ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 46(4): Ho. 525-532, (2008).

EFFECT OF HYDRO-HEATING TREATMENTS ON LE-CONTE PEAR FRUITS QUALITY AT COLD STORAGE

BY

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ABSTRACT

Mature Le-Conte pear fruits (*Pyrus leconti, Rehd*) were harvested at the third week of August in 2007 & 2008 seasons. Five post harvest treatments were applied on nearly uniform fruits [dipping in: tap water (control), hot water (50 ± 2°C), hot solution (50 ± 2°C) of Ascorbic acid 1 %, hot solution (50 ± 2°C) of sodium benzoate 100 mM and the last treatment fruits were dipped in hot water (50 ± 2°C), dried and coated with black cumin (*Nigella sativa*) oil]. Results in both seasons showed that the hydro-heating treatments and plant oil coating were more effective in maintaining fruit quality, storability and reducing disorders.

Key words: Le-Conte pears; hot water; Ascorbic acid; sodium benzoate; black cumin oil coating; cold storage; fruit quality.

INTRODUCTION

"Le-Conte" (*Pyrus leconti, Rehd*), is the most important pear cultivar in Egypt. It is essential to know that pear fruits when picked at the optimal physiological age with the possible short post harvest handling then kept under the optimal storage conditions to slow biological and physiological changes, will all help in extending the shelf life and marketing time of the fruits.

Economic losses caused by post-harvest diseases are among the most important concerns for growers, post-harvest fruit decay has typically been controlled by application of synthetic fungicides. However, important problems associated with the massive use of these chemicals, such as proliferation at resistant strains of pathogens and concerns about public health and environmental contamination, have increased the need for alternatives (Crisosto 2006). Among these alternative treatments:-

a- Hot water dipping treatments.

Post harvest heat treatments are currently used commercially in several countries, for examples as hot water dips, hot water brushing techniques and hot air treatments. High temperature treatments of fruit are more effective to control fungal pathogens, insects and decay (Covey, 1989; Barkai-Golan and Freguson *et al.*, 2002). Abd El-Wahab (2007) reported that different hot water dips reduced the percentage of decay, weight loss and phenols of Apricot and peach.

b. Sodium benzoate:

This compound leaves low or undetectable residues on the fruit and is approved for many industrial and agricultural applications. And it is registered as generally recognized as Save (GRAS).

The efficiency of the GRAS increases with the increase of solution temperature (up to 55-60 °C) (Crisosto, 2006).

Selected properties of sodium benzoate Environmental Protection Agency code 9103, Formula ($C_7H_5NaO_2$), Mol. wt. (144.11), with primary activity on bacteria and secondary activity on Yeasts, (Hall, 1988).

c. Ascorbic acid as antioxidant.
d. Fruit coating.

Using permeable fruit coating to create a modified atmosphere in apples and pears improved retention of texture and titrable acids in cold storage and reduced storage disorders, (Elson *et al.*, 1985). Ju-ZhiGvo *et al.* (2001) used plant oils (maize or soybean oil emulsion) by dipping pre-climacteric bartlett pears immediately after harvest and stored at 0°C, both treatments inhibited disorders. Oil treated fruit exhibited normal colour change and had higher soluble solids and total acidity. Togrul and Arslan (2004) used soybean oil to extend shelf life of peach and pear fruits. Mehaisen (2005) reported that olive oil coating was the most effective in maintaining fruit quality and storability of pear fruits.

This work aims to study the effect of hydro heating treatments and *Negilla sativa* oil (natural coating) as alternative of fungicides on fruit quality to stop or reduce post harvest disorder of Le-Conte pears at cold storage and shelf life.

MATERIALS AND METHODS

1- Plant material:

This investigation was carried out during two successive seasons (2007 & 2008) at Hort. Res. Inst. Giza, Egypt. In both season, Le-Conte pear fruits were harvested at maturity stage according to El-Azzouni *et al.* (1975) from a private orchard at Moshtohor region, Tokh, Qalyoubia Governorate, Egypt, at the third week of August and directly transported (through 1 h.) to the laboratory. Uniform fruits were washed with tap water and air dried.

2- Treatments and storage conditions:

Uniform fruits were divided into five groups, the first group was dipped in tap water at (18-22 °C) for 5 min., as control, the second group was dipped in hot water (50 °C ± 2) for 5 min., the third group was dipped in hot solution (50 °C ± 2) of Ascorbic acid (1 %) as antioxidant for 5 min., the fourth group was dipped in a hot solution (50 °C ± 2) of sodium benzoate (NaBz) (100 mM) for 5 min., the last group was dipped in hot water (50 °C ± 2), dried and coated with thin layer with black cumin oil (*Negilla stiva*) as natural coating.

All fruits of each treatment were divided into three replicates and packed in one layer (12 pears) inside carton boxes. All the boxes were stored at 0 °C and 85-90 % RH

For physical and chemical determinations, a sample consisting of 3 fruits were taken randomly from each replicate within each treatment at 15 days intervals.

Physical and chemical characteristics:

Fruit weight loss and post-harvest disorders (decayed and discoloration fruits) were calculated as percentage, peel colour was measured using Hunter Colourimeter Model Dp 9000 and a/b ratio was calculated, Fruit firmness was estimated by Lfra texture analyzer using a penetrating needle of 1 mm of diameter, 10 mm in distance, speed 2 mm per second and the peak of resistance was recorded per gram, total soluble solids were determined by A`bbe refractometer in fruit juice and total acids % as malic acid determined according to A.O.A.C. (1985).

Shelf life, a sample of ten fruits of each replicate was taken out at the end of cold storage (0°C) and left at room temperature (18-20 °C) for six days, the discoloration areas were calculated and considered as an indicator of shelf life.

All obtained data were subjected to analysis of variance according to Snedecor and Cochran (1980). Differences among means were compared using Duncan Multiple Ranges Test (Duncan, 1955) at 5 % level.

RESULTS AND DISCUSSION

1- Fruit physical composition:

1-1- Post harvest fruit disorders:

Results in Table (1) showed that post harvest disorders significantly increased by extending the storage period during storage at 0°C in both seasons for all treatments concerning the effect of various hot water dipping treatments (hot water, ascorbic acid and sodium benzoate), it was observed that these treatments were significantly effective in minimizing disorders than control (tap water), meanwhile, fruits treated with black cumin oil as natural coating showed much lower values (2.89 – 3.54) than other treatments. These results agree with those of Ju-ZhiGuo *et al.* (2001) who reported that pre-climacteric Bartlett pears were dipped of 3 minutes in either maize or soybean oil emulsion immediately after harvest and stored at 0°C. both treatments inhibited disorders. Mehaisen (2005) revealed that olive oil coating treatment was the most effective in reducing disorders in pear fruits stored at 0°C.

1-2- Fruit weight loss percentage:

Data in Table (2) showed that the weight loss percentage significantly increased by prolonging the storage periods during storage at 0°C for 3 months in both seasons.

The hydro heating treatments were more effective in reducing weight loss than control (tap water), pears treated with black cumin oil coating after dipping in hot water induced a remarkable reduction in fruit weight loss in both seasons (2.23-1.79) as compared with other treatments. These results are similar to those of Ismail (1997), Mehaisen and El-Sharkwy (2005), Mehaisen (2005) and Abd El-Wahab (2007).

1-3- Fruit colour:

Figure (1) indicated that pear fruits coated with black seed oil delayed development of colour during cold storage and exhibited normal colour change than others. The obtained data were in harmony with results of Ju-ZhiGuo *et al.* (2001) who reported that pear fruits treated with either maize or soybean oil after harvest and stored at 0°C for 15 weeks maintained fruit colour, Merwe *et al.* (2002) who revealed that simper fresh coating on pear resulted in greener skin colour without loss of fruit quality and Mehaisen (2005) who found that olive oil coating delayed the change fruit colour.

1-4- Fruit firmness:

Data presented in Table (3) showed that flesh firmness of pear fruits significantly decreased by extending storage period with all treatments during storage at 0°C. in both seasons. Pear fruits coated with black cumin oil showed higher texture than all treatments. In both seasons oil coating has a remarkable effect in reducing fruit flesh firmness (300.3 & 287.0) followed by Ascorbic acid (282.4 & 279.3) and sodium benzoate (267.0 & 280.0), but hot water dipping has less effect as compared with other treatments, these results are in agreement with those of Ismail (1997) who found that coating Le-Conte pears with semperfish significantly increased firmness. These results are similar to those of Merwe *et al.* (2002), Mehaisen and El-Sharkawy (2005) who reported that Guava fruits coated with olive oil were firmer then uncoated ones, which may be due to the effect of coating in inhibiting respiration rate.

Mehaisen (2005) reported that pear fruits coated with olive oil maintained fruit firmness. Abd El-Wahab (2007) found that hot water treatments did not show any significant differences on fruit firmness of apricot and peach either after cold storage period or shelf life at room temperature.

2- Fruit chemical changes (TSS & TSS/acid ratio) during cold storage:

Data in Table (4 & 5) showed that changes in TSS and TSS/acid ratio had no significant differences among treatments meanwhile, fruits were dipped in ascorbic acid and which coated with oil had lower values of TSS % and total acidity ratio % in both seasons than other treatments.

Table (1): Effect of post-harvest treatments on post harvest disorders percentage of Le-Conte pear fruit during storage at 0°C in (2007 & 2008 seasons).

Season	1st season							
Storage periods (days) / Dipping treatments for 5 min.	0	15	30	45	60	75	90	Mean
Control (tap water)	0.00	2.00	16.80	25.40	35.80	43.40	42.80	23.24A
Hot water	0.00	2.80	15.80	22.00	24.00	40.00	50.20	22.11B
Sodium benzoate	0.00	2.30	6.40	14.50	20.40	26.50	33.00	14.73C
Ascorbic acid	0.00	0.00	0.00	3.30	8.53	15.40	20.00	6.75D
Hot water + oil coating	0.00	0.00	0.00	0.00	5.40	6.40	8.40	2.89E
Mean	0.0G	1.42F	7.80E	13.04D	18.83C	26.34B	30.88A	
L.S.D at 5 %	T = 0.21			P.= 0.25			T x P = 0.56	
	2nd season							
Control (tap water)	0.00	2.10	13.00	17.80	25.03	34.70	51.00	20.51A
Hot water	0.00	2.80	8.00	15.20	26.00	31.00	50.50	19.10B
Sodium benzoate	0.00	2.80	6.00	13.00	21.40	28.50	36.00	15.39C
Ascorbic acid	0.00	0.00	0.00	3.60	9.00	18.00	22.00	7.51D
Hot water + oil coating	0.00	0.00	0.00	0.00	6.20	6.80	9.80	3.54E
Mean	0.0G	1.54F	5.40E	9.92D	17.52C	24.20B	33.86A	
L.S.D at 5 %	T = 0.21			P.= 0.25			T x P = 0.26	

Table (2): Effect of post-harvest treatments on weight loss percentage of Le-Conte pear fruit during storage at 0°C in (2007 & 2008 seasons).

Season	1st season							
Storage periods (days) / Dipping treatments for 5 min.	0	15	30	45	60	75	90	Mean
Control (tap water)	0.00	1.90	2.30	4.00	5.00	5.80	6.60	3.79A
Hot water	0.00	1.20	3.00	3.20	4.20	5.20	6.20	3.19B
Sodium benzoate	0.00	1.50	3.00	3.50	4.00	4.40	5.40	3.13B
Ascorbic acid	0.00	1.50	2.20	3.00	3.50	4.50	5.00	2.81C
Hot water + oil coating	0.00	0.85	1.60	2.30	3.30	3.50	4.10	2.23D
Mean	0.00G	1.41F	2.46E	3.20D	4.00C	4.68B	5.45A	
L.S.D at 5 %	T = 0.065			P.= 0.074			T x P = 0.17	
	2nd season							
Control (tap water)	0.00	2.20	4.00	4.50	5.80	6.00	6.20	4.10A
Hot water	0.00	1.80	3.40	4.20	4.50	5.43	6.00	3.60B
Sodium benzoate	0.00	1.80	2.50	3.40	4.20	5.00	5.50	3.20C
Ascorbic acid	0.00	0.80	1.30	2.30	3.10	3.90	4.50	2.27D
Hot water + oil coating	0.00	0.60	1.10	1.70	2.50	3.10	3.50	1.79E
Mean	0.00G	1.44F	2.46E	3.22D	4.02C	4.69B	5.14A	
L.S.D at 5 %	T = 0.064			P.= 0.077			T x P = 0.17	

T = Treatment P = Storage T x P = The interaction between TxP

These data were in the line with those obtained by Koksal *et al.* (1994), Ju-ZhiGuo *et al.* (2001), Togrul and Arslan (2004) and Mehaisen (2005).

3- Shelf life:

Data in Fig. (2) cleared that hydro heating treatments extended shelf life by reducing discoloration areas on fruit surface. Black cumin oil coating was more effective, followed by Ascorbic acid treatment than others. These results are similar to those of Ismail (1997), Merwe *et al.* (2002), Togrul and Arslan (2004) and Mehaisen (2005).

Table (3): Effect of post-harvest treatments on firmness of Le-Conte pear fruit during storage at 0°C in (2007 & 2008 seasons).

Season	1st season							
Storage periods (days) / Dipping treatments for 5 min.	0	15	30	45	60	75	90	Mean
Control (tap water)	368.0	361.0	357.0	286.0	279.0	190.0	97.0	**277.0B**
Hot water	368.0	353.0	292.0	286.0	267.0	187.0	107.0	**265.7C**
Sodium benzoate	368.0	357.0	341.0	292.0	265.0	170.0	82.0	**267.9C**
Ascorbic acid	368.0	356.0	330.0	311.0	295.0	200.0	117.0	**282.4B**
Hot water + oil coating	368.0	363.0	358.0	340.0	329.0	222.0	122.0	**300.3A**
Mean	**368.0A**	**358.0B**	**335.7C**	**303.0D**	**287.1E**	**193.0F**	**105.0G**	
L.S.D at 5 %	T = 6.4			P.= 7.57			T x P = 16.93	
	2nd season							
Control (tap water)	361.0	354.0	330.0	319.0	287.0	198.0	115.0	**280.6B**
Hot water	361.0	360.0	310.0	286.7	276.0	184.0	97.0	**267.8C**
Sodium benzoate	361.0	344.0	304.0	349.0	305.0	199.0	98.0	**280.0B**
Ascorbic acid	361.0	357.0	343.0	331.0	297.0	189.0	77.0	**279.3A**
Hot water + oil coating	361.0	354.0	338.0	328.0	306.3	210.0	112.0	**287.0A**
Mean	**361.0A**	**353.8B**	**325.0C**	**322.7D**	**294.3E**	**196.3F**	**99.8G**	
L.S.D at 5 %	T = 1.721			P.= 2.036			T x P = 4.55	

Table (4): Effect of post-harvest treatments on total soluble solids (%) of Le-Conte pear fruit during storage at 0°C in (2007 & 2008 seasons).

Season	1st season							
Storage periods (days) / Dipping treatments for 5 min.	0	15	30	45	60	75	90	Mean
Control (tap water)	11.80	11.90	12.10	12.50	12.90	13.40	14.00	**12.60B**
Hot water	11.80	12.00	12.70	12.80	12.90	13.10	13.20	**12.64B**
Sodium benzoate	11.80	12.10	12.20	13.00	13.20	13.40	13.47	**12.74AB**
Ascorbic acid	11.80	12.00	12.40	13.00	13.30	13.50	13.80	**12.83A**
Hot water + oil coating	11.80	12.00	12.70	13.10	13.30	13.40	13.60	**12.84A**
Mean	**11.80G**	**12.00F**	**12.42E**	**12.88D**	**13.12C**	**13.36B**	**13.61A**	
L.S.D at 5 %	T = 0.119			P.= 0.1402			T x P = 0.313	
	2nd season							
Control (tap water)	12.00	12.21	12.40	12.80	13.20	13.50	13.90	**12.84B**
Hot water	12.00	12.10	12.60	12.93	13.00	13.10	13.20	**12.70C**
Sodium benzoate	12.00	12.20	12.30	12.90	13.43	13.40	13.60	**12.83B**
Ascorbic acid	12.00	12.10	12.50	13.13	13.27	13.60	13.90	**12.93AB**
Hot water + oil coating	12.00	12.30	12.80	13.20	13.50	13.70	13.80	**13.04A**
Mean	**12.00G**	**12.16F**	**12.52E**	**12.99D**	**13.28C**	**13.68B**	**13.68A**	
L.S.D at 5 %	T = 0.128			P.= 0.1511			T x P = 0.338	

T = Treatment P = Storage T x P = The interaction between T x P

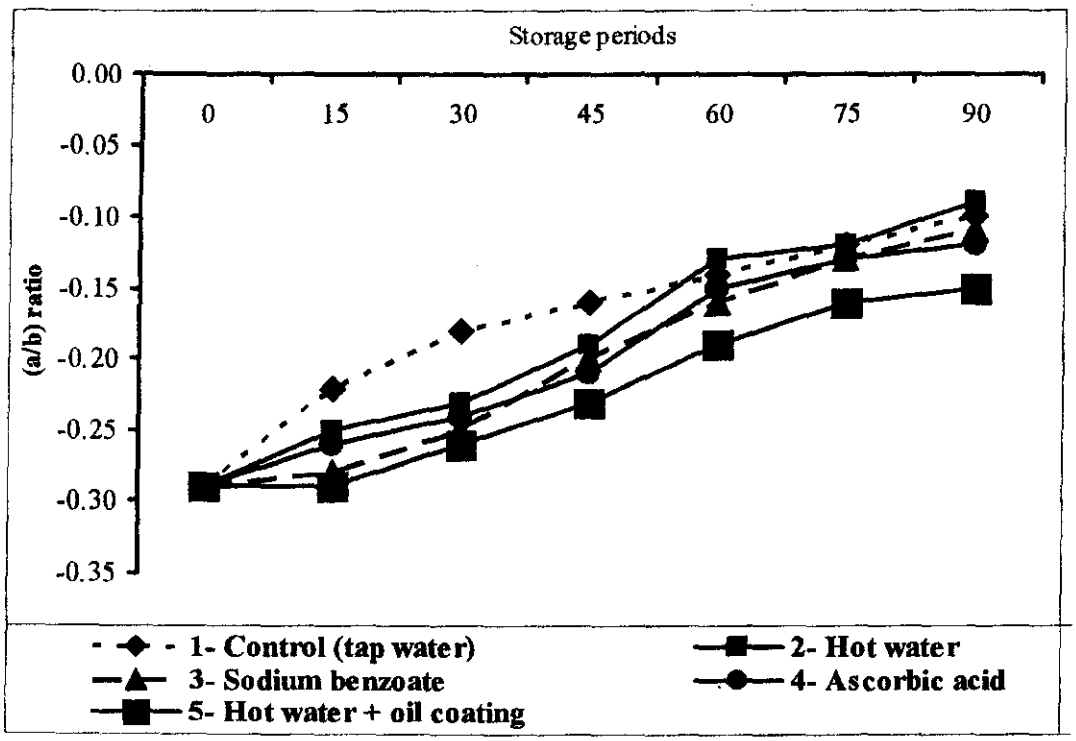

Fig. (1): Effect of post harvest treatments on fruit colour during cold storage (0 °C) average of two seasons.

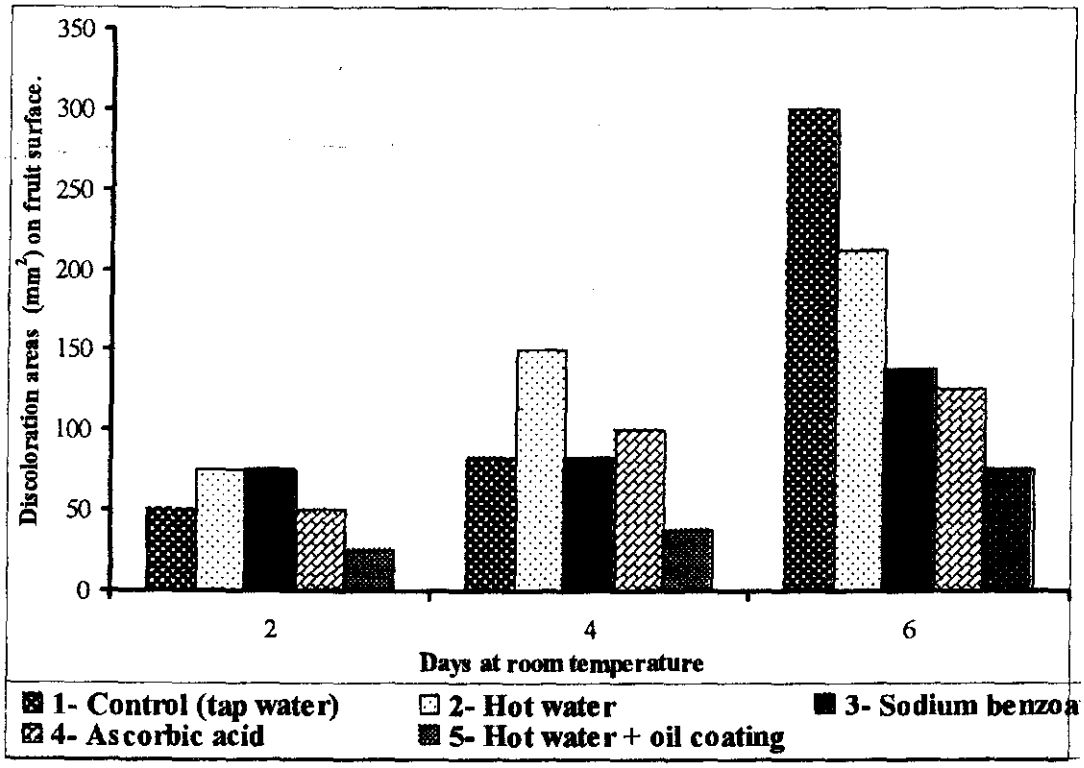

Fig. (2): Effect of post harvest treatments on fruit shelf life (average of two seasons).

Table (5): Effect of post-harvest treatments on total acidity (%) of Le-Conte pear fruit during storage at 0° C in (2007 & 2008 seasons).

Season	1st season							
Storage periods (days) / Dipping treatments for 5 min.	0	15	30	45	60	75	90	Mean
Control (tap water)	0.39	0.38	0.35	0.33	0.31	0.28	0.23	**0.32A**
Hot water	0.39	0.37	0.34	0.32	0.31	0.25	0.21	**0.31B**
Sodium benzoate	0.39	0.36	0.36	0.31	0.28	0.24	0.22	**0.31B**
Ascorbic acid	0.39	0.35	0.32	0.28	0.26	0.24	0.16	**0.28C**
Hot water + oil coating	0.39	0.32	0.30	0.26	0.25	0.24	0.21	**0.28C**
Mean	**0.39A**	**0.036B**	**0.33C**	**0.30D**	**0.28E**	**0.25F**	**0.21G**	
L.S.D at 5 %	T = 0.0062			P.= 0.0073			T x P = 0.0163	
	2nd season							
Control (tap water)	0.36	0.36	0.34	0.31	0.29	0.25	0.22	**0.30A**
Hot water	0.36	0.34	0.35	0.31	0.25	0.22	0.21	**0.29B**
Sodium benzoate	0.36	0.35	0.33	0.30	0.26	0.23	0.20	**0.29B**
Ascorbic acid	0.36	0.34	0.33	0.28	0.24	0.22	0.18	**0.28C**
Hot water + oil coating	0.36	0.33	0.30	0.25	0.24	0.22	0.20	**0.27D**
Mean	**0.36A**	**0.34B**	**0.33C**	**0.29D**	**0.25E**	**0.23F**	**0.20G**	
L.S.D at 5 %	T = 0.0062			P.= 0.0073			T x P = 0.016	

T = Treatment P = Storage T x P = The interaction between T x P

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تأثير المعاملات المضافة إلى الماء الساخن على صفات الجودة لثمار الكمثرى الليكونت أثناء التخزين المبرد

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أجريت هذه الدراسة خلال موسمى ٢٠٠٧، ٢٠٠٨ بقسم بحوث تداول الفاكهة بمعهد بحوث البساتين بالجيزة على ثمار كمثرى الليكونت. جمعت الثمار بعناية من بستان خاص بمنطقة مشتهر – طوخ – قليوبية فى الأسبوع الثالث من شهر أغسطس عندما وصلت الثمار إلى إكتمال النمو ونقلت مباشرة إلى المعمل حيث تم فرز الثمار وغسلها بالماء وتركت لتجف ثم قسمت الثمار إلى خمس مجموعات:

- ثمار المجموعة الأولى غمرت فى ماء عادى (١٨ – ٢٢ °م).
- ثمار المجموعة الثانية غمرت فى ماء ساخن (٥٠ ± ٢ °م).
- ثمار المجموعة الثالثة غمرت فى محلول ساخن (٥٠ ± ٢ °م) من بنزوات الصوديوم (١٠٠ ملليمول).
- المجموعة الرابعة غمرت فى محلول ساخن (٥٠ ± ٢ °م) من حامض الأسكوربيك ١%.
- المجموعة الخامسة غمرت فى ماء ساخن (٥٠ ± ٢ °م) ثم جففت وغلفت بطبقة رقيقة جداً من زيت الحبة السوداء كمعاملة تغليف طبيعية بديلة للمركبات الصناعية.

ثم قسمت كل معاملة إلى ثلاث مكررات وتم تعبئة كل مكررة فى صناديق من الكرتون يحتوى الواحد منها على ١٢ ثمرة، وخزنت على درجة حرارة الصفر المئوى لمدة ثلاثة أشهر.

أوضحت نتائج هذه الدراسة أن الغمر فى الماء الساخن أو المعاملات المضافة إليه أو المعاملة بالزيت النباتى (منتج طبيعى) كمعاملة تغليف حسنت من صفات الجودة والقدرة التخزينية وقللت من نسبة التالف بالمقارنة بالثمار الغير معاملة.