

Effect of Some Postharvest Treatments on Quality and Storability of Date Palm fruits Zaghloul and Samany Cultivars

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ABSTRACT



This experiment was carried out during two successive seasons (2012 and 2013) in the postharvest laboratory of Agricultural Development System (ADS) project in Faculty of Agriculture, Cairo University, Egypt on two date palm fruits cvs. Zaghloul and Samany harvested at full coloured stage (khalal) to investigate the efficiency of using some natural substances *i.e.* arabic gum at 10%, black cumin (*Nigella sativa*) oil at 1% as well as their combination besides untreated fruits as a control under cold storage on fruit quality of date palm fruits. The obtained results showed that, 10 % arabic gum + 1% black cumin oil and 1% black cumin oil succeeded in reducing weight loss and fruit decay percentages for Zaghloul date palm, while arabic gum at 10% and 10% arabic gum + 1% black cumin oil gave the lowest weight loss and fruit decay percentages in Samany date palm. However, the highest values of fruit firmness were scored by 10% arabic gum + 1% black cumin oil and black cumin oil at 1% for both cultivars. Coating date palm fruits with combination of arabic gum 10% + black cumin oil 1% or arabic gum 10% only enhance of fruit chemical properties (total soluble solids and total sugar) However, While, there was no clear trend for treatments effect on fruit total acidity content for both cultivars under the study.

Key words: Arabic gum, black cumin oil, cold storage, date palm, fruit quality.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.), one of the ancient domestic fruit trees in the Middle East countries and their fruits play an important role in the nutritious pattern of many people. It can grow well under drastic environmental conditions which may be not suitable for many fruit species. In Egypt many date palm cultivars are grown in different regions according to the diversity of their climatic necessity, particularly average temperature and relative humidity that affect fruit growth and development.

Date palm cultivars divided into three main groups according to its fruit moisture content, *i.e.* soft, semi-dry and dry cultivars, Zaghloul and Samany are the best soft types date palm cultivars in Egypt and highly demanded in the local markets (selim *et al.*, 1970).

The extension of fruit life is an important aim to be attained, many storage techniques have been developed to extent the marketing distances and holding periods for commodities after harvest. Different preservation methodologies have been studied. One method of extending post harvest shelf life is the use of edible coating (Baldwin *et al.*, 1995). Edible coating provide a semi permeable barrier against oxygen, carbon dioxide (CO₂), moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction (Baldwin *et al.*, 1999).

The application of edible coatings can improve the physical strength of food products, reduce particle clustering, and improve visual and tactile features on product surfaces (Cuq, *et al.*, 1995; Cisneros-Zevallos, *et al.*, 1997). The coatings can also protect food products from moisture migration, microbial growth on

the surface and induced chemical changes, oxidation of nutrients, etc.

Edible coatings can act as barriers against, gases, or vapors and as carriers of active substances such as antioxidants, antimicrobials, colors and flavors (Miller, *et al.*, 1998). These functions enhance the quality of food products, resulting in shelf life extension and safety improvement (Guilbert and Gontard, 2005).

Arabic gum, one of the biopolymers, extracted from stems of *Acacia senegal* trees comprising galactose, rhamnose, arabinose and glucuronic acid (Anderson *et al.*, 1991). When arabic gum used showed some positive results and significantly delayed maturity of cold stored apples (El-Anany *et al.*, 2009). Also, coating of papaya fruits with Arabic gum at 10% has been found to enhance the shelf life and postharvest quality during storage and marketing through delaying the ripening process by inhibiting the respiration rate in the papaya fruit and improves the postharvest quality during cold storage (Zuhair *et al.*, 2013).

Essential oils are made up of many different volatile compounds and the composition of the oil quite often varies between species (Mishra and Dubey, 1994). It is difficult to associate the antifungal activity to single compounds or classes of compounds. It seems that the antifungal and antimicrobial effects are the result of many compounds acting synergistically (Bagamboula *et al.*, 2004). Thus, there would be negligible chance of development of resistant races of fungi after application of essential oils to fruit and vegetables. As a consequence essential oils are one of the most promising candidate groups of natural compounds for the development of safer antifungal agents.

Furthermore, treated the fruits with essential oils (black cumin) led to reduce of weight loss and decay percentages, as well as the respiration rate of fruits (El-Sharony and Amin, 2014). Therefore, the aim of the present work is the possibility of using some safety compounds as natural postharvest treatments such as arabic gum and black cumin oil to improve the fruit quality and fruit storability during cold storage periods of dates palm cvs Zaghloul and Samany.

MATERIALS AND METHODS

Two cultivars of dates palm (*Phoenix dactylifera* L.) Zaghloul and Samany were obtained from Researches and Experiments Station at the Faculty of Agriculture, Cairo University, Giza Governorate, Egypt. Fruits were collected at Khalal stage during 2012 & 2013 seasons and selected mature fruits, undamaged, free from apparent pathogen infection and were uniformed in shape, weight and colour for each cultivar of study. Fruits were transported to the laboratory of Agriculture Development Systems (ADS) project in the Faculty of Agriculture, Cairo University.

Treatments and storage condition

The selected fruits from each cultivar washed, air dried and placed into plastic baskets. Fruits of each cultivar were divided into four groups to carry out the following treatments:

- 1- Control (tap water plus tween 80).
- 2- Arabic gum at 10%: conducted by dissolving 100 g of arabic gum powder in 1000 ml water. The solution was stirred with low heat 40°C for 30 min using a hot plate magnetic stirrer, and subsequently the fruits were soaked for 5 minutes.
- 3- Black cumin oil at 1%: The emulsion of black cumin oil was prepared by mixing oil with tween 80 in water (Ju *et al.*, 2000). Fruits immersed in black cumin oil at 1% for 5min.
- 4- Arabic gum at 10% + black cumin oil at 1%: fruits placed in the plastic basket and immersed in combination solution 1:1 (v/v) from arabic gum 10% and black cumin oil 1% for 5 min.

All the treated and untreated fruits left to dry aerobically. Each treatment was divided into two sections, I: to estimate the physical properties (percentages of weight loss and decay and fruit firmness).

II: to estimate the chemical characteristics (fruit content of total soluble solids, total sugars and total acidity). Each section has three replicates (1.5 Kg/replicate). Then, each replicate was packed in perforated carton boxes. All treated and untreated fruits of two date palm cultivars stored at 0 ± 1°C and relative humidity (RH) 85-90%. The initial fruit quality characteristics of two date palm cultivars before treatments were measured (zero time). Each 15 days intervals, fruit samples were taken from cold storage and fruit quality measurements were assessed.

Measurements

1. Physical Properties:

1.1. Weight Loss (%): Fruits were periodically weighed and the loss in mass weight was recorded for each replicate. Data were calculated as percentage from the initial weight, the following formula is used:

$$\text{Fruit weight loss \%} = \frac{\text{Initial weight} - \text{Weight at specific interval}}{\text{Initial weight}} \times 100$$

1.2. Decay Percentage (%): Evaluated by skin appearance, shriveling, chilling injury, and pathogenic rots. In every inspection, decayed fruits were discarded and the weight of fruits per replicate was used to express decay percentage. The following formula is used:

$$\text{Decay Percentage (\%)} = \frac{\text{Weight of discard fruits}}{\text{Initial weight}} \times 100$$

1.3. Fruit Firmness (Lb\inch²): Fruit firmness was determined as Lb\inch² using fruit pressure tester mod. FT 327 (3-27 Lbs).

2. Chemical Properties:

- 2.1. Total Soluble Solids Percentage (TSS %): Determined in date palm fruit juice using a hand refractometer.
- 2.2. Total Sugars (g/100 g "fresh weight" FW): Determined in stored date fruits by method described by (A.O.A.C., 1995).
- 2.3. Total Acidity (TA): Estimated as g malic acid /100 ml juice according to (A.O.A.C., 1995).

Statistical Analysis

The statistical analysis of the present data was carried out according to Snedecor and Cochran (1989). Means of the obtained results at different treatments were compared using new LSD test at 5% level.

RESULTS AND DISCUSSIONS

Effect of some postharvest treatments on fruit physical properties of date palm cvs Zaghloul and Samany

Fruit weight loss percentage

The results in Tables (1 & 2) showed that, there were no significant differences between the treatments in both seasons for Zaghloul date palm fruits. However, arabic gum at 10% gave the lowest weight loss in Samany date palm fruits in the first and second seasons. With respect to the effect of cold storage period, data in the same Tables clear that date palm fruit weigh loss percentage was increased with increasing the storage period. So, sixty days of cold storage period in Zaghloul fruits and seventy five days of cold storage period in Samany fruits recorded the highest values, whereas the lowest values were obtained after fifteen days under cold storage period in two cultivars in both seasons (regardless the initial readings).

Table (1): Effect of some postharvest treatments on weight loss percentage of date palm cv. Zaghloul stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012					
	0	15	Storage periods (days)			Mean
			30	45	60	
Control	0.00	1.00	1.77	3.63	4.88	2.25 A
Arabic gum 10 %	0.00	1.53	1.97	3.70	4.20	2.28 A
Black cumin oil 1%	0.00	1.53	1.93	2.40	3.63	1.90 A
Arabic gum 10 % + black cumin oil 1%	0.00	1.17	1.23	2.52	3.37	1.66 A
Mean	0.00C	1.31 B	1.72 B	3.06 A	4.02 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% =2.11

Treatment	Season 2013					
	0	15	30	45	60	Mean
Arabic gum 10 %	0.00	0.50	0.78	0.83	1.73	0.77 A
Black cumin oil 1%	0.00	0.54	0.72	0.97	1.50	0.75 A
Arabic gum 10 % + black cumin oil 1%	0.00	0.25	0.31	1.45	1.83	0.77 A
Mean	0.00 E	0.43 D	0.61 C	1.16 B	1.65 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.278

Table (2): Effect of some postharvest treatments on weight loss percentage of date palm cv. Samany stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						
	0	15	30	Storage periods (days)			Mean
				45	60	75	
Control	0.00	0.93	4.93	7.75	9.77	13.18	6.09 A
Arabic gum 10 %	0.00	0.48	2.17	4.03	6.33	10.20	3.87 C
Black cumin oil 1%	0.00	0.74	3.96	6.13	9.80	12.71	5.56 B
Arabic gum 10 % + black cumin oil 1%	0.00	0.61	3.62	6.77	8.88	12.11	5.33 B
Mean	0.00 F	0.69 E	3.67 D	6.17 C	8.69 B	12.05 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% =0.856

Treatment	Season 2013						
	0	15	30	45	60	75	Mean
Arabic gum 10 %	0.00	0.39	1.28	2.02	2.33	3.93	1.66 C
Black cumin oil 1%	0.00	0.60	2.34	3.07	4.69	5.91	2.77 B
Arabic gum 10 % + black cumin oil 1%	0.00	0.49	2.14	3.40	4.25	5.63	2.65 B
Mean	0.00 F	0.56 E	2.17 D	3.09 C	4.32 B	5.70 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.497

Regarding to the interaction effect between the tested postharvest treatments and storage periods, it was observed that for both cultivars of date palm fruits the lowest fruit weight loss percentage was obtained by the combinations of fifteen days storage period, especially those interacted with control “untreated” and 10 % arabic gum + 1% black cumin oil in Zaghloul fruits in the first and second seasons, respectively and arabic gum at 10% for Samany fruits in both seasons. On the contrary, the highest values in this parameter were

gained by the interactions of sixty days cold storage period for Zaghloul fruits, particularly that of control treatment in the first season and 10 % arabic gum + 1% black cumin oil treatment in the second season. Whereas, the highest values of Samany fruits weight loss percentage was scored by the combinations of seventy five days cold storage period, especially untreated fruits in both seasons. The reduction of weight loss may be due to edible coating provide a semi permeable barrier against oxygen, carbon dioxide (CO₂),

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moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction (Baldwin *et al.*, 1999). The obtained results are in agreement with the findings by El-Anany *et al.*, (2009) who reported that, apple fruits coating with arabic gum showed a significant delay of weight loss during cold storage compared to uncoated one.

Fruit decay percentage

Results in Tables (3 & 4) demonstrated that, 10 % arabic gum + 1% black cumin oil and black cumin oil at 1% succeeded in reducing fruit decay percentage for Zaghloul date palm, while arabic gum at 10% and 10% arabic gum + 1% black cumin oil gave the lowest decay percentage in Samany date palm in both seasons. Regarding to the effect of cold storage periods, it is obvious from Tables (3 & 4) that, fruit decay percentage of date palms were increased as the storage period prolonged. So, sixty days of cold storage period in Zaghloul cv. and seventy five days of cold storage period in Samany cv. scored the highest values in this concern. As for the interaction effect between the tested postharvest treatments and cold storage periods, the reported data in Tables (3 & 4) illustrated that irrespective the initial time the lowest fruit decay per-

centage were recorded by the interactions of fifteen days cold storage period, especially those interacted with Arabic gum at 10% in Zaghloul fruits in the first season and Arabic gum at 10% +black cumin oil at 1% in the second one and arabic gum at 10% for Samany fruits in both seasons. On reverse, the highest fruit decay percentage were recorded by the interactions of sixty days cold storage period for Zaghloul fruits, particularly that of control treatment in the first season and arabic gum at 10 % treatment in the second season. Whereas, the highest decay percentage of Samany fruits was scored by the combinations of seventy five days cold storage period, especially untreated fruits in both seasons. The rest interactions of the storage periods came in-between in both seasons.

The inhibitory effects of plant oils and arabic gum on microbial growth reported by (Suwitchayanon and Kunasakdaku, 2009). Also, essential oils are mainly conjugated to phenolic compounds which accumulate in some plant cells and have positive effects on pathogen control (Plotto, *et al.*, 2003). The obtained results of arabic gum and black cumin essential oils in reducing fruit decay of date palm are in harmony with Atia (2011) on date palm, Singh *et al.*, (2012), on citrus, and Oz and Ulukanl (2012) on pomegranate.

Table (3): Effect of some postharvest treatments on decay percentage of date palm cv. Zaghloul stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012					Mean
	Storage periods (days)					
	0	15	30	45	60	
Control	0.00	0.53	1.03	6.33	9.14	3.40 A
Arabic gum 10 %	0.00	0.31	0.41	5.63	6.96	2.66 B
Black cumin oil 1%	0.00	0.40	0.45	1.67	7.03	1.91 C
Arabic gum 10 % + black cumin oil 1%	0.00	0.45	0.73	1.92	6.00	1.82 C
Mean	0.00	0.42	0.66	3.89	7.28	
	D	C	C	B	A	
*L.S.D for the interaction effect between treatments and storage periods at 5% =0.817						
Treatment	Season 2013					Mean
	Storage periods (days)					
	0	15	30	45	60	
Control	0.00	2.15	4.41	6.08	7.08	3.95 A
Arabic gum 10 %	0.00	1.66	2.99	5.97	7.52	3.63 A
Black cumin oil 1%	0.00	0.97	3.00	5.21	5.52	2.94 B
Arabic gum 10 % + black cumin oil 1%	0.00	0.78	2.87	5.36	6.71	3.14 B
Mean	0.00	1.39	3.32	5.66	6.71	
	E	D	C	B	A	
*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.938						

Table (4):Effect of some postharvest treatments on decay percentage of date palm cv. Samany stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	0.00	2.44	4.83	6.32	8.84	9.03	5.24 A
Arabic gum 10 %	0.00	1.83	4.23	5.73	6.94	6.45	4.20 C
Black cumini oil 1%	0.00	3.34	5.04	5.78	7.12	7.74	4.84 B
Arabic gum 10 % + black cumini oil 1%	0.00	3.14	4.49	5.55	6.79	7.41	4.56 B
Mean	0.00	2.69	4.65	5.85	7.42	7.66	
	E	D	C	B	A	A	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.933

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	0.00	2.01	3.66	4.55	5.94	6.22	3.73 A
Arabic gum 10 %	0.00	1.51	3.20	4.12	4.44	4.67	2.99 C
Black cumini oil 1%	0.00	2.75	3.82	4.16	4.79	5.33	3.47 B
Arabic gum 10 % + black cumini oil 1%	0.00	2.16	3.09	3.82	4.67	5.10	3.14 C
Mean	0.00	2.11	3.44	4.16	4.96	5.33 A	
	E	D	C	B	A		

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.661

Fruit firmness (Lb/inch²)

It was obvious from results in Tables (5 & 6) that, fruit firmness of date palm was affected by using all examined postharvest treatments especially in the second season for Zaghoul cv. and in both seasons for Samany cv., whereas, the highest values of fruit firmness were scored by black cumini oil at 1% in Zaghoul cv. in the second season without significant differences with the control and arabic gum at 10% + black cumini oil at 1%, while arabic gum at 10% + black cumini oil at 1%, arabic gum at 10% and black cumini oil at 1% gave the highest fruit firmness in both seasons for Samany cv. Respecting to the effect of cold storage periods, results in Tables (5 & 6) declared that, fruit firmness of date palms were decreased as the storage period prolonged. So, initial time of storage scored the

highest fruit firmness while, sixty days of cold storage period for Zaghoul fruits and seventy five of cold storage period for Samany fruits registered the lowest values of fruit firmness. The rest storage periods gave in-between values in this respect in both seasons. Concerning the interaction effect between postharvest and cold storage periods, data in the same tables show that the interactions of fifteen days storage period (irrespective the initial readings) recorded the highest values of fruit firmness, especially untreated fruits "control" in Zaghoul cv. and Arabic gum at 10% in Samany cv. in both seasons. On the other hand the lowest fruit firmness for Zaghoul cv. was observed with control and Arabic gum 10% in sixty days cold storage condition in the first and second seasons, respectively.

Table (5): Effect of some postharvest treatments on fruit firmness (Lb/inch²) of date palm cv. Zaghoul stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	17.47	17.33	17.17	17.07	16.63	17.13 A	
Arabic gum 10 %	17.47	17.27	17.17	17.00	16.87	17.15 A	
Black cumini oil 1%	17.47	17.23	17.17	17.13	17.03	17.21 A	
Arabic gum 10 % + black cumini oil 1%	17.47	17.30	17.20	17.17	17.13	17.25 A	
Mean	17.47	17.28	17.18	17.09	16.92		
	A	AB	BC	BC	C		

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.559

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	17.35	17.30	17.10	16.50	16.03	16.86 AB	
Arabic gum 10 %	17.35	17.30	17.00	15.90	14.83	16.48 B	
Black cumini oil 1%	17.35	17.20	17.10	16.90	16.80	17.07 A	
Arabic gum 10 % + black cumini oil 1%	17.35	17.20	17.03	16.37	16.33	16.86 AB	
Mean	17.35	17.25	17.06	16.42	16.00		
	A	A	A	B	B		

*L.S.D for the interaction effect between treatments and storage periods at 5% = 1.344

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Table (6): Effect of some postharvest treatments on fruit firmness (Lb/inch²) of date palm cv Samany stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	17.33	17.30	17.13	16.93	16.77	16.13	16.93 B
Arabic gum 10 %	17.33	17.33	17.27	17.20	17.13	17.13	17.23 A
Black cumin oil 1%	17.33	17.30	17.23	17.22	17.03	16.97	17.18 A
Arabic gum 10 % + black cumin oil 1%	17.33	17.33	17.30	17.28	17.20	17.07	17.25 A
Mean	17.33 A	17.32 AB	17.23 AB	17.16 AB	17.03 BC	16.83 C	

*L.S.D for the interaction effect between treatments and storage periods at 5% =0.606

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	17.35	17.23	17.20	17.20	17.00	16.30	17.05 B
Arabic gum 10 %	17.35	17.35	17.30	17.22	17.18	17.13	17.22 A
Black cumin oil 1%	17.35	17.30	17.25	17.10	17.00	16.85	17.14 AB
Arabic gum 10 % + black cumin oil 1%	17.35	17.33	17.31	17.26	17.21	17.12	17.26 A
Mean	17.35 A	17.30 A	17.26 A	17.19 AB	17.10 AB	16.85 B	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.376

However, the lowest fruit firmness for Samany cv. was recorded with control for seventy five Days of cold storage in both seasons. The obtained results are in harmony with Bayindirli (1995) on citrus, Yaman and Bayoindirli (2002) on cherries and El-Anany *et al.*,(2009) on apples who reported that, coat the apple fruits improves fruit firmness during storage process as compared to uncoated fruits.

Effect of post harvest treatments on fruit chemical properties

Total soluble solid percentage (TSS %)

Results in Tables (7 & 8) demonstrated that, TSS percentage of date palm fruits in two cultivars registered

high significant increment as a result of exposing to all tested postharvest treatments with superiority of arabic gum at 10% in both seasons. However, the highest values of total soluble solids were gained by using the treatments of 10% arabic gum + 1% black cumin oil with the same value with arabic gum at 10% in the first season and arabic gum at 10 % only in the second one for Zaghoul date palm fruits, while arabic gum at 10% gave the highest value of total soluble solids in both seasons for Samany date palm fruits. Clear from the same Tables that prolonging storage period up to sixty days for Zaghoul fruits and seventy five days for Samany fruits induced a pronounced positive effect on fruit total soluble solids content in both seasons.

Table (7): Effect of some postharvest treatments on total soluble solids percentage of date palm cv. Zaghoul stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60		
Control	26.58	27.44	29.38	31.04	32.28		29.34 B
Arabic gum 10 %	26.58	27.48	29.65	31.86	38.47		30.81 A
Black cumin oil 1%	26.58	27.60	28.07	29.92	34.28		29.29 B
Arabic gum 10 % + black cumin oil 1%	26.58	28.30	30.68	32.17	36.33		30.81 A
Mean	26.58 E	27.70 D	29.44 C	31.25 B	35.34 A		

*L.S.D for the interaction effect between treatments and storage periods at 5% =1.808

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60		
Control	28.74	29.61	30.54	33.43	36.38		31.74 C
Arabic gum 10 %	28.74	35.31	35.76	38.18	40.45		35.69 A
Black cumin oil 1%	28.74	33.70	33.47	37.84	39.89		34.73 B
Arabic gum 10 % + black cumin oil 1%	28.74	31.38	32.01	32.88	36.34		32.27 C
Mean	28.74 D	32.50 C	32.94 C	35.58 B	38.26 A		

*L.S.D for the interaction effect between treatments and storage periods at 5% = 2.087

Table (8): Effect of some postharvest treatments on total soluble solids percentage of date palm cv. Samany stored at $0 \pm 1^\circ\text{C}$ in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	23.59	25.00	27.25	31.10	35.12	38.04	30.02 C
Arabic gum 10 %	23.59	28.50	32.48	34.70	37.87	39.80	32.82 A
Black cummin oil 1%	23.59	29.57	31.10	32.82	35.82	38.57	31.91 B
Arabic gum 10 % + black cummin oil 1%	23.59	27.03	30.76	33.80	35.38	38.87	31.57 B
Mean	23.59 F	27.52 E	30.40 D	33.11 C	36.05 B	38.82 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 1.652

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	26.46	27.33	28.66	30.93	33.05	36.53	30.49 C
Arabic gum 10 %	26.46	29.81	31.98	34.09	36.12	38.82	32.88 A
Black cummin oil 1%	26.46	27.66	29.00	31.42	35.57	37.31	31.24 B
Arabic gum 10 % + black cummin oil 1%	26.46	28.07	29.13	31.96	34.59	34.93	30.86 BC
Mean	26.46 F	28.22 E	29.69 D	32.10 C	34.83 B	36.90 A	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 1.832

Regarding to the interaction effect between the tested postharvest treatments and storage periods, results showed that, arabic gum at 10% for sixty days cold storage of Zaghloul fruits and for seventy five days cold storage of Samany fruits succeeded in increasing total soluble solids and scored the highest values in this parameter in both seasons.

On the reverse, the lowest values of total soluble solids regardless the initial readings were gained at fifteen days cold storage period, especially untreated fruits in both date palm cultivars during the first and second seasons.

Total sugar (g/100 FW)

Results in Tables (9 & 10) demonstrated that, total

sugar content of date palm fruits registered high significant increment as a result of exposing to all tested postharvest treatments. However, the highest values of total sugar content were gained by using the treatments of 10% arabic gum+ 1% black cummin oil and arabic gum at 10% in the first season and arabic gum at 10 % in the second one for Zaghloul date palm, while arabic gum at 10% gave the highest value of total sugar content in both seasons for Samany date palm. However, control fruit recorded the lowest value of total sugar content in both seasons for two cultivars.

Besides, fruit total sugar content of date palm fruits was gradually decreased as storage period prolonged in both seasons.

Table (9): Effect of some postharvest treatments on total sugar (g/100 FW) of date palm cv. Zaghloul stored at $0 \pm 1^\circ\text{C}$ in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	22.10	22.33	23.58	23.93	24.17	23.22 B	
Arabic gum 10 %	22.10	22.37	23.80	24.57	28.80	24.33 A	
Black cummin oil 1%	22.10	22.47	22.53	23.07	25.67	23.17 B	
Arabic gum 10 % + black cummin oil 1%	22.10	23.03	24.63	24.80	27.20	24.35 A	
Mean	22.10 C	22.55 C	23.64 B	24.09 B	26.46 A		

L.S.D for the interaction effect between treatments and storage periods at 5% = 1.403

Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	23.70	23.90	24.33	26.27	28.00	25.24 C	
Arabic gum 10 %	23.70	25.83	28.13	30.00	31.13	27.76 A	
Black cummin oil 1%	23.70	24.60	26.67	29.73	30.70	27.08 B	
Arabic gum 10 % + black cummin oil 1%	23.70	25.33	25.50	25.83	27.97	25.67 C	
Mean	23.70 E	24.92 D	26.16 C	27.96 B	29.45 A		

*L.S.D for the interaction effect between treatments and storage periods at 5% = 1.209

Table (10): Effect of some postharvest treatments on total sugar (g/100 FW) of date palm cv. Samany stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	19.62	20.35	21.70	24.20	26.87	28.70	23.57 C
Arabic gum 10 %	19.62	23.20	25.87	27.00	28.97	30.03	25.78 A
Black cumin oil 1%	19.62	24.07	24.77	25.53	27.40	29.10	25.08 B
Arabic gum 10 % + black cumin oil 1%	19.62	22.00	24.50	26.30	27.07	29.33	24.80 B
Mean	19.62 F	22.40 E	24.21 D	25.76 C	27.58 B	29.29 A	
*L.S.D for the interaction effect between treatments and storage periods at 5% = 1.295							
Treatment	Season 2013						Mean
	Storage periods (days)						
	0	15	30	45	60	75	
Control	22.00	22.07	22.47	23.13	24.00	26.63	23.38 C
Arabic gum 10 %	22.00	24.07	25.07	25.50	26.23	28.30	25.19 A
Black cumin oil 1%	22.00	22.33	22.37	23.50	25.83	27.20	23.93 B
Arabic gum 10 % + black cumin oil 1%	22.00	22.67	22.83	23.90	25.12	25.47	23.66 BC
Mean	22.00 E	22.78 D	23.28 D	24.01 C	25.30 B	26.90 A	
*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.376							

Regarding to the interaction effect between the tested postharvest treatments and storage periods, results showed that, arabic gum at 10% under cold storage for sixty days succeeded in increasing total sugar of Zaghoul date palm fruits. However, the highest fruits total sugar content was observed for Samany cv. when the fruits were treated with arabic gum at 10% for seventy five days under cold storage condition in both seasons. On the opposite, the lowest fruit total sugar content were scored by the interactions of fifteen days cold storage period (irrespective initial time), particularly those interacted with control treatment in two cultivars in both seasons. The remained interactions of the studies storage period came in-between.

Total acidity (%)

The effect of postharvest treatments, data in Tables (11 & 12) cleared that, there was no clear trend for treatments effects on fruit total acidity contents. Whereas, the lowest percentages of acidity were recorded by black cumin oil at 1% in the first season or arabic gum at 10% + black cumin oil at 1% in the second one for Zaghoul fruits. However, for Samany fruits there were no significant differences of treatments on fruit total acidity content in the first season, while in the second one control treatment gave the lowest value of total acidity without significant differences with black cumin oil 1%. Additionally prolonging the storage period induced a remarkable decrease in fruit total acidity content of date palm fruits for both cultivars, hence the initial readings scored the highest values of this parameter in comparison with the other studied storage periods. Whereas, the lowest values of total acidity content were recorded by sixty days cold storage for Zaghoul date fruits and seventy five says cold storage for Samany fruits.

Concerning to the interaction effect between the tested postharvest treatments and storage periods, results indicated that coated Zaghoul date palm fruits with 1% black cumin oil and 10% arabic gum after sixty days cold storage period scored the lowest percentage of acidity in the first and second seasons, respectively. Whereas, 1% black cumin oil and control treatments for Samany fruits after seventy five days cold storage period registered the lowest values of this parameter in both seasons. On the other hand the highest percentages of fruit acidity in Zaghoul and Samany fruits were gained at initial readings in both seasons. The rest interactions gave in between values in this respect.

The obtained results of arabic gum and black cumin oil in enhancing chemical fruit quality of date palm fruits are in harmony with El-Anany *et al.*, (2009), Rabiei *et al.*, (2011) and Shirzadeh and Kazemi, (2012) on apple fruits, Baiea and El-Badawy (2013) and El-Sharony and Amin (2014) on navel orange fruits and Mehdi *et al.*, (2011) on banana and papaya fruits. They declared that edible coating of fruits including arabic gum and black cumin oil appeared to be a good mixture for maintaining the quality of fruits during storage.

CONCLUSION

In conclusion, the results of current investigation indicated that, date palm fruits coated with 10% arabic gum + 1% black cumin oil and arabic gum at 10% showed a good effects on reduce weight loss and fruit decay percentages, delay the change of fruit firmness and enhance of chemical fruit properties (total soluble solids, total sugar and total acidity) of date palm cvs. Zaghoul for sixty days and Samany for seventy five days during cold storage at 0 ± 1 °C.

Table (11): Effect of some postharvest treatments on total acidity percentage of date palm cv. Zaghloul stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012					
	Storage periods (days)					Mean
	0	15	30	45	60	
Control	1.02	0.86	0.70	0.66	0.64	0.78 AB
Arabic gum 10 %	1.02	0.90	0.84	0.80	0.70	0.85 A
Black cummin oil 1%	1.02	0.73	0.63	0.53	0.50	0.68 C
Arabic gum 10 % + black cummin oil 1%	1.02	0.75	0.70	0.67	0.65	0.76 BC
Mean	1.02	0.81	0.72	0.67	0.62	
	A	B	C	CD	D	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.194

Treatment	Season 2013					
	Storage periods (days)					Mean
	0	15	30	45	60	
Control	0.84	0.63	0.57	0.48	0.42	0.59 A
Arabic gum 10 %	0.84	0.56	0.47	0.45	0.23	0.51 B
Black cummin oil 1%	0.84	0.64	0.49	0.49	0.42	0.58 A
Arabic gum 10 % + black cummin oil 1%	0.84	0.52	0.40	0.39	0.35	0.50 B
Mean	0.84	0.59	0.48	0.45	0.35	
	A	B	C	C	D	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.096

Table (12): Effect of some postharvest treatments on total acidity percentage of date palm cv. Samany stored at 0 ± 1 °C in 2012 and 2013 seasons.

Treatment	Season 2012						
	Storage periods (days)					Mean	
	0	15	30	45	60		
Control	0.60	0.55	0.45	0.35	0.31	0.25	0.42 A
Arabic gum 10 %	0.60	0.52	0.39	0.34	0.32	0.28	0.41 A
Black cummin oil 1%	0.60	0.50	0.45	0.40	0.33	0.25	0.42 A
Arabic gum 10 % + black cummin oil 1%	0.60	0.48	0.45	0.40	0.33	0.28	0.43 A
Mean	0.60 A	0.51 B	0.44 C	0.37 D	0.33 D	0.27 E	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.107

Treatment	Season 2013						
	Storage periods (days)					Mean	
	0	15	30	45	60		
Control	0.42	0.35	0.29	0.27	0.25	0.21	0.30 B
Arabic gum 10 %	0.42	0.35	0.32	0.29	0.28	0.23	0.32 A
Black cummin oil 1%	0.42	0.38	0.33	0.27	0.22	0.21	0.31 AB
Arabic gum 10 % + black cummin oil 1%	0.42	0.39	0.33	0.29	0.27	0.22	0.32 A
Mean	0.42	0.37	0.32	0.28	0.25	0.22	
	A	B	C	D	E	F	

*L.S.D for the interaction effect between treatments and storage periods at 5% = 0.107

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