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INFLUENCE OF INTERMITTENT WARMING ON REDUCING CHILLING INJURY AND KEEPING QUALITY OF "VALENCIA" EXPORT ORANGES

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ABSTRACT

During 2004 and 2005 seasons, consignment of "Valencia" oranges was obtained from citrus packinghouse before shipping to overseas markets. The fruits were stored for up to 15 weeks at the following temperature regimes (a) Continuous temperature at 5 °C (control), the remained fruits were subjected to intermittent warming (IW) cycles of (b) 18 days[d] at 5°C + 36 hours[h] at 20°C; (c) 18 d at 5°C + 48h at 20°C; (d) 18d at 5°C + 60h at 20°C; (e) 18d at 5°C + 72h at 20°C; (f) 13d at 5°C + 24h at 20°C; (g) 6d at 5°C + 12h at 20°C and (h) 6d at 5°C + 24h at 20°C, with RH 85-90%. All fruits then were held at 20°C with RH 80-90% for one week to simulate retial marketing.

The results indicated that, in both experimental seasons, as the storage period advanced, the percentages of unmarketable fruits, weight loss, total soluble solids (TSS) and TSS: acid ratio were significantly increased. Meanwhile, the percentages of titratable acidity (TA), fruit juice (%) and values of ascorbic acid (V.C) significantly decreased, as an average for all treatments. The highest significant unmarketable (%) existed in fruits stored continuously at 5°C (control) (37.22 and 33.33% in first and second season, respectively), compared with those in oranges treated with IW treatments (9.44- 24.44% in first season and 10.55 – 27.22% in the second), as an average for all storage periods. In addition, during the following shelf life period, those percentages were significantly decreased from 90% in both seasons in fruits stored continuously at 5°C to 46.66 -73.33% and 40.00- 73.33% in first and second seasons, respectively in ones treated with intermittent warming treatments. Moreover, IW had a great effect on decreasing fruit weight loss percentages.

The effectiveness of IW treatments on improving physical properties, was not clearly noticed on chemical ones such as TSS, TA, fruit juice (%), TSS: TA and V.C content. In spite of the efficiency of IW on TA was not clearly obvious, it was found that fruits treated with long cycle IW treatments (b),(c), (d) and (e) showed highest percentages followed by medium one (f) then those of short cycles (g) and (h).

The best IW treatment was (g) (6d at 5°C + 12h at 20°C) as the most clear reduction in unmarketable fruits (%)associated with that treatment especially during storage period, while the worst one was (f) (13 d at 5°C + 24h at 20°C) whereas the rest of IW treatments showed medium effects. Generally, there were no significant differences among long cycles intermittent warming treatments (b), (c), (d) and (e) on reducing the percentages of unmarketable fruits and weight loss. Also between short cycles IW treatments (g) and (h) on reducing weight loss.

Keywords: "Valencia" orange fruits, storage, intermittent warming and chilling injury.

INTRODUCTION

Egypt is considered as one of the most important producers of citrus fruits. The total area nearly 327838 feddans produced 2887599 tons of fruits. Valencia oranges occupied 47953 feddans representing 14.627% of the total citrus fruit area and their production reached 437165 tons (According to statistics of Ministry of Agriculture, 2006).

More efforts are recommended to raise the export potential of the exsisting markets, beside opening new international markets for the export of the local citrus fruit production. In order to achieve these goals, more attention should be directed to solve problems facing production, handling and marketing processes.

Egypt "Valencia" oranges are often exported between February and May. After discharge from packinghouse, fruits are placed in refrigerated containers (4-6°C) and shipped to overseas markets in countries such as Saudi Arabia, Arab Gulf, Middle East, Iran, Europe, Far East, Russia, Kenya, Sengal and Australia. Because of transportation and custom conditions, the fruits remain almost 5 days before shipping, besides the long journey may take about a month. On arrival, fruits remain again for inspection.

Chilling injury (CI) is a serious problem on long-term storage of export "Valencia" oranges. Investigations with various horticultural crops have shown periodic interruption of cold storage by fruit exposure to short periods of warming, to prevent or reduce CI development and maintain fruit quality for longer period, (Wang, 1993). "Thompson Navel" oranges indicated significantly lower CI and respiratory rates when stored under temperature cycles, rather than under constant temperature, (Arras and Usai, 1992). Several techniques have been applied to alleviate CI in lemons stored for 2-6 months in relative humidity > 90%. These techniques include using moderate temperatures (~13), intermittent fruits warming during cold storage and some chemicals. Reduction in decay and physiological disorders was best with two cycles of 2 weeks at 2°C and 2 weeks at 13°C and relative humidity > 95%, (Artes *et al.*, 1993). IW delayed the onset of CI of "Olinda" oranges fruits by 10 weeks when stored with cycles of 3 weeks at 3°C followed by 2 weeks at 15°C compared with continuous storage at 3°C (chilling temperature), (Schirra and Cohen, 1999).

In connection with governmental strategies in the agricultural sector for improvement of the Egyptian export oranges it is important to define clearly the most effective intermittent warming treatment, during long-term storage of "Valancia" oranges, on:

1- Reducing chilling injury and disorders.
2- Physical and chemical changes of fruits during cold storage.

MATERIAL AND METHODS

The present study was carried out during the two successive seasons 2004 and 2005 using "Valencia" oranges. Fruits were obtained from "Sonac" company in Damnhour, Behira Governorate, which is considered as

the best citrus packinghouse of Egypt (accredited with both ISO 9002 and HACCP certificates). It's capacity is 80 tons of citrus fruits per hour, 25000 tons of "Valencia" oranges were exported per season.

In effective procedures, fruits were harvested from definite excellent private orchards in Behera Governorate. Most of the trees were about fifteen years old, budded on sour orange rootstock, planted in clay soil at 5 x 5 meters apart and received the standard horticultural practices. Just as oranges arrived at the citrus packinghouse, all treatments were done. Sound fruits free from any visible blemishes or brusies were selected, treated with fungicide (SOPP at 2% for 2 min), rinsed in water and soap, dried (40°-50°C for 3-5 min), waxed (Citrosol wax emulsion containing T.B.Z and I.M.Z at 0.50% and 0.25%, respectively), dried again (40-50°C for 3-5 min.), examined again, sized and finally packed in export cartons.

In the fourth week of April, in each of the experimental seasons, 49 small export cartons, 30 fruits each (10 fruits for each replicate) were taken. One of them was used for an initial sample for physical parameters and chemical analysis. The remaining cartons (48) were divided into 8 equal groups (treatments), i.e each treatment was represented by 6 cartons (5 for storage periods and one for shelf life). In other words, 6 storage periods x 3 replicates x 10 fruits = 180 fruits /each treatment. Each of these 8 groups was treated with one of the following treatments:

(a) Fruits were stored continuously at 5°C (control)

Other remaining groups (7) were subjected to intermittent warming cycles, i.e., fruits stored at 5°C (for definite periods), followed by subjection to warming at 20°C (for definite intervals) then returned to storage at 5°C again as follows

(b) 18 days at 5°C + 36 hours at 20°C.
(c) 18 days at 5°C + 48 hours at 20°C.
(d) 18 days at 5°C + 60 hours at 20°C.
(e) 18 days at 5°C + 72 hours at 20°C.
(f) 13 days at 5°C + 24 hours at 20°C.
(g) 6 days at 5°C + 12 hours at 20°C.
(h) 6 days at 5°C + 24 hours at 20°C.

All fruits were stored at 85-90 % RH.

Fruits were kept as long as they were suitable for human consumption and the percentage of unmarketable fruits didn't reach nearly 75%. In addition, at the end of storage, fruits were held one week for shelf life at 20°C at 80-90% RH to simulate retail marketing. "Valencia" orange fruits were evaluated at a 3 week-interval throughout the storage period, to study the effect of various treatments on:

A- Physical properties:

1- Unmarketable fruits (during storage and after one week of shelf life), the number of unmarketable fruits due to chilling injury, decay and shrinkage was calculated as percentage from the total number of each sample.
2- Weight loss, as a percentage from the initial weight.

B- Chemical properties:

1- Total soluble solids (TSS), were determined using a hand refractometer.

2- Titratable acidity (TA), was determined by titration against 0.1 N sodium hydroxide, according to the A.O.A.C. (1985).
3- TSS/ TA ratio.
4- Fruit juice, it's weight was calculated as a percentage from the fruit weight (w/w).
5- Ascorbic acid (V.C), was determined by titration against 2.6 dichlorophenol indophenol blue dye, according to the A.O.A.C. (1985).

All data were statistically analyzed according to Snedecor and Cochran (1971). The design was completely randomized with two factors experiment, treatments and storage periods, (split in time). The L.S.D method at (0.05) was used to compare the average of treatments (T), storage periods (P) and their interaction (TXP).

RESULTS AND DISCUSSION

A- Physical Properties

1- Unmarketable fruits:

1.1. During storage

The data nominated in Table (1) declared that, in both seasons of study, there was a gradual increase in the percentages of unmarketable fruits with the progress of storage period. As an average for all experimental treatments, the differences were significant among all storage periods, except between the first and second ones. This could be due to fruit shrinkage as a result of moisture loss; fruit chilling injury, fungal attack of the fruits such as green and blue molds and Alternaria rot and fruit senescence and consequently rapid deterioration of the fruits. These findings agreed with those obtained by Bertolini *et al.* (1991) on "Femminello comune lemons". Also Saltveit and Morris (1990) reported that CI generally results from exposure of tropical or subtropical plants to temperature bellow 10-15°C.

The data also revealed that, in both seasons, as an average for the whole storage period, the fruits continuously stored at 5°C had higher significant percentages of unmarketable fruits (37.222 and 33.333% in first and second seasons, respectively) than those treated with IW treatments (9.444 - 24.444 and 10.556 - 27.222% in first and second seasons, respectively).

Reduction of unmarketable fruits by intermittent warming treatments supported the hypothesis that IW maintains cellular membrane integrity as the pectinesterase activity was lower in intermittently warmed fruits than in ones continuously stored at chilling temperatures, which resulted in reducing CI and keeping fruit quality. The above mentioned data and the related discussion were in accordance with those found by Arras and Usai (1992) on "Thompson Navel" oranges, Artes *et al.*, (1993) on "Primofiori" lemons, Schirra and Mulas (1995) on "Fortune" mandarin, Schirra and Cohen (1999) on "Olinda" oranges and Artes *et al.* (1999)on peaches.

Regarding IW treatments, the least significant percentages of unmarketable fruits were found in those treated with IW treatment (g) (6d at 5°C + 12h at 20°C) as an average for the whole storage period.

Table (1): Effect of intermittent warming treatments on the percentage of unmarketable "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	0.000	0.000	30.000	53.333	63.333	76.666	37.222	0.000	0.000	30.00	40.000	50.000	80.000	33.333
(b) 18 d at 5°C + 36 h at 20°C.	0.000	0.000	0.000	30.000	30.000	40.000	16.667	0.000	0.000	0.000	0.000	33.333	50.000	13.889
(c) 18 d at 5°C + 48 h at 20°C.	0.000	0.000	10.000	10.000	23.333	50.000	15.556	0.000	0.000	3.333	10.000	26.666	46.666	14.444
(d) 18 d at 5°C + 60 h at 20°C.	0.000	0.000	10.000	20.000	36.666	40.000	17.778	0.000	0.000	10.000	26.666	40.000	43.333	20.000
(e) 18 d at 5°C + 72 h at 20°C.	0.000	0.000	10.000	13.333	26.666	50.000	16.667	0.000	0.000	0.000	13.333	36.666	43.333	15.556
(f) 13 d at 5°C + 24 h at 20°C.	0.000	0.000	23.333	36.666	40.000	46.666	24.444	0.000	0.000	10.000	40.000	46.666	66.666	27.222
(g) 6 d at 5°C + 12 h at 20°C.	0.000	0.000	0.000	0.000	26.666	30.000	9.444	0.000	0.000	0.000	0.000	30.000	33.333	10.556
(h) 6 d at 5°C + 24 h at 20°C.	0.000	0.000	10.000	20.000	33.333	40.000	17.222	0.000	0.000	10.000	20.000	40.000	50.000	20.000
Average	0.000	0.000	11.667	22.917	35.000	46.667		0.000	0.000	7.917	18.750	37.917	51.667	
L.S.D 0.05	Treatments 4.079		Storage period 3.316			Interaction 9.381		Treatments 2.427		Storage period 2.042			Interaction 5.776	

On the contrary, the highest ones were existed in fruits treated with treatment (f) (13d at 5 °C + 24h at 20°C). No significant differences were detected among unmarketable fruits (%) of those treated with the long cycle IW treatments (18d at 5°C plus any hours at 20°C) except, treatment (d) (in second season only) as the differences were significant.

The superiority of IW treatment (g) (6d at 5°C + 12h at 20°C) on reducing unmarketable fruits (%) was in harmony with those previously found by Arras and Usai (1991) on "Murcott" mandarins, El-Shiekh (2002) and El-Hefnawi (2002) on "Balady" limes.

1.2 After one week of shelf life

The data presented in Table (2) clearly showed that, fruits stored continuously at 5°C gave the highest significant percentages of unmarketable fruits after one week of shelf life (90.000% in both seasons) compared with those treated with IW treatments (46.667-73.333% and 40.000-73.333% in first and second season, respectively) except the treatment (f) (13 d at 5°C + 24h at 20°C) (in first season) as the differences were not significant.

Concerning IW treatments, the treatments (f) (13d at 5°C + 24h at 20°C) showed the highest percentages of unmarketable fruits (73.333% in both seasons) compared with other treatments. However, the differences were not significant between those values and others of treatments (b), (c) and (e) (in first season) and (b) and (h) (in second one). On the other side, the least significant unmarketable fruits (%) were existed in ones of treatment (g) (6d at 5°C + 12h at 20°C) (46.667 and 40.000% in first and second season, respectively), except those of treatments (b), (c), (d) and (h) in first season and (c), (d) and (e) in second one as the differences were not significant. The above mentioned results were in line those obtained by Arras and Usai (1992) on "Thompson Navel" oranges.

Table (2): Effect of intermittent warming treatments on the percentage of unmarketable "Valencia" orange fruits after one week of shelf life.

Intermittent warming treatments	One week of shelf life after cold storage period	
	First season	Second season
(a) Continuous storage at 5°C	90.000	90.000
(b) 18 d at 5°C + 36 h at 20°C.	60.000	70.000
(c) 18 d at 5°C + 48 h at 20°C.	60.000	50.000
(d) 18 d at 5°C + 60 h at 20°C.	50.000	43.333
(e) 18 d at 5°C + 72 h at 20°C.	70.000	50.000
(f) 13 d at 5°C + 24 h at 20°C.	73.333	73.333
(g) 6 d at 5°C + 12 h at 20°C.	46.667	40.000
(h) 6 d at 5°C + 24 h at 20°C.	50.000	60.000
L.S.D 0.05	18.016	14.568

2. Weight loss

The data illustrated in Table (3) showed that the percentages of weight loss were significantly increased as the storage period advanced. As an average for all storage periods, the highest significant percentages of weight loss were found in fruits continuously stored at 5°C (8.277 and 8.469%) compared with those treated with intermittent warming treatments (5.571-7.154 and 5.291-7.498% in first and second seasons, respectively). The reduction in weight loss by using intermittent warming treatments was confirmed by those obtained by Tugwell and Chvyl (1995) and El-Hefnawi (2002).

In respect to intermittent warming treatments, the data indicated that, as an average of all storage periods, treatment (f) (13d at 5°C + 24h at 20°C) showed the highest significant percentages of weight loss compared with other IW treatments, except (c), (g) and (h) ones (in first season) as the differences were not significant. On the other side, treatment (d) (18d at 5°C + 60h at 20°C) displayed the least significant weight loss (%) nevertheless treatments (b) and (e) (in first season only) almost showed the same values as the differences were not significant.

The data also showed that, as an average for all storage periods, no significant differences were detected among weight loss percentages of fruits treated with long cycles IW treatments (18d at 5°C plus any hours at 20°C) except treatments (c) in the first season and (d) in the second. The same trend was also noticed concerning short cycles IW treatments (6d at 5°C + 12 or 24h at 20°C), as the differences were also not significant between them in both seasons.

B. Chemical Properties

1. Total soluble solids (TSS)

The data presented in Table (4) showed that the percentages of TSS, as an average for experimental treatments, generally increased with the progress of storage time, in both years of study.

As an average for all storage periods, fruits stored continuously at 5°C generally had higher TSS percentages than those of fruits treated with IW treatments. However, the differences were not significant except ones treated with long cycles IW treatments {(b), (c), (d) and (e)} in first season only. No significant differences were also noticed among TSS percentages of all IW treatments in both experimental seasons except treatment (h) in first one.

It can be noticed that TSS percentages was not greatly affected by IW treatments. These findings were supported by those reported by Artes *et al* (1993) on "Primofiori" lemons and Schirra and Cohen (1999) on "Olinda" oranges. In addition Kluge *et al.* (1996) recorded that IW had no effect on total soluble solids in peach fruits. However, the results were not in line with the findings of El-Shiekh (2002) and El-Hefnawi (2002) on "Balady" limes, they noticed that TSS increased with IW treatments.

Table (3): Effect of intermittent warming treatments on the percentage of weight loss of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	-	2.636	5.610	8.596	10.970	13.570	8.277	-	2.596	5.566	8.633	11.446	14.103	8.469
(b)18 d at 5°C + 36 h at 20°C.	-	1.873	4.033	6.173	7.790	9.493	5.873	-	2.170	4.303	6.673	8.790	10.880	6.563
(c)18 d at 5°C + 48 h at 20°C.	-	2.200	4.390	7.110	9.000	11.100	6.760	-	1.960	3.820	6.320	8.083	10.113	6.059
(d)18 d at 5°C + 60 h at 20°C.	-	1.776	3.713	5.710	7.516	9.140	5.571	-	1.586	3.473	5.450	7.280	8.663	5.291
(e)18 d at 5°C + 72 h at 20°C.	-	1.920	4.046	6.176	8.213	9.963	6.064	-	2.080	3.736	6.440	8.503	10.160	6.184
(f)13 d at 5°C + 24 h at 20°C.	-	2.180	4.843	7.403	9.580	11.763	7.154	-	2.223	5.240	7.886	10.000	12.160	7.498
(g)6 d at 5°C + 12 h at 20°C.	-	1.973	4.450	7.233	9.316	11.110	6.817	-	1.893	3.910	6.783	8.823	10.433	6.369
(h)6 d at 5°C + 24 h at 20°C.	-	2.060	4.420	6.753	8.610	10.706	6.510	-	1.913	4.333	7.066	9.046	10.850	6.642
Average	-	2.077	4.438	6.894	8.874	10.855		-	2.052	4.297	6.904	8.996	10.920	
L.S.D	Treatments			Storage period			Interaction	Treatments			Storage period			Interaction
0.05	0.654			0.164			0.465	0.670			0.146			0.413

Table (4): Effect of intermittent warming treatments on the percentage of total soluble solids (TSS) of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	10.400	10.533	10.666	10.066	11.800	11.466	10.822	10.333	10.733	11.066	10.200	11.000	10.933	11.711
(b) 18 d at 5°C + 36 h at 20°C.	10.400	10.066	10.000	10.800	11.066	11.200	10.588	10.333	10.400	10.800	12.200	11.066	10.533	10.889
(c) 18 d at 5°C + 48 h at 20°C.	10.400	10.600	11.066	9.730	10.933	11.000	10.622	10.333	10.466	10.400	10.266	11.400	10.333	10.533
(d) 18 d at 5°C + 60 h at 20°C.	10.400	10.866	11.133	10.600	10.600	10.200	10.633	10.333	11.200	11.933	10.866	10.800	10.666	10.976
(e) 18 d at 5°C + 72 h at 20°C.	10.400	10.200	10.400	11.200	11.000	10.533	10.622	10.333	10.733	10.866	10.200	10.300	11.200	10.611
(f) 13 d at 5°C + 24 h at 20°C.	10.400	10.600	11.000	11.200	10.600	10.733	10.755	10.333	10.400	10.466	10.933	10.666	10.800	10.600
(g) 6 d at 5°C + 12 h at 20°C.	10.400	10.933	11.200	10.466	11.066	10.400	10.744	10.333	10.600	10.733	10.600	11.000	11.400	10.778
(h) 6 d at 5°C + 24 h at 20°C.	10.400	10.733	11.066	11.466	11.266	10.533	10.911	10.333	10.200	10.133	10.733	11.400	10.600	10.567
Average	10.400	10.566	10.816	10.691	11.041	10.758		10.333	10.592	10.800	10.750	10.958	10.808	
L.S.D	Treatments			Storage period			Interaction	Treatments			Storage period			Interaction
0.05	0.185			0.181			0.514	N.S.			0.232			0.656

2. Titratable acidity (TA)

The data obtained in Table (5) showed that, as an average for all treatments, the initial citric acid percentages significantly decreased from 0.862 to 0.730% and from 0.887 to 0.719% in first and second seasons, respectively, at the end of storage period (15 weeks). This reduction could be explained, as the citric acid is a respiratory substrate and its consumption in respiration increases with the progress of storage period and resulted in observed decrease. The reduction in acidity with the advanced of storage time was previously reported by El-Zayat *et al.* (1998) on lime fruits and El-Wahab (2000) on "Washington Navel" orange.

In both experimental seasons, as an average of all storage periods, the least significant percentages of citric acid were existed in fruits treated with short cycle IW treatment (h) (6d at 5°C + 24h at 20°C) compared with those of all other treatments, except ones stored continuously at 5°C (in first season). The data also indicated that no significant differences were found among citric acid percentages of fruits treated with long cycle IW treatments (b), (c) and (d).

In spite of the effectiveness of IW treatments on values of citric acid was not clearly obvious generally, it could be noticed that, fruits treated with long cycle IW treatments (b), (c), (d) or (e) showed highest percentages of citric acid followed by medium one treatment (f) then those of short cycles treatments (g) or (h).

The obtained results are in harmony with those reported by Artes *et al.* (1993) on "Primofiori" lemons and Schirra and Cohen (1999) on "Olinda" oranges. Moreover, Kluge *et al.* (1996) found that IW had no effect on total titratable acidity in peach fruits. However, El-Hefnawi (2002) on "Balady" limes reported that, the IW treatments showed significant decrease in juice total acidity compared with the constant temperature in first experimental season. While, El-Sheikh (2002) on "Balady" limes found that fruit acidity increased as a result of the intermittent warming treatments in both seasons of study.

3. TSS: TA ratio

The data demonstrated in Table (6) revealed that in both years of study as an average for all treatments, the initial TSS: acid ratios significantly increased from 12.083 to 15.066 and from 11.640 to 15.343 in first and second seasons, respectively, at the end of storage time.

In both experimental seasons, as an average for all storage periods the highest significant TSS: acid ratios were found in ones treated with IW treatment (h) (6d at 5°C + 24h at 20°C) compared with those of all other treatments. These results were supported by those found by El-Shiekh (2002) on "Balady" limes. The data also showed that, no significant differences were detected among TSS: acid ratios of fruits treated with long cycles IW treatments (b), (c), (d) and (e), except last one (e) in first season. Generally, those values were significantly lower than ones treated with short cycles (g) or (h).

It seems quiet clear that, TSS: TA ratio did not greatly influenced by IW treatments. The obtained results were in line with those found by Schirra and Cohen (1999) on "Olinda" oranges.

Table (5): Effect of intermittent warming treatments on percent citric acid of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	0.862	0.826	0.724	0.689	0.824	0.754	0.780	0.887	0.876	0.876	0.724	0.788	0.800	0.825
(b) 18 d at 5°C + 36 h at 20°C.	0.862	0.836	0.841	0.899	0.833	0.811	0.847	0.887	0.875	0.899	0.922	0.911	0.705	0.866
(c) 18 d at 5°C + 48 h at 20°C.	0.862	0.925	0.991	0.737	0.857	0.807	0.863	0.887	0.945	0.915	0.816	0.800	0.774	0.856
(d) 18 d at 5°C + 60 h at 20°C.	0.862	0.895	0.872	0.812	0.820	0.752	0.835	0.887	0.897	0.872	0.852	0.907	0.777	0.865
(e) 18 d at 5°C + 72 h at 20°C.	0.862	0.900	0.907	0.792	0.788	0.603	0.808	0.887	0.904	0.922	0.709	0.740	0.777	0.823
(f) 13 d at 5°C + 24 h at 20°C.	0.862	0.874	0.831	0.750	0.689	0.863	0.811	0.887	0.855	0.800	0.787	0.760	0.731	0.803
(g) 6 d at 5°C + 12 h at 20°C.	0.862	0.874	0.808	0.773	0.824	0.716	0.809	0.887	0.837	0.754	0.808	0.734	0.663	0.780
(h) 6 d at 5°C + 24 h at 20°C.	0.862	0.854	0.808	0.674	0.739	0.534	0.745	0.887	0.823	0.701	0.724	0.717	0.528	0.730
Average	0.862	0.873	0.848	0.766	0.797	0.730		0.887	0.876	0.842	0.793	0.794	0.719	
L.S.D 0.05	Treatments 0.038			Storage period 0.029		Interaction 0.083		Treatments 0.033		Storage period 0.026			Interaction 0.074	

Table (6): Effect of intermittent warming treatments on TSS: Acid ratio of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	12.083	12.743	14.726	14.606	14.436	15.200	13.966	11.640	12.246	12.650	14.086	13.953	13.673	13.042
(b) 18 d at 5°C + 36 h at 20°C.	12.083	12.056	11.986	12.016	13.343	13.806	12.549	11.640	11.896	12.050	13.236	12.143	14.923	12.648
(c) 18 d at 5°C + 48 h at 20°C.	12.083	11.520	11.170	13.193	12.843	13.673	12.414	11.640	11.090	11.410	12.583	14.316	13.340	12.397
(d) 18 d at 5°C + 60 h at 20°C.	12.083	12.136	12.773	13.050	12.930	13.556	12.755	11.640	12.476	13.680	12.776	11.940	13.723	12.706
(e) 18 d at 5°C + 72 h at 20°C.	12.083	11.333	11.463	14.313	13.986	17.456	13.439	11.640	11.870	11.783	14.396	14.013	14.416	13.020
(f) 13 d at 5°C + 24 h at 20°C.	12.083	12.123	13.256	14.923	15.380	12.513	13.380	11.640	12.186	13.080	13.886	14.173	14.766	13.289
(g) 6 d at 5°C + 12 h at 20°C.	12.083	12.506	13.883	13.530	13.603	14.530	13.356	11.640	12.653	14.266	13.260	15.216	17.190	14.038
(h) 6 d at 5°C + 24 h at 20°C.	12.083	12.563	13.693	16.986	15.250	19.790	15.061	11.640	12.533	14.456	14.830	15.910	20.710	15.013
Average	12.083	12.123	12.869	14.078	13.972	15.066		11.640	12.119	12.922	13.632	13.958	15.343	
L.S.D 0.05	Treatments 0.473		Storage period 0.474			Interaction 1.341		Treatments 0.673		Storage period 0.618			Interaction 1.750	

4. Fruit juice:

The data introduced in Table (7) showed that, in both seasons, as an average for all treatments, the initial juice percentages were decreased significantly at the end of storage period. The results were confirmed with those found on "Balady" limes by El-Hefnawi (2002).

As an average for all storage periods, no significant differences were existed between juice percentages of fruits stored continuously at 5°C and those of oranges treated with all IW treatments, , except treatment (f)(in second seasons) as the differences were significant. Regarding IW treatments, it could be mentioned that, no significant differences were detected among juice percentages of all treatments in first season and the same trend almost showed in second one.

The inefficient of IW treatments on juice percentages was previously noticed by El-Hefnawy (2002) in first season. Moreover, El-Shiekh (2002) reported that no significant differences were noticed in limes fruit juice content as affected by the different IW treatments in both experimental seasons.

5. Ascorbic acid (V.C):

The data introduced in Table (8) recorded that in both years of study, as an average for all treatments, the initial values of V.C decreased significantly at the end of storage period. Similary El-Shiekh (2002) and El-Hefnawi (2002) found that significant reduction in V.C content was with the advanced in cold storage period. However, Artes *et al.* (1993) found that the concentration of ascorbic acid was increased.

In first season, no significant differences were found between V.C values in juice of fruits stored continuously at 5°C and those of ones treated with IW treatments, as an average for all storage periods, except (c), (e) and (g) treatments as the differences were significant. In addition, the V.C values of those treatments {(c), (e) and (g)} were significantly lower than ones of all other treatments. Meanwhile in second season no significant differences were existed among V.C values of all experimental treatments.

It could be concluded that, IW treatments almost had no effect on V.C content. Similarly Arras and Usai (1992) found that V.C values of "Thompson Navel" oranges generally proved to be little affected by different cold-storage temperature cycles compared with those of fruits stored at a constant storage temperature 6°C. However, El-Hefnawi (2002) on limes recorded significant increase in second season and reduction in first one in V.C values of IW treatments compared with the constant one.

Table (7): Effect of intermittent warming treatments on percentage of juice of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a)Continuous storage at 5°C	58.660	51.246	43.636	38.703	34.366	47.523	45.689	56.866	52.260	38.416	32.710	39.723	38.043	43.003
(b)18 d at 5°C + 36 h at 20°C.	58.660	48.980	37.160	42.100	38.063	38.846	43.968	56.866	45.843	34.696	30.800	42.436	39.316	41.660
(c)18 d at 5°C + 48 h at 20°C.	58.660	48.770	39.396	41.430	34.003	42.163	44.071	56.866	50.273	39.286	35.626	39.136	46.223	44.569
(d)18 d at 5°C + 60 h at 20°C.	58.660	49.800	37.926	44.480	34.200	35.410	43.413	56.866	50.390	40.600	40.840	35.363	39.453	43.919
(e)18 d at 5°C + 72 h at 20°C.	58.660	49.750	42.396	40.383	35.483	36.756	43.906	56.866	51.056	42.243	41.456	35.480	35.316	43.737
(f)13 d at 5°C + 24 h at 20°C.	58.660	55.046	45.133	44.666	42.270	40.183	47.660	56.866	53.023	40.960	49.033	44.863	41.193	47.657
(g)6 d at 5°C + 12 h at 20°C.	58.660	51.070	45.113	39.126	34.556	36.023	44.092	56.866	52.186	41.053	44.580	34.530	41.573	45.132
(h)6 d at 5°C + 24 h at 20°C.	58.660	50.976	38.036	46.333	32.396	33.236	43.273	56.866	50.063	37.730	43.333	38.000	40.846	44.473
Average	58.660	50.705	41.100	42.153	35.667	38.768		56.866	50.637	39.373	39.797	38.692	40.246	
L.S.D 0.05	Treatments N.S.			Storage period 2.215			Interaction 6.265	Treatments 2.898			Storage period 2.093			Interaction 5.921

Table (8): Effect of intermittent warming treatments on V.C (mg/100ml juice) of "Valencia" orange fruits during cold storage.

Intermittent warming treatments	Weeks in storage													
	First season (2004)							Second season (2005)						
	0	3	6	9	12	15	Average	0	3	6	9	12	15	Average
(a) Continuous storage at 5°C	38.610	39.570	40.303	35.263	39.606	37.263	38.436	37.243	39.186	39.666	35.893	43.146	37.820	38.826
(b) 18 d at 5°C + 36 h at 20°C.	38.610	38.000	37.183	45.090	37.473	37.876	39.039	37.243	36.233	35.000	41.766	41.266	33.126	37.406
(c) 18 d at 5°C + 48 h at 20°C.	38.610	38.710	36.546	31.570	37.193	36.090	36.453	37.243	39.000	37.513	40.473	36.010	31.340	36.930
(d) 18 d at 5°C + 60 h at 20°C.	38.610	39.503	40.000	37.113	39.270	32.233	37.788	37.243	39.106	41.546	38.050	37.810	29.886	37.274
(e) 18 d at 5°C + 72 h at 20°C.	38.610	37.896	36.846	37.110	35.680	28.100	35.707	37.243	38.416	37.346	34.340	36.293	37.263	36.817
(f) 13 d at 5°C + 24 h at 20°C.	38.610	39.276	40.300	41.690	32.700	40.506	38.847	37.243	36.156	31.820	36.190	34.216	35.476	35.184
(g) 6 d at 5°C + 12 h at 20°C.	38.610	38.870	39.090	34.636	33.900	34.020	36.521	37.243	38.166	40.000	37.046	35.113	35.806	37.289
(h) 6 d at 5°C + 24 h at 20°C.	38.610	41.053	43.726	46.770	34.216	27.820	38.699	37.243	38.066	36.816	38.330	35.396	27.206	35.677
Average	38.610	39.110	39.250	38.655	36.255	34.239		37.243	38.042	37.589	37.806	37.382	33.491	
L.S.D 0.05	Treatments 1.225		Storage period 1.061			Interaction 3.002		Treatments N.S.		Storage period 1.332			Interaction 3.768	

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تاثير طرق الطهى المختلفة على صفات لحم الدجاج

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احتفظت أجزاء لحم الدجاج المختبرة والمطبوخة تحت ضغط وبالغليان بنسبة أعلى من الرطوبة والليبيدات الكلية عن عينات لحم الدجاج المشوية والمطهية بالميكروويف. ومن ناحية أخرى احتفظت عينات لحم صدر وفخذ الدجاج المطهية تحت ضغط بأعلى نسبة من النيتروجين الكلى والبروتين الكلى والنيتروجين الكلى الذائب والنيتروجين البروتينى الذائب ونيتروجين الأكتوميوسين الذائب والنيتروجين غير البروتيني متبوعة بالطهي بالميكروويف ثم الشي والطهى بالغليان. بينما احتفظت العينات بأعلى نسبة من الرماد والمعادن بعد الطهي بالميكروويف عن طرق الطهى الأخرى لكل من عينات لحم فخذ وصدر الدجاج وجدت زيادة ملحوظة في الرقم الحمضى ورقم البيروكسيد ورقم حمض الثيوباربيتيوريك فى حالة الشى لكل من عينات لحم الصدر والفخذ وتبين من النتائج المتحصل عليها أن عينات لحم صدر الدجاج بعد أى طريقة من طرق الطهى لها رقم بيروكسيد ورقم حموضة وثيوباربيتيوريك أقل من عينات لحم الفخذ. كانت أعلى نسبة زيادة في الأحماض الدهنية المشبعة فى كل من عينات لحم الصدر أو الفخذ المشوية. بينما كانت أقل زيادة لنسبها بعد الطهي تحت ضغط لنفس العينات بالمقارنة بالعينات الغير مطهية. بينما كان اتجاه الأحماض الدهنية غير المشبعة عكسيا مقارنة بالأحماض الدهنية المشبعة. ولقد كان لعينات لحم فخذ الدجاج نسب أعلى من الأحماض الدهنية غير المشبعة للمشبعة عنها فى عينات لحم الصدر وبعد أى طريقة طهى. لقد احتفظت عينات لحم صدر وفخذ الدجاج المطهية تحت ضغط بنسب أعلى من الأحماض الأمينية الأساسية وغير الأساسية والكلية متبوعة بتناقص فى حالة الطهى بالغليان والميكروويف والشى، ولكن لم يلاحظ بين طرق الطهى هذه اختلافات معنوية لمحتواها من الاحماض الأمينية.