

Effect of Some Post Harvest Treatments on Fruit Quality of Dates During Cold Storage

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THIS INVESTIGATION was carried out during two successive seasons (2012 and 2013) on Om El-Ferakh date fruits. Palm trees grown on loamy soil in a private orchard at Edko, Beheira Governorate, Egypt. In this work the effect of some postharvest treatments: paraffin, lemon grass oils and low density polyethylene bags (LDPE) on fruit quality attributes during cold storage has been investigated. Fruits were stored at 5°C, 90% relative humidity (RH). Assessments were carried out at seven days intervals. After 21 days, results indicated that all treatments especially paraffin oil or lemon grass oil decreased total tannins percentage comparing to control. In addition, treatments with paraffin oil and lemon grass oil recorded the highest value of fruit texture, color, total soluble solids and total sugars, while they decreased fruit weight loss, decay percentage, acidity and total phenols during storage period. These treatments had a good effect on keeping quality of date fruits during storage.

Keywords: Om El-Ferakh, Tannins, Polyethylene bag, Paraffin oil, Lemon grass oil.

Date palm (*Phoenix dactylifera* L.) is the major fruit tree in most Arabian countries and it is widely grown in the Middle East countries. Date fruit can be considered as a complete diet since they contain all the necessary ingredient required for human body, (Ibrahim and Haggag, 1993). There are three types of dates, the soft (khalal and Rutab) the semi-dry and dry. The most famous varieties of the soft type in Egypt are Zaghoul, Samany and Om El-Ferakh. Om El-Ferakh date cultivar is one of the Egyptian date varieties which used for local consumption. Arab production of date about reach about 70 % of global production, however, nearly 49% of the production is exported, while in Egypt the amounts of productivity is more than 1.1 million tons per year (Anonymous, 2013). About 10 thousand tons of the production s exported per year, accounting for less than 1% of total volume of the crop. Storage industry of dates is required in order to extend the market availability all year round and consequently increase the farmer's profitability. On the other hand, the postharvest fruit losses are considerable. It can be caused by improper fruit handling, marketing facilities and non suitable policies.

Some storage trials of fruits at relatively low temperatures (Al-Yahia, 1986), coating of fruits with polypropylene films (Thompson *et al.*, 2003) or storing them in polyethylene bags (Higazy *et al.*, 2003) were examined.

To minimize fruit losses and improve date palm profitability, it is recommended to harvest fruits at the suitable and proper stage of maturity, use ideal method of harvesting, grading, packaging and storage (El-Hadidy, 2004).

Lemongrass (*Cymbopogon citrates* L.) is a plant in the grass family that contain 1 to 2% essential oil on a dry basis with widely variation of the chemical composition as a function of genetic diversity, habitat and agronomic treatment of the culture the efficiency of lemongrass oil against postharvest pathogens with emphasis for the possible future use of the essential oil as alternative antimould compounds (Carlson *et al.*, 2001), (Wijesekara *et al.*, 1997)The optimal temperature to store the fruits of dates is from zero to 4 °C (Al-Redhaiman, 2005) and a relative humidity of 85 – 90 % to be saved for a month or more depending on the cultivar, lower temperature for greater marketing period, which led to growing need for tests to transactions postharvest using a safe natural alternatives to control the increase in storage capacity of the fruits to prolong the storage period.

Alternative methods are needed because of the wide spread use of chemicals has led to the proliferation of resistant strains of the pathogens (Palou *et al.*, 2002). Furthermore, the concern about public health and environmental issues has increased the need for alternatives (Palou *et al.*, 2002). Food and Drug Administration also proposed exempt from residue tolerances on all agricultural commodities by the United States Environmental Protection Agency (Tuset *et al.*, 1996 and Obagwu & Korsten, 2003), and is listed as approved ingredients on products labeled "organic" as proposed by the United States Department of Agriculture (De-Pasquale and Montville, 1990).

The main goal of this study is find out and test some safe and natural materials such as low density polyethylene bags (LDPE) and spraying fruits using (paraffin or lemon grass oils and packed in bags) in order to prolong the storage period of “Om El-Frakh” date fruits

Materials and Methods

This investigation was carried out during two successive seasons (2012 & 2013) on “Om El-Frakh” date fruits to evaluate the effect of paraffin and lemon grass oils and low density poly ethylene bags (LDPE) as postharvest treatments to maintain fruit quality under cold storage. In this study, dates fruits were harvested according to skin color in the maturity. Fruits were selected based on their uniformity and freedom of damages and defects. Fruits were divided into five groups and received the following treatments:

T1: Fruits were sprayed with water, air dried and then packed in local polyethylene bags (control).

- T2:** Fruits were packed in low density green colored polyethylene bags, (AG fresh Company).
T3: Fruits were packed in low density white color polyethylene bags (LDPE) (life span Company).
T4: Fruits were sprayed with (paraffin oil at concentration of 7.5%) and then packed in local polyethylene bags.
T5: Fruits were sprayed with (lemon grass oil at concentration of 0.5%) and then packed in local polyethylene bags.

Treated fruits were held in carton boxes. Every treatment consisted of six boxes, each box contains 5 bags with total 30 bags, each bag contains 5 fruits.

All treatments were rearranged in a complete randomized design and stored at 5°C, 90% RH for 21, days. Three replicates of each treatment were taken and fruits were examined for quality parameters at day 0, 7, 14, and at 21days.

Physical and chemical properties of fruits during storage were estimated as follows:

Fruit physical properties

Weight loss percentage was calculated as the difference between fruit weight at the start of storage and fruit weight at the inspection dates using the following equation:

$$\text{Loss in fruit weight \%} = \frac{\text{Initial weight} - \text{Weight at time of sampling}}{\text{The initial weight of fruit}} \times 100$$

Decay Percentage: The discarded fruits included all the injured or spoiled fruits resulting from fungus or bacteria, shriveling and other various defects, were calculated and expressed as decay percentage.

Pulp texture (g/cm²) was recorded by Lira texture analyzer instrument using a penetrating cylinder of 1 mm of diameter, to a constant distance (3 and 5 mm) inside the fruits pulp and by a constant speed 2 mm per sec., and the peak of resistance was recorded per g.

Fruit color (Hue angle): (l* value, c* value,) (L c / h value) surface color of fruit was measured using a colorimeter ((Model CR-400, Minolta, Japan) which provided CIE L*, a* and b* value. Negative a* values indicate green and higher positive a* values red color. Higher positive b* value indicate a more yellow skin color and negative b* values color. The values were then used to calculate hue degree (h0 =arctangent b/ a*) where 0° =red-purple, 90° = yellow, 180° = bluish- green and 270° =blue. (Mc Guire 1992).

Carbon dioxide (CO₂) and oxygen (O₂) concentration: Bags headspace gas concentrations (CO₂ and O₂) were measured using CO₂\ O₂ analyzer (Model 902D O₂/ CO₂ Headspace Analyzer). O₂ and CO₂ values were expressed as percentage.(Lurice, and Pesis, 1992).

Chemical properties

Total soluble solids percentage (TSS %): of the edible pulp was estimated by abbey digital refractometer. Three different readings for each replicate were recorded and the average was calculated (A.O.A.C., 1990).

Total acidity percentage: of the flesh was determined as malic acid by titration with a solution of 0.1 N. (Na OH), using phenolphthalein as an indicator. The average amount of sodium hydroxide used in each titration was recorded and total acidity was calculated as gm / 100 gm fresh weight (A.O.A.C., 1990).

Total sugars percentage (g/100g dry weight): metrically determined as (g glucose/100 g dry weight) according to the method described by (Murphy (1958).

Total phenols compounds (g/ 100g f.wt): Extraction of phenol compounds was conducted according to the method described by Daniel and George (1972).

Total tannins percentage (g/ 100gf.wt): was evaluated according to the method of Yeshajahu and Clifton (1977). The results were calculated as g/ 100 g fresh weight.

Statistical analysis

Obtained data were statistically analyzed according Snedecor and Cochran (1990) Means for treatment were compared by the least significant difference (L.S.D.) at 5% level of probability in the two seasons of the experiment.

Results and Discussions

Fruit physical properties

Fruit weight loss %

Table 1 showed the effect of some postharvest treatments on weight loss% of Om El-Ferakh date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons. A gradual increase in weight loss was shown towards the end of the storage period (21 days). The percentage of weight loss was increased during storage period. The lowest weight loss recorded (2.46 & 3.31%) were obtained by T5, in the two seasons, respectively. On the other hand, control treatment (T1) exhibited the highest weight loss value (4.51 & 4.20%) in the two seasons, respectively. However, lemon grass oil (T5) treatment exhibited the lowest weight loss% than other treatments. Regarding the interaction between the postharvest treatments and storage period appeared significant differences in most cases. After 21 days of storage, the least values (3.32 & 5.33%) were obtained by T5 in both seasons, respectively. On the contrary T1 gave the highest value (6.88 & 7.44%), respectively, during cold storage at 5°C and 90% RH in both seasons. Kamal (1995) and Ali (1999) noticed that, (Samani and Zaghoul cvs.) were stored at 5°C and 90% RH for 2 months. These results are in partial agreement with those found by Schmilovitch *et al.*, (1999), Zakaria & Ismail (2000) and Hassan (2004) who stated that the percentage of weight loss of

navel orange fruits which coated with vegetables oils 2% were significantly reduced than non coated.

TABLE 1. Effect of some post-harvest treatments on weight loss % of “Om El-Ferakh” date fruits. stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Weight loss (%)										
Period Treatments	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)
	First season					Second season				
T1	0	5.51	5.66	6.88	4.51	0	3.85	5.52	7.44	4.2
T2	0	3.02	4.85	6.67	3.64	0	3.57	5.17	6.64	3.85
T3	0	3.24	5.59	6.83	3.92	0	3.7	5.19	6.72	3.9
T4	0	2.87	4.31	3.65	2.71	0	3.33	5.02	5.72	3.52
T5	0	2.77	3.73	3.32	2.46	0	3.1	4.82	5.33	3.31
Means (D)	0	3.48	4.83	5.47		0	3.51	5.14	6.37	
LSD =0.05	LSD (T) = 0.74					LSD (T) = 0.68				
For.	LSD (D) = 0.66					LSD (D) = 0.61				
	LSD (TXD) = 1.48					LSD (TXD) = 1.36				

Decay %

It is obvious from data presented in Table 2 that, decay percentage of dates during cold storage increased gradually and significantly with the extension of the storage period during the two investigated seasons. However, fruits reached its maximum decay after 21 days. Although there were no significant differences among all storage periods, treatments or packed in decay percentage until 14 days of storage period, the decayed fruits until 14 days were significantly lower than those at storage period of 21 days at the end of storage period. Concerning the effect of storage treatments, it was found that the higher percentage of the decayed fruits was at control fruits (3.45 and 4.43%), respectively, while the lowest value was recorded by spraying lemon grass oil, and packed in polyethylene bags (LDPE) which had the least decay percentage (1.85 and 2.43 %), respectively during cold storage at 5°C and 90% RH in the both seasons. In addition, these results are in line with those obtained by Anthony *et al.*, (2003) indicated that cinnamon and eucalyptus oil-enrichment reduced fruit decay and improved fruit quality of tomato and strawberries. These findings are, also, obtained by Schmilovitch, (1999), Zakaria & Ismail,(2000) and Hassan (2004). Who stated that the decay percentage of Navel orange fruits which coated with vegetables oils 2% were significantly reduced than non coated.

TABLE 2. Effect of some post-harvest treatments on decay % of “Om El-Ferakh” date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

		Decay (%)									
Period	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)	
	First Season					Second Season					
Treatments											
T1	0.00	0.00	3.50	10.30	3.45	0.00	0.00	3.70	14.00	4.43	
T2	0.00	0.00	2.30	7.00	2.33	0.00	0.00	2.50	9.30	2.95	
T3	0.00	0.00	2.50	7.50	2.50	0.00	0.00	2.60	9.80	3.10	
T4	0.00	0.00	2.40	5.30	1.93	0.00	0.00	2.40	7.50	2.48	
T5	0.00	0.00	2.30	5.10	1.85	0.00	0.00	2.30	7.40	2.43	
Means (D)	0.00	0.00	2.60	7.04		0.00	0.00	2.70	9.60		
LSD =0.05	LSD (T) = 1.47					LSD (T) = 1.54					
For.	LSD (D) = 1.31					LSD (D) = 1.38					
	LSD (TXD) = 2.94					LSD (TXD) = 3.08					

Texture (gm/cm²)

Data in Table 3 showed the effect of some safe environmental treatments on fruit texture. All the used treatments greatly increased fruit texture than control during cold storage durations in both seasons. However, lemon grass oil treatment exhibited the highest fruit texture (251.92 and 257.50 g/cm²) than other treatments. With respect to the interaction between the effect of treatments and storage period at the end of cold storage period (21 days) at 5°C and 90% RH, lemon grass oil recorded the highest value of fruit texture (251.92 and 257.50 g/cm²) while, control fruits recorded the lowest value of fruit texture (223.67 and 237.33 g/cm²) in both seasons. The data also revealed that all treatments significantly increased fruit texture, as an average for all storage period. These results are in accordance with those obtained by El-Hadidy (2004) on “Sewi” semi dry dates”, El-Seidy (1994), El-Shiekh *et al.*, (2002), El-Shemy, *et al.*, (2007) on “Le Conte” pear fruits. and Nunes *et al.*, (2007) on ‘Valencia’ oranges.

TABLE 3. Effect of some post-harvest treatments on texture g/cm² of “Om El-Ferakh” date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

		Texture g/cm ²									
Period	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)	
	First season					Second Season					
Treatments											
T1	261.7	234.7	207.7	190.7	223.7	265.0	245.0	225.0	214.3	237.3	
T2	261.7	253.7	239.3	235.3	247.5	265.0	253.7	251.0	234.3	251.0	
T3	261.7	252.7	238.3	224.0	244.2	265.0	252.7	250.0	232.7	250.1	
T4	261.7	254.3	244.7	239.0	249.9	265.0	264.3	253.7	240.3	255.8	
T5	261.7	256.7	249.3	240.0	251.9	265.0	266.0	254.7	244.3	257.5	
Means (D)	261.7	250.4	235.9	225.8		265.0	256.3	246.9	233.2		
LSD =0.05	LSD (T) = 17.31					LSD (T) = 14.07					
For.	LSD (D) = 15.48					LSD (D) = 12.58					
	LSD (TXD) = 34.62					LSD (TXD) = 28.14					

Fruit color % (Hue angle)

Table 4 illustrated that color development (Lc/h value) Hue angle of fruits were treated with all the used treatments compared with control in both seasons. Lemon grass oil treatment exhibited the highest fruit color than other treatments. Regarding the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, the highest value (31.15 and 30.90%) of fruit color was recorded with lemon grass oil, while, control fruits recorded the lowest value (20.33 and 22.08%) of fruit color in both seasons. The results were obtained by Nezam El-Din and El-Hameed (1997), who reported that Khalal stage of "Bent Aisha" date was developed to rutab stage by oven drying (at 65°C). To extend the shelf-life of this date (Rutab) it was preserved by drying. The dried dates were of good color and quality. Moreover, El-Hadidy (2004) on "Sewi" semi dry dates" and (El-Oraby and Ali, 2002) who stated that the color of Star Ruby, Red Blush and Rio Red cultivars of grapefruits showed a gradual increase with storage period. Generally, treated fruits with coatings, delayed the development of color during storage in comparison with untreated.

TABLE 4. Effect of some post-harvest treatments on color % of "Om El-Ferakh" date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Color (Hue angle)										
Period Treatments	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)
	First Season					Second Season				
T1	25.50	23.50	20.00	12.30	20.33	26.30	22.80	22.50	16.70	22.08
T2	25.50	23.80	24.20	22.70	24.05	26.30	24.50	23.20	27.70	25.43
T3	25.30	23.70	24.00	19.30	23.08	26.30	24.40	23.10	19.50	23.33
T4	25.50	24.10	24.70	41.40	28.93	26.30	24.90	24.20	40.20	28.90
T5	25.50	24.20	27.90	47.00	31.15	26.30	25.20	26.30	45.80	30.90
Means (D)	25.46	23.86	24.16	28.54		26.30	24.36	23.86	29.98	
LSD =0.05	LSD (T) = 6.71					LSD (T) = 5.94				
For.	LSD (D) = 6.00					LSD (D) = 5.31				
	LSD (TXD) = 13.42					LSD (TXD) = 11.88				

CO₂ and O₂ concentrations

Data in Fig. 1 clearly showed that, in both seasons of study, all used treatments greatly decreased gases concentrations than control during cold storage durations. However, lemon grass oil treatment exhibited the lowest concentrations of (O₂ and CO₂ production) (1.50 & 1.39%) and (17.43 & 17.99 %) than other treatments. With respect to the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, lemon grass oil recorded the lowest O₂ and CO₂ concentrations, while control fruits had the highest concentrations in both seasons. These data illustrated that cold temperature reduced gases productions, fruit deterioration, and extend fruit life.

The results obtained by Dangyang *et al.* (1991), Kader (1998) and Underhill *et al.* (1999) supported our finding.

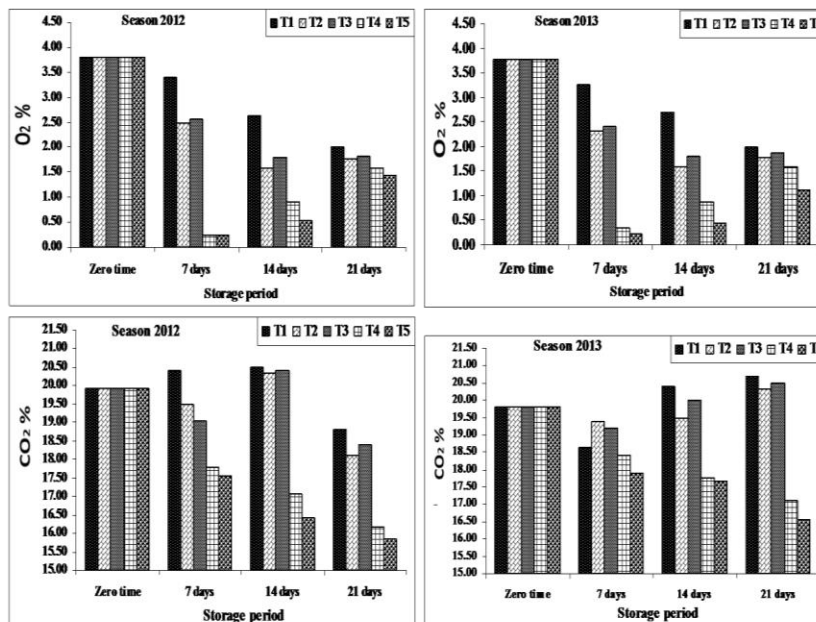


Fig. 1. Effect of some post-harvest treatments on O₂ and CO₂ (%) Om El-Ferakh" date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

TSS

As shown in Table 5 all the used treatments greatly increased TSS% of dates during cold storage as compared to control in both seasons. However, lemon grass oil treatment exhibited the highest TSS % (18.27 & 17.82%). Moreover, the percentage of TSS markedly increased with cold storage period extension to 21 days. This obviously means that date fruits improve their quality during cold storage than other treatments. Regarding the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, the highest value of TSS% was recorded by lemon grass oil, while, control fruits recorded the lowest value of TSS% (17.81 & 17.52%) in both seasons. Similar results were obtained by Kamal (1995), Benyamine (1999) and El-Zayat, *et al.* (2002) at the end of cold storage period (21 days) at 5°C and 90% RH, these findings are in accordance with those obtained by (El-Oraby and Ali, 2002) who stated that a gradual increase in TSS% occurred as the storage duration prolonged and there was no obvious different between treated and untreated fruits of grapefruit. The increment in the percentage of TSS could be due to the degradation of complex insoluble compounds like starch to simple content in the fruits and that changes increased with the storage time where it allowed the accumulation of TSS in the fruits.

The results obtained by El-Seidy (1994), El-Shiekh *et al.* (2002) and El-Shemy *et al.* (2007) on “Le Conte” pear fruits.

TABLE 5. Effect of some post-harvest treatments on TSS % of “Om El-Ferakh” date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Period Treatments	TSS (%)									
	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)
	First Season					Second Season				
T1	17.63	17.68	17.83	18.10	17.81	17.25	17.42	17.55	17.88	17.53
T2	17.63	17.80	17.92	18.17	17.88	17.25	17.45	17.68	18.17	17.64
T3	17.63	17.70	17.85	18.15	17.83	17.25	17.45	17.65	18.05	17.60
T4	17.63	17.85	18.02	18.30	17.95	17.25	17.65	17.75	18.33	17.75
T5	17.63	18.08	18.47	18.90	18.27	17.25	17.68	17.85	18.50	17.82
Means (D)	17.63	17.82	18.02	18.32		17.25	17.53	17.70	18.19	
LSD =0.05	LSD (T) = 0.13					LSD (T) = 0.17				
For.	LSD (D) = 0.12					LSD (D) = 0.14				
	LSD (TXD) = 0.26					LSD (TXD) = 0.34				

Total acidity

Data in Table 6 showed the effect of some safe environmental treatments on fruit acidity. All used treatments greatly decreased fruit acidity than control during cold storage durations in both seasons. However, lemon grass oil treatment exhibited the lowest fruit acidity (0.28 % and 0.28 %) than other treatments. The present results showed that acidity percentage mostly decreased after 2 weeks storage then sharply after 3 weeks. With respect to the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, lemon grass oil recorded the lowest value of fruit acidity while, control fruits recorded the highest value of fruit acidity (0.32 and 0.31%) in both seasons. These data are agreement with Colelli *et al.* (1991), Nezam El-Din & El-Hameed (1997) and Hamdi (1999). Moreover El Zayat *et al.* (2002) tested some methods to preserve the quality of “Sewi” semi dry dates after being dried traditionally by exposure to the sun, he found that acidity tended to increase with time in cold storage and respective value were (0.23 to 0.30 %). So, semi dry dates could be kept for 3 months at 5°C in good conditions.

TABLE 6. Effect of some post-harvest treatments on total acidity % of “Om El-Ferakh” date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Total acidity (%)											
Period Treatments	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)	
	Season 1					Season 2					
T1	0.30	0.35	0.31	0.30	0.32	0.32	0.37	0.29	0.27	0.31	
T2	0.30	0.33	0.31	0.22	0.29	0.32	0.32	0.27	0.24	0.29	
T3	0.30	0.34	0.31	0.23	0.30	0.32	0.35	0.29	0.24	0.30	
T4	0.30	0.33	0.29	0.22	0.29	0.32	0.33	0.27	0.22	0.29	
T5	0.30	0.33	0.28	0.21	0.28	0.32	0.34	0.26	0.21	0.28	
Means (D)	0.30	0.34	0.30	0.24		0.32	0.34	0.28	0.24		
LSD =0.05 for	LSD (T) = 0.03				LSD (T) = 0.02						
	LSD (D) = 0.02				LSD (D) = 0.01						
	LSD (TXD) = 0.05				LSD (TXD) = 0.03						

Total sugars percentage

As shown in Table 7 all the used treatments greatly increased fruit sugar content of dates during cold storage as compared to control in both seasons. However, lemon grass oil treatment exhibited the highest total sugars than other treatments. The present results throughout both studied seasons showed that, fruit total sugars increased during storage period from 0 to 14 days, then decreased after 21 days. Regarding the interaction between the effect of treatments and storage period, at 5°C and 90% RH, the highest value of total sugars was recorded by lemon grass oil while, control fruits recorded the lowest value of total sugars (67.53 and 66.58%) in both seasons. Similarly, Abd El-Motty, (1995) designed to improve the ripening methods of both “Hayani” and “Sewi” dates, respectively. Results of this work showed an increase of total sugars % in “Sewi” dates obtained with naturally or artificially ripening process. El-Hammady *et al.* (2003) reported the effect of normal ripening (sun dried) or artificial ripening process on storability of “Sewi” semi dry dates. The change in total sugars content during storage at (0°C) and (5°C) for 5 months were determined. Generally, normal ripening of “Sewi” dates was superior to artificial ripening in producing fruits with high contents of total sugars %. Moreover, El-Hadidy (2004) indicated the effect of artificial ripening process on handling and storability of “Sewi” semi dry dates. The change in total sugars during 0 or 5°C ± 2 and 90% RH for 5 months were determined. Generally, artificial ripening of “Sewi” dates produced fruits with high total sugars. Similar results were obtained by Kamal (1995) and El-Zayat *et al.* (2002). After 14 days (74.8 and 73.7%). So, this treatment effectively improved date fruit quality.

TABLE 7. Effect of some post-harvest treatments on total sugars gm/100g d. wt. of “Om El-Ferakh” date fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Total sugars gm/100g d. wt.										
Period Treatments	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)
	Season 1					Season 2				
T1	65.30	67.70	69.20	67.90	67.53	64.70	66.50	68.30	66.80	66.58
T2	65.30	69.60	71.80	69.50	69.05	64.70	68.90	70.70	68.60	68.23
T3	65.30	69.50	71.60	68.60	68.75	64.70	67.60	69.60	67.40	67.33
T4	65.30	70.60	72.50	70.80	69.80	64.70	69.70	71.50	69.70	68.90
T5	65.30	72.50	74.80	72.30	71.23	64.70	71.50	73.70	71.40	70.33
Means (D)	65.30	69.98	71.98	69.82		64.70	68.84	70.76	68.78	
LSD =0.05	LSD (T) = 2.23					LSD (T) = 2.29				
For.	LSD (D) = 1.99					LSD (D) = 1.05				
	LSD (TXD) = 4.46					LSD (TXD) = 4.58				

Total phenol percentage

Data in Table 8 showed the effect of some safe environmental treatments on fruit content of total phenols. All the used treatments greatly decreased total phenols than control during cold storage durations in both seasons. However, lemon grass oil treatment exhibited the lowest fruit content of total phenol (0.21 and 0.21%) than other treatments. In later research, changes in total polyphenol (TPP), ascorbic acid (AA) and antioxidant activity together with other quality characteristics were monitored on minimally processed "Cactus" pear fruit during 9 days of refrigerated storage (Piga *et al.*, 2003) on pear fruits. Results showed that AA and antioxidant activity remained unchanged, while TPP decreased after 6 days of cold storage. Total phenol content of “Om El-Ferakh” dates sharply decreased with storage period from 0 to 14 days then sharply increased after 21 days in an opposite, trend to total sugars content. So, may be firm relationship between them. With respect to the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, lemon grass oil recorded the lowest value of fruit content of total phenols while, control fruits recorded the highest value of fruit content of total phenols in both seasons. However, the same trend was found by Maier & Metzlet (1965) and Abd El-Motty (1995). In general, the levels of essential oils and their compounds necessary to inhibit microbial growth are higher in foods than in culture media. This is due to interactions between phenolic compounds and the food matrix (Nuchas and Tassou, 2000).

TABLE 8. Effect of some post-harvest treatments on total phenol% of “Om El-Ferakh” fruits stored at 5°C, 90 % RH during 2012 and 2013 seasons.

Period Treatments	Zero	7	14	21	Means	Zero	7	14	21	Means
	time	days	days	days	(T)	time	days	days	days	(T)
	Season 1					Season 2				
T1	0.29	0.24	0.17	0.36	0.27	0.28	0.23	0.17	0.32	0.25
T2	0.29	0.22	0.17	0.26	0.24	0.28	0.21	0.16	0.25	0.23
T3	0.29	0.23	0.17	0.27	0.24	0.28	0.22	0.16	0.26	0.23
T4	0.29	0.22	0.16	0.26	0.23	0.28	0.20	0.16	0.25	0.22
T5	0.29	0.20	0.15	0.19	0.21	0.28	0.19	0.15	0.21	0.21
Means (D)	0.29	0.22	0.16	0.27		0.28	0.21	0.16	0.26	
LSD =0.05	LSD (T) =				0.03	LSD (T) =				0.02
For.	LSD (D) =				0.02	LSD (D) =				0.01
	LSD (TXD) =				0.05	LSD (TXD) =				0.03

Total Tannins percentage

As shown in Table 9 all the used treatment greatly decreased fruit content of total tannins of dates during cold storage as compared to control in both seasons. However, lemon grass oil treatment exhibited the lowest total tannins than other treatments. We can notice that, through 1st week of cold storage, a sharp decrease in total tannins with all treatments was noticed then the rate of decrease became less. However, after a sharp decrease in tannins content, we can notice a sharp increase in fruit decay percentage. Table 2 So, there is a negative relationship between fruit decay and its content of tannins. Regarding the interaction between the effect of treatments and storage period, at the end of cold storage period (21 days) at 5°C and 90% RH, the lowest value of total tannins was recorded (2.01 & 1.93 %) by lemon grass oil, while, control fruits recorded the highest value of total tannins (2.07 & 2.0%) in both seasons. Similar results were obtained by Maier & Metzler (1965) and Abd El-Motty (1995). they found that soluble form of tannins convert into insoluble ones during Rutab stage. They also added that high content of soluble and insoluble forms of tannins might protect fruits at this stage (Rutab) because such oxidized phenols are more active as antifungal agent than oxidized materials. Moreover, total sugars, total acidity, total phenols and total tannins support the taste balance which distinguished each variety than others. Similar results were obtained by El-Samahy *et al.* (2006).

TABLE 9. Effect of some post-harvest treatments on total tannins % of “Om El-Ferakh” date fruits stored at 5 °C, 90 % RH during 2012 and 2013 seasons.

Total tannins (%)										
Period Treatments	Zero time	7 days	14 days	21 days	Means (T)	Zero time	7 days	14 days	21 days	Means (T)
	Season 1					Season 2				
T1	2.32	2.03	1.99	1.94	2.07	2.23	1.98	1.94	1.89	2.01
T2	2.32	1.95	1.96	1.88	2.03	2.23	1.96	1.87	1.82	1.97
T3	2.32	1.94	1.97	1.87	2.03	2.23	1.95	1.92	1.84	1.99
T4	2.32	2.16	1.92	1.86	2.07	2.23	1.94	1.83	1.76	1.94
T5	2.32	2.03	1.87	1.81	2.01	2.23	1.92	1.82	1.75	1.93
Means (D)	2.32	2.02	1.94	1.87		2.23	1.95	1.88	1.81	
LSD =0.05	LSD (T) = 0.04					LSD (T) = 0.05				
For.	LSD (D) = 0.03					LSD (D) = 0.04				
	LSD (TXD) = 0.07					LSD (TXD) = 0.09				

Conclusion

All the studied treatments with paraffin oil, lemon grass oil and packed in polyethylene bags (LDPE) recorded the highest value of texture, color, total soluble solids and total sugars, while they decreased fruit weight loss, decay percentage, acidity, and total phenols during storage period. The studied treatments are very important to reduce gases productions (O₂ and CO₂ concentrations). These treatments had a good effect on keeping and improving quality of date fruits during storage.

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تأثير بعض معاملات ما بعد الحصاد على جودة ثمار البلح أثناء التخزين المبرد

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أجريت هذه الدراسة عام ٢٠١٢ – ٢٠١٣ على ثمار بلح صنف أم الفراح مزروعة في مزرعة خاصة ادكو - محافظة البحيرة بهدف تقييم تأثير المعاملات بكل من زيت البارافين وزيت حشيشة الليمون بالإضافة إلى التعبئة في أكياس من البولي ايثيلين. ثم دراسة تأثير التغيرات في جودة الثمار خلال التخزين على ٥ م^٥ لمدة ٢١ يوم.

بعد فترة التخزين المبرد لمدة ٢١ يوم على درجة ٥ م^٥ ، ٩٠٪ رطوبة نسبية، أشارت النتائج أن جميع المعاملات وخاصة الرش بزيت البرافين أو زيت حشيشة الليمون والمعبأة في أكياس بولي ايثيلين قللت من نسبة التانينات مقارنة بثمار الكونترول. بالإضافة إلى ذلك أعطت المعاملتان الرش بزيت البرافين ٧,٥٪ أو حشيشة الليمون ٥,٥٪ أعلى القيم بالنسبة للصلابة، اللون، نسبة المواد الصلبة الذائبة الكلية ، السكريات الكلية المحافظة على جودة الثمار أثناء التخزين بينما قللت من تركيز الغازات في التنفس، الفقد في وزن الثمار، نسبة التالف من للثمار، نسبة الحموضة، نسبة الفينولات الكلية أثناء التخزين مقارنة بالثمار الأخرى.