

EFFECT OF SOME PHYSICAL TREATMENTS AND PACKING ON FRUIT QUALITY HOLLIWOOD PLUM C.V DURING COLD STORAGE

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ABSTRACT

This study was carried out during two successive seasons of 2003 and 2004 at the Hort. Res. Inst. Fruit Handling Department on Holliflower plum fruits. Fruits were harvested at the early morning at maturity stage from a private farm in Kalubia governorate. Fruits were packed in carton boxes capacity of 3 kg and directly transported to the laboratory. Fruits were divided into randomly four treatments, control (untreated fruits), Coating fruit surface with a very thin layer of paraffin oil, dipping the fruit in acetic acid 10% solution for three minutes, and polishing the fruits were used. Fruits were packed in dishes of foam 1kg /dish and covered with polyethylene 10 micron. Then at 0°C and R.H 90-95% for 30 days in both seasons.

Physical and chemical properties of the fruits were estimated every 7 days interval during storage, plus 7 days at room temperature as shelf life for mentioned the marketing period. All postharvest treatments used significantly decreased weight loss, decay percentage, fruit softening, darkness, and the changing of total soluble solids and total acidity of fruits during storage compared with the control. Also this study confirmed that postharvest treatment with paraffin oil was the best one in order to keep plum fruit quality during storage and marketing.

INTRODUCTION

Plums (*Prunus salicina*) are occupying an important share in the total fruit production of Egypt. Total areas reached about 3603 faddans in 2002. Plums are mainly marketed as fresh consumption as well as for drying. They are also used for canning, freezing, jam and jelly products. (Crisosto, C.H. 1994).

In most of plum cultivars grown in Egypt, harvest time is determined by skin color changes that are described for each cultivar. A color chart guide is used to determine maturity for some cultivars. (Kader. *et al.*1989) & Kader (1986).

Using paraffin oil reduced weight loss from 23% in fruits of the control to around 8.5% in the treated fruits (Singh and Bhargava (1977).

Moreover, dipping fruits in wax emulsion reduced weight loss and prolonged storage life at both room temperature and cold room (Garg *et al.*1976).

Dundar *et al.*(1999) found that, fruits were harvested and stored at 1°C and 85-90% RH for 4 to 9 weeks, weight loss increased with time prolonged during storage for Japanese plum, Black Amber, Climax, Stanley, Beauty and Blue free.

Kotze *et al.* (1989) harvested plum cv Santa Rosa at optimum maturity and stored them for 4 weeks at -0.5 °C followed by 7 days at 3 °C, 13 days at -0.5 °C followed by 15 days at 7.2 °C 14 days at -0.5 °C followed by 1 day at 20 °C and a further 13 days at -0.5 °C. They found that fruits stored

for 13 days at -0.5 °C followed by 15 days at 7.2 °C had the highest incidence of the disorder.

Kader (1986) & (1989) mentioned that, control atmosphere delayed fruit ripening and softening.

Turk *et al.* (1994) reported that, peaches fruits (cv.J.H.Hale) and plums (cv.stanley) were wrapped in polyethylene PE 35mm, polypropylene (pp12mm) or polyvinyl chloride (pvc80mm) and stored at 0°C and 90-95% R.H. They found that, peaches stored for 6-7 weeks with Pvc wrapping had the best firmness for Stanly; the best treatment was pp which resulted in the firmest fruits and the best overall appearance after storage for 6-7 weeks. The present work , paraffin oil, acetic acid and polishing, were conducted as a postharvest treatments to prolong the marketing period, keeping quality and appearance of plum fruits Lined with perforated polyethylene 10 mm thickness.

MATERIALS AND METHODS

This study was carried out at the Hort Res Inst., Fruit handling department during two successive seasons of 2003 and 2004. Plum fruits of Holliwod cv were harvested at maturity stage: 90 days from full bloom, and when T.S.S reached about 13%, (Josan and chohan 1982), (Kader and Mitcheli 1998) . In the early morning, Fruits were harvested from a private farm at kalubia Governorate. Then packed in carton boxes (4 kg), and transported directly, to laboratory.

Fruits were washed thoroughly and left to dry except those of intended to be polished. Then fruits were divided randomly into the following treatments

- 1- Control (untreated).
- 2- Fruits were coated with then layer of 2 % Paraffin oil for three minutes.
- 3- Fruits were dipped in 10 % acetic acid for three minutes.
- 4- Fruits were cleaned by using velvet cloth without washing (Polishing).

All the fruits were packed in foam plates and covered with polyethylene (thin 10/micron). Fruits were stored at 0C, and 90-95%.RH.

Physical and chemical characteristics were measured at 7 day intervals. Fruits were transferred gradually to room condition (21±2 °C and RH 50 – 60 %) at the end of storage to simulate marketing period.

Fruit physical studies:

Weight loss (%):

Weight loss Percentage was determined for by weighting each replicate (20fruits) separately then weighting it again after every week of storage and the weight loss was calculated to the initial weight as follow:-

$$\frac{\{(\text{Initial weight of fruits} - \text{weight of fruits at sampling date}) / (\text{Initial weight of fruits}) \times 100\}}{}$$

Decay percentage:

Decay percentage calculated per 20fruits representing for each replicate.

At 5 % decay, the sample was discarded:-

$$\frac{\text{Decayed fruit weight} \times 100}{\text{initial weight of all fruits}}$$

Peel color measurement:

Peel color was determined by using a Hunter colorimeter type (DP-900) for the estimation of L^* , a^* , b^* values. Color was represented as a^* (green-red) and b^* (blue-yellow) scale readings and a subsequent calculation of the corresponding hue angle. This angle increases from 90° (yellow) to become more green and reaches dark green at 180° (McGuire, 1992, Voss, 1992).

Fruit texture:

Fruit texture was recorded by Ibra texture analyzer instrument using penetrate cylinder of 1 mm diameter, to constant distance 3, 5 and 7 by constant speeds of 2mm/second. The results were expressed as the resistance force to penetrating tester, in units of pressure per gram

Fruit chemical analysis:

Total soluble solids (TSS %)

TSS % was determined using Carl-Zeiss hand refractometer

Total acidity %

Total acidity % was estimated according to A.O.A.C method (1990). The results were expressed as percent malic acid per 100ml juice

Shelf-life:-

At the end of storage period, three replicates from each treatment were left gradually at ambient temperature conditions (23 °C and RH 50 – 60 %) for 7 days to simulate the marketing environment. Changes in physical and chemical characteristics of fruits were recorded, at the end of shelf life period i.e. colour transmission, weight loss%, decay%, Hunter (L^* , a^* , b^*), T.S.S%, and total acidity.

Statistical analysis:

All treatment used in this study were arranged as factorial experiment in complete randomized design was used in this study. Each treatment was replicated three times; according to Snedcor and Cochran (1990). Means were compared by LSD test at 5% level.

RESULTS AND DISCUSSION

Weight Loss percentage:-

Data shown in Table (1) cleared that, weight loss percentage significantly increased gradually with increasing in cold storage period, and reached its maximum after four weeks during storage in both seasons. The obtained data also cleared that all treated fruits showed the lowest values of weight loss percentage comparing with untreated fruits, in both seasons, respectively since the loss weight reached (6.96&7.33) after 4 weeks from storage.

These results are in harmony with those obtained by Dundar *et al.* (1997) on Japanese plum, Black Amber, Climax, Stanley, Beauty and stored under 1°C and 85-90% R.H for 4-9 weeks. They found that weight loss % increased with increasing storage period. On the other hand, Kaundal *et al.* (2000) they found that wax emulsion (3, 6 and 9 %) increased physiological loss in weight of plum fruits during 30 days of storage.

Table (1): Effect of some postharvest treatments on Weight loss (%) of Hollivood Plum fruits, stored at (0 °C) during seasons 2003 and 2004.

Season 2003					
Treatments(B) Period in weeks(A)	Control	Paraffin	Acetic acid	Polishing	Mean
0	0.00	0.00	0.00	0.00	0.00
1	2.60	0.52	0.75	0.73	1.15
2	4.48	0.81	0.97	0.92	1.80
3	5.30	1.01	1.19	1.20	2.18
4	6.96	1.39	1.40	1.52	2.82
Mean	3.87	0.74	0.86	0.88	1.59
Season 2004					
0	0.00	0.00	0.00	0.00	0.00
1	3.43	0.59	0.79	0.79	1.40
2	4.63	0.83	1.29	0.97	1.93
3	5.84	1.09	1.49	1.35	2.44
4	7.33	1.50	1.54	1.61	2.99
Mean	4.25	0.80	1.02	0.94	1.75
L.S.D at 5 %	A		B		A*B
2003	0.23		0.20		0.45
2004	0.18		0.17		0.37

Decay percentage:-

Decay percentage significantly increased gradually with storage period prolonged (Table2).

Table (2): Effect of some postharvest treatments on decay (%) of Hollivood Plum fruits, stored at (0 °C) during seasons 2003 and 2004.

Season 2003					
Treatments(B) Period in weeks(A)	Control	Paraffin	Acetic acid	Polishing	Mean
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	5.00	0.00	0.00	0.00	1.25
4	10.00	0.00	0.00	0.00	2.50
Mean	3.00	0.00	0.00	0.00	0.75
Season 2004					
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.9	0.00	0.00	0.00	.22
3	4.5	0.00	0.00	0.00	1.25
4	8.4	0.00	0.00	0.00	2.50
Mean	2.76	0.00	0.00	0.00	0.79
L.S.D at 5 %	A		B		A*B
2003	0.008		0.007		0.017
2004	0.009		0.008		0.017

Obvious the results that all studied postharvest treatments prevented decay incidence of fruits till four weeks under cold storage while 10.0% of the untreated fruits were decayed after the same period of storage. These results are in harmony with those obtained by Goleberg *et al.* (1979) reported that paraffin oil inhibited the development of superficial scald in Australian apples cvs. Also, these results are agree with the findings of Sholberg and Gaunce (1996), which they reported that acetic acid was effective in reducing decay percentage in peaches, nectarine, apricot and cherries.

Fruit color:

Data presented in Table (3, 4) clearly indicated that, color directly changed from green yellow (hue angle >90 °C) to yellow (hue angle < 90°C) with prolonging the storage period.

Also the obtained data of lightness (L*) value indicated that ostarvest for fruits treated with acetic acid and polishing, gave a higher values a* and the highest values of hue angle while fruits treated with paraffin oil followed by untreated fruits showed a lower values of L* and hue angle, respectively in both seasons. On the other hand, data showed that there was no significant differences between all treatments and untreated fruits concerning its effect on L* value in both seasons during storage at 0°C, but L* value decreased gradually during cold storage in all treated and untreated fruits. These results coincided with those obtained by Abdi *et al.* ; (1997) on plums cvs, Radiant, Gulfruby, and Shira when harvested at 3 maturity stage and stored at 0 °C. They found significant differences in skin color during ripening and after cold storage. Kaundal *et al.* (2000) on plum. Moreover they found that fruit color improved from red –purple at harvest to dark purple after 30 days of storage

Table (3): Effect of some postharvest treatments on Hunter (L* value) of Holliwood Plum fruits, stored at (0 °C) during seasons 2003 and 2004.

Season 2003					
Treatments(B) Period in weeks(A)	Control	Paraffin	Acetic acid	Polishing	Mean
0	47.00	47.00	47.00	47.00	47.00
1	34.13	35.04	36.10	34.53	34.95
2	33.56	32.75	33.04	32.80	33.04
3	26.96	26.94	27.60	28.12	26.99
4	25.38	26.87	25.95	26.28	26.53
Mean	33.40	33.72	33.94	33.75	33.70
Season 2004					
0	50.00	50.00	50.00	50.00	50.00
1	33.33	34.27	35.00	33.55	33.62
2	32.96	32.57	33.32	33.56	33.52
3	27.00	27.82	27.36	28.72	27.31
4	25.32	26.84	26.69	26.84	26.84
Mean	33.72	34.30	34.47	34.53	34.26
L.S.D at 5 %	A		B		A*B
2003	6.950		N.S		15.54
2004	2.640		N.S		5.902

Table (4): Effect of some postharvest treatments on Hunter (hue angle value) of Holliwood Plum fruits, stored at (0 °C) during seasons 2003 and 2004.

Season 2003					
Treatments(B)	Control	Paraffin	Acetic acid	Polishing	Mean
Period in weeks(A)					
0	69.24	69.24	69.24	69.24	69.24
1	20.05	26.90	37.81	32.07	29.20
2	19.42	18.40	13.04	24.61	18.86
3	8.21	5.98	5.5	9.59	7.32
4	6.44	5.29	0.45	9.01	5.29
Mean	24.67	25.16	25.08	28.9	25.97
Season 2004					
0	79.95	79.95	79.95	79.95	79.95
1	20.91	26.87	33.81	28.5	27.52
2	16.46	16.85	17.38	23.21	18.47
3	10.00	8.70	13.79	10.92	10.85
4	5.54	6.62	9.51	9.95	7.90
Mean	26.57	27.79	30.88	30.50	28.93
L.S.D at 5 %	A		B		A*B
2003	2.610		N.S		5.835
2004	3.121		N.S		6.761

Texture:

Data in Tables (5, 6 and7), clearly showed that value of fruit texture gradually decreased as the storage period increased in both seasons.

Table (5): Effect of some postharvest treatments on fruit texture (3mm) of Holliwood Plum stored at (0 °C) during2003 and 2004 seasons.

Season 2003					
Treatments(B)	Control	Paraffin	Acetic acid	Polishing	Mean
Period in weeks(A)					
0	46.67	46.67	46.67	46.67	46.67
1	21.33	36.33	34.00	35.00	31.67
2	19.47	30.67	27.00	32.00	27.28
3	16.67	19.47	19.47	19.47	18.77
4	15.00	16.00	12.00	15.33	14.58
Mean	23.83	29.83	27.83	29.69	27.79
Season 2004					
0	45.33	45.33	45.33	45.33	45.33
1	26.67	40.67	34.33	34.33	34.00
2	19.00	18.17	27.00	27.67	22.96
3	16.17	19.00	19.00	19.00	18.29
4	11.33	13.33	17.50	15.67	14.46
Mean	23.70	27.30	28.63	28.40	27.01
L.S.D at 5 %	A		B		A*B
2003	3.323		2.972		6.646
2004	2.650		2.370		5.300

Table(6): Effect of some postharvest treatments on fruit texture (5mm) of Holliwood Plum stored at (0 °C) during 2003 and 2004 seasons.

Season 2003					
Treatments(B)	Control	Paraffin	Acetic acid	Polishing	Mean
Period in weeks(A)					
0	55.67	55.67	55.67	55.67	55.67
1	31.07	44.00	44.67	45.67	41.35
2	27.67	31.07	33.33	35.33	31.85
3	21.67	27.33	31.07	31.07	27.78
4	18.67	23.67	22.67	19.67	21.17
Mean	30.95	36.35	37.48	37.48	35.56
Season 2004					
0	54.00	54.00	54.00	54.00	54.00
1	35.33	43.67	46.33	42.67	42.00
2	25.00	43.33	35.33	35.33	34.75
3	23.17	35.33	23.83	27.33	27.42
4	19.33	28.00	22.33	21.67	22.83
Mean	31.37	40.87	36.37	36.20	36.20
L.S.D at 5 %	A		B		A*B
2003	4.144		3.706		8.287
2004	3.768		3.370		7.535

Table (7): Effect of postharvest treatments on fruit texture (7mm) of Holliwood Plum fruits, stored at (0 °C) during 2003 and 2004 seasons.

Season 2003					
Treatments(B)	Control	Paraffin	Acetic acid	Polishing	Mean
Period in weeks(A)					
0	64.67	64.67	64.67	64.67	64.67
1	40.00	50.00	53.67	54.00	49.41
2	29.67	39.00	40.00	44.00	38.17
3	26.67	34.00	37.33	40.00	34.50
4	28.00	29.33	30.00	31.00	29.58
Mean	37.80	43.40	45.13	46.73	43.26
Season 2004					
0	62.33	62.33	62.33	62.33	62.33
1	46.67	55.00	51.33	56.00	52.25
2	22.57	46.67	46.67	46.67	40.64
3	24.67	32.67	33.17	30.00	30.13
4	22.33	30.67	25.33	28.67	26.75
Mean	35.71	45.47	43.77	44.73	42.42
L.S.D at 5 %	A		B		A*B
2003	5.01		4.48		10.01
2004	3.73		3.34		7.47

Also it is obvious that fruits treated with polishing, acetic acid and paraffin had the highest values of texture at 3mm than untreated fruits (control). Plum Fruits texture treated with paraffin gave the highest values of texture at 5mm comparing with the control after 4 weeks under cold storage at 0°C in both seasons. On the other hand .Kaundal *et al.* (2000) on plum fruits, they found that wax emulsion (3, 6 and 9 %) decreased fruit firmness during 30 days of storage.

T.S.S %:

Results of Table (8) showed that total soluble solid percentage of Hollivood plum fruit were nearly constant with prolonged storage in both seasons. The effect of the postharvest treatments were not significant in both seasons. These results partially were in agreement with those obtained by Dundar *et al.* (1997) on Japanese plum, fruits Black Amber, Climax, Stanley, Beauty and Bluefree cvs., harvested and stored at 1 °C and 85-90 % RH for 4-9 weeks. They mentioned that T.S.S % increased as storage period prolonged. Also, Kaundal *et al.*(2000) on plum fruits they found that wax emulsion (3, 6 and 9 %) were not significant affected on T.S.S % during data 20,30 and 40days storage

Table (8): Effect of postharvest treatments on T.S.S. (%) of Hollivood Plum fruits, stored at (0 °C) during2003 and 2004 seasons.

Season 2003					
Treatments(B) Period in weeks(A)	Control	Paraffin	Acetic acid	Polishing	Mean
0	13.30	13.30	13.30	13.30	13.30
1	13.40	13.35	13.37	13.38	13.37
2	13.50	13.39	13.52	13.43	13.46
3	13.59	13.46	13.59	13.52	13.54
4	13.63	13.52	13.62	13.61	13.60
Mean	13.48	13.40	13.48	13.45	13.45
Season 2004					
0	13.47	13.47	13.47	13.47	13.47
1	13.51	13.50	13.71	13.50	13.56
2	13.58	13.55	13.61	13.57	13.58
3	13.64	13.61	13.68	13.61	13.64
4	13.72	13.68	13.71	13.70	13.70
Mean	13.58	13.56	13.64	13.57	13.59
L.S.D at 5 %	A		B		A*B
2003	N.S		N.S		N.S
2004	N.S		N.S		N.S

Total acidity:-

As shown in Table (9) data indicated that total acidity in fruit juice content of Hollivood plum fruits decreased gradually and significantly with prolonging storage period in both seasons.

Also it is clear from the same table that, all postharvest studied treatments significantly reduced total acidity during cold storage which means

shelf life longer than control fruits. Kaundal *et al.* (2000) on plum fruits, they found that acidity was lowest (1.02-1.10%) with wax emulsion (3, 6 and 9%) at 30 days of storage

Table (9): Effect of postharvest treatments on fruit Acidity of Holliwod Plum stored at (0 °C) during 2003 and 2004 seasons.

Season 2003					
Treatments(B)	Control	Paraffin	Acetic acid	Polishing	Mean
Period in weeks(A)					
0	1.61	1.61	1.61	1.61	1.61
1	1.30	1.53	1.58	1.59	1.50
2	1.25	1.38	1.49	1.44	1.39
3	1.07	1.23	1.43	1.36	1.28
4	1.02	1.07	1.07	1.07	1.05
Mean	1.25	1.36	1.44	1.41	1.37
Season 2004					
0	1.64	1.64	1.64	1.64	1.64
1	1.31	1.54	1.57	1.63	1.51
2	1.27	1.37	1.54	1.44	1.41
3	1.16	1.21	1.41	1.32	1.27
4	1.05	1.19	1.16	1.16	1.14
Mean	1.29	1.39	1.46	1.44	1.39
L.S.D at 5 %	A		B		A*B
2003	0.045		0.040		0.091
2004	0.046		0.041		0.092

Shelf -life:

Fruit behaviour during the simulating marketing period for 7 days after removal from cold storage gradually at ambient temperature 23°C and RH 50-60 % is shown in Table (10). Fruit decay and weight loss % were the highest values in untreated fruits followed by fruits treated with polishing in the first season and treated with acetic acid in the second season.

In addition, the data presented that fruits treated with paraffin oil gave the highest values in L* value (lightness) than all treatments in both seasons concerning shelf life period.

These results demonstrate a beneficial effect of all treatments, in slowing the changes in fruit texture at (3&5 and 7mm) compared with untreated fruits. Data also indicated that untreated fruits showed the highest values of T.S.S and the lowest of total acidity as compared to other treatments in both seasons

Shelf life of fruits showed are in agreement with those reported by El-Oraby. S. 1991 on quava fruits which found that fruits treated with paraffin oil showed long shelf -life. Shelf life of fruits results are in agreement with those reported by Bhakat *et al.*(1997) on hog plum, they found that fruits treated with wax emulsion stored well up to 12 days with minimum spoilage (33.3%) and physiological loss, while 100% spoilage had occurred for untreated fruits by 12 day of storage the T.S.S % increased , but total acidity reduced during storage under the study.

Table (10): Effect of some physical treatments on Hollywood Plum cv. stored in foam plates 7 days after removal from cold storage at 0 ° C to ambient temperature.

1 st season 2003									
Properties	Decay	Weight	Texture (mm)			Hunter		T.S.S	Acidity
Treatments		Loss	3	5	7	L	Hue angle(h)		
Control	8.74	5.49	11.67	12.63	17.33	28.36	25.90	14.2	1.01
Parafination	2.01	3.657	29.90	36.98	40.19	31.28	18.60	13.6	1.20
Acetic acid	3.8	3.64	24.31	28.14	33.94	26.94	17.73	13.8	1.10
Polishing	3.9	4.167	22.98	27.21	31.33	25.94	17.19	13.9	1.05
L.S.D at5%	1.16	1.33	4.18	3.25	6.55	N.S	N.S	0.25	0.046
2 nd season 2004									
Properties	Decay	Weight	Texture (mm)			Hunter		T.S.S	Acidity
Treatments		Loss	3	5	7	L	Hue angle(h)		
Control	7.60	6.15	18.67	20.33	23.33	28.18	22.29	14.0	0.96
Parafination	1.9	3.79	39.33	40.67	46	31.64	19.18	13.8	1.06
Acetic acid	4.01	4.99	28.67	29.33	36.67	29.49	18.15	13.9	1.0
Polishing	4.4	5.02	27.33	32.33	41.67	28.72	17.99	13.6	1.01
L.S.D at5%	1.07	1.13	4.56	5.12	7.09	N.S	N.S	0.19	0.032

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تأثير بعض المعاملات الطبيعية على جودة ثمار البرقوق (هوليود) أثناء التخزين المبرد
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أجريت هذه الدراسة خلال موسمي ٢٠٠٣ و٢٠٠٤ بمعهد بحوث البساتين قسم بحوث تداول الفاكهة على ثمار البرقوق صنف هوليود. ثم قطفتم الثمار عند مرحلة اكتمال النمو من مزرعة خاصة بمحافظة القليوبية. تم تعبئة الثمار في عبوات كرتون سعة ٣/كجم ونقلت مباشرة إلى معمل بحوث تداول الفاكهة. حيث تم فرز الثمار وقسمت عشوائياً إلى المعاملات الآتية : المقارنة (بدون معاملة) ثم معاملة الثمار بزيت البرافين (طبقة رقيقة على سطح الثمار) بتركيز ٢ % - غمس الثمار في محلول حمض ألكليك بتركيز ١٠ % لمدة ٣ دقائق و تلميع الثمار بقطعة من القماش المخملي . ثم عبئت الثمار في أطباق من الفوم سعة ١كجم للطبق الواحد . غلف الطبق بمادة البولي ايثيلين بسك ١٠مكرون ثم خزنت الثمار على درجة حرارة الصفر المئوي ورطوبة نسبية من ٩٠-٩٥% لمدة ٣٠ يوماً في كلا الموسمين ثم تم تقدير بعض الصفات الطبيعية والكيميائية طوال فترة التخزين وفي نهاية فترة التخزين تم تخزين الثمار على درجة حرارة الغرفة لدراسة القدرة التسويقية. لقد أظهرت النتائج أن جميع المعاملات قللت معنوياً نسبة الفقد في الوزن والتالف وصلابة الثمار والتغير في اللون والبريق والمواد الصلبة الذائبة الكلية وكذلك الحموضة الكلية أثناء التخزين المبرد مقارنة بالثمار الغير معاملة . كما أظهرت النتائج إن معاملة الثمار بزيت البرافين والتخزين على درجة الصفر المئوي كانت المعاملة الأفضل حيث أدت إلى المحافظة على جودة وحيوية الثمار مع زيادة العمر التخزيني للثمار وكذلك تحسين القدرة التسويقية للثمار .