.90 and 1.8 in both seasons)**.**

2.3.2. During shelf life

The effect of interaction between CSP x HWT was statistically insignificant of FWL %, PTI, pulp and peel (% and firmness), juice (% and volume), acidity %, TSS%, TSS/acid ratio, vitamin C and TI after 3 days shelf life in both seasons. While**,** after 6 days shelf life was significant for juice% and the lowest values from the 20 days cold storage x (F+W+20^{o}Cx5min.) treatment in the first season and (F+IMZ+20^{o}Cx5min.) treatment in the second season and the highest values came from 30 days cold storage x (F+HW+70^{o}Cx10 Sec.) treatment in both seasons. In this respect, the lowest values juice volume/kg fruits recorded from the 20 days cold storage x (F+W+20^{o}Cx5min.) treatment in the first season and (F+W+20^{o}Cx5min.) & (F+IMZ+20^{o}Cx5min.) treatments in the second season. While, the highest values came from 30 days cold storage x (F+HW+70^{o}Cx10 Sec.) treatment in both seasons. In addition, the effect of interaction between CSP x HWT was statistically significant on TSS percentage after 6 days shelf life without evident trend in both seasons (Tables. 4-10).

These results agreed with those Schirra *et al.,* (2004**),**who reported that no significant effect noticed on acidity %; TSS %; fruit firmness; PTI; juice volume and Vitamin C. In addition, Hong *et al.*, (2007) reported that no significant effect noticed on acidity % ; TSS % ; fruit firmness and TSS/acid ratio.

Conclusively, results of the present work, generally, make possible to recommended storage of Ponkan tangarine fruits at 2^{o}C to 30 days after treatment by hot water at 52^{o}Cx2min. or 60^{o}Cx20 Sec. and fungicide for 5min. to amid fruits disinfestations and decreasing chilling injury and decay percentage without decreasing of fruit quality attributes.

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تقليل أضرار البرودة لثمار اليوسفي الصينيخلال معاملة الحجر الزراعى المبرده عن طريق أستعمال بعض معاملات الماء الدافئ والأيمازليل

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أجرى هذا البحث أثناء موسمي ٢٠٠٩ ، ٢٠١٠ في معمل معاملات ما بعد الحصاد بقسم البساتين بكلية الزراعة جامعة الزقازيق لتقدير فعالية خمسه معاملات بالإيمازليل والماء الساخن وهى : ١-نقع الثمار بالماء على درجة ٥ درجه مئوية لمدة ٥ دقائق ، ٢- نقع الثمار بالإيمازليل بتركيز ١٠٠٠ جزء فى المليون على درجة ٥ درجه مئوية لمدة ٥ دقائق ، ٣- نقع الثمار بالماء الدافئ على درجة ٥٢ درجه مئوية لمدة ٢ دقيقه، ٤- نقع الثمار بالماء الدافئ على درجة ٦٠ درجه مئوية لمدة ٢٠ ثانيه، ٥- نقع الثمار بالماء الدافئ على درجة ٧٠ درجه مئوية لمدة ١٠ ثواني وثلاث فترات تخزين على درجة حرارة ٢ درجة مئوية ورطوبة نسبية ٩٠- ٩٥ % (١٠ ، ٢٠ ، ٣٠ يوم) وتفاعلاتهم على قدرة ثمار اليوسفي صنف بونكان على التخزين وحيويتها أثناء العرض.

أدت زيادة فترة تخزين الثمار إلى زيادات مضطردة لكل من نسبه ظهورأضرار البرودة وإصابة الثمار وأضرار الحرارة العالية و الفقد في الوزن الغض والحموضه أثناء التخزين البارد ؛ وأيضا نسبه الفقد فى الوزن ونسبه اللب ونسبه العصير وحجم العصير للكيلو جرام ثمار وصلابة القشره ونسبه المواد الصلبة الذائبة والدليل التكنولوجى **أثناء فترة التخزين البارد. وعلى العكس مع زياده مده التخزين البارد تقل كل من صلابة اللب والقشرة ونسبه المواد الصلبة الذائبة للحموضة ومحتوى الثمار من فيتامين ج. وكذلك مع زياده مده التخزين البارد يقل كل من النسبه المئويه للقشره وصلابة اللب ونسبه المواد الصلبة الذائبة للحموضة ومحتوى الثمار من فيتامين ج أثناء فتره العرض.**

أدت المعاملات الحرارية بالماء والطهرات الفطرية لثمار الصينى إلى خفض كل من نسبه أضرار البرودة وتلف الثمار أثناء فترة التخزين البارد وأثناء فتره العرض. ولم تؤثر المعاملات على صفات الجوده للثمار أثناء فترة التخزين البارد وأثناء فتره العرض.