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Effect of Some Post-Harvest Treatments on Storability and Quality of Manfaluty Pomegranate Fruits at Ambient Temperature

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Abstract

This investigation was conducted during two seasons of 2012 and 2013 to study the effect of some post- harvest treatments on storability and quality of Manfalouty pomegranate fruits during storage at ambient temperature. The storage treatments are *Nigalla sativa* coating oil or wrapping singly or in combination. Sample of each treatments were randomly taken weekly.

The obtained data illustrated that undesirable fruits percentage and fruit weight loss %, increased by extending room temperature storage period till 7 weeks. The most clear reduction was associated with untreated fruits where the less values were related with fruit oil coating or fungicidal tissue paper wrappeing singly or in combination. While, juice volume per 100 gm arils gradually decreased by extending room temperature storage period.

Generally, all treatments of oil coating or any of wrapping materials singly or in combination of oil +fungicidal treated tissue paper wrapping, *Nigella sativa* essential oil, *Nigella sativa* essential oil coating + perforated polyethylene wrapping, fungicidal treated tissue paper wrapping and perforated significantly reduced the undesirable fruit and fruit weight loss percentage and significantly increased the juice volume contents compared the untreated fruits during room temperature storage for seven weeks.

Its clear to notice that prolonging room temperature storage for 7 weeks caused an increase of total soluble solids % and TSS/acid ratio. While Titratable acidity and vitamin C contents in stored fruits were reduced. Moreover, all treatments significantly decreased the TSS, acidity and increased the TSS/acid ratio and vitamin C content compared to untreated ones.

So, it could be concluded that it is important to use *Nigella sativa* essential oil coating and polyolephinic heat-shrinkable film wrapping to extend the storage life of pomegranate fruits and kept the original quality of the freshly harvested of Manfaluty pomegranate fruits.

Keywords: *Punica granatum, fruit storage*, *Pomegranate Fruits*

Introduction

Pomegranate, *Punica granatum* belongs to the family Punicaceae and is one of the oldest known edible fruits (Singh, 1997 and Arabi *et al*. 2008). It is an important fruit crop of many tropical and subtropical regions of the world, grown especially in the moderate climates of Mediterranean countries. The pomegranate area of Assiut Governorate was estimated to be about 26% of the total acreage in Egypt (34450) feddan according to the annual of the Ministry of Agriculture in 2013.

The pomegranate has reversal nutritive, industrial, medicinal values, and some pharmacological properties (Schubert *et al*., 1999; Jeune Louise *et al*., 2005).

Pomegranate fruits is one of the crops demand for exporting. As production has increased ,proper storage and marketing of these fruit is needed to meet the demand in domestic and export markets (El-Oraby *et al*. 2009).The main problems associated with export prolonged storage life of Pomegranate fruit are weight loss, shrinkage ,decay development, chilling injury, appearance of skin blemishes, especially scald and maintains fruit quality during transport and storage. During the last few years, the activity in research on Pomegranate postharvest storage has been used the physical treatment to extend the storage life of Pomegranate, keeping the original quality of the freshly harvested fruits (Porat *et al*. 2007; El-Oraby *et al*. 2009). Edible coatings applied on fruits and vegetables to improve appearance, delay ripening reduce water loss and decay and extend shelf life. Coatings formed suitable atmosphere around fruit's surface for decreasing respiration rate of fruit and can improve the environmental conditions, i.e. temperature and humidity (Baldwin *et al*., 1999; Saucedo-Pompa *et al*., 2007). Many bioactive properties have been attributed to *Nigella sativa* L. seeds, fixed and/or essential oil, including antibacterial (Hanafy and Hatem, 1991; Farrag *et al*. 2000) antifungal (Akgul, 1989; Khan *et al*., 2003) and antioxidant activities (Burits and Bucar, 2000). Several effects have been attributed to active principles of *Nigella sativa* L. which includes thymoquinone, thymohydroquinone, dithymoquinone, thymol, carvacrol, nigellicine, nigellimine-x-oxide, nigellidine and alpha-hedrin; (Swamy and Tan, 2000; Ali and Blunden, 2003; Mashhadian and Rakhshandeh 2005) also *Nigella sativa* L. fixed or a essential oil used as food preservative in different parts of the world (Abdul Hannan *et al*. 2008).

This study aimed to recognize the benefit of using different coating and packaging materials on the storability and quality of Manfaloti Pomegranates stored at room temperature

Materials and Methods

This study was conducted during the two seasons of 2012 and 2013 on Manfaluty Pomegranate fruits obtained from Orchard of the Faculty of Agriculture, Assiut University. Fruits harvested on the first week of October at uniform stage of maturity sample of 576 fruits free of damage, diseases and insects are selected randomly. Fruits were used immediately after harvested, surface washed with tap water and then air dried. Fruits randomly divided into eight equal groups (treatments). Each treatment was divided into three replicates 24 uniform fruits were chosen at random for each replicate. The treatments were carried out as following:

1- Control (Untreated fruits, T_1).

2- Fungicidal treated tissue paper wrapping (T_2).

3- Polyolephinic heat-shrinkable film wrapping (T_3).

4- 0.25%perforated high density polyethylene 0.09 mm wrapping (T_4).

5- *Nigella sativa* essential oil coating (T_5).

6- *Nigella sativa* essential oil coating + fungicidal treated tissue paper wrapping (T_6).

7- *Nigella sativa* essential oil coating + polyoliphinic heat-shrinkable film wrapping (T_7).

8- *Nigella sativa* essential oil coating +0.25% perforated high density polyethylene 0.09 mm wrapping (T_8).

All fruits weighted then stored at ambient temperature (20-25 C and 50-60 RH). Fruits of each treatment were evaluated at week interval throughout storage period, until the decay percentage reached 50% to study the effect of different experimental treatment on physical and chemical properties.

Physical characteristics:

1- Fruit decay %, the number of decayed fruits was calculated as percentage from total number of each sample.

2- Weight loss as a percentage from initial weight was calculated.

3- Juice content was expressed as juice volume produced from 100 g arils.

Chemical juice characteristics:

1- Total soluble solids (TSS) % was determined by using a hand refractometer.

2- Titratable acidity in fruit juice was calculated as gram citric acid agains 0.1 NaoH according to A.O.A.C. (1999).

3- Total soluble solids (TSS)/acid ratio was calculated by dividing TSS on total acidity.

4- L-ascorbic acid (V.C) was determined by titration against 2,6 dichlorophenol indophenol blue dye, according to the A.O.A.C. (1999).

This experiment was two factors and designed as completely randomize with three replicates. Data were tabulated and statistically analyzed and the difference between treatment means were compared using L.S.D. values at 5% level, (Snedecor and Cochran, 1990).

Results

1- The percentages of fruit decay and fruit weight loss:

Data presented in Tables (1 & 2) showed the effect of coating and wrapping materials on the percentages of decay and weight loss of Manfalouty pomegranate fruits during ambient condition storage in 2012 and 2013 seasons. It was obvious that the results took similar trend during the two studied seasons.

Data presented in Tables 1 and 2 illustrated that the percentage of fruit decay and fruit weight loss were significantly increased by extending the storage period. These traits were slightly increased and gradually from the beginning of storage till the 7th week. However, there was no decay has been detected till the 5th week of storage in wrapping or oil coating singly or combinations during both seasons of study.

The results also revealed that oil coating or wrapping singly or in combination significantly decreased the undesirable fruit percentage and fruit weight loss percentage during ambient storage for seven weeks compared to the control (T_1). Using either *Nigella sativa* essential oil coating (T_5), *Nigella sativa* essential oil coating plus fungicidal tissue paper wrapping (T_6), *Nigella sativa* essential oil coating plus polyoliphinic heat shrinkable film wrapping (T_7) or *Nigella sativa* essential oil coating plus 0.25% perforated high density polyethylene 0.09 mm wrapping (T_8) had the best results, however T6, T5

and T8 gave the least percentage of decayed fruits (5.0 & 4.41%), (5.39 & 6.53%) and (8.38& 8.28%), as well as T_7, T_5 and T_8 gave the least percentage of fruit weight loss (7.81 & 8.69%), (8.77 & 9.74%) and (10.39 & 11.30%), against the control (29.84 & 28.37%) and (18.23 & 20.28%) for the two studied traits during the two studied seasons, respectively. The decrement percentage of decayed fruits due to T_6, T_5 or T_8 compared to the control (T_1) attained 83.24 & 84.45%, 81.19 & 76.98% and 71.92 & 70.81% as well as fruit weight loss due to T_7, T_5 or T_8 compared to (T_1) attained 57.16 & 57.15%, 51.89 & 51.97% and 43.00 & 44.28% during the two studied seasons, respectively.

In addition, interaction of treatments and storage period effects data in Tables (1 & 2) indicated that all combinations induced a significant reduce in decayed fruits and fruit weight loss percentages compared to control. Moreover, using oil coating plus fungicidal tissue paper wrapping (T_6) recorded the least decayed fruits (39.93 & 35.29) against the highest value (83.33 & 78.00) on untreated fruit (T_1) after seven weeks of ambient condition storage. Also, using oil coating plus heat shrinkable film wrapping (T_7) gave the least fruit weight loss (18.75 & 19.85%) compared to the highest one (32.15 & 33.40%) due to control after seven weeks of storage.

These finding declared the importance of using Nigella sativa essential oil coating singly or combination with fungicidal tissue paper or heat shrinkable film wrapping to extend the room temperature storage duration of Manfalouty pomegranate fruits.

Table 1. Effect of coating and wrapping material on decay % of Manfalouty pomegranate fruits during ambient condition storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	0	9.72	13.86	21.44	29.55	38.78	42.06	83.33	29.84
T_2	0	0	0	0	0	20.00	29.17	44.19	11.67
T_3	0	0	0	14.29	18.52	29.68	35.35	69.84	20.96
T_4	0	0	0	10.72	11.11	25.98	29.7	46.29	15.48
T_5	0	0	0	0	0	0	0	43.14	5.39
T_6	0	0	0	0	0	0	0	39.93	5.00
T_7	0	0	0	0	15	27.45	31.62	57.87	16.49
T_8	0	0	0	0	0	0	25.93	41.18	8.38
Mean (P)	0	1.22	1.73	5.81	9.27	17.74	24.23	53.22	
LSD 5%	**T**: 0.92 **P**: 1.06 **TP**: 2.99								
2013 season									
T_1	0	8.31	13.64	21.05	26.76	36.36	42.82	78.00	28.37
T_2	0	0	0	0	0	20.00	25.00	45.45	11.31
T_3	0	0	0	14.24	16.67	26.67	36.36	67.43	20.17
T_4	0	0	0	9.52	16. 52	25.53	30.76	44.44	15.85
T_5	0	0	0	0	0	0	11.11	41.18	6.53
T_6	0	0	0	0	0	0	0	35.29	4.41
T_7	0	0	0	0	10	22.22	28.57	60.00	15.1
T_8	0	0	0	0	0	0	27.78	38.46	8.28
Mean (P)	0	1.04	1.71	5.69	8.74	16.35	25.3	51.28	
LSD 5%	**T**: 1.31 **P**: 0.86 **TP**: 2.43								

1- Control (untreated fruits, T_1).
2- Fungicidal treated tissue paper wrapping (T_2).
3- Polyolephinic heat-shrinkable film wrapping (T_3).
4- 0.25%perforated high density polyethylene 0.09 mm wrapping (T_4).
5- *Nigella sativa* essential oil coating (T_5).
6- *Nigella sativa* essential oil coating + fungicidal treated tissue paper wrapping (T_6).
7- *Nigella sativa* essential oil coating + polyoliphinic heat-shrinkable film wrapping (T_7).
8- *Nigella sativa* essential oil coating +0.25% perforated high density polyethylene 0.09 mm wrapping (T_8).

Table 2. Effect of coating and wrapping materials on weight loss % of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	0	8.7	12.3	14.6	22.65	25.2	28.7	33.7	18.23
T_2	0	8.5	11.7	14.5	20.6	23.74	28.1	31.38	17.32
T_3	0	5.11	6.77	13.3	16.8	20.1	25.3	28.3	14.46
T_4	0	7.5	11.3	13.6	18.5	20.6	27.9	31.0	16.30
T_5	0	2.12	2.8	6.1	8.1	11.22	15.5	24.3	8.77
T_6	0	3.8	4.52	11.11	15.78	22.2	26.06	30.57	14.26
T_7	0	1.5	2.7	3.3	8.0	10.4	14.4	22.2	7.81
T_8	0	3.2	4.3	7.1	12.4	13.7	15.3	27.1	10.39
Mean (P)	0	5.05	7.05	10.45	15.35	18.4	22.66	28.57	
LSD 5%	**T:** 0.29 **P:** 0. 41 **TP:** 0.40								
2013 season									
T_1	0	9.6	13.6	16.3	25.2	28.1	31.9	37.5	20.28
T_2	0	9.4	13.0	16.2	22.9	26.4	31.2	34.8	19.24
T_3	0	5.7	7.5	12.3	17.5	22.4	28.0	32.32	15.72
T_4	0	8.3	12.6	15.1	18.6	22.9	31.0	32.9	17.68
T_5	0	2.4	3.1	6.7	9.0	12.5	17.2	27.0	9.74
T_6	0	4.2	5.0	14.8	20.6	21.7	26.9	30.5	15.39
T_7	0	1.6	2.9	3.7	8.9	11.6	16.1	24.7	8.69
T_8	0	3.6	4.7	7.9	13.8	15.3	16.9	28.2	11.3
Mean (P)	0	5.6	7.8	11.62	17.06	20.11	24.9	30.99	
LSD 5%	**T**: 0.34 **P**: 0.21 **TP**: 0.59								

2- Fruit quality:

The data concerning the effect of various ambient storage treatments on arils juice content and some chemical constituents of Manfalouty pomegranate juice during 2012 and 2013 seasons are presented in Tables 3, 4, 5, 6 and 7.

As general view, data indicated that fruit quality, in terms of total soluble solids and TSS/acid ratio, significantly increased during storage duration up to seven weeks. Contrarly, arils juice content, titratable acidity and ascorbic acid (V. C) significantly decreased by extending storage duration.

It is clear from the previous data that all treatments significantly increased juice volume compared to control during the two studied seasons. Storage under room temperature condition treated with either T_5 or T_7 gave the best effect of preserving the reduction of juice volume. Using T_5 or T_7 gave the highest arils juice volume (68.19 & 66.10 ml) and (69.64 & 66.71 ml) compared with control which gave the lowest values (64.86 & 62.81 ml) during the two studied seasons, respectively. Other treatments recorded intermediate values and there were insignificant differences between most of them. Contrarly, it could be noticed that wrapping

or oil coating used singly or in combination significantly decreased the juice TSS% and titratable acidity percentages compared to untreated ones. The highest values of TSS and acidity % were found in untreated fruit juice (16.73 & 16.51%) and (0.94 & 0.88%) compared to the lowest values (15.91 & 16.00) and (0.78 & 0.76%) fruit that oil coating plus heat shrinkable film wrapping (T_7) in both seasons, respectively. Moreover, data showed that all treated fruits gave a significant TSS/acid ratio compared to untreated fruit. The highest values were recorded by T_7 (21.05 & 21.31) compared to the lowest values (18.39 & 18.98) of untreated fruits during the two studied seasons, respectively.

Moreover, data in Table (7) declared that all treatment failed to show any significant effects on vitamin (C) contents. Using either oil coating (T_5) or oil coating plus heat shrinkable film wrapping (T_7) gave the best effects on chemical juice quality compared to other treatments. These treatments unsignificantly increased the V.C. content (24.95 & 22.87 mg/100ml) and (27.89 & 23.56 mg/100 ml) compared to untreated one (23.97 & 22.64 mg/100 ml juice) during the two studied seasons, respectively.

The interaction effects between treatments and storage period (Tables 3, 4, 5, 6 & 7) indicated that all combination induced significant effects in fruit quality compared to control (untreated one). Using either oil coating (T_5) or oil coating plus heat shrinkable film wrapping (T_7) gave the highest value of juice volume (61.40 & 60.60 ml) and (62.30 & 61.60 ml) , TSS(16.80 & 17.20) and(16.50 & 17.00) and TSS/acid ratio (25.29 & 24.57) and (25.78 & 26.56) acidity (0.68 & 0.70%) and (0.64 & 0.64%) and V.C. (24.84 & 23.41 mg/100 ml) and (24.89 & 23.53 mg/100 ml) compared to untreated fruit which gave the lowest juice volume (56.9 & 55.2 ml), TSS/acid ratio (22.77 & 23.00) and V.C. (23.97 & 22.66 mg/100ml) and the highest one of TSS (18.9 & 18.4%) and acidity percentage (0.83 & 0.80%) after seven weeks of storage in both studied seasons, respectively. the other combination gave a significant intermediate values of these studied traits.

Therefore, it could be concluded that it is important to use *Nigella sativa* essential oil coating and polyoliphinic heat shrinkable film wrapping to prolong the storage period and maintain the quality of pomegranate fruits under room temperature.

Table 3. Effect of coating and wrapping materials on juice volume/100 g of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	72.2	71.5	66.7	65.3	63.8	62.2	60.3	56.9	64.86
T_2	72.1	71.1	69.0	64.7	64.5	62	61.3	58.8	65.52
T_3	71.9	71.1	70.7	69.6	66.4	65.3	62	59.3	67.09
T_4	72.2	70.9	70	69.1	67.8	66.7	61.1	58.7	67.06
T_5	72.3	71.5	70	69.1	68.2	68.2	63.8	61.4	68.19
T_6	72.2	71.9	71	69.6	66.2	65.3	63.6	60	67.48
T_7	72.3	72.2	71.9	71.6	70.9	68.9	65.1	62.3	69.64
T_8	72	71.6	69.6	69	68.1	67.1	64.9	59.6	67.74
Mean (P)	72.15	71.16	70.07	68.5	66.99	65.73	62.76	69.69	
LSD 5%	**T:** 0.59	**P:** 0.52	**TP:** 1.49						
2013 season									
T_1	70.1	69.4	64.7	63.4	61.9	60.4	58.4	55.2	62.81
T_2	69.9	68.6	66.2	63.7	62.5	60.1	59.5	57.0	63.19
T_3	70.1	69.6	68.8	67	65.9	64.7	59.3	56.2	65.08
T_4	69.8	68.9	68.5	67.5	64.5	63.4	60.1	57.7	65.05
T_5	70.5	69.6	67.9	67	66.2	65.6	61.9	60.6	66.10
T_6	69.8	69.4	67.5	67.1	66	62.1	61.4	57.8	65.14
T_7	70.1	70.0	69.8	69.4	68.8	66.8	63.2	61.6	66.71
T_8	70.1	70.0	69.8	67.5	64.2	63.4	61.6	58.1	65.59
Mean (P)	70.0	69.33	67.93	66.58	65.00	63.31	60.68	57.03	
LSD 5%	**T:** 0.81	**P:** 0.74	**TP:** 2.22						

Table 4. Effect of coating and wrapping materials on TSS% of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	15.3	15.5	16.2	16.0	16.7	17.4	17.8	18.9	16.73
T_2	15.2	15.2	15.8	16.0	16.2	16.2	17.3	18.5	16.3
T_3	15.4	15.3	16.0	15.9	16.0	16.1	16.7	16.9	16.04
T_4	15.2	15.3	16.2	15.8	16.6	16.6	16.8	17.2	16.17
T_5	15.1	15.2	15.6	16.2	16.0	16.2	16.4	16.8	15.98
T_6	15.2	15.3	15.7	16.0	16.2	16.3	16.0	17.5	16.03
T_7	15.2	15.0	15.3	16.2	16.3	16.4	16.4	16.5	15.91
T_8	15.3	15.2	15.0	16.5	16.5	16.6	16.5	17.0	16.04
Mean (P)	15.24	15.25	15.73	16.06	16.31	16.48	16.74	17.39	
LSD 5%	**T:** 0.41	**P:** 0.34	**TP:** 0.94						
2013 season									
T_1	15.3	15.4	15.8	16.2	16.4	17.1	17.5	18.4	16.51
T_2	15.2	15.3	15.7	15.9	16.0	16.6	17.4	17.6	16.16
T_3	15.3	15.3	15.6	16.1	16.2	16.3	16.8	17.5	16.14
T_4	15.3	15.3	15.9	15.8	16.3	16.6	17.0	17.3	16.19
T_5	15.2	15.3	15.5	16.0	16.2	16.4	16.7	17.2	16.08
T_6	15.2	15.2	15.4	15.7	16.2	16.3	16.5	17.7	16.03
T_7	15.3	15.3	15.5	15.8	16.0	16.3	16.2	17.0	16.00
T_8	15.3	15.3	15.2	16.0	16.3	16.5	16.7	17.3	16.07
Mean (P)	15.26	15.3	15.58	15.94	16.2	16.51	16.88	17.6	
LSD 5%	**T:** 0.31	**P:** 0.22	**TP:** 0.62						

Table 5. Effect of coating and wrapping materials on Acidity of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	1.18	1.10	0.96	0.89	0.86	0.86	0.83	0.83	0.84
T_2	1.16	1.02	0.90	0.80	0.80	0.78	0.74	0.70	0.86
T_3	1.18	1.10	0.93	0.86	0.88	0.80	0.76	0.76	0.90
T_4	1.15	0.96	0.96	0.80	0.85	0.80	0.80	0.78	0.89
T_5	1.20	0.86	0.80	0.78	0.75	0.70	0.70	0.68	0.81
T_6	1.18	1.05	0.93	0.85	0.86	0.80	0.80	0.78	0.90
T_7	1.15	0.83	0.80	0.76	0.70	0.70	0.68	0.64	0.78
T_8	1.20	0.90	0.82	0.80	0.80	0.74	0.70	0.70	0.83
Mean (P)	1.17	0.98	0.89	0.82	0.80	0.77	0.75	0.73	
LSD 5%	**T:** 0.08	**P:** 0.06	**TP:** 0.017						
2013 season									
T_1	0.96	0.96	0.93	0.96	0.86	0.83	0.80	0.80	0.88
T_2	0.96	0.90	0.86	0.83	0.80	0.80	0.76	0.75	0.83
T_3	0.98	0.90	0.89	0.85	0.82	0.80	0.80	0.75	0.85
T_4	0.96	0.90	0.90	0.83	0.83	0.80	0.76	0.76	0.84
T_5	0.93	0.90	0.82	0.82	0.76	0.76	0.70	0.70	0.79
T_6	0.95	0.93	0.90	0.86	0.83	0.80	0.80	0.76	0.85
T_7	0.93	0.85	0.79	0.76	0.73	0.70	0.68	0.64	0.76
T_8	0.93	0.90	0.83	0.80	0.76	0.76	0.73	0.73	0.80
Mean (P)	0.95	0.91	0.86	0.83	0.80	0.78	0.75	0.74	
LSD 5%	**T:** 0.06	**P:** 0.05	**TP:** 0.14						

Table 6. Effect of coating and wrapping materials on TSS/acid ratio of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	12.97	14.09	18.20	17.98	19.42	20.23	21.45	22.77	18.39
T_2	13.10	14.90	19.75	20.00	20.25	20.77	23.38	26.43	19.82
T_3	13.05	13.91	17.20	18.49	19.28	20.13	23.16	22.24	18.43
T_4	13.22	15.94	16.88	17.56	19.53	20.75	21.00	22.05	18.37
T_5	12.80	17.67	19.50	20.77	21.33	23.14	23.43	25.29	20.49
T_6	12.88	14.57	16.88	18.82	20.25	20.38	20.00	22.44	18.28
T_7	13.22	18.07	19.13	21.32	23.29	23.43	24.12	25.78	21.05
T_8	12.75	16.89	18.29	20.63	20.63	22.43	23.57	23.71	19.86
Mean (P)	13.00	15.65	18.23	19.45	20.50	21.41	22.51	23.84	
LSD 5%	**T:** 0.88	**P:** 0.58	**TP:** 1.58						
2013 season									
T_1	15.93	16.15	17.42	16.88	19.29	20.60	21.88	23.00	18.89
T_2	15.83	16.89	18.59	19.16	20.00	20.75	22.89	23.47	19.70
T_3	15.71	17.00	17.98	18.94	19.76	20.38	21.00	23.33	19.26
T_4	15.83	17.00	18.00	19.04	19.64	20.75	22.37	22.76	19.42
T_5	16.24	16.89	19.02	19.51	21.32	21.58	23.86	24.57	20.37
T_6	16.00	16.45	17.44	18.26	19.52	20.88	20.63	23.29	19.00
T_7	16.34	17.65	19.37	20.79	21.92	23.29	24.55	26.56	21.31
T_8	16.45	16.89	18.07	20.00	21.45	21.71	22.88	23.70	20.14
Mean (P)	16.04	16.87	18.24	19.07	20.36	21.18	22.51	23.84	
LSD 5%	**T:** 0.91	**P:** 0.64	**TP:** 1.68						

Table 7. Effect of coating and wrapping materials on V.C. of Manfalouty pomegranate fruits during ambient conditions storage in 2012 and 2013 seasons.

Treatments	Zero date	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	Mean (T)
2012 season									
T_1	25.47	25.34	24.60	24.20	23.80	23.15	22.80	22.37	23.97
T_2	25.37	25.60	25.07	24.83	24.49	24.09	23.60	23.18	24.53
T_3	26.13	25.69	25.32	24.76	24.60	24.24	23.63	23.33	24.71
T_4	25.73	25.47	25.14	24.27	23.80	23.62	23.47	22.82	24.29
T_5	26.39	25.57	25.47	24.43	24.94	24.50	23.85	23.60	24.84
T_6	26.09	25.94	25.47	24.90	24.47	23.53	23.15	22.91	24.56
T_7	25.87	26.05	25.51	25.24	24.54	24.40	23.85	23.65	24.89
T_8	26.11	25.50	24.87	24.50	24.00	23.88	23.50	23.00	24.42
Mean (P)	25.86	25.65	25.18	24.64	24.33	23.93	23.48	23.11	
LSD 5%	**T:** N.S. **P:** 1.20 **TP:** 3.38								
2013 season									
T_1	24.80	24.40	23.94	23.15	21.75	21.45	21.00	20.81	22.66
T_2	24.57	24.20	23.98	23.44	22.41	21.86	21.49	21.01	22.87
T_3	24.84	24.77	24.44	23.75	22.43	22.29	21.83	21.18	23.19
T_4	24.94	24.84	24.20	23.95	22.64	21.57	21.17	21.00	23.04
T_5	25.10	24.65	24.34	24.23	22.77	22.52	21.98	21.67	23.41
T_6	24.64	24.43	23.87	23.49	22.33	21.98	21.35	21.33	22.93
T_7	24.93	24.72	24.41	23.91	23.43	22.60	22.33	21.92	23.53
T_8	25.00	25.00	24.11	23.80	22.51	22.00	21.50	21.12	23.13
Mean (P)	24.85	24.63	24.16	23.84	22.53	22.06	21.58	21.23	
LSD 5%	**T:** N.S. **P:** 0.95 **TP:** 2.68								

Discussion

Handling and storage are the important and a vital interest to fruit production and its quality. It is necessary to discover a cheap and effective storage method to increase its shelf-life by decreasing the natural physiological deterioration and preventing the activity of decay organisms (Baldwin *et al*., 1999).

Fresh weight loss and decayed fruit percentage were increased by extending storage duration. Increased weight loss with increasing storage is common in fruits. Fruit weight loss could be due to the loss in moisture content. These results are in accordance with those obtained by El-Kassas *et al*. (1995), Waskar *et al*. (1999), Artes *et al*. (2000), Sarkale *et al*. (2003), Arabi *et al*. (2008) and El-Oraby *et al*. (2009). The positive effects of oils on decreasing fruit loss might be attributed to make a thin film of oil surrounding the fruit peel and induced a modification of micro-climatic of fruits. Oil coating and wrapping methods act or permeable barrier against oxygen, carbon dioxide and moisture, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al*., 1999 and Park, 1999).

Most observed, decay of pomegranate fruits during storage are mostly cause of *Penicillium* sp. Coating and wrapping are partial retention of gas exchange through the fruit peel and inhibits the act of ethylene. Inhibition can give more prevention against post-harvest decay and the water loss from the peel induce a reduce the incidence of fruit decay during storage. Moreover, *Nigella sativa*

oil had many bioactive properties, including antibacterial (Farrag *et al*., 2000), antifungal (Khan *et al*., 2003), and antioxidant activities (Burits and Bucar, 2000 and Badawy *et al*. 2011).

The above mentioned findings are in accordance with those obtained by Nanda *et al*. (2001), El-Oraby and Esmat (2004) and Aquinae *et al*. (2010). They concluded that using oil coating and wrapping significantly decreased the weight loss and decayed fruit percentage compared to untreated fruits during the storage and hence they extended storage duration. Juice content, titratable acidity and ascorbic acid (V.C) were significantly declined with extended storage duration. The rate of decreases in these traits were low due to use oil coating and wrapping. This reduction may be due to the loss in moisture. Ascorbic acid content is an important constituent of different fruits and the retention of it has a major importance during post handling of pomegranate fruits. Ascorbic acid losses to be associated with storage injury symptom development. Coating or wrapping treatments reduce respiration rates and may, therefore delay the utilization of organic acid during storage. On the other hand, total soluble solids and TSS/acid were increased gradually as prolong the storage period were high in treated fruits. This increase could be due to solubilization of compounds other than carbohydrates or to loss water of fruits. In addition, it is known that during storage there is antagonistic relation between TSS and acidity while water loss and TSS increase but acidity decrease that due to the process of respiration in fruits, because fruits consume acidity for respiration thereby total soluble increase more than acidity, then TSS/acid ratio increase.

These results confirmed the previous findings of Koksal (1989), Waskar *et al*. (1999), Artes *et al*. (2000), Nanda *et al*. (2001), El-Oraby *et al*., 2009 and Aquinoa *et al*., 2010). They declared from their studies on pomegranate fruits that using oil coating and wrapping would keep the fruits and maintain their quality for longest period.

Conclusion

According to the previous results recommended it could be concluded that using *Nigella sativa* essential oil coating as well fungicidal tissue paper or polyolephinic heat shrinkable film wrapping singly or incombination would keep the Manfalouty pomegranate fruits and maintain their quality for longest storage period.

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تأثير بعض معاملات ما بعد الحصاد علي جودة وقابلية ثمار الرمان المنفلوطي للتخزين علي درجة حرارة الغرفة

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الملخص

أجريت هذه التجربة خلال موسمين متعاقبين ٢٠١٢ ، ٢٠١٣ وذلك لدراسة تأثير بعض معاملات ما بعد الحصاد علي جودة وقابلية ثمار الرمان المنفلوطي للتخزين علي درجة حرارة الغرفة ، وشملت هذه المعاملات تغطية الثمار بزيت حبة البركة منفرداً أو خليطاً مع معاملات لف الثمار ، حيث ثم أخذ عينات عشوائية من هذه المعاملات أسبوعيا. أوضحت النتائج أن إطالة فترة التخزين علي درجة حرارة الغرفة لمدة سبعة أسابيع أدت إلي زيادة في كل من النسبة المئوية للثمار التالفة والنسبة المئوية للفقد في وزن الثمار حيث كان معدل الزيادة أعلي للثمار الغير معاملة بينما سجلت معاملات تغطية الثمار بزيت حبة البركة أو معاملات لف الثمار بالورق المعامل بمضادات فطرية كمعاملات منفردة أو خليطة أقل قيم للزيادة ، بينما أدت إطالة فترة التخزين علي درجة حرارة الغرفة إلي نقص تدريجي في حجم العصير لكل ١٠٠ جرام من الحبات.

ويمكن القول أن جميع معاملات تغطية أو لف الثمار فردياً أو خليطاً أدت إلي خفض معنوي في كل من النسبة المئوية للثمار التالفة والنسبة المئوية للفقد في وزن الثمار بينما أدت لزيادة معنوية في مكونات العصير مقارنة بالثمار الغير معاملة وذلك خلال فترة التخزين علي درجة حرارة الغرفة لمدة سبعة أسابيع حيث أدت إطالة فترة التخزين إلي زيادة في نسبة المواد الطلبة الذائبة الكلية % T.S.S ونسبة المواد الصلبة الذائبة الكلية إلي الحموضة بينما إنخفض محتوي الثمار من الحموضة وفيتامين ج مقارنة بالثمار الغير معاملة .

مما سبق يمكن القول أنه يمكن تغطية ثمار الرمان بزيت حبة البركة مع لف الثمار بغلاف من مادة البولي أولفينيك القابل للإنكماش بالحرارة لإطالة فترة تخزين الثمار مع المحافظة علي خصائص الجودة بها .