PHYSIOLOGICAL STUDIES ON "MARISOL" CLEMENTINE FRUITS II- EFFECT OF ROOTSTOCK TYPES ON FRUIT STORABILITY

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Abstract

This investigation was carried out during two successive seasons (2005&2006) at Hort. Res. Institute, Fruit Handling Department, Giza to study the effect of the rootstock type and storage temperature on Marisol clementine fruit storability.

Marisol trees grown in a private farm at Ismailia Governorate, grafted on Sour orange, Carrizo citrange, Cleopatra mandarin and "Swingle" Citrumelo rootstocks were selected for this study. Mature fruits of each treatment in both seasons, were picked, washed, dried, sorted to obtain uniform samples then stored at 5°C or 10°C and 90- 95% RH up to 8 weeks. Physical and chemical properties at 15 day intervals were determined during storage.

Weight loss percentage, decay percentage, total soluble solids and TSS/total acidity ratio increased gradually with the increasing of storage period. On the contrary, fruit gravity, fruit firmness, juice percentage, total acidity and ascorbic acid contents decreased gradually with the increasing of storage period. Furthermore, fruit color changed directly from greenish-yellow to yellow to orange-yellow.

Fruits from trees grafted on Sour orange rootstock had weight loss, decay incidence, fruit color development, TSS and ascorbic acid contents significantly less and fruit gravity, fruit firmness, fruit juice content and total acidity significantly higher than fruits from trees grafted on the other rootstocks. However, some of these differences were due to preharvest factors.

Fruits stored at 5°C significantly had less weight loss than those stored at 10°C Furthermore, storage at 5°C significantly reduced the deterioration rate of fruit gravity, fruit coloration, softening, juice content and changes rate of TSS, Total acidity, TSS/ total acidity ratio and ascorbic acid in comparison with storage at 10°C. On contrast, fruits stored at 5°C significantly had higher decay percentage in comparison with fruits stored at 10°C not only because the increasing of chilling injured fruits associated with storage at 5°C, but also for the improvement of fruit color happened at 10°C storage temperature.

It can be concluded that, clementine fruits "Marisol cv." are able to be stored for 45 days at 10°C and 90-95% RH with negligible changes of fruit properties and quality. Moreover, rootstock types under this study nearly had a little effect on fruit storability.

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Fruits stored at 5°C significantly had less weight loss than those stored at 10°C Furthermore, storage at 5°C significantly reduced the deterioration rate of fruit gravity, fruit coloration, softening, juice content and changes rate of TSS, Total acidity, TSS/ total acidity ratio and ascorbic acid in comparison with storage at 10°C. On contrast, fruits stored at 5°C significantly had higher decay percentage in comparison with fruits stored at 10°C not only because the increasing of chilling injured fruits associated with storage at 5°C, but also for the improvement of fruit color happened at 10°C storage temperature.

It can be concluded that, clementine fruits "Marisol cv." are able to be stored for 45 days at 10°C and 90-95% RH with negligible changes of fruit properties and quality. Moreover, rootstock types under this study nearly had a little effect on fruit storability.

INTRODUCTION

Citrus is one of the most important fruit crops in Egypt (382027 Fadan, in 2006). There is a good opportunity for citrus species other than orange to increase its exported quantity to Europe countries under the Egyptian Europe Association agreement. The concentration of the Egyptian local Mandarin fruit production during a short period and its sensitivity to post harvest and handling management obligate to search about new mandarin verities especially early and late ones which have a good ability for marketing and handling process.

There are new mandarin cultivars and hybrids have been introduced to the Egyptian Horticultural process, however there is lack of information about the behavior these new cultivars concerning maturation and post harvest management.

Post harvest life of mandarin fruits depends on complicated interactions between the physiology of the fruit and its pathogens. Storage temperature is of the prime importance; when the same variety grows under different climatic conditions it needs different storage temperature.

D'Hallewin et al. (1994) mentioned that storage behavior of Avana mandarin was more affected by rootstock and fruit on Sour orange had the lowest loss through disease during storage, but had the greatest chilling injury. Moreover, quality parameters were affected by rootstock at harvest and these differences remained during storage and shelf life.

Farih et al. (1995) reported that, clementine cultivars Sidi Aissa, Ain Taoujdate and Cadoux fruits from trees on Cleopatra mandarin rootstock showed greater resistance to storage rots than other rootstocks (Sour orange, rough lemon, Troyer citrange). On contrary, *Valbuena (1996)* indicated that Persian lime fruits on trees grafted on Cleopatra mandarin rootstock had postharvest damage and disease significantly higher than fruits from trees grown on Volkamer lemon. On the other hand, Fremont tangerine fruit on Volkameriana followed by fruits on Rangpur lime had the lowest weight loss % during storage while the highest were found in fruits on Sour orange rootstock. The lowest values of juice content were found in fruits on Sour orange, while fruits on Carrizo citrange had the highest TSS. Also, acidity % of fruits decreased during storage period and fruits from trees on Sour orange had the highest acidity percentage, *(Ali, 2002)*.

El-Hilali et al. (2003) demonstrated that, mandarin fruit quality characteristics varied according to the rootstock type. *Hong et al. (2007)* reported that weight loss and the total amount of Satsuma mandarin decayed fruit increased throughout the cool storage period, but at a more rapid rate during the subsequent storage at 18 ◦c.

Furthermore, fruit firmness, SSC, TA and fruit maturity index (SSC/TA) gradually decreased during cold and ambient storage.

The purpose of this study is to determine the effect of four rootstock types (Sour Orange, Carrizo citrange, Cleopatra mandarin and "Swingle" Citrumelo) on "Marisol" Clementine fruits quality and storability at two different low storage temperatures (5°C and 10°C).

MATERIALS AND METHODS

This investigation was carried out during two successive seasons (2005 & 2006) at Hort. Res. Institute, Fruit Handling Department, Giza Governorate, Egypt.

Trees were grown in a private farm at "Wady El-Mullak" region, Ismailia Governorate. During February 2005, 36 Marisol trees grafted on Sour Orange, Carrizo citrange, Cleopatra mandarin and "Swingle" Citrumelo rootstocks were selected for this study (9 trees for each rootstock). Trees were 7 years old, healthy of uniformed vigor growth, planted at 2×5 m under drip irrigation system and subjected to all agricultural practices as the Egyptian ministry of agriculture recommendations.

At maturity stage (the first part of this work) mature fruits of each treatment in both seasons, were picked, washed, dried, sorted to obtain uniform samples then stored at 5°Cor 10°C and 90- 95% RH up to 8 weeks. Each treatment had six carton boxes (each box had 12 fruits), representing six replicates, three replicates were used for the determination of the physical and chemical properties at 15 day intervals. The other three replicates were used to estimate the weight loss and decay percentage (either pathology or physiology) of fruits during storage.

The determination procedures were as follow:

1- **Weight loss percentage**: thirty six fruits (three boxes each had twelve fruits) were individually weighted and the differences between its weight at the beginning of the experiment and at the examination day were represented as weight loss percentage.
2- **Decay percentage**: the weight of unmarketable fruits due to pathological and physiological disorders was determined and this value was calculated.
3- **Fruit gravity** by dividing fruits size on fruit weight.
4- **Fruit firmness** was measured in 6 fruits (3 readings per each fruit) by Lfra texture analyzer instrument using a penetrating cylinder of 1 mm in diameter to a constant distance 5 mm inside the skin of fruits and by a constant speed 2 mm per sec. and the peak of resistance was recorded per gram on squire centimeter.

5- Peel colour changes during storage was estimated by a Hunter colorimeter type (Dp-9000) for the estimation of "L", "a" and "b" values and to evaluate color values as Hue angle and values were calculated according to *Mc Gjuire (1992).*

6- Juice content was estimated by squeezing 12 fruits (as three replicates) by handy squeezer and then juice percentage was calculated (w/w).

7- Total soluble solids contents of (T.S.S. %), **Acidity** (as citric acid) and **Ascorbic acid** were estimated according to *A.O.A.C. (1995).*

All data for fruit parameters studied were analyzed as a complete randomized design with factorial treatments as described by *Snedecor and Cochran (1980).*

RESULTS AND DISCUSSION

A- Physical characteristics

1- Weight loss percentage

According to data presented in Table (1) weight loss percentage of Marisol clementine fruits increased significantly with the increase of storage period. Weight loss percentage of fruits stored at 10°C was significantly higher than that of fruits stored at 5°C. On the other hand, fruits on Sour orange rootstock had weight loss significantly less than fruits from trees on Carrizo, Cleopatra and Citrumelo rootstocks. While, weight loss percentage of fruits produced from trees on Cleopatra rootstock during storage was significantly less than those on Carrizo, and Citrumelo rootstocks.

Table. 1. Effect of rootstock types and storage temperature on "Marisol" Clementine fruits weight loss percentage during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.4	2.5	2.0	2.3	2.0	0.7	1.3	1.0	1.6	1.1	1.6
30	2.8	4.9	3.9	4.6	4.1	1.3	2.5	2.0	3.2	2.3	3.2
45	5.0	8.1	6.4	7.9	6.9	3.7	4.7	3.9	5.6	4.5	5.7
60	7.8	13.6	10.7	12.9	11.3	6.4	10.0	7.3	9.8	8.4	9.8
Means	3.4	5.8	4.6	5.6	4.9	2.4	3.7	2.9	4.0	3.3	---
Second season (2006)											
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.3	1.7	1.0	1.3	1.4	0.9	1.4	1.7	1.4	1.4	1.4
30	2.7	3.5	2.1	2.6	2.7	1.8	2.7	1.8	2.8	2.3	2.5
45	5.4	7.0	4.2	5.3	5.4	3.6	5.4	5.0	5.7	4.9	5.2
60	9.4	9.4	9.4	10.8	9.8	6.4	9.1	9.1	7.2	7.9	8.9
Means	3.8	4.3	3.4	4.0	3.9	2.5	3.7	3.5	3.4	3.3	---

Rootstock means				
Rootstock	1	2	3	4
1st season	2.9	4.8	3.7	4.8
2nd season	3.1	4.0	3.4	3.7

Abbreviations:-	
1 = Sour orange	2 = Carrizo
3 = Cleopatra	4 = Citrumelo

L.S.D. at 5%	A = Storage Temp.	C = Storage period	B = Rootstock Types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	0.15	0.22	0.24	0.31	0.35	0.49	0.69
2nd season	0.25	0.36	0.40	0.50	0.56	0.79	1.12

These results agree with those mentioned by *D'Hallewin et al. (1994), Valbuena (1996), Reynaldo (1999) and Ali (2002),* who reported that weight loss percentage of citrus fruit was affected by rootstock types. Furthermore, these results agree with those illustrated by *Mohamed et al. (2003, a), Mohamed et al. (2003, b)* and *alferez et al. (2005),* who mentioned that weight loss percentage of citrus fruits increased gradually and significantly with prolonged storage period.

2- Decay percentage

Data shown in Table (2) illustrated that decay percentage of fruits increased gradually and significantly with the increase of storage period.

Moreover fruits stored at 5°C significantly had decay incidence higher than that stored at 10°C regardless of rootstocks types due to the increasing of chilling injured fruits associated with storage at 5°C. On the other side, fruits on Sour orange rootstock had significantly decay incidence less than that of fruits on the other rootstocks. Furthermore there were significant differences among fruits on Carrizo, Cleopatra and Citrumelo concerning decay incidence during the two seasons of this study.

These results are in agreement with those obtained by *El-Zeftawi et al. (1989), Valbuena (1996)* and *Ritenour et al. (2004),* who demonstrated that decay incidence of citrus fruits was significantly different according to rootstock type. Furthermore, these results agree with those illustrated by *Mohamed et al. (2003, a), Mohamed et al. (2003, b)* and *alferez et al. (2005),* who mentioned that decay percentage of citrus fruits increased gradually and significantly with prolonged storage.

3- Fruit gravity

Data shown in Table (3) demonstrated that fruit gravity decreased gradually and significantly with the increasing of storage period during both seasons. Storage fruits at

5°C reduced the deterioration rate of fruit gravity during storage in comparison with those stored at 10°C. On the other hand, gravity of fruits produced from trees on Sour orange was significantly higher as compared with those on the other rootstocks. However, these differences return to the effect of rootstock during pre-harvest period and still appear during storage period.

4- Fruit color

Fruit color data presented in Table (4) as Hue angle value, cleared that fruit color changed directly from greenish-yellow (Hue angle is more than 90°) to yellow (Hue angle is less than 90°) to orange-yellow (Hue angle is around 60°) during storage in the two seasons in this work. Moreover, data show that 5°C storage temperatures

significantly decreased the coloration rate during storage compared with 10°C during the two seasons in this work.

Table 2. Effect of rootstock types and storage temperatures on of "Marisol" lementine fruits decay percentage during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	3.8	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.5
45	0.0	0.0	3.8	0.0	1.0	6.1	10.3	6.4	7.4	7.5	4.2
60	10.7	50.1	38.2	43.4	35.6	29.0	70.7	61.4	35.3	49.1	42.3
Means	2.1	10.0	9.2	8.7	7.5	7.0	16.2	13.5	8.5	11.3	---
Second season (2006)											
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	13.5	9.9	14.3	9.4	4.7
60	0.0	0.0	2.9	3.3	1.6	6.9	24.6	34.7	36.9	25.8	13.7
Means	0.0	0.0	0.58	0.66	0.31	1.37	7.62	8.92	10.24	7.04	---

Rootstock means				
Rootstock	1	2	3	4
1st season	4.58	13.10	11.36	8.61
2nd season	0.69	3.81	4.75	5.45
L.S.D. at 5%				

Abbreviations:-		
1 = Sour orange		2 = Carrizo
3 = Cleopatra		4 = Citrumelo
A=Storage temp	C=Storage period	B=rootstock types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	1.74	2.46	2.75	3.48	3.89	5.5	7.77
2nd season	1.95	2.61	2.92	3.7	4.13	5.84	8.26

Data also indicated that color changes of fruits produced from trees on Carrizo, Cleopatra and Citrumelo rootstocks were significantly more accelerated than those on Sour Orange rootstock. Furthermore, color changes of fruits from trees grafted on Carrizo rootstock were significantly more accelerated than those on Cleopatra and Citrumelo rootstocks during the second season. However these changes were due to the preharvest period effect.

Table 3. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits gravity during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	0.86	0.81	0.83	0.80	0.82	0.86	0.81	0.83	0.80	0.82	0.82
15	0.80	0.81	0.82	0.77	0.80	0.86	0.83	0.83	0.79	0.83	0.82
30	0.80	0.80	0 80	0.74	0.79	0.84	0.81	0.82	0.76	0.81	0.80
45	0.77	0.71	0.75	0.70	0.73	0.80	0.69	0.81	0.71	0.75	0.74
60	0.72	0.67	0.71	0.66	0.69	0.71	0.63	0.74	0.72	0.70	0.70
Means	0.79	0.76	0.78	0.74	0.77	0.82	0.76	0.81	0.76	0.78	---
Second season (2006)											
0	0.88	0.85	0.85	0.84	0.85	0.88	0.85	0.85	0.84	0.85	0.85
15	0.85	0.82	0.79	0.78	0.81	0.81	0.85	0.80	0.78	0.81	0.81
30	0.75	0.72	0.70	0.71	0.72	0.76	0.74	0.74	0.73	0.74	0.73
45	0.69	0.66	0.68	0.66	0.67	0.78	0.72	0.70	0.67	0.72	0.70
60	0.69	0.59	0.60	0.65	0.63	0.67	0.67	0.70	0.69	0.68	0.66
Means	0.77	0.73	0.72	0.73	0.74	0.78	0.77	0.76	0.74	0.76	---

Rootstock means				
Rootstock	1	2	3	4
1st season	0.80	0.76	0.80	0.75
2nd season	0.78	0.75	0.74	0.73

Abbreviations:	
1 = Sour orange	2 = Carrizo
3 = Cleopatra	4 = Citrumelo

L.S.D. at 5%	A=Storage temp	C=Storage period	B=rootstock types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	N.S.	0.016	0.018	0.023	N.S.	N.S.	N.S.
2nd season	0.0163	0.0223	0.0257	N.S.	N.S.	N.S.	N.S.

Table 4. Effect of rootstock types and storage temperatures on of "Marisol" Clementine fruits color represented as Hue angle value during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	104.1	94.6	105.4	101.8	101.5	104.1	94.6	105.4	101.8	101.5	101.5
15	95.1	92.0	90.6	93.3	92.7	97.0	100.8	98.4	92.8	97.3	95.0
30	85.9	82.2	85.5	81.2	83.7	99.8	95.7	97.2	100.2	98.2	91.0
45	66.9	59.7	63.0	67.7	64.3	95.1	88.6	78.5	79.6	85.5	74.9
60	47.8	37.1	40.5	44.2	42.4	73.5	71.5	59.8	58.9	65.9	54.2
Means	80.0	73.1	77.0	77.7	76.9	93.9	90.3	87.9	86.7	89.7	---
Second season (2006)											
0	98.1	75.1	86.4	82.3	85.5	98.1	75.1	86.4	82.3	85.5	85.5
15	85.4	64.5	72.7	75.0	74.4	94.2	72.8	79.7	84.0	82.7	78.5
30	78.1	58.0	62.9	63.4	65.6	82.1	68.7	75.8	74.3	75.2	70.4
45	54.0	53.8	55.9	57.2	55.2	71.5	70.4	69.9	75.1	71.8	63.5
60	50.8	51.4	53.0	51.7	51.8	70.0	64.6	71.8	64.7	67.8	59.8
Means	73.3	60.6	66.2	65.9	66.5	83.2	70.3	76.7	76.1	76.6	---

Rootstock means				
Rootstock	1	2	3	4
1st season	86.9	81.7	82.4	82.2
2nd season	78.2	65.4	71.5	71.0

Abbreviations:-	
1 = Sour orange	2 = Carrizo
3 = Cleopatra	4 = Citrumelo
A=Storage temp	C=Storage period
B=rootstock types	

L.S.D. at 5%

Factors	A	B	C	a*b	a*c	b*c	a*b*c
• **1st season**	2.81	3.97	4.44	5.61	6.28	N.S.	N.S.
2nd season	1.78	2.52	2.82	N.S.	3.98	5.64	N.S.

These results are in harmony with those obtained by *Schirra, et al. (1997)* who demonstrated that Star Ruby grapefruit color was nearly not affected by storage period, but storage temperature resulted in increase in a/b hunter value ratio at the high storage temperature.

5- Fruit firmness

Fruit firmness (Table 5) of Marisol significantly decreased with the extension of storage period regardless of rootstock or storage temperature. Moreover, 5°c storage temperature significantly reduced fruit softening rate during storage regardless of rootstock types in this study. On the other hand, firmness of fruits produced from trees on Sour orange was significantly higher than that on the other rootstocks during both seasons. However these differences appeared at harvest and lasted during storage.

These results are in line with those demonstrated by *Alferez et al. (2005)* who mentioned that orange fruit firmness significantly decreased with the increasing of cold storage period. Furthermore, these results are in harmony with those mentioned by *El-Hilali et al. (2003)* who mentioned that mandarin fruit firmness during storage significantly differed according to rootstock.

6- Juice percentage

Juice content of fruits (Table 6) decreased gradually and significantly with the increasing of storage period. Moreover, 5°C storage temperatures reduced the deterioration rate of juice content compared with 10°C storage temperature. Furthermore, data indicated that juice content of fruits produced from trees on Sour orange were significantly higher than those on the other rootstocks during the two seasons in this work.

These results agree with those obtained by *Ali (2002)* and *El-Hilali et al. (2003)* who mentioned that juice percentage of mandarin stored fruits differs according to rootstock types. Furthermore these results are in harmony with those illustrated by *Ramanjulu and Reddy (1989)* and *Mohamed et al. (2003, a&b),* they demonstrated that juice percentage of Valencia orange and grapefruit fruit decreased with the extension of storage period.

Table 5. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits firmness during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period	Treatments					Treatments					
(days)	1	2	3	4	Means	1	2	3	4	Means	
0	97.5	88.7	91.1	90.5	92.0	97.5	88.7	91.1	90.5	92.0	92.0
15	97.4	81.2	68.0	69.3	79.0	95.5	80.6	72.1	74.4	80.6	79.8
30	80.0	63.8	52.9	52.4	62.3	96.2	62.6	61.1	62.7	70.7	66.5
45	60.1	51.5	42.2	41.1	48.7	80.0	51.9	48.5	49.1	57.4	53.1
60	42.0	30.4	25.4	25.5	30.8	48.6	38.8	37.9	32.8	39.5	35.2
Means	75.4	63.1	55.9	55.8	62.6	83.6	64.5	62.1	61.9	68.0	---
Second season (2006)											
0	108.4	95.0	101.1	103.3	102.0	108.4	95.0	101.1	103.3	102.0	102.0
15	89.2	82.6	69.0	86.2	81.8	100.5	83.3	76.6	97.0	89.3	85.5
30	77.6	76.1	66.0	63.0	70.7	80.6	74.2	75.0	86.0	78.9	74.8
45	62.0	68.7	63.4	41.4	58.9	59.7	60.1	69.6	70.5	65.0	61.9
60	58.6	43.8	54.6	36.4	48.4	61.9	63.5	66.5	42.3	58.6	53.5
Means	79.1	73.2	70.8	66.1	72.3	82.2	75.2	77.8	79.8	78.7	---

Rootstock means				
Rootstock	1	2	3	4
1st season	79.5	63.8	59.0	58.8
2nd season	80.7	74.2	74.3	73.0

Abbreviations:	
1 = Sour orange	2 = Carrizo
3 = Cleopatra	4 = Citrumelo

A=Storage temp	C=Storage period	B=rootstock types

L.S.D. at 5%

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	2.51	3.54	3.95	N.S.	N.S.	N.S.	N.S.
2nd season	4.82	6.81	7.61	N.S.	N.S.	N.S.	N.S.

Table 6. Effect of rootstock types and storage temperatures on of "Marisol" Clementine fruits juice percentage during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	51.2	48.6	51.6	48.3	49.9	51.2	48.6	51.6	48.3	49.9	49.9
15	53.0	49.7	50.4	48.6	50.4	53.0	48.2	49.6	48.6	49.9	50.1
30	54.0	50.8	49.2	48.9	50.7	54.0	47.8	45.6	48.9	49.1	49.9
45	43.3	38.1	41.3	35.7	39.6	41.1	35.0	44.8	39.6	40.1	39.9
60	32.7	25.5	27.5	22.5	27.0	28.2	22.3	37.9	30.3	29.7	28.4
Means	46.8	42.6	44.0	40.8	43.5	45.5	40.4	45.9	43.1	43.7	---
Second season (2006)											
0	52.2	52.2	53.9	51.9	52.6	52.2	52.2	53.9	51.9	52.6	52.6
15	48.8	45.3	45.5	40.4	45.0	49.6	47.9	47.7	46.9	48.0	46.5
30	44.3	40.7	38.1	43.4	41.6	47.9	44 9	45.2	43.1	45.3	43.4
45	45.4	38.4	37.0	46.9	41.9	47.2	43.5	41.5	41.6	43.5	42.7
60	39.7	36.0	30.7	37.4	36.0	46.3	42.0	42.6	39.4	42.6	39.3
Means	46.1	42.5	41.0	44.0	43.4	48.6	46.1	46.2	44.6	46.4	---

Rootstock means				
Rootstock	1	2	3	4
1st season	46.2	41.5	44.9	42.0
2nd season	47.4	44.3	43.6	44.3

Abbreviations:-		
1 = Sour orange	2 = Carrizo	
3 = Cleopatra	4 = Citrumelo	
A=Storage temp	C=Storage period	B=rootstock types

L.S.D. at 5%							
Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	N.S.	1.74	1.95	2.46	N.S.	N.S.	N.S.
2nd season	1.17	1.66	1.85	2.35	2.62	3.71	N.S.

B- Chemical properties

1- Total soluble solid, total acidity, TSS/acid ratio and Ascorbic acid contents

According to data shown in tables (7, 8, 9 and 10) it is clear that total soluble solid contents and TSS/total acidity ratio increased, while total acidity and ascorbic acid contents decreased gradually and significantly with the increasing of storage period. The storage temperature of 5°C significantly reduced the changes rate of TSS, total acidity and ascorbic acid during storage.

Data also reveal that fruits produced from trees on trees grafted on Carrizo, Cleopatra and Citrumelo rootstocks had TSS and ascorbic acid contents significantly higher than that produced from trees on Sour orange rootstock during the two seasons. On the other hand, data illustrated that fruits from trees grafted on Carrizo, Cleopatra and Citrumelo rootstocks had total acidity content significantly less and TSS/acid ratio higher than those on Sour orange. However, it appears that these effects return to the effect of these rootstocks during preharvest period.

Table 7. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits TSS contents during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	9.2	9.9	9.5	9.6	9.55	9.2	9.9	9.5	9.6	9.59	9.57
15	9.5	10.1	9.8	9.7	9.79	9.5	9.9	9.5	9.7	9.68	9.73
30	9.7	10.3	10.1	9.8	9.98	9.7	9.8	9.5	9.8	9.73	9.85
45	8.7	10.0	9.7	9.3	9.41	8.9	11.5	9.7	10.3	10.16	9.78
60	7.7	8.7	8.3	7.8	8.10	7.9	10.5	8.3	9.2	9.02	8.56
Means	8.95	9.81	9.48	9.22	9.37	9.03	10.33	9.28	9.73	9.59	---
Second season (2006)											
0	9.1	9.4	9.6	9.7	9.5	9.1	9.4	9.6	9.7	9.5	9.45
15	9.5	10.3	10.0	10.4	10.0	9.0	9.8	10.1	9.9	9.7	9.87
30	9.2	10.6	10.2	9.6	9.9	9.9	10.3	9.8	10.0	10.0	9.94
45	8.9	10.1	9.7	8.6	9.3	9.8	10.2	9.6	9.5	9.8	9.55
60	8.3	9.4	8.4	8.4	8.6	9.2	9.7	9.3	9.5	9.4	9.03
Means	8.97	9.97	9.58	9.33	9.47	9.40	9.88	9.69	9.71	9.67	---

Rootstock means				
Rootstock	1	2	3	4
1st season	9.0	10.1	9.4	9.5
2nd season	9.2	9.9	9.6	9.5
L.S.D. at 5%				

Abbreviations:-		
1= Sour orange	2= Carrizo	
3= Cleopatra	4= Citrumelo	
A=Storage temp	C=Storage period	B=rootstock types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	0.14	0.198	0.221	N.S.	N.S.	0.442	N.S.
2nd season	0.128	0.181	0.202	0.256	N.S.	0.405	N.S.

These results are in line with those obtained by *Ramanjulu and Reddy (1989)* and *Mohamed et al. (2003, a&b),* who found that total soluble solids increased while total acidity and ascorbic acid decreased with the prolonging of the storage period. In contrast, these results disagree with those mentioned by *Su et al. (1988)* who reported that total soluble solids, total acidity and ascorbic acid contents of orange remained constant during storage.

Table 8. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits total acidity percentage during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	0.95	0.88	0.92	0.87	0.91	0.95	0.88	0.92	0.87	0.91	0.91
15	0.92	0.82	0.91	0.85	0.87	0.96	0.82	0.99	0.81	0.90	0.89
30	0.90	0.79	0.88	0.83	0.85	0.94	0.79	0.96	0.81	0.87	0.86
45	0.84	0.73	0.76	0.74	0.77	0.91	0.78	0.90	0.78	0.84	0.80
60	0.80	0.69	0.71	0.69	0.72	0.85	0.78	0.81	0.75	0.79	0.76
Means	0.88	0.78	0.83	0.80	0.82	0.92	0.81	0.92	0.80	0.86	---
Second season (2006)											
0	0.97	0.91	0.90	0.94	0.93	0.97	0.91	0.90	0.94	0.929	0.93
15	0.95	0.90	0.91	0.89	0.91	0.94	0.95	0.91	0.97	0.944	0.93
30	0.89	0.86	0.85	0.81	0.85	0.93	0.84	0.89	0.85	0.877	0.86
45	0.88	0.76	0.79	0.77	0.80	0.89	0.80	0.87	0.82	0.847	0.82
60	0.81	0.70	0.72	0.71	0.74	0.84	0.75	0.77	0.79	0.786	0.76
Means	0.90	0.83	0.83	0.83	0.85	0.92	0.85	0.87	0.87	0.88	---

Rootstock means				
Rootstock	1	2	3	4
1st season	0.901	0.796	0.875	0.799
2nd season	0.906	0.838	0.851	0.849

Abbreviations:-		
1= Sour orange	2 = Carrizo	
3= Cleopatra	4 = Citrumelo	
A=Storage temp	C=Storage period	B=rootstock types

L.S.D. at 5%

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	0.030	0.043	0.048	N.S.	N.S.	N.S.	N.S.
2nd season	0.028	0.040	0.045	N.S.	N.S.	0.089	N.S.

On the other hand, these results agree with those obtained by *D'hallewin et al. (1994), Reynaldo (1999), Ali (2002) and El-Hilali et al (2003)* who mentioned that total soluble solids, total acidity and ascorbic acid contents were affected by rootstock types. In contrast, *El-Zeftawi et al. (1989)* reported that Valencia orange fruit was not influenced by rootstock types.

Table 9. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits TSS/TA ratio during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	9.6	11.3	10.3	11.1	10.6	9.6	11.3	10.3	11.1	10.6	10.6
15	10.4	12.3	10.8	11.4	11.2	9.9	12.0	9.6	11.9	10.9	11.0
30	10.9	13.0	11.5	11.8	11.8	10.4	12.4	9.9	12.1	11.2	11.5
45	10.3	13.7	12.8	12.5	12.3	9.8	14.8	10.8	13.3	12.1	12.2
60	9.5	12.5	11.7	11.2	11.3	9.3	13.6	10.2	12.4	11.4	11.3
Means	10.1	12.6	11.4	11.6	11.4	9.8	12.8	10.2	12.1	11.2	---
Second season (2006)											
0	9.4	10.4	10.7	10.3	10.2	9.4	10.4	10.7	10.3	10.2	10.2
15	10.0	11.4	11.0	11.6	11.0	9.6	10.3	11.1	10.2	10.3	10.7
30	10.3	12.3	12.0	11.9	11.6	10.6	12.3	11.0	11.8	11.4	11.5
45	10.1	13.3	12.3	11.1	11.7	10.9	12.7	11.1	11.6	11.6	11.6
60	10.3	13.5	11.6	11.8	11.8	11.0	12.9	12.1	12.0	12.0	11.9
Means	10.0	12.2	11.5	11.3	11.3	10.3	11.7	11.2	11.2	11.1	---

Rootstock means				
Rootstock	1	2	3	4
1st season	10.0	12.7	10.8	11.9
2nd season	10.2	11.9	11.4	11.3
L.S.D. at 5%				

Abbreviations:-		
1= Sour orange	2= Carrizo	
3= Cleopatra	4= Citrumelo	
A=Storage temp	C=Storage period	B=rootstock types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	N.S.	0.543	0.607	N.S.	0.859	N.S.	N.S.
2nd season	N.S.	0.516	0.577	N.S.	N.S.	1.15	N.S.

Table 10. Effect of rootstock types and storage temperatures on "Marisol" Clementine fruits V.C contents during storage.

First season (2005)											
St. temp.	10° C					5° C					Means
St. period (days)	Treatments					Treatments					
	1	2	3	4	Means	1	2	3	4	Means	
0	13.2	14.3	14.2	15.8	14.4	13.2	14.3	14.2	15.8	14.4	14.4
15	12.3	13.0	12.9	14.4	13.1	12.3	13.1	13.0	14.5	13.2	13.2
30	10.0	11.7	11.6	13.0	11.6	10.2	11.9	11.7	13.1	11.7	11.7
45	5.6	9.1	9.1	10.1	8.5	5.9	11.3	10.6	11.7	9.9	9.2
60	2.3	9.1	9.5	10.3	7.8	3.9	9.5	9.3	10.4	8.3	8.0
Means	8.7	11.4	11.5	12.7	11.1	9.1	12.0	11.8	13.1	11.5	---
Second season (2006)											
0	24.2	25.8	26.2	23.5	24.9	24.2	25.8	26.2	23.5	24.9	24.9
15	22.0	21.9	22.5	19.3	21.4	21.9	22.0	22.8	21.2	22.0	21.7
30	19.9	17.9	18.8	16.5	18.3	19.6	18.3	19.4	20.2	19.4	18.8
45	16.2	16.8	15.7	15.2	16.0	17.3	17.5	17.2	17.5	17.4	16.7
60	15.0	15.3	13.5	17.1	15.2	15.3	17.3	14.0	16.5	15.8	15.5
Means	19.5	19.5	19.4	18.3	19.2	19.7	20.2	19.9	19.8	19.9	---

Rootstock means				
Rootstock	1	2	3	4
1st season	8.9	11.7	11.6	12.9
2nd season	19.6	19.9	19.6	19.0
L.S.D. at 5%				

Abbreviations:-		
1= Sour orange	2= Carrizo	
3= Cleopatra	4= Citrumelo	
A=Storage temp	C=Storage period	B=rootstock types

Factors	A	B	C	a*b	a*c	b*c	a*b*c
1st season	0.37	0.53	0.74	N.S.	N.S.	1.17	N.S.
2nd season	0.56	0.80	0.89	N.S.	N.S.	1.78	N.S.

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PHYSIOLOGICAL STUDIES ON "MARISOL" CLEMENTINE FRUITS

II- EFFECT OF ROOTSTOCK TYPES ON FRUIT STORABILITY

دراســـات فسيـــولوجيـــة على ثمـــار الكليـــمـــنـــتـــيـــن

صـــنـــف "مارى سول"

٢- تأثير نوع الأصل على القدرة التخزينية للثمار

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تعتبر الموالح من المحاصيل التصديرية الهامة بالنسبة للدخل القومى المصرى. فقد بلغت المساحة المنزرعة من الموالح فى عام ٢٠٠٦ حوالى ٣٨٢٠٢٧ فدان. ووصل الإنتاج حوالى ٣٢١١٢٠٩ طن. وهناك فرصة كبيرة لزيادة المصدر من الموالح غير التقليدية إلى السوق الأوروبي.

أجريت هذه الدراسة بمعهد بحوث البساتين- قسم بحوث تداول الفاكهة بالتعاون مع قسم البساتين بكلية الزراعة- جامعة قناة السويس بالإسماعيلية خلال موسمي ٢٠٠٥ و ٢٠٠٦. بهدف تحديد تأثير نوع الأصل على القدرة التخزينية لثمار اليوسفى كليمنتين (صنف **مارى سول**) تحت ظروف التخزين المبرد عند كل من ٥ و ١٠ درجة مئوية و ٩٠ إلى ٩٥ % رطوبة نسبية.

جمعت الثمار من أشجار عمر ٧ سنوات منزرعة بمنطقة وادي الملاك بحافظة الإسماعيلية و مطعومة على أصول كل من النارنج - اليوسفي كليوباترا - الكاريزو سترانج - سوينجل سترومبلو عند وصول الثمار إلى مرحلة اكتمال النمو (الدراسة الأولى من البحث) ونقلت إلى المعمل حيث تم غسيل وتجفيف الثمار ثم تخزينها على درجة ٥ و ١٠ درجة مئوية لمدة ٨ أسابيع . ثم فحص الثمار دوريا كل خمسة عشر يوما لدراسة التغيرات فى الخواص الطبيعية والكيميائية للثمار أثناء التخزين.

وقد تبين من الدراسة ما يلى :

زادت نسبة التالف والفقد فى الوزن فى الثمار المخزنة بغض النظر عن درجة حرارة التخزين مع تقدم الثمار فى التخزين. كذلك زادت نسبة المواد الصلبة الذائبة وكذلك نسبة المواد الصلبة الذائبة إلى نسبة الحموضة الكلية بينما انخفض محتوى الثمار من العصير وكذلك صلابة الثمار و الأحماض الكلية وفيتامين ج والكثافة النوعية للثمار بزيادة الفترة التخزينية. وكذلك تغير لون الثمار من الأصفر المخضر إلى الأصفر ثم إلى الأصفر البرتقالى مع تقدم الثمار فى التخزين.

كانت نسبة الفقد فى الوزن و نسبة التالف و معدل التغير فى اللون فى ثمار اليوسفى كليمنتين من الأشجار المطعومة على اصل النارنج وكذلك نسبة المواد الصلبة الذائبة و محتواها من فيتامين ج اقل منها مقارنة بالمطعمة على الأصول الأخرى. وعلى العكس كانت الكثافة النوعية و الصلابة ومحتوى الثمار من العصير و نسبة الحموضة الكلية أعلى منها بالمقارنة بالثمار المأخوذة من الأشجار المطعومة على الأصول الأخرى. ومع هذا فان الكثير من هذه الاختلافات يرجع إلى تأثير نوع الأصل فى مرحلة ما قبل الحصاد واستمر أثناء التخزين.

أدى التخزين على درجة ١٠ مئوية إلى زيادة نسبة الفقد فى الوزن وكذلك الإسراع من عملية التلوين وزيادة نسبة المواد الصلبة الذائبة ونسبة المواد الصلبة الذائبة إلى الحموضة الكلية ونقص محتوى الثمار من العصير والحموضة الكلية وفيتامين ج وزيادة النقص فى الكثافة النوعية للثمار وذلك بالمقارنة بتلك المخزنة على درجة ٥ مئوية إلا ان التخزين على درجة ١٠ مئوية لم يقلل من نسبة التالف فقط و ذلك نتيجة حدوث أضرار للبرودة فى تلك المخزنة على درجة ٥ مئوية مما أدى إلى زيادة نسبة التالف فى الثمار المخزنة عند هذه الدرجة وانما كذلك ادى الى تحسين تلوين الثمار .

وعليه يمكن القول ان ثمار اليوسفى كليمنتين صنف **مارى سول** يمكن تخزينها على درجة ١٠ مئوية و ٩٠ – كليمنتين ٩٥% رطوبة نسبية ولمدة ٤٥ يوما مع تغير طفيف فى خواص الثمار بما لا يؤثر على خصائص الجودة فى الثمار.بينما كان تأثير نوع الأصل (الأصول تحت الدراسة) على القدرة التخزينيه للثمار محدودا.