Improving Fruit Quality and Storability of "Zaghloul" Date Palm Fruits by Using Safe Pre and Postharvest Substances

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Abstract

The present study was conducted during 2012 and 2013 seasons on "Zaghloul" date palm fruits. Spathes were sprayed three times at growth start, after fruit setting and at one month later with four substances namely Amino acids enriched with micronutrients (Fe, Zn, Mn, B and Mo), Sugar alcohol enriched with micronutrients (B, Fe, Mn, Zn and N), Algae extract formulation containing (potassium oxide, phosphorus oxide , N, Zn, Fe and Mn) in concentration of 2% and Licorice root extraction (*Glycyrrhiza Glabra* L.) in concentration of 7%. Sprayed fruits were harvested at khalal stage and immersion in 1% chitosan as postharvest application and then fruits stored up to 3 months at 0°C and relative humidity (RH) 90-95% in order to study the effect of all treatments on fruit quality and storability of "Zaghloul" date palm. All treatments increasing fruit firmness, total soluble solids (ºBrix) and total sugars and decreasing weight loss percentage, discarded percentage, and total soluble tannins as compared with the control treatment. The best results with regard to fruit quality and storability of "Zaghloul" date palms were obtained with spraying licorice root extraction three times and immersion in 1% chitosan.

Keywords: "Zaghloul" date palm, spraying, amino acids, sugar alcohol, algae extract, licorice root extract, chitosan, cold storage, quality.

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Introduction

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruit trees in the world. It is known as "tree of life" because of its resilience, its need for limited water inputs, its long term productivity and its multiple purpose qualities. In Egypt, dates are important traditional crops according to (FAO, 2009). The date palm is extensively cultivated for its edible fruit. It is used on both fresh and dry forms. Being rich in sugar it is a source of energy. Most of the carbohydrates in date in the form of fructose and glucose are easily absorbed by the human body (Al-Farsi *et al*., 2005). Date palm is the most successful and important subsistence crop in most of the hot arid desert regions (Botes and Zaid, 1999). Generally, whole dates are harvested and marketed at three stages of development: mature firm (Bisir or Khalal), full ripe (Rutab) and dry (Tamr). The decision for harvesting at one or other stage depends on cultivar characteristics, especially soluble tannins levels, climatic conditions and market demand

(Glasner *et al*., 1999). Amino acids with their ant-oxidative properties play an important role in plant defense against oxidative stress induced by unfavorable conditions. They are responsible for enhancing the biosynthesis of proteins, plant pigments, vitamins and natural hormones such as IAA and ethylene and stimulating cell division (Sies, 1997). Amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by a process in which ribosomes catalyze the polymerization of amino acids (Davies, 1982). Amino acids can directly or indirectly influence the physiological activities in plant growth and development. Moreover, the exogenous application of amino acids have been reported to modulate the growth, yield and fruit quality of Red Globe and Red Roomy grapes (Ahmed, 2003; khan *et al*., 2012). Application of amino acids as foliar spray had a positive effect on productivity, fruit quality, improving growth and fruit characteristics of 'Florida Prince' peach (Abd El-Razek and Saleh, 2012). Mixture of amino acids and micronutrients (15% amino acids, 2.9% F, 1.4% Zn and 0.7% Mn) in concentrations of 1.0 cm^2/l improved quality of green bean (Abdel-Mawgoud *et al*., 2011). Amino acid was very effective in improving yield and fruit quality of Balady mandarin trees (Faissal *et al.*, 2014). Sugars, alcohol sugars, organic acids and vitamins are very useful as indicators of metabolic activities in fruits and they indicate the changes in a qualitative structure of fruits. The variations in taste, firmness and appearance of fruits can be due to the alterations in contents and ratios of organic acids, sugars and alcohols (Doyon *et al*., 1991).The metabolism of cellular contents, important for the taste of fruits (e.g. sugars, organic acids, polysaccharides, pigments and aromatic components) changes significantly during the development of the fruits. So the care for the quality of fruit and yield by metabolic control of these substances during the growth period and during the development of fruits is of special importance. Sprayed with sugar alcohol formulation containing (0.2% B, 0.3% Iron, 3.2% Mn, 2% Zn and 5% N) improved yield and fruit quality (Abdel-Mawgoud *et al*., 2011). Algae extract as a new bio fertilizer containing N, P, K, Ca, Mg, and S as well as Zn, Fe, Mn, Cu, Mo, and Co, some growth regulators, polyamines and vitamins applied to improve nutritional status, vegetative growth, yield and fruit quality in different orchard as well as vineyards. In addition, bio-fertilization is very safe for human and environment to reduce pollution and decrease mineral usage fertilization as well as saving fertilization cost and using algal extract above 50% which increased TSS, and total sugars and decreasing total acidity rather than control (Eman and Abd-Allah, 2008). Fornes *et al*. (2002) reported that algae extract increased the yield of Clementine mandarin by 11%. Therefore, spraying algae extract was accompanied with hastening fruit quality compared to the untreated vines. Slight promotion was detected on fruit quality as a result of using algae extract increased TSS and total sugars. Licorice (*Glycyrrhiza glabra* L), the root has been used medically for many years (Gibson, 1978). Licorice is a ligneous perennial shrub growing in mediterranean region and Asia widespread in Turkey, Italy, Spain, Russia, Syria, Iran and China (Asada and Yoshikawa, 2000). Licorice has been reported to have antioxidant, antibacterial, antiviral and expectorant activity (DerMarderosian, 2001).The Chitosan coating is safe (Hirano *et al*., 1990). Chitosan (poly-B - (1-4) N-acetyl-d-gluco amine), is a natural antimicrobial compound. It can be obtained from crustacean shells (crabs, shrimp and crayfishes) either by chemical or microbiological processes (Devlieghere *et al*., 2004). Previous studies showed that using chitosan in

different fruit crops was very effective in improving quality. It decreases the respiration rates, inhibits fungal development and delays ripening because of a reduction in the evolution of ethylene and carbon dioxide (Du and Iwahroi, 1997). Also, Choi (2007) who reported that chitosan enhanced storability of grape by efficiently delaying reduction of fresh weight. Romanazzi *et al*. (2009) who found that immersed the berries of Thompson Seedless and Crimson Seedless grapes for 10 m in chitosan solutions was most effective to control gray mold postharvest decay on clusters stored 60 d at 0 ◦C. Zhang and Liu (2011) who studied that chitosan maintained postharvest quality and beneficially influenced firmness, total soluble solid content, titratable acidity, ascorbic acid content and water content of citrus fruit after 56 days of storage at 15°C. Shiri *et al*. (2013) who reported that coated table grapes with 0.5% or 1% chitosan and then stored at 0 °C for 60 days showed less weight loss, decay and gave the higher levels of titratable acidity. Micro nutrients (B, Iron, Mn, Zn and Mo) play many important regulatory roles in activating various enzymes, biosynthesis of organic foods, plant pigments, vitamins and hormones and enhancing cell division as well as water and nutrient uptake (Blevins and Lukaszweski, 1998). Micro elements had also important role in fruit set, retention, development and cause efficient yield and quality improvement (Khan *et al*., 1993). Higazy *et al*. (2002) found that, storing Zaghloul fruits at 0ºC reduced weight loss and prolonged storage life of fruits compared with control. The objectives of this study were to evaluate the effectiveness of chitosan on spraying fruits by amino acids, sugar alcohol, algae extract and licorice for reducing postharvest decay and the effect on quality properties during cold storage for 90 days of Zaghloul date palm.

Materials and methods

1. Plant materials:

This investigation was carried out during two successive seasons in 2012 and 2013 on "Zaghloul" date palms (as soft cultivar). It is grown on the experimental farm at the Central laboratory for Date Palm Researches and Development, Agricultural Research Center (ARC), Giza, Egypt. The experiment was designed as a completely randomized block design each treatment was replicated three times, one palm per each. Therefore, fifteen uniform in vigor "Zaghloul" date palms of 20 years old received normal cultural practices were selected for achieving of this study.

2. Pre-harvest treatments:

2.1. Spraying of amino acid enriched with micronutrients (Fe, Zn, B, Mo and Mn) at (2.0 cm/l)
2.2. Spraying of sugar alcohol enriched with micronutrients (B, Fe, Mn, Zn and N) at (2.0 cm/l)
2.3. Spraying of green algae enriched with (potassium oxide, phosphorus oxide, N, Zn, Fe and Mn) at (2.0 cm/l)
2.4. Spraying of licorice root extract (*Glycyrrhiza Glabra* L.) at (7.0 g/l)
2.5. Control (untreated fruits).

3. Purchase and preparations of pre-harvest substances:

3.1. Amino acids: Amino acid solution (Amino Tec (Mix), as commercial name) obtained from Techno green for industrial production) company having the following composition: Free amino acid (7.4%)**,** soluble iron (1.2%), soluble zinc (0.8%), soluble manganese (1%), soluble boron (0.1%) and soluble molybdenum (0.1%) W/ V.

3.2.Sugar alcohol: sugar alcohols solution (Manni-Plex, as commercial name) obtained from Techno green for industrial production) company having the following composition: (Mannitol, Sorbitol, Glycerol) and minerals (zinc 2.4%, manganese 3%, iron 1.2% and boron 0.3%).

3.3. Algae extract formulation: Algae extract (oligo-x, as commercial name) obtained from Agas (Arabian group for agricultural service) company having the following composition: Oligo-x a mixture of green algae and minerals (potassium oxide 12%, phosphorus oxide 0.5%, N 1%, Zn 0.3%, Fe 0.2% and Mn 0.1%).

3.4. **Licorice root extract:** The licorice powder (7g) was mixed with 1000 mL distilled water. Mixtures were heated to 60°C under stirring for 4 hour and after cooling down, the solution was filtered with a fluted filter and the licorice extract stored in the refrigerator at 4ºC until the absorptive bubble separation then next day spraying fruits (Short *et al*., 2005).

All treatments were sprayed three times at growth start (1st week of Mar.), after fruit setting (last week of April) and at one month later (last week of May) in both seasons and were harvested randomly at khalal stage in first September during 2012 and 2013 seasons. The fruits were harvested when attained full color (bright red).fruits were transported to the laboratory of Agriculture Development Systems (ADS) project in the Faculty of Agriculture, Cairo University without signs of mechanical damage and deterioration were selected and standardized showing homogeneous size, color and form, The selected fruits from each treatment, washed, air dried and placed into plastic baskets then randomly distributed into 5 groups.

4. Post-harvest chitosan applications:

All previous treatments treated by dipping for 10 min in chitosan 1 % (w/ v) and dried after dipping by drying equipment.

Chitosan: was obtained from sigma Chemicals Company.

5. Storage studies:

Sprayed Fruits from each treatment and dipping in chitosan were placed in performed carton boxes for each treatment, one box to determine fruit decay, the second to determine weight loss and the third for determine fruit quality parameters, each box contained of (2 kg of fruits/ replicate) was replicated three times, and the experiment was repeated twice (2012 and 2013 seasons). During the storage period all the physical and chemical characteristics will be determined in fruits sample every 18 days during 3 months period at different sampling time (i.e. 18,36,54,72 and 90) days. All treated and untreated fruits stored at 0ºC and relative humidity (RH) 90-95 % up to 90 days.

6. Quality assessments:

6.1. Physical properties:

6.1.1. Weight loss (%): Fruits were periodically weighted and the loss in mass weight was recorded for each replicate. Data were calculated as percentage from the initial weight:

$$\text{Weight loss\%} = \frac{\text{Weight loss in (g.)}}{\text{The initial weight of the fruits at the beginning of storage (g.)}} \times 100$$

6.1.2. Discarded (%): The discarded fruits included all the injured or spoiled fruits resulting from fungus or bacterial, shriveling and various invidious were calculated and expressed as discarded percentage:

$$\text{Discarded\%} = \frac{\text{Discarded fruits (g.)}}{\text{Initial weight (g.)}} \times 100$$

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

6.2. Chemical properties:

6.2.1. Total soluble solids in (ºBrix): Determined in date palm fruit juice using digital refractometer meter (Model PR-32, Atago, Japan) by squeezing the juice.

6.2.2. Total sugars (g/ 100g FW): in the methanol extract using the phenol sulfuric acid method and the concentration was calculated as g / 100 g fresh weight the method described by (Smith *et al*., 1956).

6.2.3. Total soluble tannins (mg/ 100g FW): was determined in fruits according to (Taira, 1996).

5. Statistical analysis: The current study followed a complete randomized block design with factorial analysis, with three replicates for each treatment. The obtained data were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1980) using SAS software (2006) and significant between means were differentiated and tested by multiple range test of Duncan (1955) at significance level of 5%.

Results and discussion

Physical properties:

Weight loss (%): Results presented in Tables (1 and 2) clear that weight loss % increased with the advance of cold storage period. Concerning the effect of treatments, the highest significant values of weight loss (3.41 and 3.29 %) were obtained by the control. On the other hand, the lowest significant values of weight loss (0.23 and 0.09 %) were recorded by licorice + chitosan

1% treatment during cold storage at 0ºC in the first and second season, respectively. Regarding the interaction between treatments and storage period, after 90 days storage, the lowest significant values (0.51 and 0.19 %) of weight loss were obtained by licorice + chitosan 1% as postharvest treatments during cold storage at 0 ºC in the two seasons, respectively. However, the highest significant values (7.90 and 7.65 %) were recorded by untreated fruits (the control treatment) during cold storage at 0ºC in the two seasons, respectively. The reduction in weight loss percentage by Licorice + chitosan treated fruits during cold storage could be chitosan enable epidermal tissues to control water loss and reduce respiratory exchange (Shiri *et al*., 2013). Postharvest application of chitosan delayed loss of water, maintained the quality attributes during storage (Dang *et al*., 2010). Higazy *et al*. (2002) found that, storing "Zaghloul" fruits at 0ºC reduced weight loss and prolonged storage life of fruits compared with control.

Table (1): Effect of safe pre harvest treatments and postharvest chitosan application on weight loss (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)					
	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.00	0.85 ^{o}	1.75 ^{j}	2.19 ^{h}	2.74 ^{f}	1.50 ^{C}
Sugar alcohol+ Chitosan	0.00	0.50 ^{q}	1.03 ^{n}	1.50 ^{l}	2.02 ^{i}	1.01 ^{E}
Algae extract+ Chitosan	0.00	0.76 ^{p}	1.63 ^{k}	2.05 ^{i}	2.51 ^{g}	1.39 ^{D}
Licorice+ Chitosan	0.00	0.11 ^{t}	0.20 ^{s}	0.33 ^{r}	0.51 ^{q}	0.23 ^{F}
Chitosan1%	0.00	0.90 ^{o}	2.48 ^{g}	3.97 ^{d}	4.90 ^{c}	2.45 ^{B}
Control	0.00	1.16 ^{m}	2.99 ^{e}	5.00 ^{b}	7.90 ^{a}	3.41 ^{A}
Mean	0.00 ^{E}	0.71 ^{D}	1.68 ^{C}	2.51 ^{B}	3.43 ^{A}	

Means of the same letter are not significantly different at 5% level.

Table (2): Effect of safe pre harvest treatments and postharvest chitosan application on weight loss (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)					
	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.00	0.56 ^{o}	1.00 ^{l}	1.82 ^{j}	2.32 ^{g}	1.14 ^{C}
Sugar alcohol+ Chitosan	0.00	0.14 ^{rs}	0.71 ^{n}	1.06 ^{k}	1.93 ^{i}	0.77 ^{E}
Algae extract+ Chitosan	0.00	0.42 ^{p}	0.96 ^{l}	1.93 ^{i}	2.20 ^{h}	1.10 ^{D}
Licorice+ Chitosan	0.00	0.00 ^{t}	0.10 ^{s}	0.15 ^{qr}	0.19 ^{q}	0.09 ^{F}
Chitosan1%	0.00	0.85 ^{m}	2.38 ^{f}	3.37 ^{d}	4.49 ^{c}	2.22 ^{B}
Control	0.00	1.09 ^{k}	2.83 ^{e}	4.87 ^{b}	7.65 ^{a}	3.29 ^{A}
Mean	0.00 ^{E}	0.51 ^{D}	1.33 ^{C}	2.20 ^{B}	3.13 ^{A}	

Means of the same letter are not significantly different at 5% level.

Discarded (%): As shown in Tables (3 and 4) fruit discarded percentage was significantly affected by the conducted treatment and storage period. Control treatment recorded the highest fruit discarded at the end of storage period (42.17 and 40.00 %) in the 1st and 2nd season respectively. While, licorice + chitosan 1% treatment recorded the lowest fruit discarded percentage (5.66 and 4.67 %) in both seasons compared with the other treatments.

Concerning the effect of storage period, the discarded percentage start to increase during the day 54 in control treatment and the day 75 in application of chitosan only and the highest discarded percentage recorded at the end of storage period, While the lowest was recorded for licorice + chitosan 1% treatment during cold storage at the end of 90 days in both studied seasons. The interaction between treatments and storage period were significant. Chitosan could be ascribed to formation of a thin film on the fruit surface protect from rots .Chitosan semi- permeable coating around plant tissue (Badawy and Rabea, 2009). Reported that Chitosan has been proven to to be effective in controlling *B. cinerea* and plant defense in table grapes through postharvest applications (Romanazzi *et al*., 2012). Also, Couey (1982) noted that, postharvest fungus diseases could be controlled by low temperature.

Table (3): Effect of safe pre harvest treatments and postharvest chitosan application on discarded (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)					
	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.00	0.00 ^{l}	2.33 ^{j}	7.33 ^{g}	13.66 ^{d}	4.65 ^{C}
Sugar alcohol+ Chitosan	0.00	0.00 ^{l}	1.00 ^{jkl}	3.67 ^{i}	9.67 ^{f}	2.86 ^{E}
Algae extract+ Chitosan	0.00	0.00 ^{l}	2.00 ^{jk}	6.33 ^{gh}	11.33 ^{e}	3.92 ^{D}
Licorice+ Chitosan	0.00	0.00 ^{l}	0.00 ^{l}	0.66 ^{kl}	5.66 ^{h}	1.26 ^{F}
Chitosan1%	0.00	0.00 ^{l}	6.33 ^{gh}	13.00 ^{d}	25.00 ^{b}	8.86 ^{B}
Control	0.00	2.00 ^{jk}	9.55 ^{f}	21.52 ^{c}	42.17 ^{a}	15.04 ^{A}
Mean	0.00 ^{D}	0.33 ^{D}	3.53 ^{C}	8.75 ^{B}	17.91 ^{A}	

Means of the same letter are not significantly different at 5% level.

Table (4): Effect of safe pre harvest treatments and postharvest chitosan application on discarded (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)					
	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.00	0.00 ^{l}	2.00 ^{j}	6.33 ^{g}	12.66 ^{d}	4.20 ^{C}
Sugar alcohol+ Chitosan	0.00	0.00 ^{l}	0.67 ^{kl}	3.00 ^{i}	8.33 ^{f}	2.40 ^{E}
Algae extract+ Chitosan	0.00	0.00 ^{l}	1.33 ^{jk}	5.33 ^{gh}	10.66 ^{e}	3.46 ^{D}
Licorice+ Chitosan	0.00	0.00 ^{l}	0.00 ^{l}	0.00 ^{l}	4.67 ^{h}	0.93 ^{F}
Chitosan1%	0.00	0.00 ^{l}	5.67 ^{gh}	11.00 ^{e}	21.00 ^{b}	7.53 ^{B}
Control	0.00	1.33 ^{jk}	8.00 ^{f}	18.00 ^{c}	40.00 ^{a}	13.47 ^{A}
Mean	0.00 ^{D}	0.22 ^{D}	2.94 ^{C}	7.27 ^{B}	16.22 ^{A}	

Means of the same letter are not significantly different at 5% level.

Fruit firmness (g/cm²): Data presented in Tables (5 and 6) showed that fruit firmness were significantly affected by storage period and the experimental treatments. Fruit firmness were gradually decreased during storage period from 149.33 and 150.67 g/cm² (as an average) in the zero day at the beginning of the storage to 118.33 and 120.83 g/cm² in the 90 day at the end of storage during cold storage at 0 ºC in the two seasons, respectively. On the average, significantly the highest flesh firmness was attained by licorice + chitosan 1% treatment during cold storage. On the other hand the control treatment gave the lowest significant values in both studied seasons. Interaction between treatments and storage period were significant. In several others works chitosan coating maintained firmness during storage period (Xu *et al*., 2007; Shiri *et al.,* 2013). In addition, licorice + chitosan coating increased the stability of the cell wall and middle lamella of fruits tissue and improved resistant to fungal pathogens. Meanwhile, Licorice was exhibited as antimicrobial activity against both Gram-positive and Gram-negative bacteria (Gupta *et al*., 2008).

Table (5): Effect of safe pre harvest treatments and postharvest chitosan application on fruit firmness (g/ cm²) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	150.00 ^{abc}	149.00 ^{bcd}	147.00 ^{def}	143.00 ^{gh}	137.00 ^{i}	121.00 ^{l}	141.17 ^{D}
Sugar alcohol+ Chitosan	150.00 ^{abc}	149.00 ^{bcd}	148.00 ^{cde}	146.00 ^{ef}	141.00 ^{h}	132.00 ^{j}	144.33 ^{B}
Algae extract+ Chitosan	150.00 ^{abc}	149.00 ^{bcd}	147.00 ^{def}	145.00 ^{fg}	138.00 ^{i}	126.00 ^{k}	142.50 ^{C}
Licorice+ Chitosan	152.00 ^{a}	151.00 ^{ab}	151.00 ^{ab}	148.00 ^{cde}	143.00 ^{gh}	137.00 ^{i}	147.00 ^{A}
Chitosan1%	147.00 ^{def}	146.00 ^{ef}	142.00 ^{h}	136.00 ^{i}	126.00 ^{k}	106.00 ^{n}	133.83 ^{E}
Control	147.00 ^{def}	146.00 ^{ef}	141.00 ^{h}	130.00 ^{j}	114.00 ^{m}	91.00 ^{o}	128.16 ^{F}
Mean	149.33 ^{A}	148.33 ^{B}	146.00 ^{C}	141.33 ^{D}	133.16 ^{E}	118.33 ^{F}	

Means of the same letter are not significantly different at 5% level.

Table (6): Effect of safe pre harvest treatments and postharvest chitosan application on fruit firmness (g/ cm²) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	151.00 ^{abc}	150.00 ^{bcd}	148.00 ^{def}	146.00 ^{gh}	139.00 ^{i}	123.00 ^{l}	142.83 ^{D}
Sugar alcohol+ Chitosan	151.00 ^{abc}	150.00 ^{bcd}	149.00 ^{cde}	148.00 ^{ef}	143.00 ^{h}	134.00 ^{j}	145.83 ^{B}
Algae extract+ Chitosan	151.00 ^{abc}	150.00 ^{bcd}	148.00 ^{def}	146.00 ^{fg}	140.00 ^{i}	128.00 ^{k}	143.83 ^{C}
Licorice+ Chitosan	153.00 ^{a}	152.00 ^{ab}	152.00 ^{ab}	150.00 ^{cde}	145.00 ^{gh}	140.00 ^{i}	148.67 ^{A}
Chitosan1%	149.00 ^{def}	148.00 ^{ef}	144.00 ^{h}	138.00 ^{i}	128.00 ^{k}	108.00 ^{n}	135.83 ^{E}
Control	149.00 ^{def}	148.00 ^{ef}	142.00 ^{h}	131.00 ^{j}	116.00 ^{m}	92.00 ^{o}	129.67 ^{F}
Mean	150.67 ^{A}	149.66 ^{B}	147.16 ^{C}	143.16 ^{D}	135.16 ^{E}	120.83 ^{F}	

Means of the same letter are not significantly different at 5% level.

Chemical properties:

Total soluble solids in (ºBrix): Results presented in Tables **(**7 and 8) showing the effect of conducted treatments and number of storage days on total sugars contents of Zaghloul date palm fruits in the two seasons. The results indicated that fruit content of total sugars were significantly affected by the experimental treatment and storage period. Total sugar had increased gradually during storage period, the highest sugars content recorded in the day 90 in all treatments. In respect to the effect of conducted treatments on total sugars contents results revealed that, licorice + chitosan 1% treatment gave the highest total sugars content (39.32 and 39.93) Meanwhile, Chitosan 1% treatment gave the lowest total sugars contents (22.30 and 23.69) followed by control treatment containing (24.71 and 25.10) during cold storage in both seasons, respectively. Interaction between treatments and storage period were significant. The lower total soluble solids due to the slower change from carbohydrates to sugars (Rohani *et al*., 1997). Spraying licorice root extraction gave the highest total soluble solids. Mango fruit coated with a chitosan had less soluble solids, than fruits untreated (Salvador-Figueroa *et al*., 2011).

Total sugars (g/ 100g FW): As shown in Tables (9 and 10), total sugars was significantly affected by the conducted treatment and storage period. The lowest total sugars were recorded at beginning of storage period (24.42 and 25.52) and increased gradually during storage period until the 90 day (30.47 and 31.53). In the 1st season licorice + chitosan 1% treatment recorded the highest total sugars (31.93) compared with the other treatment, also in the 2nd season licorice + chitosan 1% treatment recorded the highest value (32.83). Chitosan 1% treatment recorded the lowest value in both seasons (19.76 and 21.06) followed by control treatment (20.23 and 21.80) during cold storage in both studied seasons. Interaction between treatments and storage period were significant. A similar effect was observed for chitosan decreased ripening (Du and Iwahroi, 1997). Spraying algae extract increasing fruit quality (Balakrishnan *et al*., 2007). Meanwhile, spraying licorice and dipping in chitosan improving fruit quality in terms of increasing total sugars.

Table (7): Effect of safe pre harvest treatments and postharvest chitosan application on total soluble solids in (ºBrix) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	31.28 ^{x}	32.28 ^{w}	34.26 ^{t}	35.28 ^{s}	35.68 ^{r}	35.98 ^{o}	34.12 ^{D}
Sugar alcohol+ Chitosan	36.03 ^{n}	37.03 ^{k}	37.82 ^{j}	38.41 ^{h}	38.53 ^{g}	38.60 ^{f}	37.73 ^{B}
Algae extract+ Chitosan	32.85 ^{v}	33.85 ^{u}	35.74 ^{q}	35.84 ^{p}	36.14 ^{m}	36.28 ^{l}	35.12 ^{C}
Licorice+ Chitosan	37.89 ^{i}	38.89 ^{e}	39.39 ^{d}	39.85 ^{c}	39.93 ^{b}	39.98 ^{a}	39.32 ^{A}
Chitosan1%	17.42 ^{i}	18.42 ^{h}	22.15 ^{f}	23.15 ^{e}	25.54 ^{c}	27.12 ^{a}	22.30 ^{F}
Control	17.42 ^{i}	20.42 ^{g}	24.71 ^{d}	26.72 ^{b}	28.72 ^{z}	30.31 ^{y}	24.71 ^{E}
Mean	28.81 ^{F}	30.15 ^{E}	32.34 ^{D}	33.37 ^{C}	33.92 ^{B}	34.37 ^{A}	

Means of the same letter are not significantly different at 5% level.

Table (8): Effect of safe pre harvest treatments and postharvest chitosan application on total soluble solids in (ºBrix) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	32.93 ^{x}	33.93 ^{w}	35.85 ^{t}	36.93 ^{q}	37.34 ^{p}	37.53 ^{o}	35.75 ^{D}
Sugar alcohol+ Chitosan	36 .57 ^{s}	37.57 ^{n}	38.29 ^{j}	39.13 ^{h}	39.35 ^{g}	39.39 ^{f}	38.38 ^{B}
Algae extract+ Chitosan	34.76 ^{v}	35.76 ^{u}	36.69 ^{r}	37.76 ^{m}	38.09 ^{l}	38.22 ^{k}	36.88 ^{C}
Licorice+ Chitosan	39.01 ^{i}	40.01 ^{e}	40.07 ^{d}	40.11 ^{c}	40.19 ^{b}	40.23 ^{a}	39.93 ^{A}
Chitosan1%	19.14 ^{i}	20.14 ^{h}	23.11 ^{f}	25.13 ^{e}	26.54 ^{c}	28.07 ^{z}	23.69 ^{F}
Control	19.14 ^{i}	22.14 ^{g}	25.74 ^{d}	26.73 ^{b}	27.73 ^{a}	29.12 ^{y}	25.10 ^{E}
Mean	30.25 ^{F}	31.59 ^{E}	33.29 ^{D}	34.46 ^{C}	35.04 ^{B}	35.42 ^{A}	

Means of the same letter are not significantly different at 5% level.

Table (9): Effect of safe pre harvest treatments and postharvest chitosan application on total sugar (mg/100g FW) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	25.94 ^{o}	26.05 ^{o}	27.13 ^{n}	29.99 ^{jk}	31.58 ^{ef}	32.13 ^{d}	28.80 ^{D}
Sugar alcohol+ Chitosan	29.17 ^{l}	29.26 ^{l}	29.71 ^{k}	30.89 ^{gh}	32.16 ^{d}	33.10 ^{c}	30.71 ^{B}
Algae extract+ Chitosan	26.81 ^{n}	26.95 ^{n}	28.00 ^{m}	30.17 ^{ij}	31.96 ^{de}	32.86 ^{c}	29.45 ^{C}
Licorice+ Chitosan	30.53 ^{hi}	30.64 ^{gh}	31.02 ^{g}	31.45 ^{f}	33.57 ^{b}	34.35 ^{a}	31.93 ^{A}
Chitosan1%	17.06 ^{t}	17.12 ^{t}	17.25 ^{t}	20.02 ^{r}	22.85 ^{q}	24.24 ^{p}	19.76 ^{F}
Control	17.06 ^{t}	17.17 ^{t}	17.75 ^{s}	20.12 ^{r}	23.16 ^{q}	26.15 ^{o}	20.23 ^{E}
Mean	24.42 ^{E}	24.53 ^{E}	25.14 ^{D}	27.10 ^{C}	29.21 ^{B}	30.47 ^{A}	

Means of the same letter are not significantly different at 5% level.

Table (10): Effect of safe pre harvest treatments and postharvest chitosan application on total sugar (mg/100g FW) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	26.94 ^{n}	26.99 ^{n}	28.16 ^{m}	30.98 ^{i}	32.66 ^{ef}	33.23 ^{d}	29.82 ^{D}
Sugar alcohol+ Chitosan	30.36 ^{j}	30.38 ^{j}	30.93 ^{i}	31.99 ^{g}	33.18 ^{d}	34.41 ^{b}	31.87 ^{B}
Algae extract+ Chitosan	27.89 ^{m}	28.56 ^{l}	29.14 ^{k}	31.37 ^{h}	32.92 ^{ed}	33.94 ^{c}	30.63 ^{C}
Licorice+ Chitosan	31.84 ^{g}	31.98 ^{g}	32.03 ^{g}	32.53 ^{f}	33.83 ^{c}	34.78 ^{a}	32.83 ^{A}
Chitosan1%	18.04 ^{w}	18.65 ^{v}	19.83 ^{t}	21.17 ^{s}	23.09 ^{q}	25.61 ^{o}	21.06 ^{F}
Control	18.04 ^{w}	19.01 ^{u}	20.01 ^{t}	22.40 ^{r}	24.18 ^{p}	27.21 ^{n}	21.80 ^{E}
Mean	25.52 ^{F}	25.92 ^{E}	26.68 ^{D}	28.41 ^{C}	29.97 ^{B}	31.53 ^{A}	

Means of the same letter are not significantly different at 5% level.

Total soluble tannins (mg/ 100g FW): Results presented in Tables (11 and 12) show the effect of conducted treatments and number of storage days on tannins contents of Zaghloul date palm fruits in the two studied seasons. Concerning the effect of conducted treatments on tannins content results revealed that, Licorice + Chitosan treatment gave the lowest tannins content (0.193 and 0.185). Meanwhile, Chitosan 1% gave the highest tannins contents (0.372 and 0.367) followed by control treatments (0.365 and 0.351) in both studied season, respectively. Corresponding to the effect of number of storage days, total tannins decreased continuously during the storage. At the 90 days of storage fruit had the lowest tannins contents (0.180 and 0.167) compared with the fruits at the beginning of storage which had a higher tannins contents (0.347 and 0.341) in both seasons, respectively. Spraying algae extract increasing fruit quality (Balakrishnan *et al*., 2007). Also, sprayed fruits with licorice and dipping in chitosan decreasing total soluble tannins gradually during cold storage period.

Table (11): Effect of safe pre harvest treatments and postharvest chitosan application on total tannins (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2012 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.379 ^{de}	0.369 ^{f}	0.355 ^{g}	0.343 ^{hi}	0.276 ^{l}	0.167 ^{t}	0.315 ^{C}
Sugar alcohol+ Chitosan	0.286 ^{k}	0.276 ^{l}	0.265 ^{m}	0.256 ^{n}	0.236 ^{opq}	0.145 ^{v}	0.244 ^{E}
Algae extract+ Chitosan	0.349 ^{gh}	0.339 ^{i}	0.303 ^{j}	0.285 ^{k}	0.254 ^{n}	0.158 ^{u}	0.281 ^{D}
Licorice+ Chitosan	0.239 ^{op}	0.229 ^{q}	0.201 ^{r}	0.186 ^{s}	0.172 ^{t}	0.133 ^{w}	0.193 ^{F}
Chitosan1%	0.416 ^{a}	0.406 ^{b}	0.403 ^{bc}	0.395 ^{c}	0.372 ^{ef}	0.244 ^{o}	0.372 ^{A}
Control	0.416 ^{a}	0.402 ^{bc}	0.398 ^{bc}	0.383 ^{d}	0.365 ^{f}	0.231 ^{pq}	0.365 ^{B}
Mean	0.347 ^{A}	0.337 ^{B}	0.321 ^{C}	0.308 ^{D}	0.279 ^{E}	0.180 ^{F}	

Means of the same letter are not significantly different at 5% level.

Table (12): Effect of safe pre harvest treatments and postharvest chitosan application on total tannins (%) of "Zaghloul" date palm fruits during cold storage at 0ºC in 2013 season.

Treatments	Storage Period (days)						
	0	18	36	54	75	90	Mean
Amino acids+ Chitosan	0.369 ^{de}	0.359 ^{ef}	0.353 ^{efg}	0.336 ^{gh}	0.273 ^{jk}	0.161 ^{p}	0.308 ^{C}
Sugar alcohol+ Chitosan	0.279 ^{j}	0.269 ^{jkl}	0.254 ^{klm}	0.230 ^{n}	0.226 ^{n}	0.134 ^{qr}	0.232 ^{E}
Algae extract+ Chitosan	0.338 ^{fgh}	0.328 ^{h}	0.303 ^{i}	0.281 ^{j}	0.239 ^{mn}	0.144 ^{pq}	0.272 ^{D}
Licorice+ Chitosan	0.235 ^{mn}	0.225 ^{n}	0.195 ^{o}	0.181 ^{o}	0.160 ^{p}	0.116 ^{r}	0.185 ^{F}
Chitosan1%	0.414 ^{a}	0.404 ^{ab}	0.397 ^{abc}	0.383 ^{cd}	0.355 ^{efg}	0.253 ^{lm}	0.367 ^{A}
Control	0.414 ^{a}	0.397 ^{abc}	0.386 ^{bcd}	0.372 ^{cde}	0.346 ^{fgh}	0.196 ^{o}	0.351 ^{B}
Mean	0.341 ^{A}	0.330 ^{B}	0.315 ^{C}	0.297 ^{D}	0.266 ^{E}	0.167 ^{F}	

Means of the same letter are not significantly different at 5% level.

Conclusion

The results presented in this study indicated that sprayed spathes with licorice as pre harvest of Zaghloul date palm and immersion in chitosan 1% as postharvest was the most effective in reducing postharvest discarded and maintain on compositional changes by delaying physical and chemical changes and so extending postharvest life. All treatments increasing fruit firmness, total soluble solids (ºBrix), and total sugars and decreasing weight loss percentage, discarded percentage and total soluble tannins as compared with the control treatment. All treatments are safe and simple which could be employed for long storage and fruit intended for long distance shipping for export.

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تحسين الجودة والقدرة التخزينية لثمار نخيل البلح الزغلول بإستخدام مواد آمنة قبل وبعد الحصاد

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الملخص العربي

أجريت هذه الدراسة خلال عامى ٢٠١٢ ، ٢٠١٣ على اشجار نخيل بلح صنف زغلول. تم رش السوباطات في ثلاث مواعيد، بداية النمو وبعد عقد الثمار ثم بعد شهر بأربعة مواد مختلفة وهى، أحماض أمينية غنية بالعناصرالصغرى (الحديد ، الزنك، البورون، المولبدنيوم والمنجنيز)- سكريات كحولية غنية بالعناصر الصغرى (البورون، الحديد، المنجنيز، الزنك والنيتروجين) - مستخلص طحالب يحتوى على (أكسيد بوتاسيوم،أكسيد فوسفور، نيتروجين، زنك، حديد و منجنيز) وذلك بتركيز ٢% ومستخلص جذور العرقسوس وذلك بتركيز٧%. تم حصاد الثمارالمرشوشة في مرحلة الخلال ثم غمرت في الشيتوزان ١% كتطبيق لمعاملة ما بعد الحصاد ثم بعد ذلك تم تخزينها لمدة ثلاثة أشهر على صفر درجة مئوية و رطوبة نسبية ٩٠- ٩٥% من اجل دراسة تأثيرهذه المعاملات على تحسين الجودة والقدرة التخزينية لثمار نخيل البلح الزغلول. كل المعاملات زادت من (الصلابة، المواد الصلبة الذائبة الكلية، السكريات الكلية والمحتوى من الأنثوسيانين) وخفضت من (الفاقد فى الوزن ، نسبة الفاقد ومحتوى الثمار من التانينات) مقارنة بالثمار الغير معاملة. وقد تم الحصول على أفضل النتائج فيما يتعلق بجودة ثمار نخيل البلح الزغلول عند رش الثمار بمستخلص جذور العرقسوس ثلاث مرات والغمرفى الشيتوزان١٪.

الكلمات الدالة: نخيل البلح الزغلول – الرش – الأحماض الأمينية – السكريات الكحولية - مستخلص الطحالب – مستخلص جذور العرقسوس– الشيتوسان – التخزين المبرد - الجودة.