EFFECT OF SOME BIOLOGICAL AND CHEMICAL POSTHARVEST TREATMENTS ON STORABILITY OF WASHINGTON NAVEL ORANGES (*Citrus sinensis* Osbeck)

B- CALCIUM CHLORIDE TREATMENTS

By

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ABSTRACT

The present study was carried out in horticulture department, Faculty of Agriculture, Kafrelsheikh University, during 2006/07 - 2007/08 seasons on Washington navel orange fruits. The treated fruits were stored at room temperature (21 ± 2 °C RH 65-75%) for 45 days and at cold storage (7 °C RH 90-95%) for 75 days. Three post harvest dipping treatments were investigated; Control (distilled water), $CaCl_2$ 2% and $CaCl_2$ 4%. Navel oranges were analyzed for SSC, titratable acidity, total sugars, reducing sugars, vitamin C. Fruit rot and fruit weight loss were calculated. Storability of Washington navel fruits was extended by using the $CaCl_2$ treatments. This was observed in both the room and cold stage conditions. However, cold stored fruits continued to be in marketable condition much longer than those in room temperature. It also, kept most of the important physical and chemical fruit properties under cold storage. It was also observed that the 2% $CaCl_2$ treatment was much better than either the control or the 4% $CaCl_2$ treatments.

Keywords: Post harvest; *Citrus sinensis* Osbeck; storability; Fruit quality; Ca Cl_2; navel oranges

INTRODUCTION

Washigton navel orange (*Citrus Sinensi* osbeck) is one of the most important citrus fruits in Egypt. It has a significant importance not only in the local market but also for export. In Egypt, newly reclaimed land areas in west desert is one of the most important areas cultivated with all citrus varieties. Citrus fruits are left on the trees for long time. Under Egyptian conditions, it is a common practice to store mature navel orange fruits until the suitable time for marketing. Thus harvest

date may be delayed for several months. This delayed harvest might affect flowering of the following season, the yield and fruit quality, as well as shorten fruits life in storage. In addition, citrus fruits are nearby to waste materials, disease pathogen , and become a serious export problem(**Chikaizumi *et al.*, 1997; Hussien 2001** and **Abd-El-Khair and Omima Hafez 2006**). Certain strategies, such as pre- or postharvest application of calcium salts, against fruit decay are proposed (**Conway and Sams 1984; Sapers and Simmons 1998** and **El-Gaouth *et al.* 1992**). Pre- and postharvest calcium applications have been used to delay ageing or ripening to reduce postharvest decay and control of many diseases in fruits and vegetable. **Poovaiah 1986** and **Saftner *et al.* (1997)** reported that postharvest calcium treatment of apples provided broad-spectrum protection against the postharvest pathogens of *P. expansum* and *B. cinerea*. Calcium chloride treatments represent a safe and potentially effective method for increasing the storage life and quality of some fruits .Different studies explained that calcium chloride reduced post harvest decay, controlled development of physiological disorders, improved quality and delayed aging or ripening (**Mignani *et al.*, 1995; Gracia *et al.*, 1996; De-Souza *et al.*, 1999 and Hong and Lee, 1999).**

The present study aimed to evaluate the effect of post-harvest $CaCl_2$ (2 & 4%) treatments on storability at room temperature (21 ± 2 °C & RH 65-75%) and cold storage (7 °C & RH 90-95%) of Washington navel orange fruits.

MATERIALS AND METHODS

1. Fruit Material, Post harvest treatments and Storage Regime:-

Mature fruits (SSC:acid ratio 8:1) fruits of Washington Navel orange (*Citrus sinensis* Osbeck) were harvested in 13th, Dec., 2007 and 10th Dec., 2008 seasons from a private orchard, in Motobus distrect, Kafr El-Sheikh governorate, Egypt. The fruits were picked and washed with tap water and air dried. Three treatments were applied and each treatment was replicated three times, one box was added for chemical analysis, each replicate contained 8kg fruits for each treatment. These treatments were as follows:-

1-**Control** (distilled water) 2- **$CaCl_2$** (2%) for 10 min 3- **$CaCl_2$** (4%) for 10 min

Fruits were divided into two groups , the first group was stored at room temperature 21 ± 2 °C & RH 65-75%) and the second one was stored at cold storage at 7 °C & RH 90-95%).

2.2. Measurements:

At two weeks intervals, samples (5 fruits) of each replicate / treatment were taken to the following chemical properties determinations:-

1-Soluble solids content percentage (SSC %): as described by Association of Official Agriculture Chemists **(A.O.A.C, 1990).**

2-Titratable acidity: It was determined according to **Chen and Mellenthin (1981)**

3-Vitamin C: as described by **(A.O.A.C, 1990).**

4- Weight loss (%): was calculated as a percentage of the average loss in fruit weight under different treatments, separately, at examined date in relation to the initial weight of the whole fruits.

Weight loss% =(Initial weight-Weight at examined date / Initial weight) x100

5- Fruit rot percentage: Fruits affected with either pathological or physiological disorders were counted and calculated as Percentage (treatments were stopped at 50% rotted fruits).

6- Total sugars and reducing sugars: as described by **(A.O.A.C, 1990).**

2.3. Statistical analysis:

Experiment was designed as completely randomized block deign (three replicates/treatment). Data were tested by analysis of variance **(Little and Hills 1972).** Duncan's multiple range test was used for comparison among the treatments means **(Duncan 1955).**

RESULTS

3.1. Effect of $CaCl_2$ (2 & 4 %) dipping treatments on navel oranges during storage at room temperature (21±2 ^{0}C & RH 65-75%) and cold storage (7 ^{0}C & RH 90-95%) on:

3. 2- SSC (%):

Data presented in Table (1) showed that, the effect of $CaCl_2$ at 2% and 4% beside control dipping on chemical properties of navel orange fruits in two weeks intervals during storage at room temperature and cold storage. No significant variations among treatments in both seasons were found in all treatments, control fruits recorded the lowest SSC value during all periods of storage in both seasons, SSC content was increased as a progress of storage periods. Fruits in cold condition had the lowest SSC content as compared with the other treatments in room temperature conditions. Calcium chloride treatment at 2% showed the highest value in all treatments during storage. On the other hand, the lowest content of SSC were recorded by control treatment in the same periods of storage in both seasons.

Table (1): Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on SSC % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	11.25	11.25	12.37	12.03	12.37	12.18	12.53	12.15	-	12.18	-	12.00
$CaCl_2$ 2%	11.25	11.25	12.55	12.41	12.65	12.37	12.81	12.56	-	13.25	-	13.07
$CaCl_2$ 4%	11.25	11.25	12.38	12.05	12.38	12.64	12.70	12.81	-	12.77	-	12.69
F. test			NS	NS	NS	NS	NS	NS		NS		NS
	2008											
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	11.22	11.22	12.39	12.03	12.39	12.20	12.35	12.38	-	12.44	-	12.32
$CaCl_2$ 2%	11.22	11.22	12.50	12.33	12.50	12.57	12.43	12.75	-	12.94	-	12.83
$CaCl_2$ 4%	11.22	11.22	12.45	12.31	12.45	12.46	12.24	12.72	-	12.88	-	12.91
F. test			NS	NS	NS	NS	NS	NS		NS		NS

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

3.2-Tatratable acidity (%):

As for titratable acidity, (Table 2). Acidy content decrease with progress of periods and recorded the lowest values at the end of storage in different types of storages, $CaCl_2$ 4% dipping treatment recorded (0.97, 0.93, 0.90, 0.89 and 0.83%) the highest percentages of acidity during all periods of storage either at room or cold conditions . Control fruits had the lowest content of acidity and recorded 0.90, 0.81, 0.71, 0.80 and 0.74 % after 15, 30, 45, 60 and 75 days in both seasons , respectively at cold storage.

3.3- Vitamin C (*mg/100ml juice*):

Table (3) showed that, vitamin C were gradually decreased as the storage period progressed in all dipping fruits in different post harvest treatments. Cold storage improved fruit content of vitamin C by different treatments as compared with fruits at room temperature conditions, specially fruits which treated by $CaCl_2$ 2%, it had the highest values either in cold or room conditions. On the other hand control fruits had the lowest content of vitamin C in both types of storage.

3. 4-Total sugars%

Regarding to data in Table (4), It noticed that variations among treatments during both seasons were non significant either room or cold storage, $CaCl_2$ 2% treatment had the highest values in total sugars as compared with other treatments in room temperature or in cold storage. Control fruits were recorded the lowest content of total sugars content (8.18, 8.39, 8.59,9.08 and 8.88%) after 15, 30, 45, 60 and 75 days of storage in both seasons at cold storage, respectively.

3.5-Reducing sugars content

Table (5) showed that, reducing sugars content was gradually increased as the storage period progress but no significant variation among treatments were found. Fruits at room temperature had higher content of reducing sugars as compared with the treatments in cold condition after 15 and 30 days of storage but after 45, 60 and 75 days were the highest content. $CaCl_2$ 2% treatment recorded the highest content of reducing sugars during storage periods as compared with other treatments, while control fruits showed the lowest content in both seasons (4.32, 4.44, 4.32, 4.64 and 4.48 %, respectively).

3. 6- Fruit rot percentage:

Regarding to Table (6), the highest fruit rot percentages in this respect (17.95, 28.16 and 38.46 %) were recorded by control in both seasons at room temperature and 5.13, 10.25, 12.82, 20.51 and 20.61 % at cold storage, respectively.

Table (2):Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on acidity % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	1.03	1.03	0.90	0.92b	0.81b	0.90	0.71c	0.83b	-	0.86b	-	0.78
$CaCl_2$ 2%	1.03	1.03	0.89	0.95a	0.87a	0.92	0.76a	0.88a	-	0.86b	-	0.80
$CaCl_2$ 4%	1.03	1.03	0.91	0.95a	0.82b	0.91	0.73	0.90a	-	0.89a	-	0.80
F. test			NS	*	**	NS	**	**		*		NS
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	1.10	1.10	0.92	0.93b	0.82	0.89c	0.71b	0.86b	-	0.80c	-	0.74
$CaCl_2$ 2%	1.10	1.10	0.91	0.95b	0.80	0.91b	0.76a	0.86b	-	0.82b	-	0.79
$CaCl_2$ 4%	1.10	1.10	0.92	0.97a	0.82	0.93a	0.76a	0.89a	-	0.89a	-	0.83
F. test			NS	**	NS	**	**	*		**		NS

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

Table (3): Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on vitamin C content (mg/100 ml juice) of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	58.91	58.91	50.12	53.48	45.15	51.03b	38.36b	45.59b	-	44.00b	-	39.74c
$CaCl_2$ 2%	58.91	58.91	50.77	53.08	46.56	53.09a	43.68a	51.75a	-	48.65a	-	46.58a
$CaCl_2$ 4%	58.91	58.91	52.45	53.93	47.71	53.06a	43.51a	51.71a	-	48.57a	-	45.85b
F. test			NS	NS	NS	**	**	**	-	**	-	**
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	57.40	57.40	50.62	50.88b	44.93b	51.87	36.53b	46.99c	-	42.72c	-	37.83c
$CaCl_2$ 2%	57.40	57.40	52.47	54.31a	49.73a	53.03	41.42a	51.84a	-	51.10a	-	49.69a
$CaCl_2$ 4%	57.40	57.40	50.70	54.10a	42.66c	52.17	41.08a	49.60b	-	49.33b	-	46.62b
F. test			NS	**	**	NS	**	**	-	**	-	**

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

Table (4):Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on total sugars % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	9.40	9.40	8.54	8.18	8.74	8.39	8.68	8.69	-	9.12	-	9.12
$CaCl_2$ 2%	9.40	9.40	8.61	8.58	8.79	8.95	8.76	9.44	-	9.84	-	9.72
$CaCl_2$ 4%	9.40	9.40	8.60	8.48	8.92	8.76	8.81	9.22	-	9.66	-	9.50
F. test			NS	NS	NS	NS	NS	NS		NS		NS
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	8.95	8.95	8.48	8.28	8.73	8.49	8.59	8.84	-	9.08	-	8.88
$CaCl_2$ 2%	8.95	8.95	8.81	8.50	8.85	8.91	8.85	9.40	-	9.75	-	9.58
$CaCl_2$ 4%	8.95	8.95	8.60	8.38	8.72	8.69	8.79	9.13	-	9.41	-	9.15
F. test			NS	NS	NS	NS	NS	NS		NS		NS

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

Table (5): Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on reducing sugars % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	3.62	3.62	4.34	4.32	4.51	4.46	4.40	4.51	-	4.64	-	4.48
$CaCl_2$ 2%	3.62	3.62	4.73	4.60	4.83	4.74	4.62	4.88	-	4.84	-	4.71
$CaCl_2$ 4%	3.62	3.62	4.76	4.55	4.81	4.67	4.44	4.78	-	4.85	-	4.82
F. test			NS	NS	NS	NS	NS	NS		NS		NS
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	3.43	3.43	4.34	4.50	4.44	5.54	4.32	4.66	-	4.66	-	4.57
$CaCl_2$ 2%	3.43	3.43	4.93	4.67	4.90	4.76	4.80	4.88	-	4.85	-	4.84
$CaCl_2$ 4%	3.43	3.43	4.44	4.63	4.66	4.76	4.67	4.85	-	4.90	-	4.83
F. test			NS	NS	NS	NS	NS	NS		NS		NS

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

Table (6):Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on fruit rot % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	0.00	0.00	10.25	5.13a	23.05a	7. 78a	39.29a	12.82a	-	15.38	-	20.15a
$CaCl_2$ 2%	0.00	0.00	7.68	0.00b	12.82c	5.13b	20.45b	7.69b	-	15.38	-	15.28b
$CaCl_2$ 4%	0.00	0.00	10.25	0.00b	15.38b	5.13b	17.85c	7.69b	-	15.37	-	15.38b
F. test			NS	**	**	*	**	**		NS		*
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	0.00	0.00	17.95a	2.67	28.16a	10.25a	38.46a	12.82b	-	20.51a	-	20.61a
$CaCl_2$ 2%	0.00	0.00	10.25c	0.00	12.77c	7.69b	17.85c	10.25c	-	15.38b	-	17.95b
$CaCl_2$ 4%	0.00	0.00	12.82b	2.56	15.37b	10.00a	20.46b	15.38a	-	20.51a	-	20.56a
F. test			**	NS	*	*	**	*		**		**

Means followed by a common letter are not significantly different at the 5% level by DMRT

Room T. =Storage at room temperature *Cold S. = storage at cold storage*

On the other hand, the lowest fruit rot percentage (0.00 & 10.25 %) were recorded after 15 days by treatment $CaCl_2$ 2% in cold storage and room temperature, respectively. Generally, fruit dipped at $CaCl_2$ at 2% treatment had the lowest fruit rot percentages in cold or room temperature as compared with other treatments in all periods of storage.

3.7-weight loss (%):

Results at Table (7) showed that, during storage periods (room temperature and cold storage) there were no significant variation among treatments during in both seasons except in after 45 days at room temperature and after 60 and 75 days in cold storage, respectively. Control treatment had the highest weight loss percentages (7.38, 11.84 and 20.97%) at room conditions and at cold storage (2.57, 3.79, 5.73,10.84 and 18.30 %) after 15, 30,45,60 and 75 days, respectively. On the other hand, the lowest values were 5.50, 5.85 and 14.41% at room temperature and 0.87, 1.73, 2.91, 6.49 and 11.24 % recorded by treatment $CaCl_2$ at 2% in both seasons.

DISCUSSION

Navel orange is one of the World's most important fruit crops as many other fruits. Citrus fruits are susceptible to a number of decay causing organisms. The green and blue moulds are the most prevalent post-harvest decays affecting orange fruit followed by other diseases. $CaCl_2$ application (2 and 4%) can improve fruit quality of navel orange during either in room temperature or at cold storage . Storability of Washington navel orange fruits was extended by using the $CaCl_2$ treatments. This was observed in both the room and cold storage conditions. However, cold stored fruits continued to be in marketable condition much longer than those in room temperature. It also, kept most of the important physical and chemical fruit properties under cold storage. It was also observed that the 2% $CaCl_2$ treatment was much better than either the control or the 4%$CaCl_2$ treatments. Dipping at 2% recorded the highest SSC, Vitamin C, reducing sugars content in fruit during storage (room temperature & cold storage) and reduce fruit rot and fruit weight loss. This dipping application may be used to reduce physiological disorders as **Bangerth (1976)** observed . **Mohamed *et al.*, 1993** and **Agar *et al.*, 1999** found an increase in vitamin C content of apples , tomatoes and kiwifruit treated with calcium chloride during storage.

Table (7): Effect of $CaCl_2$ 2% and $CaCl_2$ 4% on weight loss % of Washington navel orange fruits during storage at room temperature and cold storage (2006/2007 and 2007/2008) seasons.

Treat.	2007											
	0		15		30		45		60		75	
	Room T.	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	0.00	0.00	6.55	0.89	10.92	3.72	17.79a	5.73	-	9.55a	-	13.22
$CaCl_2$ 2%	0.00	0.00	5.50	0.87	8.85	1.73	14.41b	2.91	-	6.49b	-	11.24
$CaCl_2$ 4%	0.00	0.00	5.78	1.07	9.24	1.83	15.57b	3.11	-	6.92b	-	12.50
F. test			NS	NS	NS	NS	*	NS		*		NS
2008												
Treat.	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*	*Room T.*	*Cold S.*
Cont.	0.00	0.00	7.38	2.57	11.84	3.79	20..97a	5.15	-	10.84	-	18.30a
$CaCl_2$ 2%	0.00	0.00	5.90	2.22	9.52	3.00	16.48b	5.22	-	9.44	-	15.75c
$CaCl_2$ 4%	0.00	0.00	7.36	1.69	10.77	2.63	17.12b	4.67	-	10.45	-	16.19b
F. test			NS	NS	NS	NS	**	NS		NS		*

Means followed by A common letter are not significantly different at the 5% level by DMRT

Room T.=Storage at room temperature *Cold S.= storage at cold storage*

Calcium chloride is commonly used industrially as a firming agent for canned tomatoes and cucumber pickles. **Tian *et al* (2002)** reported that calcium chloride at 2% inhibited the growth and spore germination of *R. stolonifer*, The firming effect provided by calcium chloride can be explained by: (1) the complexing of calcium ions with cell wall and middle lamella pectin **(Grant *et al.*, 1973** and **Morris, 1980);** (2) stabilization of the cell membrane by the calcium ions **(Picchioni *et al.*, 1995);** and : or (3) effect of calcium on cell turgor pressure **(Mignani *et al.*, 1995).**

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الملخص العربي

تأثير بعض المعاملات الحيويه والكيماويه علي القدرة التخزينيه لثمار البرتقال ابوسره بعد الحصاد

ب-المعامله بكلوريد الكالسيوم

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أجريت هذه الدراسة بقسم البساتين بكلية الزراعة جامعة كفر الشيخ علي البرتقال ابو سره المأخوذة من أشجار نامية بمزرعة خاصة في منطقه مطوبس بمحافظة كفر الشيخ – مصر. حيث يعتبر البرتقال الفاكهة المتاحة خلال فترة الشتاء وخصوصا البرتقال ابوسره. وقد أخذت عينات ثمار البرتقال أبوسره وأجريت عليها الدراسة بثلاث معاملات غمس لمدة ١٠ دقائق كالتالي:

١ – كنترول (ماء مقطر)

٢- كلوريد الكالسيوم (٢%)

٣-كلوريد الكالسيوم (٤%)

ثم قسمت إلي مجموعتين الأولي خزنت في تحت درجة حرارة الغرفة (٢١± ٢ م + رطوبة نسبيه ٦٥-٧٥%) ولمدة ٤٥ يوم والمجموعة الثانية خزنت في ثلاجات (٧م + رطوبة نسبيه ٩٠-٩٥%) ولمدة ٧٥ يوم. وقد أجريت بعض القياسات اثناء التخزين منها تقدير نسب السكريات الذائبة الكلية والحموضة والسكريات الكلية والمختزلة ومحتوي الثمار من فيتامين ج وتقدير نسب الثمار التالفة والفقد في الوزن للثمار المخزنه.

وقد اظهرت النتائج طول القدره التخزينيه لثمار البرتقال ابوسره المعامله بكلوريد الكالسيوم ٢% سواء المخزنه في جو حرارة الغرفه او في الجو المبرد وقد وجد ان تخزين الثمار بصوره تسويقيه جيدة ولمده اطول عند التخزين في جو مبرد وانها تحتفظ باغلب صفاتها الفيزيقيه و الكيماويه عند غمس الثمار في التركيز ٢% كلوريد كالسيوم مقارنة بالمعاملات الاخري.