Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Maintaining Storability of Brahee Date Palm Fruits with Postharvest Edible Coating by using Alginate Salts

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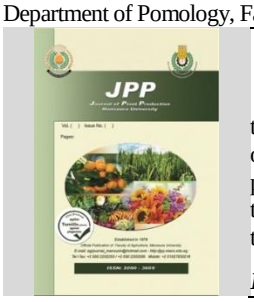

ABSTRACT

The behavior of Brahee date palm fruits during cold storage at 4°c and ambient condition in response to calcium and sodium alginate edible coating at 1, 3and 5% was studied during 2016 and 2017 seasons. The obtained results showed the pronounced effect of calcium and sodium alginate at 3% on maintaining different physicochemical parameters which were determined during this study compared with other concentrations of them or control. But the preference was for the fruits coated with calcium alginate at 3%; hence it maintained the characteristics of Barhee date fruits tell the end of the storage period during 2016 and 2017 seasons.

Keywords: Date palm – Barhee – edible coating - alginate – cold storage –shelf life.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is a popular fruit tree in North Africa as date fruits are a significant wellspring of vitality and basic supplements and have some therapeutic advantages (Aleid *et al*., 2014). It includes many cultivars but Egyptian farmers in Delta region prefer some of them like Zaghlol, Hayany, Samany and recently Barhee cultivar which has a preferable among Egyptian consumers as a fresh fruit at the mature full yellow (bisir) stage due to its crispy flavor and low contents of soluble tannins but at the rutab stage (ripening), fruit market value decreases for its softer and sweeter pulp.

Under Egyptian conditions, 'Barhee' dates attain the bisir stage during tough summer (mid-August to early September). After harvest, fruits mature hastily, particularly in ambient conditions, and consequently forfeit much of their merchandising esteem. Thus, there was a critical requirement to control fruit postharvest ripening for prolonging the shelf life of harvested bisir fruit with the least physiological and physical disturbance.

In this respect, researchers have used several methods for extending the shelf life of Barhee date fruit like immersing in GA3, NAA and benzyladenine (Adel and Mohamed, 2011) or pre-harvest applications at the hababouk phase and at the starter of changing fruit color with different hormones (Kassem *et al.*, 2011). Recently, there is a great concern in naturalistic components as favorable procedure for preserving fruit characteristic and curtailment fungi infections; hence, edible coatings are comprised of edible compounds such as lipids, proteins, and polysaccharides and can be consumed as a part of food (Cagri *et al.*, 2004 and Fakhouri *et al.*, 2015). These coatings enhance the shelf life of food commodities by refining their internal atmosphere. These act as a semipermeable block and diminish respiration and transpiration average and hence retard senescence (Gao *et al.*, 2015).

Alginate is one of the polysaccharides utilized in the edible coating preparation; hence, it is a hydrophilic biopolymer derived from brown marine algae that has a coating role for its unrivaled colloidal feature, which involve its use for intensification, abeyance forming, gel forming and emulsion stabilizing (Acevedo *et al.*, 2012). It is an extraordinary compound because of being inexpensive, biocompatible, biodegradable and non-toxic compared to natural casings (Comaposada *et al.*, 2015). Other properties of alginates are their capability to form thermo-irreversible gels at ambient condition, by cross-linking with di- or trivalent ions (Bruchet and Melman, 2015).

Generally, there is a little literature information about utilizing alginate salts on the storage ability of Barhee date fruits. So, there was a necessity to study the effect of alginate salts like sodium and calcium alginate at different concentrations as a polysaccharide edible coating on the behavior of Barhee date fruits during cold storage and ambient temperature.

MATERIALS AND METHODS

Barhee date palm fruits were harvested at full maturity phase, according to skin color (the whole fruit should be yellow, and the yellowish- green area should not exceed 10%) from commercial orchard at the village of Rashid near the village of Abu Rawash center of Kerdasa in Giza Governorate, Egypt in first of September then transferred to Post-graduate Laboratory of Pomology Department, Mansoura Univ. during 2016 and 2017 seasons. All date palms fruits were assorted depends on similar size and the absence of physical disorder, and then sterilized with 1% sodium hypochlorite (v/v) for 2 min, swill in distilled water carefully and left to dry at room temperature (21°C) for 3 h.

Experiment Design and Layout

The experiment was laid out rendering a completely randomized design having two factors (edible coating and

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DOI: 10.21608/jpp.2019.71517

storage days) and three replications. The edible coatings used were calcium alginate and sodium alginate; whereas, control treatment comprised of non-coated fruits. The treated fruits were evaluated for their quality attributes on days 0, 15, 30 and 45.

Preparation of edible coating Solutions

Sodium Alginate Solution

Sodium alginate (Oxford Lab. Chem., ISO:9001-2008, India) coating emulsion (1, 3 and 5%, w/v) were intended by disbanding 20, 60 and 100 g in 2000 mL of distilled water upon stirring at 70 °C for 2 h. Then glycerol at 20% v/v was added as plasticizer after cooling to 20 °C, according to Poverenov *et al.* (2014).

Calcium Alginate Solution

Sodium alginate (Oxford Lab. Chem., ISO:9001-2008, India) and calcium chloride (SDFCL, India) salts were applied to form a calcium alginate gel (Rojas-Graü *et al.*, 2007). Sodium alginate and calcium chloride solutions (both of them 1, 3 and 5 % w/v) were intended by disbanding these salts in distilled water, then heating the Sodium alginate solution at 70 °C, while stirring, until the solution became clear. After cooling to 20 °C, glycerol at 20% v/v was added as plasticizer according to Poverenov *et al.* (2014).

Coating application and Storage

The clean dried Barhee date fruits were divided into 7 main lots, three of them for soaking in different concentrations of Sodium alginate solutions for 2 min. The other three were treated by Calcium alginate by following three stages (1) dipping into sodium alginate solutions for 2 min, (2) allowing 1 min for vanishing the remaining solution and then (3) submerging the fruit for 2 min in the identical solutions of $CaCl_2$ (Olivas *et al.*, 2007) and the residual lot for control which was soaked in distilled water.

After the coating application, the fruits were air-dried for 2 h. The dried coated fruits were placed in a ventilated carton box (50×30×12 cm); hence, each treatment was constituted by six carton box. Each carton box was divided into three parts, each part represents a replicate which contains a known weight of fruits, then all boxes (72 boxes) were taken for cold storage at 4±1˚C and 90-95% relative humidity (RH). Two carton boxes of each treatment were taken at 15, 30 and 45 days intervals, one of them for physical and chemical analysis of fruits quality during cold storage and the other box was held for 7 days at room temperature (as shelf-life) at 25 ± 2 ˚C to estimate the alteration in physiochemical properties of fruits during ambient conditions. Taking into consideration that fresh fruits were analyzed for their quality on day 0.

Fruit Physical analyses

Weight Loss (%):

It was determined according to the following equation.

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

Decay Percentage (%):

Assessed by skin appearance, withering, chilling damage, and pathogenic decays. Hence, the decayed fruits per each replicate were weighted and disposed of, then decay percentage was assessed according to the following equation:

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

Rutab percentage (%):

The rutab fruits were disposed of according to change in color to dark brown and softening of about 20% of its surface and its percentage was assessed according to the following equation:

$$\text{Rutab \%} = \frac{\text{Weight of rutab fruits}}{\text{Initial weight}} \text{ X } 100$$

Fruit firmness (Lb/inch^2):

It was estimated as Lb/inch^2 by utilizing a hand Effegi-Penetrometers attached to plunger 3 mm diameter.

Moisture (%):

Weight of fresh sample from each replicate was dried to a constant weight (g) in an air-drying oven at 70˚C, then the dry weight of the sample was recorded. The moisture content of the sample on a dry basis was calculated as a percentage.

Fruit Chemical analyses:

Soluble solids content (SSC) (Brix %)

It was determined by a digital refractometer in fruit juice as Brix % (DR 6000, A. Kruss Optronic GmbH, Hamburg, Germany).

Titratable acidity (%):

It was determined as a percentage of malic acid in fruit juice (AOAC, 1980).

SSC/Acid ratio:

It was determined as a ratio between SSC and total titratable acidity.

Total sugars percentage (g/100 g dry weight):

It was determined by using phenol 18% and sulphuric acid 96% and the samples were measured at 490 nm by spectrophotometer (Sadasivam and Manickam, 1996).

Fruit tannins content (mg/100 g Fresh weight):

Soluble tannins were extracts from 5 g of fruit tissue by 80% methanol and 0.5 ml Folin-ciocalteu reagent. And the absorbance was measured at 750 nm using a UV-Vis spectrophotometer. The blank contained only water and the reagents. Soluble tannins were estimated from a calibration curve obtained by measuring the absorbance of known concentrations of gallic acid (Taira, 1996).

Statistical analysis

Obtained data during both seasons of this study were statistically analyzed as a factorial experiment in a complete randomized block design with three replicates by analysis of variance (ANOVA) (Snedecor and Cochran, 1994), utilizing the statistical software package SAS (SAS Institute Inc., 2000, Statistical Software, Cary, NC., USA). Comparisons between means were made by using the least significant differences test (LSD) at 5% level of probability (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

Fruit weight loss (%):

Regarding the effect of the examined treatments, Table 1 illustrated that all evaluated treatments succeeded in reducing weight loss percentage of Barhee date palms fruits during storage duration in comparison with uncoated fruits (control) during both seasons. Generally, the treatment of 3% calcium alginate proved to be the most efficient in this concern, followed by 3% sodium alginate treatment; hence, alginate coating diminished weight loss by barring water vapor transition, inhibited microbial growth, belated ripening and diminished changes in physicochemical fruit properties

(Narsaiah *et al.*, 2015). Especially, calcium alginate coating which acts efficaciously as a water vapor block during storage duration by preventing water loss; hence, it produces a high relative humidity at the fruit surface, thus reducing the slope to the outer surface (Olivas *et al.*, 2007).

As for the impact of cold storage durations, it is quite clear from Table 1 that "Barhee" date palm fruits lost weight with the progress of storage duration during ambient and cold storage. So, 45 days under cold storage recorded the highest value of the loss, whereas "irrespective of the initial reading" the lowest value was obtained after fifteen days of cold storage of both seasons. The variations between the aforementioned cold storage durations were highly significant. The obtained results go in the same line with Chiabrando and Giacalone (2017) who studied the effects of sodium alginate coating on the storability of blueberries and found that sodium alginate (1.5%) gave acceptable results for extending the shelf life up to 45 days without adversely affecting the quality. Moreover, Aloui *et al.* (2014) found that sodium alginate at 2% level diminishing weight loss, retaining firmness and retardant repining process during the storage of grapefruit.

Considering the interaction effect between tested edible coating treatments and storage durations, data in Table 1 displayed that the interactions of fifteen days storage duration had the lowest percentages of weight loss especially, fruit coating with sodium and calcium alginate at 3% but calcium alginate at 3% treatment was the best in this respect. On the contrary, the highest percentage of weight loss was observed under those of 45 days storage period combinations, particularly those uncoated fruits "control" during both seasons. The other combinations showed intermediate values in this concern during ambient and chilled storage.

Table 1. Weight loss percentage in "Barhee date palm" fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 seasons.

Treatment	Weight Loss % (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	0	1.08	1.33	1.62	1.01	0	10.16	11.32	12.61	8.53
Sodium alginate 3%	0	0.78	0.89	1.28	0.74	0	10.05	10.61	11.71	8.09
Sodium alginate 5%	0	1.55	2.08	2.09	1.43	0	12.13	12.92	14.47	9.88
Calcium alginate 1%	0	0.99	1.07	1.54	0.90	0	10.07	10.98	12.49	8.39
Calcium alginate 3%	0	0.59	0.74	0.97	0.58	0	9.87	10.34	11.19	7.85
Calcium alginate 5%	0	1.23	1.67	1.89	1.20	0	10.39	12.76	13.74	9.22
Control	0	2.19	3.85	3.99	2.51	0	13.06	13.44	24.76	12.82
Mean	0	1.20	1.66	1.91	-	0	10.82	11.77	14.43	-
LSD at 5%	Treatment (T) = 0.03 Storage period (S) = 0.02 T x S = 0.05					Treatment (T) = 0.01 Storage period (S) = 0.01 T x S = 0.02				
	Weight Loss % (Season 2017)									
Treatment	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	0	1.18	1.43	1.72	1.08	0	10.36	11.52	12.81	8.67
Sodium alginate 3%	0	0.88	0.99	1.38	0.81	0	10.25	10.81	11.91	8.24
Sodium alginate 5%	0	1.65	2.18	2.19	1.51	0	12.33	13.12	14.67	10.03
Calcium alginate 1%	0	1.09	1.17	1.64	0.98	0	10.27	11.18	12.69	8.54
Calcium alginate 3%	0	0.69	0.84	1.07	0.65	0	10.07	10.54	11.39	8.00
Calcium alginate 5%	0	1.33	1.77	1.99	1.27	0	10.59	12.96	13.94	9.37
Control	0	2.29	3.95	4.09	2.58	0	13.26	13.64	24.96	12.97
Mean	0	1.30	1.76	2.01	-	0	11.02	11.97	14.62	-
LSD at 5%	Treatment (T) = 0.05 Storage period (S) = 0.06 T x S = 0.17					Treatment (T) = 0.03 Storage period (S) = 0.02 T x S = 0.07				

The recorded results on weight loss of "Barhee" date palms fruits compatible with what was mentioned by Moraes *et al.* (2012) who demonstrated that alginate coating had the highest tensile strength and lowest water vapor permeability. Which leads to its use as a prophylactic barrier on fruits. Furthermore, alginate coating significantly diminishes respiration rates and thus the production of ethylene in climacteric fruits such as plum cultivars (Valero *et al.*, 2013). That might be due to alginate coatings enhance the resistance of fruit surface to gas prevalence by obstructing its pores, resulting in a modified internal atmosphere of relatively high CO_2 and low O_2 (Maftoonazad *et al.*, 2008).

Decay percentage:

Data in Table 2 declared that all tested edible coatings applications did not show any infected fruits during the first 30 days of storage period but decay percentage was observed significantly of "Barhee" date palm fruits at the end of storage duration (45 days), with superior for uncoated fruits as compared with coated fruits as an average during both seasons. Fruits treated with 3% calcium alginate statistically recorded the lowest fruit decay percentages, followed by 3% sodium alginate treatment during both seasons. Our results are consistent with those of Fan *et al.* (2009) who mentioned the effectiveness of the edible alginate coating in reducing the infection of fungi caries from strawberries during storage compared to the control; furthermore, the increment in alginate condensation from 1 : 3 % might decrease oxygen permeability due to the hindering of oxygen molecules passing through the more closely packed alginate network which reduce the growth of mold (Hajer *et al.*, 2014).

On the reverse, the highest fruit decay percentages were coupled with control followed by the high concentrations of sodium alginate and calcium alginate, respectively. That might be due to the restrictive action of edible coating on gas reciprocation which promotes physiological disorders on the fruit surface, possibly by motivating fermentation and the cumulation of toxic metabolites. This evidence may encourage cellular death of

tissue and the increment of visible decay (Risse *et al.*, 1987 and Moayednia *et al.*, 2010).

Referring to the interaction impact between edible coatings applications and storage durations, data in Table 2 indicated that the combination of 45 days storage period was the most promising in producing the highest values of this parameter, especially those of uncoated fruits as an average of the two seasons. On the contrary, the lowest values of decay percentage were scored by the combination of 45 days storage periods, particularly those coated with 3% calcium alginate during both seasons. However, Cold storage for 45 days diminished the storability of "Barhee" date fruits, hence it recorded the highest values in this scene compared to the obtained values of fifteen and thirty days cold storage (Table 2).

Table 2. Decay percentage in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 seasons.

Treatment	Decay % (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	0	0	0	26.11	6.53	0	0	0	27.14	6.78
Sodium alginate 3%	0	0	0	12.36	3.09	0	0	0	17.4	4.35
Sodium alginate 5%	0	0	0	30.59	7.65	0	0	0	33.47	8.37
Calcium alginate 1%	0	0	0	18.82	4.70	0	0	0	19.01	4.75
Calcium alginate 3%	0	0	0	4.82	1.21	0	0	0	10.87	2.72
Calcium alginate 5%	0	0	0	27.33	6.83	0	0	0	27.58	6.89
Control	0	0	0	35.05	8.76	0	0	0	42.12	10.53
Mean	0	0	0	22.15	-	0	0	0	25.37	-
LSD at 5%	Treatment (T) = 0.59 Storage period(S) = 0.45 T x S = 1.19					Treatment (T) = 0.59 Storage period(S) = 0.45 T x S = 1.19				
Treatment	Decay % (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	0	0	0	26.21	6.55	0	0	0	27.34	6.84
Sodium alginate 3%	0	0	0	12.46	3.12	0	0	0	17.6	4.40
Sodium alginate 5%	0	0	0	30.69	7.67	0	0	0	33.67	8.42
Calcium alginate 1%	0	0	0	18.92	4.73	0	0	0	19.21	4.80
Calcium alginate 3%	0	0	0	4.92	1.23	0	0	0	11.07	2.77
Calcium alginate 5%	0	0	0	27.43	6.86	0	0	0	27.78	6.95
Control	0	0	0	35.15	8.79	0	0	0	42.32	10.58
Mean	0	0	0	22.25	-	0	0	0	25.57	-
LSD at 5%	Treatment (T) = 0.69 Storage period(S) = 0.55 T x S = 1.29					Treatment (T) = 0.67 Storage period(S) = 0.53 T x S = 1.31				

Rutab percentage

It was clear from the results in Table 3 that all examined edible coating applications significantly improved the transmutation of Barhee date fruits from the bisir to the rutab phase during both seasons; hence; Barhee date fruits start maturity at the apex, alteration in color to brown or black and becomes soft (Pourdarbani *et al.*, 2012). Generally, all treatments increased the rutab percentage of Barhee date fruits as the storage duration was elongated but the fruits coated with calcium alginate 3% presented the lowest percentage compared to other treatments or control which showed the highest percentage in this sense during gold storage and ambient condition during both seasons. The results go in line with the findings of Huertas *et al.*, ((2012) who reported that alginate coating is a beneficial tool to retard the fruit ripening after harvest by reducing respiration rate, firmness losses, and color alteration.

Referring to the impact of stor age periods, the mentioned table indicates that, regardless of the initial reading, the rutab percentage of "Barhee" date fruits was gradually increased as the cold storage duration was increased from 15 to 45 days. However, stored "Barhee" fruits for 45 days scored the highest values as compared with storage periods for 15 days during both seasons.

Regarding the interaction impact between the tested edible coatings treatments and storage periods, results in Table 3 demonstrated that "irrespective of the initial data (zero storage period)" the lowest values of rutab percentage were recorded at 15 days of storage durations, especially 3% calcium alginate-coated fruits. Conversely, the highest values of this parameter were registered by 45 days of storage periods, especially those of uncoated fruits during both seasons during ambient and cold storage.

Firmness:

The firmness of Barhee date fruits took a diminishing trend proportionate with the progression of storage durations (Table 4) and that is consequent of an increment of cell wall hydrolases, which have been correlating to ethylene production (Brummell and Harpster, 2001). Also, cell wall hydrolases cellulose, pectinesterase (PE) and polygalacturonase (PG) in fruits have increased during ripening, which increases the loss of flesh firmness (Abu-Goukh and Bashir, 2003).

It is obvious that the reduction in firmness was less in coated fruits as compared to control; hence, fruits coating with calcium alginate at 3 % have the potential interest for keeping fruit firmness under cold storage and room temperature conditions during both seasons and that might be due to the function of calcium in conserving cell wall structure and membranes (Soliva-Fortuny and Martin-Belloso, 2003). Indeed, values of fruit firmness are consequential with weight loss results; hence, treatments increasing weight loss values were those which presented the lowest firmness (Navarro-Tarazaga *et al.*, 2011).

Otherwise, retentivity of fruit firmness by coated applications could be elucidated by delayed loosestrife of

cell wall ingredient, particularly water-insoluble and NaOH insoluble pectin, for the impact of the interior fruit atmosphere with high CO_2 and low O_2 on diminishing cell wall hydrolases which lead to fruit softening (Valero and Serrano, 2010).

Moreover, Huertas *et al.* (2012) demonstrated that the fruit firmness was enhanced in cherries coated with alginate while uncoated samples improved significantly fruit softening. However, fruits coated with alginate at 3% were more effective than 1 and 5% in enhancing the firmness of Barhee date fruits, particularly at the end of storage duration, either during cold storage or after 7 Days during shelf life.

Table 3. Rutab (%) in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 seasons.

Treatment	Rutab % (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	0	8.59	17.02	30.9	14.13	0	14	21.16	35.67	17.71
Sodium alginate 3%	0	7.21	11.01	25.28	10.88	0	11.23	16.1	29.53	14.22
Sodium alginate 5%	0	15.76	22.75	39.39	19.48	0	16.02	23.81	42	20.46
Calcium alginate 1%	0	7.74	16.65	29.53	13.48	0	12.88	19.69	34.75	16.83
Calcium alginate 3%	0	3.91	9.58	25.00	9.62	0	5.21	15.71	26	11.73
Calcium alginate 5%	0	14.74	20.33	35.51	17.65	0	15.84	23.17	39	19.5
Control	0	16.85	23.47	42.23	20.64	0	21.41	27.57	47.92	24.23
Mean	0	10.69	17.26	32.55	-	0	13.79	21.03	36.41	-
LSD at 5%		Treatment (T) = 0.46 Storage period(S) = 0.35 T x S = 0.92					Treatment (T) = 0.51 Storage period(S) = 0.39 T x S = 1.02			
Treatment	Rutab % (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	0	8.69	17.12	31	14.20	0	14.2	21.36	35.87	17.86
Sodium alginate 3%	0	7.31	11.11	25.38	10.95	0	11.43	16.3	29.73	14.37
Sodium alginate 5%	0	15.86	22.85	39.49	19.55	0	16.22	24.01	42.2	20.61
Calcium alginate 1%	0	7.84	16.75	29.63	13.56	0	13.08	19.89	34.95	16.98
Calcium alginate 3%	0	4.01	9.68	25.1	9.69	0	5.41	15.91	26.2	11.88
Calcium alginate 5%	0	14.84	20.43	35.61	17.72	0	16.04	23.37	39.2	19.65
Control	0	16.95	23.57	42.33	20.71	0	21.61	27.77	48.12	24.38
Mean	0	10.79	17.36	32.65	-	0	13.99	21.23	36.61	-
LSD at 5%		Treatment (T) = 0.66 Storage period(S) = 0.55 T x S = 1.02					Treatment (T) = 0.71 Storage period(S) = 0.59 T x S = 1.09			

Table 4. Firmness in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 seasons.

Treatment	Firmness (Lb/inch^2) (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	18.85	14.62	8.23	4.55	11.56	18.85	8.1	6.22	2.47	8.91
Sodium alginate 3%	18.85	16.28	10.29	5.35	12.69	18.85	9.6	6.73	3.4	9.65
Sodium alginate 5%	18.85	12.05	6.48	3.18	10.14	18.85	5.83	4.88	1.93	7.87
Calcium alginate 1%	18.85	15.78	9.45	4.75	12.21	18.85	9.55	6.28	2.8	9.37
Calcium alginate 3%	18.85	17.08	10.88	5.9	13.18	18.85	10.02	7.85	3.47	10.05
Calcium alginate 5%	18.85	13.15	7.85	4.2	11.01	18.85	6.78	5.68	2.0	8.33
Control	18.85	8.18	5.33	2.79	8.79	18.85	5.78	3.8	0.00	7.11
Mean	18.85	13.88	8.36	4.39	-	18.85	7.95	5.92	2.29	-
LSD at 5%		Treatment (T) = 0.51 Storage period(S) = 0.38 T x S = 0.32					Treatment (T) = 0.29 Storage period(S) = 0.22 T x S = 0.57			
Treatment	Firmness (Lb/inch^2) (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	17.95	13.72	7.33	3.65	10.66	17.95	7.2	5.32	1.57	8.01
Sodium alginate 3%	17.95	15.38	9.39	4.45	11.79	17.95	8.7	5.83	2.5	8.75
Sodium alginate 5%	17.95	11.15	5.58	2.28	9.24	17.95	4.93	3.98	1.03	6.97
Calcium alginate 1%	17.95	14.88	8.55	3.85	11.31	17.95	8.65	5.38	1.9	8.47
Calcium alginate 3%	17.95	16.18	9.98	5	12.28	17.95	9.12	6.95	2.57	9.15
Calcium alginate 5%	17.95	12.25	6.95	3.3	10.11	17.95	5.88	4.78	1.1	7.43
Control	17.95	7.28	4.43	1.89	7.89	17.95	4.88	2.9	0.2	6.48
Mean	17.95	12.98	7.46	3.49	-	17.95	7.05	5.02	1.55	-
LSD at 5%		Treatment (T) = 0.49 Storage period(S) = 0.36 T x S = 0.30					Treatment (T) = 0.34 Storage period(S) = 0.26 T x S = 0.67			

Moisture percentage

In general, the moisture percentage of "Barhee" date fruits diminished with the increment in storage duration (Table 5). Hence, the uncoated "Barhee" date fruits showed a gradual reduction in moisture percentage as compared to those coated with different edible coatings.

Regarding the effect of the tested treatments, Table 5 showed that the treatment of calcium alginate proved to be

the most efficient in this concern, on average of both seasons. Fruits coated with calcium alginate 3% recorded the highest moisture content compared to other treatments as a result of the formation surface layer on the fruits of the fruit to prevent loss of moisture, reduce respiration rate, control gas exchange and water loss of fruits. The obtained data are harmonious with Huertas *et al.*, (2012) who mentioned that water vapor pressure between the fruit and the encirclement air is ordinarily minimized by both cuticle and epidermal cell layer. So, utilizing edible coating represents an additional layer and also coats the stomata causing a diminution in transpiration rate which leads to a decline in moisture.

Table 5. Moisture (%) in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 seasons.

Treatment	Moisture % (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	26.46	15.75	12.56	9.92	16.17	26.46	15.55	11.66	9.81	15..87
Sodium alginate 3%	26.46	17.51	14.62	10.73	17.33	26.46	17.32	13.04	10.41	16.81
Sodium alginate 5%	26.46	15.46	11.84	9.25	15.75	26.46	14.09	11.26	6.88	14.67
Calcium alginate 1%	26.46	16.55	13.06	10.21	16.57	26.46	16.46	12.95	10.13	16.5
Calcium alginate 3%	26.46	19.41	15.9	10.86	18.16	26.46	18.12	15.72	10.79	17.77
Calcium alginate 5%	26.46	15.62	12.53	9.78	16.09	26.46	15.46	11.47	7.64	15.25
Control	26.46	14.53	10.40	7.94	14.83	26.46	12.39	9.02	5.10	13.24
Mean	26.46	16.41	12.99	9.81	-	26.46	15.63	12.16	8.68	-
LSD at 5%	Treatment (T) = 0.40 Storage period(S) =0.30 T x S = 0.79					Treatment (T) = 0.42 Storage period(S) = 0.318 T x S = 0.841				

Treatment	Moisture % (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	24.81	14.1	10.91	8.27	14.52	24.81	14.28	10.39	8.54	14.51
Sodium alginate 3%	24.81	15.86	12.97	9.08	15.68	24.81	16.05	11.77	9.14	15.44
Sodium alginate 5%	24.81	13.81	10.19	7.6	14.10	24.81	12.82	9.99	5.61	13.31
Calcium alginate 1%	24.81	14.9	11.41	8.56	14.92	24.81	15.19	11.68	8.86	15.14
Calcium alginate 3%	24.81	17.76	14.25	9.21	16.51	24.81	16.85	14.45	9.52	16.41
Calcium alginate 5%	24.81	13.97	10.88	8.13	14.45	24.81	14.19	10.2	6.37	13.89
Control	24.81	12.88	8.75	6.29	13.18	24.81	11.12	7.75	3.83	11.88
Mean	24.81	14.75	11.34	8.16	-	24.81	14.36	10.89	7.41	-
LSD at 5%	Treatment (T) = 0.30 Storage period(S) =0.23 T x S = 0.60					Treatment (T) = 0.43 Storage period(S) = 0.32 T x S = 0.86				

As for the interaction impact between storage duration and tested edible coatings applications, data presented in Table 5 illustrated that the interactions of 15 days storage duration under cold storage recorded the highest moisture percentage especially, fruits coated with 3% calcium and sodium alginate but 3% calcium alginate treatment was the best in this respect. On the contrary, the lowest moisture percentage was observed on those of 45 days storage period combinations, particularly those uncoated fruits "control" during both seasons during ambient and chilled storage. The obtained results go in the same line with those found by Ali *et al.* (2010) and Xiao *et al.* (2010) who indicate that the efficiency of alginate coatings as a semipermeable barrier able to retard moisture and reduce respiration rate due to its hydrophilic nature of polysaccharides which make it more conspicuous as a gas impediment rather than delaying water loss.

Soluble solids content:

Data in Table 6 reveal that SSC of "Barhee" date fruits was affected by using the different edible coating treatments. However, the highest value of this parameter was gained by uncoated fruits on average of both seasons during ambient and cold storage. Also, fruits coated with high concentrations of calcium and sodium alginate (5%) increased SSC as compared with the other edible coatings on average of the two seasons.

Referring to the impact of the storage period, SSC of "Barhee" date fruits steadily increased with advancing the storage periods till reach the maximum increase after 45 days under storage period on average of both seasons.

As for the interaction impact between edible coating applications and storage durations, data in the same Table indicated that all resulted combinations increased SSC of "Barhee" date fruits as compared with the initial readings, and the superiority was for the combinations of 45 days storage period in most cases on average of the two seasons. Anyway, the highest values of this parameter were recorded by uncoated fruits at 45 days of cold storage during both seasons. On the opposite, the lowest values of this parameter were related to the combination of 15 days storage period with 3% calcium alginate coated fruits in both seasons during ambient and cold storage.

The results on this concern compatible with the findings of Duan *et al.* (2011) who stated that acid metabolism changes acid to sugar, thus total acidity decreased and SSC increased during storage duration. These results are in agreement with the findings of Chiabrando and Giacalone (2013) for nectarines fruits coated by sodium alginate.

Titratable acidity (%):

Data in Table 7 showed that the lowest fruit acidity (%) of "Barhee" was recorded by uncoated fruits; whereas, the highest fruit acidity content was scored by those treated by 3% calcium alginate on average of both seasons; hence, Díaz-Mula (2012) mentioned that the alginate coatings were efficient in retarding the loss of total acidity which happened

either during cold storage or after 7 days during shelf life in control fruits in Cherry fruit.

It was interesting to note that there was a negative relationship between fruit acidity and storage periods. Hence, as the storage period increased, the values of fruit acidity decreased to reach the maximum reduction at the longest storage period (45 days). This trend was true during both seasons during ambient and chilled storage which may be indicated to the utilize of organic acids as substrates during the metabolism of the respiration process (Gol *et al*., 2013). In this status, coatings diminish the rate of respiration process which retard the utilization of organic acids (Yaman and Bayoindirli, 2002). Furthermore, coatings supported acidity retention as compared to uncoated fruits, as a result of coating role in retarding fruits ripening (El-Anany *et al.*, 2009).

Table 6. SSC (Brix %) in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 season.

Treatment	SSC (Brix %) (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	24	26.17	28.83	30	27.25	24	28.17	30.83	32	28.75
Sodium alginate 3%	24	25	28	29	26.5	24	27	30	31	28
Sodium alginate 5%	24	27.5	30.83	31	28.33	24	29.5	32.83	33	29.83
Calcium alginate 1%	24	25.33	28.67	30	27	24	27.33	30.67	32	28.5
Calcium alginate 3%	24	23	26	28	25.25	24	25	28	30	26.75
Calcium alginate 5%	24	26.83	29.17	30.67	27.67	24	28.83	31.17	32.67	29.17
Control	24	27.67	33.33	36	30.25	24	29.67	35.33	38	31.75
Mean	24	25.93	29.26	30.67	-	24	27.93	31.26	32.67	-
LSD at 5%	Treatment (T) = 0.79 Storage period(S) = 0.60 T x S = 1.59					Treatment (T) = 0.95 Storage period(S) = 0.72 T x S = 1.9				
Treatment	SSC (Brix %) (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	24.5	26.67	29.33	30.5	27.75	24.5	28.67	31.33	32.5	29.25
Sodium alginate 3%	24.5	25.5	28.5	29.5	27.00	24.5	27.5	30.5	31.5	28.50
Sodium alginate 5%	24.5	28	31.33	31.5	28.83	24.5	30	33.33	33.5	30.33
Calcium alginate 1%	24.5	25.83	29.17	30.5	27.50	24.5	27.83	31.17	32.5	29.00
Calcium alginate 3%	24.5	23.5	26.5	28.5	25.75	24.5	25.5	28.5	30.5	27.25
Calcium alginate 5%	24.5	27.33	29.67	31.17	28.17	24.5	29.33	31.67	33.17	29.67
Control	24.5	28.17	33.83	36.5	30.75	24.5	30.17	35.83	38.5	32.25
Mean	24.5	26.43	29.76	31.17	-	24.5	28.43	31.76	33.17	-
LSD at 5%	Treatment (T) = 0.81 Storage period(S) = 0.61 T x S = 1.65					Treatment (T) = 0.77 Storage period(S) = 0.59 T x S = 1.56				

Table 7. Titratable acidity (%) in "Barhee date palm" fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 season.

Treatment	Titratable acidity (%) (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	0.199	0.179	0.143	0.116	0.159	0.199	0.156	0.138	0.098	0.148
Sodium alginate 3%	0.199	0.188	0.154	0.143	0.171	0.199	0.179	0.152	0.112	0.160
Sodium alginate 5%	0.199	0.152	0.125	0.112	0.147	0.199	0.127	0.116	0.082	0.131
Calcium alginate 1%	0.199	0.183	0.148	0.134	0.166	0.199	0.174	0.144	0.103	0.155
Calcium alginate 3%	0.199	0.192	0.168	0.152	0.178	0.199	0.179	0.161	0.116	0.164
Calcium alginate 5%	0.199	0.165	0.138	0.114	0.154	0.199	0.138	0.129	0.089	0.139
Control	0.199	0.134	0.116	0.094	0.136	0.199	0.125	0.107	0.066	0.124
Mean	0.199	0.171	0.142	0.123	-	0.199	0.154	0.135	0.095	-
LSD at 5%	Treatment (T) = 0.001 Storage period(S) = 0.001 T x S = 0.003					Treatment (T) = 0.002 Storage period(S) = 0.001 T x S = 0.003				
Treatment	Titratable acidity (%) (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	0.169	0.149	0.113	0.086	0.129	0.169	0.126	0.108	0.068	0.118
Sodium alginate 3%	0.169	0.158	0.124	0.113	0.141	0.169	0.149	0.122	0.082	0.131
Sodium alginate 5%	0.169	0.122	0.095	0.082	0.117	0.169	0.097	0.086	0.052	0.101
Calcium alginate 1%	0.169	0.153	0.118	0.104	0.136	0.169	0.144	0.114	0.073	0.125
Calcium alginate 3%	0.169	0.162	0.138	0.122	0.148	0.169	0.149	0.131	0.086	0.134
Calcium alginate 5%	0.169	0.135	0.108	0.084	0.124	0.169	0.108	0.099	0.059	0.109
Control	0.169	0.104	0.086	0.064	0.106	0.169	0.095	0.077	0.036	0.094
Mean	0.169	0.140	0.111	0.094	-	0.169	0.124	0.105	0.065	-
LSD at 5%	Treatment (T) = 0.001 Storage period(S) = 0.001 T x S = 0.003					Treatment (T) = 0.002 Storage period(S) = 0.001 T x S = 0.003				

As for the interaction impact between the studied edible coatings applications and storage durations, data in Table 7 declared that the lowest values of this parameter were recorded by using the combination of 45 days storage periods, particularly those of uncoated fruits and which coated with high concentrations of calcium and sodium alginate (5%) during both seasons. While "irrespective of the initial reading" the highest values of this parameter were scored by using the combination of 15 days storage period. The remained treatments occupied an intermediate position between the aforementioned treatments during both seasons during ambient and chilled storage.

SSC /acid ratio:

It is obvious from Table 8 that uncoated "Barhee" fruits increased significantly SSC/acid ratio compared to the edible coatings applications; hence, fruits coated with 3% calcium alginate presented the lowest values in this respect during both seasons during ambient and chilled storage.

Regarding the impact of the storage period, the SSC/acid ratio was gradually increased as the storage duration progressed. The increase in SSC/acid ratio through the storage duration fundamentally due to the increase of SSC and the deficiency in total acidity in fruit juice as the storage duration advanced.

Concerning the interaction impact between storage duration and tested edible coatings applications, values presented in Table 8 showed that the interactions of 15 days storage duration under cold storage recorded statistically the lowest SSC/acid ratio especially, fruits coated with calcium and sodium alginate at 3% but calcium alginate at 3% treatment was the best in this respect during both seasons. On the contrary, the highest SSC/acid ratio was observed on those of 45 days storage period combinations, particularly those uncoated fruits "control" during both seasons during ambient and chilled storage.

Table 8. SSC/acid ratio in "Barhee date palms" fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 season.

Treatment	SSC/acid ratio (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	120.60	146.20	201.61	258.62	181.76	120.60	180.58	223.41	326.53	212.78
Sodium alginate 3%	120.60	132.98	181.82	202.79	159.55	120.60	150.84	197.37	276.79	186.4
Sodium alginate 5%	120.60	180.92	246.64	276.79	206.24	120.60	232.29	283.02	402.44	259.59
Calcium alginate 1%	120.60	138.42	193.72	223.88	169.16	120.60	157.07	212.99	310.68	200.34
Calcium alginate 3%	120.60	119.79	154.76	184.21	144.84	120.60	139.66	173.91	258.62	173.19
Calcium alginate 5%	120.60	162.61	211.38	269.04	190.91	120.60	208.91	241.63	367.08	234.56
Control	120.60	206.49	287.33	382.98	249.35	120.60	237.36	330.19	575.76	315.98
Mean	120.6	155.34	211.04	256.90	-	120.6	186.67	237.50	359.7	-
LSD at 5%	Treatment (T) = 5.80 Storage period(S) = 4.39 T x S = 11.61					Treatment (T) = 16.58 Storage period(S) = 12.54 T x S = 33.17				
Treatment	SSC/acid ratio (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	144.97	178.99	259.56	354.65	234.54	144.97	227.54	290.09	477.94	285.14
Sodium alginate 3%	144.97	161.39	229.84	261.06	199.32	144.97	184.56	250	384.15	240.92
Sodium alginate 5%	144.97	229.51	329.78	384.15	272.10	144.97	309.28	387.56	644.23	371.51
Calcium alginate 1%	144.97	168.82	247.20	293.27	213.57	144.97	193.26	273.42	445.21	264.22
Calcium alginate 3%	144.97	145.06	192.03	233.61	178.92	144.97	171.14	217.56	354.65	222.08
Calcium alginate 5%	144.97	202.44	274.72	371.07	248.30	144.97	271.57	319.89	562.20	324.66
Control	144.97	270.87	393.37	570.31	344.88	144.97	317.58	465.32	1069.4	499.33
Mean	144.97	193.87	275.21	352.59	-	144.97	239.28	314.83	562.55	-
LSD at 5%	Treatment (T) = 5.832 Storage period(S) = 4.41 T x S = 11.67					Treatment (T) = 16.61 Storage period(S) = 12.56 T x S = 33.23				

Total sugars content (g/100g dw):

The obtained results in Table 9 illustrated that all examined edible coating treatments have increased the total sugar content of Barhee date fruits during both seasons. However, the highest total sugar content of "Barhee" date fruits was recorded by uncoated fruits followed in descending order by fruit coated with sodium alginate at 5%, while the lowest values of this parameter were scored by 3% calcium alginate-coated fruits followed in ascending order by 3% sodium alginate-coated fruits. This trend was true during both seasons during ambient and chilled storage and that might be due to edible coatings act as a semipermeable impediment and diminish transpiration and rates and respiration hence retards senescence (Gao *et al.*, 2015), especially coating with alginate which may be utilized to promote the antioxidant activity of fruits (Díaz-Mula *et al.*, 2012).

Referring to the effect of storage periods, the same table indicates that, regardless of the initial reading, the total sugars content of "Barhee" date fruits was gradually increased as the cold storage period was increased from 15 to 45 days. However, stored "Barhee" date fruits for 45 days scored the highest values as compared with storage periods for 15 days as an average of the two seasons.

Regarding the interaction impact between the tested edible coatings treatments and storage periods, data in Table 9 demonstrated that "irrespective of the initial data (zero storage duration)" the lowest values of total sugars content was registered by the combination of 15 days storage periods, particularly 3% calcium alginate-coated fruits. Conversely, the highest values of this parameter were

registered by the combination of 45 days storage periods, especially those of uncoated fruits during both seasons. This trend was true in both seasons during ambient and cold storage and that may be due to the fact about date fruits which are classified into three phases of maturity known as; Khalal, Rutab and Tamer rely upon the sugar content, color, texture, and moisture. At the first stage (Khalal), fruit gains uttermost size and weight but the moisture percentage reduces which leads to an increment in total sugar. Following that Rutab stage, where the fruit begins ripening, the moisture percentage reduces by 20% and sucrose converts to reversed sugars (Adel and Mohamed, 2011).

Table 9. Total sugar ratio in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 season.

Treatment	Total sugar (g/100g dw) (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	22.91	23.81	26.14	26.48	24.83	22.91	25.70	26.59	27.42	25.66
Sodium alginate 3%	22.91	23.68	25.83	26.23	24.66	22.91	25.13	26.39	26.74	25.29
Sodium alginate 5%	22.91	23.99	26.89	27.21	25.25	22.91	26.26	27.08	28.08	26.08
Calcium alginate 1%	22.91	23.78	25.89	26.41	24.75	22.91	25.43	26.35	27.05	25.43
Calcium alginate 3%	22.91	23.56	25.57	26.15	24.55	22.91	24.87	26.13	26.73	25.16
Calcium alginate 5%	22.91	23.87	26.66	26.98	25.10	22.91	25.96	26.86	27.73	25.87
Control	22.91	24.095	27.16	27.41	25.39	22.91	26.53	27.39	28.39	26.31
Mean	22.91	23.83	26.30	26.69	-	22.91	25.69	26.68	27.45	-
LSD at 5%	Treatment (T) = 0.27 Storage period(S) = 0.2 T x S = 0.53					Treatment (T) = 0.2 Storage period(S) = 0.14 T x S = 0.38				
Treatment	Total sugar (g/100g dw) (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	23	23.9	26.23	26.57	24.925	23	25.79	26.68	27.51	25.75
Sodium alginate 3%	23	23.77	25.92	26.32	24.75	23	25.22	26.48	26.83	25.38
Sodium alginate 5%	23	24.08	26.98	27.3	25.34	23	26.35	27.17	28.17	26.17
Calcium alginate 1%	23	23.87	25.98	26.5	24.84	23	25.52	26.44	27.14	25.53
Calcium alginate 3%	23	23.65	25.66	26.24	24.64	23	24.96	26.22	26.82	25.25
Calcium alginate 5%	23	23.96	26.75	27.07	25.19	23	26.05	26.95	27.82	25.96
Control	23	24.185	27.25	27.5	25.48	23	26.62	27.48	28.48	26.39
Mean	23	23.92	26.39	26.79	-	23	25.79	26.77	27.54	-
LSD at 5%	Treatment (T) = 0.27 Storage period(S) = 0.2 T x S = 0.53					Treatment (T) = 0.3 Storage period(S) = 0.15 T x S = 0.42				

Fruit tannins content:

It is evident from Table 10 that tannins content, which is the most predominant phenol compounds in date fruits had been affected with different treatments under this study; hence, all evaluated treatments succeeded in reducing tannins content of Barhee date fruits during storage duration.

Table 10. Tannins (mg/100 g Fresh weight) ratio in "Barhee" date palm fruits under cold storage and shelf life (seven days at room temperature) during 2016 and 2017 season.

Treatment	Tannins (mg/100 g Fresh weight) (Season 2016)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	**15**	**30**	**45**	**Mean**	**0**	**15**	**30**	**45**	**Mean**
Sodium alginate 1%	1.85	1.55	1.33	1.13	1.47	1.85	1.33	1.02	0.88	1.27
Sodium alginate 3%	1.85	1.64	1.43	1.22	1.54	1.85	1.42	1.11	0.98	1.34
Sodium alginate 5%	1.85	1.43	1.16	0.95	1.35	1.85	1.12	0.86	0.74	1.14
Calcium alginate 1%	1.85	1.70	1.51	1.31	1.59	1.85	1.52	1.18	1.05	1.40
Calcium alginate 3%	1.85	1.78	1.63	1.39	1.66	1.85	1.59	1.27	1.12	1.46
Calcium alginate 5%	1.85	1.49	1.25	1.05	1.41	1.85	1.25	0.92	0.81	1.21
Control	1.85	1.34	1.07	0.88	1.28	1.85	1.02	0.77	0.65	1.07
Mean	1.85	1.56	1.34	1.14	-	1.85	1.32	1.02	0.89	-
LSD at 5%	Treatment (T) = 0.03 Storage period(S) = 0.02 T x S = 0.06					Treatment (T) = 0.03 Storage period(S) = 0.02 T x S = 0.05				
Treatment	Tannins (mg/100 g Fresh weight) (Season 2017)									
	Cold storage (day)					7 Days during shelf life after cold storage period				
	0	15	30	45	Mean	0	15	30	45	Mean
Sodium alginate 1%	1.65	1.35	1.13	0.93	1.27	1.65	1.13	0.82	0.68	1.07
Sodium alginate 3%	1.65	1.44	1.23	1.02	1.34	1.65	1.22	0.91	0.78	1.14
Sodium alginate 5%	1.65	1.23	0.96	0.75	1.15	1.65	0.92	0.66	0.54	0.94
Calcium alginate 1%	1.65	1.5	1.31	1.11	1.39	1.65	1.32	0.98	0.85	1.20
Calcium alginate 3%	1.65	1.58	1.43	1.19	1.46	1.65	1.39	1.07	0.92	1.26
Calcium alginate 5%	1.65	1.29	1.05	0.85	1.21	1.65	1.05	0.72	0.61	1.01
Control	1.65	1.14	0.87	0.68	1.09	1.65	0.82	0.57	0.45	0.87
Mean	1.65	1.36	1.14	0.93	-	1.65	1.12	0.82	0.69	-
LSD at 5%	Treatment (T) = 0.03 Storage period(S) = 0.02 T x S = 0.06					Treatment (T) = 0.03 Storage period(S) = 0.02 T x S = 0.04				

Generally, the uncoated fruits (control) proved to be the most efficient treatment in this concern, followed by 5% sodium alginate treatment, conversely; fruit coated with calcium alginate at 3% presented the highest tannins content during storage duration during both seasons. That might be due to the unrivaled colloidal characteristic of alginate coatings and their efficiency to form unsolvable polymers by interacting with multivalent metal cations like Ca (Robles-Sánchez *et al.*, 2013) which act as naturalistic barriers on fruit skin and reduce its permeability to water vapor, O_2, and CO_2, orienting to deficiency in transpiration and respiration rate and retard ripening process; thus, maintaining the level of tannins content in Barhee date fruits coated with 3% calcium alginate.

As for the impact of storage durations, it is quite clear from Table 10 that "Barhee" date tannins content decline with the progression of storage duration during ambient and cold storage. So, 45 days under cold storage recorded the lowest value of tannins content, whereas "irrespective of the initial reading" the highest value was obtained after 15 days cold storage as an average of the two seasons.

Considering the interaction impact between tested edible coating treatments and storage duration, data in Table 10 showed that the interactions of 15 days storage duration had the highest percentages of tannins content especially, calcium and sodium alginate at 3% treated fruits but 3% calcium alginate treatment was the best in this respect. On the contrary, the lowest percentage of tannins content was observed under those of 45 days storage period combinations, particularly those uncoated fruits "control" during both seasons. The other combinations showed intermediate values in this concern during ambient and chilled storage.The decrease in tannins content during storage as ripening progressed compatible with Adel and Mohamed (2011) on Barhee dates and Zeinab *et al.* (2017) on Zaghloul dates.

In conclusion, Barhee date fruit can retain its physiochemical properties during cold storage and ambient condition by treating with postharvest edible coating of calcium alginate at 3%.

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"المحافظة على القدرة التخزينية لثمار البلح البرحى بعد الحصاد باستخدام أملاح الألجينات كأغلفة صالحة للأكل"

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قسم الفاكهة – كلية الزراعة – جامعة المنصورة – المنصورة – مصر – ٣٥٥١٦.

تمت دراسة سلوك ثمار نخيل البلح البرحى أثناء التخزين البارد عند ٤°م وجو الغرفة إستجابتاً لأغلفة الكالسيوم و الصوديوم ألجينات الصالحة للأكل عند تركيزات ١، ٣ و ٥ % خلال موسمى ٢٠١٦ و ٢٠١٧. و أظهرت النتائج المتحصل عليها تأثير واضح للكالسيوم و الصوديوم ألجينات عند تركيز ٣% فى المحافظة على مختلف الصفات الفيزيقية والكيميائية للثمار التى تم تقديرها خلال هذه الدراسة مقارنة بباقى التركيزات لكل منهما و الكونترول. و لكن الأفضلية كانت للثمار المغلفة بالكالسيوم ألجينات عند تركيز ٣% حيث حافظت على ثمار البلح البرحى حتى نهاية فترة التخزين خلال موسمى ٢٠١٦ و ٢٠١٧.