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THE EFFECT OF TREATMENT WITH CHITOSAN ON THE STORAGE ABILITY OF JUJUBE FRUITS (*Ziziphus spp*) CV.CHIBCHAB

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ABSTRACT

The current study was conducted on jujube fruits, Chibchab cultivar that were collected from a commercial orchard in the Al-Harthah region, Basra, south of Iraq for the 2018-2019 growing season in order to improve the storage ability of fruits by treating them with chitosan. The fruits were treated with three concentrations of chitosan (0, 1 and 2%) by immersing them in, then packed with perforated polyethylene bags (8 holes per bag, the diameter of the hole is 4 mm). The bag expanded to 1 kg of fruits then stored at 4°C in the refrigerator. A factorial experiment was designed using a complete randomized design (CRD) with three replicates. The most important results showed that the fruits treated with 2% chitosan outperformed the rest of the fruits with the least weight loss and the highest concentration of vitamin C, while the untreated fruits recorded the highest percentage of total soluble solids, total titratable acidity and the highest weight loss.

Keywords: Jujube fruits; chibchab cultivar; chitosan; vitamin C.

INTRODUCTION

Jujube plant (*Ziziphus Spp.*) Belongs to the family Rhamanaceae and to the genus Zizhphus, which contains more than 100 species of plants that are evergreen trees and shrubs that grow in tropical, subtropical and temperate regions of the world [1]. Jujube fruits contain sugars, proteins, organic and amino acids, vitamins, fats, fibers and mineral salts, and each 100 gm of pulp contains 20.9 calories [2].

In Iraq there are four main species of jujube, which are *Z. nummularia* L. *Z. jujuba* Lam in addition to Z. *mauritiana* Lam and Z. *spina–christi* that are the most widespread and important economically [3].

Chitosan is a vital polymer, the second largest biomaterial after cellulose, which is found in the outer structure of crustaceans, insects and fungal cell walls. It is also characterized by no toxicity and biological decay and has no local effects in

ving tissue. Chitosan is a composed of ucosamine units, which are associated with each her with a type of beta-type (1-4) cyclic bonds. possesses many free hydroxyl and amino acids at enable it to form ionic, hydrogen and hydrofluidic bonds with other molecules such as fats and proteins [4,5].

Due to the weakness of the storage ability of jujube fruits and the short period of their display in the market, the current study was conducted to improve the storage ability of jujube fruits chibchab cultivar by postharvest treating them with chitosan.

MATERIALS AND METHODS

Chitosan extraction: The shrimps were obtained from the local fish market in Basrah and the crusts were washed with ordinary water and dried by aving them exposed to the sun. The method entioned in Salman and Abadi [6] was followed the extraction of chitin from the shrimp. The rimp crust was crushed into small pieces using electric mill then process of removal of the oteins (deprotenization) by treating the crusts wi sodium hydroxide solution at a concentration 3.5% for two hours at a temperature of 65°C. 1:10 (weight / volume). After washing the crust th distilled water, the mineral elements removed the process called Demineralization by using a lution of hydrochloric acid at the concentration 1N for a period of 1/2 hour at room temperature by 1:15 (weight / volume). Crusts were washed well with water several times, then the pigment as removed by acetone and then by sodium pochlorite solution at 0.315% for 5 minutes at room temperature by 1:10 (weight / volume). Finally, the white product was washed with distilled water and dried in an oven at 60°C for 24 hours to obtain the Chitin.

Chitosan was prepared according to the method entioned by Kamil et al. [7] by removing the etyl groups (Deacetylation) by treating with 50% sodium hydroxide at 1: 10 (weight / volume) 100°C for 20 hours to obtain chitosan with low olecular weight, and then dried at 110°C for 6 hours. The resulting chitosan is white powder.

The viscosity was termined by allowing the solution the solution to flow it at a certain distance 25°C. Molecular weight was determined pending on the viscosity of the solution acc rding to No et al. [8]. The degree of removal acetyl groups was determined according to Khan et al. [9] by mixing 40 mg chitosan with 120 g potassium bromide and then pressed and dried, then determined by using the Fourier Transform Infrared Spectroscopy (FTIR) instrument.

he parameters of the product were measured as llows: Viscosity 64.16 Centi Boyz, molecular eight 720 Kdalton, and degree of removal of acetyl groups 87.6%)

Three concentrations of chitosan were prepared:

1- 0% Chitosan.
2 - 1% Chitosan.
3 - 2% Chitosan.

Jujube fruits cv. Chibchab were obtained from one of the commercial orchards in the Al-Hartha region, Basra, south of Iraq for the 2018-2019 growing season, after cleaning the fruits from the dusts and dirts and excluding the damaged and small-sized fruits, they were treated with three concentrations of chitosan (0, 1 and 2%) by immersing them, then packed with perforated polyethylene bags (8 holes per bag, the diameter of the hole is 4 mm). The diameter of the hole is 4 mm). The bag expanded to 1 kg of fruits then stored at 4°C in the refrigerator for four weeks. The following characteristics were estimated weekly:

1- Weight loss of fruits: It was calculated as a weekly percentage as follows:

$$\%\ \text{Weight Loss} = \frac{\text{Weight of fruits before storage} - \text{weight of fruits after storage}}{\text{Weight of fruits before storage}} \times 100$$

2- Percentage of total soluble solids:

Estimated using a digital refractometer.

3- Total titratable acidity:

Total titratable acidity (%) determined according to A.O.A.C. [10]. 4- Vitamin C (mg / 100g fresh weight):

Vitamin C (mg . 100 g^{-1} fresh weight)
Determined according to A.O.A.C. [10].

Complete Randomized Design was used with three replicates. The results were analyzed by the analysis of variance and mean values were compared using the Revised Least Significant Difference Test at 0.05 probability level [11].

RESULTS AND DISCUSSION

Weight loss of fruits: The results of Table (1) illustrated the effect of chitosan treatment, the storage period, and the interaction between them on the percentage of weight loss of jujube fruits cv. Chibchab stored at 4°C. The results of the same table indicate that the highest percentage of weight loss, which amounted to (3.26%), was in control fruits compared to fruits treated with chitosan, while the lowest percentage of weight loss was in fruits treated with 2% chitosan, which reached to 1.29%. The reason for the lack of weight loss in the fruits treated with 2% chitosan may be due to the fact that the dipping with chitosan led to the formation of an insulating layer on the surfaces of the fruits, thus reducing the water loss from the fruit surface by the evaporation process in addition to reducing the respiration process [12]. This result is consistent with Wang et al. [13] for winter jujube (Ziziphus jujubeMill. cv. Dongzao) and Taain et al. [14] on date palm fruits for Bream, Khalas and Habsi cultivars. It is noted from the table that the percentage of weight loss increased relatively with increasing storage periods until reached (3.35%) after four weeks of storage. This result is in agreement with Taain et al. [2] with regard to jujube fruits cv. Tufahi and the reason may be due to the loss of water from the fruit in addition to the loss of stored food by the vital processes, especially the respiration process [15].

As for the interaction between treatment with Chitosan and the storage period, the lowest percentage of weight loss was in fruits treated with 2% chitosan after a week of storage, which was 0.95%, while the highest percentage of weight loss was in untreated fruits after four weeks of storage, which was recorded 4.22%.

Percentage of total soluble solids: The results of Table (2) showed that fruits not treated with chitosan recorded the highest percentage of total soluble solids, which amounted to 23.28%, with a significant difference from treatment with 1% chitosan, while the fruits of treatment with 2% chitosan recorded the lowest percentage of total soluble solids, which amounted to 20.50%, and the results of the study agreed with Taain et al., [14] for date palm fruits.

It was noticed that the percentage of soluble solids increased as the storage period was prolonged, until it reached 24.49% at the end of the fourth week of storage. This result is consistent with Taain [16] for the date palm fruits cv. Barhi. The ripening of the fruits during storage leads to an increase in the accumulation of total soluble solids in them because the jujube fruits are considered climacteric fruits [2]. In additions, the decrease in the water content of the fruits with the increment of the storage periods caused the accumulation of total soluble solids, as there is an inverse relationship between the fruits content of total soluble solids and their water content [17].

As for the interaction between treatment with chitosan and the storage period, the same table showed that the highest percentage of total soluble solids was in untreated fruits after four weeks of storage, which amounted to 25.12%. The lowest percentage of total soluble solids was in fruits treated with 2% Chitosan after one week of storage, which was 17.45%.

Table 1. The effect of chitosan on the percentage of weight loss of jujube fruits cv. Chibchab stored at 4°C

Chitosan %	Storage period (week)				Mean of chitosan
	1	2	3	4	
0	1.79	3.14	3.91	4.22	3.26
1	1.22	2.01	2.71	3.88	2.45
2	0.95	1.07	1.22	1.95	1.29
Mean of Storage period	1.32	2.07	2.61	3.35	
RLSD 0.05	Chitosan = 1.12, Storage period=1.15, Interaction =1.22				

Table 2. The effect of chitosan on the percentage of total soluble solids of jujube fruits cv. Chibchab stored at 4°C

Chitosan%	Storage period (week)				Mean of chitosan
	1	2	3	4	
0	19.33	24.12	24.55	25.12	23.28
1	18.91	23.00	23.89	24.56	22.59
2	17.45	19.10	21.65	23.80	20.50
Mean of Storage period	18.56	22.07	23.36	24.49	
RLSD 0.05	Chitosan = 1.95, Storage period=2.07, Interaction =2.32				

Table 3. The effect of chitosan on the percentage of total titratable acidity of jujube fruits cv. Chibchab stored at 4°C

Chitosan %	Storage period (week)				Mean of chitosan
	1	2	3	4	
0	0.292	0.272	0.214	0.175	.238
1	0.237	0.215	0.182	0.162	0.199
2	.211	0.198	0.162	0.114	0.171
Mean of Storage period	0.246	0.228	0.186	0.150	
RLSD 0.05	Chitosan = 0.022, Storage period=0.078, Interaction =0.121				

Table 4. The effect of chitosan on vitamin C (mg. 100 g⁻¹) of jujube fruits cv. Chibchab stored at 4°C

Chitosan %	Storage period (week)				Mean of chitosan
	1	2	3	4	
0	167.65	163.33	150.15	138.22	154.83
1	171.20	165.78	153.25	141.63	157.96
2	175.20	173.00	160.71	151.03	164.98
Mean of Storage period	171.35	167.37	154. 70	143. 62	
RLSD 0.05	Chitosan = 6.89, Storage period=10.67, Interaction =15.51				

Percentage of total titratable acidity: It is noticed from Table (3) that the treatment with chitosan had a significant effect on the percentage of total titratable acidity of jujube fruits cv. Chibchab stored at 4°C, as the highest percentage of the total titratable acidity 0.238% for the fruits of the control treatment, with significant difference from the rest of the treatments, while the lowest percentage of total titratable acidity was in fruits treated with 2% chitosan reached to 0.171%. These results are in agreement with Srinivasa et al. [18] for mango fruits treated with chitosan. The same table showed that the total titratable acidity percentage decreased with the increment of the storage period until it reached to 0.150% after four weeks of storage, and this may be due to converting the organic acids into sugars or consuming them by respiration process [17].

The results of the same table also indicated to the significant interaction between treatment with chitosan and the period of storage, so the results showed that the highest percentage of total acidity was in untreated fruits with chitosan after four weeks of storage that gave 0.292%. The lowest percentage of total acidity was in the treated fruits with 2% chitosan after a week of storage, which gave 17.45%.

Vitamin C (mg. 100 g⁻¹ fresh weight): The results of Table 4 showed that the highest concentration of vitamin C (164.98 mg. 100 g⁻¹ fresh weight) was in the fruits treated with 2% chitosan, with a significant difference from the rest of the treatments, while the lowest concentration of vitamin C was in the fruits not treated with chitosan, which amounted to 154.83 mg. 100 g⁻¹ with not significant differences from 1% chitosan treatment. It is noted from the table that the concentration of vitamin C decreased with the increment of storage periods, and this result is in agreement with Taain et al. [19] for tomato fruits cv. Supermarimond.

The table also indicated to the significant interaction between treatment with chitosan and the storage periods in their effect on the concentration of vitamin C in fruits, as the highest concentration of vitamin C in the fruits treated with 2% chitosan was after a week of storage which was 175.20 mg. 100 g^{-1} and the lowest concentration of the vitamin was in the untreated fruits after four weeks of storage that recorded 138.22 mg. 100 g^{-1}.

CONCLUSION

The present study clearly indicated that postharvest treatment of jujube fruits cv. Chibchab with 2% chitosan improved storage ability of fruits by decreasing the weight loss of fruits [20,21] that considered one of the important marketing characteristics that must be maintained during storage because the fruits are sold by weight.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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