Effect of Citric and Ascorbic acid in improving the storability for two cultivars of Jujube fruits (*Ziziphus mauritiana Lam*)

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Abstract

The factorial experiment for the 2019 season was conducted in the laboratories of the Department of Horticulture and Gardening Engineering - College of Agriculture - University of Basra, For storing Jujube fruits, two cultivars of Al-Tufahi and Al-Armouti .In order to study different concentrations of two types of antioxidants, which are ascorbic acid and citric acid, and the interaction between them, the effect of storage temperature on the organoleptic and specific traits , and the improvement of storability during different storage periods. The fruits were immersed for 5 minutes in a solution of ascorbic acid and citric acid at a concentration of (300,150,0) mg/L and a mixture of ascorbic and citric acid at a concentration of (150,150) mg / L and (300,150) mg /L and (150,300) mg / L and ((300,300 mg / L) for each of the two acids was added to the control treatment, then it was stored at a temperature of 4 C° ± 2 C°, A factorial experiment was conducted within a Completely randomized design (CRD) with three replicated the study showed the excelled of ascorbic acid treatment of 300 mg / L in reducing weight loss and maintaining the highest amount of vitamin C, the highest percentage of total phenols, the lowest amount of carotene pigment and the highest percentage of protein, as well as The treatment with citric acid excelled the concentration of 300 mg / L, The treatment of ascorbic acid the concentration of 300 mg / L + citric acid concentration of 300 mg / L excelled in maintaining the qualitative and quantitative traits of the fruits, a decrease in the amount of vitamin C, phenols and proteins, an increase in the percentage of weight loss and an increase in carotene pigment during the progression of the storage period. The treatment of ascorbic acid the concentration of 300 mg / L + citric acid concentration of 300 mg / L excelled in maintaining the qualitative and quantitative traits of the fruits, a decrease in the amount of vitamin C, phenols and proteins, an increase in the percentage of weight loss and an increase in carotene pigment during the progression of the storage period.

*** Key words:** Jujube plant , antioxidants, storability.

تأثير حامضي الستريك والاسكوربك في تحسين القابلية الخزنية لصنفين من ثمار السدر (*Ziziphus mauritiana Lam*)

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المستخلص

أجريت التجربة العاملية لموسم 2019 في مختبرات قسم البستنة وهندسة الحدائق – كلية الزراعة – جامعة البصرة لخزن ثمار السدر صنفي تفاحي وعرموطي بهدف دراسة تراكيز مختلفة لنوعين من مضادات الأكسدة هما حامض الاسكوربيك وحامض الستريك والتداخل بينها وتاثير درجة حرارة الخزن في الصفات الحسية والنوعية وتحسين القابلية الخزنية خلال مدد خزنية مختلفة ,حيث غمرت الثمار لمدة 5 دقائق في محلول حامض الاسكوربيك وحامض الستريك بالتركيز (300,150,0) ملغم/لتر وخليط من حامض الاسكوربيك وحامض الستريك بالتركيز (150,150) ملغم /لتر و(300,150) ملغم /لتر و (150,300) ملغم /لتر و (300,300) ملغم /لتر لكل من الحامضين إضافة إلى معاملة المقارنة ,ثم خزنت في درجة حرارة 4ْم±2 استخدم تجربة عاملية ضمن التصميم العشوائي الكامل CRD وبثلاث مكررات,بينت الدراسة تفوق معاملة حامض الاسكوربيك تركيز 300 ملغم/لتر في التقليل من فقد الوزن والحفاظ على اعلى كمية

من فيتامين C واعلى نسبة من الفينولات الكلية واقل كمية من صبغة الكاروتين واعلى نسبة مئوية للبروتين وكذلك تفوق معاملة حامض الستريك تركيز 300 ملغم/لتر وتفوق معاملة حامض الاسكوربيك تركيز 300 ملغم/لتر+ حامض الستريك تركيز 300 ملغم/لتر في الحفاظ على الصفات النوعية والكمية للثمار ,انخفاض في كمية فيتامين C والفينولات والبروتينات وزيادة نسبة الفقد بالوزن وزيادة صبغة الكاروتين اثناء تقدم مدة الخزن.

*الكلمات المفتاحية : السدر, مضادات الاكسدة , قابلية الخزنية.

Introduction

Jujube plant (*Ziziphus mauritiana Lam*) is one of the oldest types of fruits whose fruits are eaten, which are mentioned in the holy books and in the Holy Quran , It is one of the Jannah plants that belongs to the Rhamnaceae family ,It is one of the large plant families that includes 55 genera and nearly 950 species and evergreen fruit trees that are endemic to tropical, subtropical and temperate and arid regions (19) and (13). Jujube fruits are distinguished by a high nutritional value due to their high content of vitamin C, minerals, sugars, proteins and organic acids, as well as the fruits of economic and medicinal importance. Jujube plant cultivation is widely spread in Central and South Asia as well as in the regions of Northern Australia, South Africa, Spain and Italy (18) and (14) and (24) In Iraq, Jujube plant cultivation has spread in central and southern Iraq, and there are many economic cultivars with early productivity and good quality, including the Al-Tufahi and Al-Armouti cultivars (11) and (1), The decrease in the marketing, nutritional and productivity value of Jujube fruits as a result of browning the fruits due to the oxidation of phenolic substances by the enzyme polyphenol oxidase, the advancement of the maturity stage and the activities of oxidation enzymes (8). Therefore, the researchers directed to reduce the risk of oxidation and reduce the discoloration and damage of the fruits during the progression of the storage period through Use of inhibitors or antioxidants by enzymes that stimulate oxidation. The antioxidant uses Ascorbic acid and Citric acid as an antioxidant to prevent the discoloration and deterioration of fruits and maintain the quality and quality of fruits (12) and (20), due to the lack of studies on the viability of Jujube fruits and their low marketing life, the current study was conducted to improve the storage behavior of Jujube fruits in the two cultivars of Al-Tufahi and Al-Armouti.

Materials and methods

The current experiment was conducted for the 2019 season, which included storing the Jujube fruits in the two cultivars of Al-Tufahi and Al-Armouti, for the purpose of studying the effect of ascorbic and Citric acid and storage period on the qualitative traits and storability. Jujube fruits were taken from one of the orchards of Al-Hartha district, north of Basra province, in the early morning during the stage of completion of growth (physiological maturity), The fruits were washed with distilled water to remove dirt and dust and exclusion of young, infected and mechanically damaged fruits, A factorial experiment was used within the complete random design CRD with three replicates, the experiment included two factors, the first factor was the cultivars which is an Al-Tufahi cultivar and which is symbolized by (S1) and Al-Armouti cultivar which is symbolized by(S2) while the second factor included nine treatments of ascorbic acid and citric acid, namely: -

1- The control treatment which is symbolized by (T0).

2- Ascorbic acid treatment at a concentration of 150 mg / L, and which is symbolized by (T1).

3- Ascorbic acid treatment at a concentration of 300 mg / L, and which is symbolized by (T2).

4- Citric acid treatment at a concentration of 150 mg / L, and which is symbolized by (T3).

5- Citric acid treatment at a concentration of 300 mg / L, and which is symbolized by (T4).

6- treatment of at a concentration of 150 mg / L + citric acid at a concentration of 150 mg / L, and which is symbolized by (T5).

7- Ascorbic acid treatment at a concentration of 150 mg / L + citric acid at a concentration of 300 mg / L, and which is symbolized by (T6).

8- The interaction treatment between ascorbic acid at a concentration of 300 mg / L + citric acid at a concentration of 150 mg / L and which is symbolized by (T7).

Jujube fruits were stored for five periods (5,10,15,20,25) days at a temperature of 4 C° ± 2, and which are symbolized by (P1, P2, P3, P4, P5). The weight loss was calculated as a percentage of the fruits at an average of once every five days for the two cultivars (Al-Tufahi and Al-Armouti) and an electronic balance was used to estimate the percentage of weight loss. Vitamin C was estimated according to what is mentioned in (9), the carotene pigment was estimated according to the method (17), The phenolic substances were estimated according to the Folin-Denis method (6), and the percentage of protein was estimated according to (9).

Results and discussion

1- Weight loss percentage:

The results in Table (1) showed that the highest percentage of weight loss when treated with antioxidants (T0, T5), which was 24.85% and 23.52% respectively, either the lowest average reached when treatment (T2) and reached 18.54% for fruits stored at a temperature of 4 C° ± 2 Storage period (P25) gave the highest average, at 39.36%.While the storage period of (P5) gave the lowest average which amounted to 12.34%. The fruits of (S1) stored at a temperature of 4 ° C ± 2 gave the highest average of loss which amounted to 23.21%, while the fruits of (S2) gave the lowest average of loss which amounted to 20.14%.The bi-interaction between the cultivars of fruits and the storage period (S2P25) gave the highest average, reaching 41.58%, while (S1P5) the lowest average, reaching 4.71%. The interaction between storage period and treatment with antioxidants (P25T0) gave the highest average of loss, reaching 43.27%. The interaction (2P5T) gave the lowest average, at 4.33%. As for the interaction between the cultivar of fruits and the treatments with antioxidants, and the triple interaction between the cultivar of fruits, the treatments and the storage period did not significantly affect. The high percentage of weight loss increases with increasing storage period as a result of water loss from the surface of the fruit through evaporation As well as the loss in the food stocks of the fruits due to the bioprocesses inside the fruit such as Respiration (21), (5) (29), the treatment with antioxidants led to a reduction in the average of weight loss and this result is consistent with what was found (5), (2).

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Table (1) The effect of antioxidants and the storage period, the interaction between them in the percentage of weight loss of the two Jujube fruits (Al-Tuffali and Al-Armouti) stored at a temperature of 4 ° C ± 2

Interaction S*T	Storage period/ day					Treatments	Storage type
	P25	P20	P15	P10	P5	T	S
23.50	41.17	34.03	24.39	12.71	5.21	T0	
18.40	33.61	25.02	17.87	10.73	4.77	T1	
17.09	32.99	23.36	16.07	9.22	3.81	T2	
20.97	38.66	29.66	19.56	12.00	4.95	T3	
19.76	37.53	27.45	18.87	10.85	4.10	T4	**S1**
22.06	40.06	31.03	21.85	12.28	5.11	T5	
21.39	39.24	29.24	21.64	11.89	4.93	T6	
19.27	36.05	27.27	18.23	9.88	4.91	T7	
18.82	34.83	26.28	17.95	10.49	4.58	T8	
26.21	45.37	36.43	26.10	16.08	7.07	T0	
22.11	40.08	31.19	21.42	12.18	5.67	T1	
19.99	37.11	27.17	19.66	11.14	4.86	T2	
24.26	43.72	33.24	23.21	14.33	6.78	T3	
23.27	42.15	32.29	22.47	13.23	6.21	T4	**S2**
24.98	44.29	34.03	24.27	15.31	6.98	T5	
22.94	40.82	31.72	22.01	14.00	6.13	T6	
22.82	40.44	31.34	22.93	12.92	6.46	T7	
22.35	40.28	30.80	21.74	12.84	6.09	T8	
N.S	**N.S**						**LSD**
Average S							
20.14	37.13	28.15	19.60	11.12	4.71	S1	**S*P**
23.21	41.58	32.02	22.65	13.56	6.25	S2	
0.972	**2.173**						**LSD**
Average T							
24.85	43.27	35.23	25.25	14.39	6.14	T0	
20.25	36.85	28.10	19.65	11.45	5.22	T1	
18.54	35.05	25.27	17.87	10.18	4.33	T2	
22.61	41.19	31.45	21.39	13.16	5.87	T3	
21.52	39.84	29.87	20.67	12.04	5.15	T4	**T*P**
23.52	42.17	32.53	23.06	13.79	6.04	T5	
22.16	40.03	30.48	21.83	12.95	5.53	T6	
21.04	38.24	29.31	20.58	11.40	5.69	T7	
20.59	37.55	28.54	19.85	11.67	5.33	T8	
2.061	**4.609**						**LSD**
	39.36	30.09	21.13	12.34	5.48	**Average p**	
	1.536					**LSD**	

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2- The effect on ascorbic acid (vitamin C) mg / 100 g w

The results in Table (2) indicated that the treatment (T2) gave the highest content of vitamin C and it reached 103.73 mg / 100 g, compared to the treatment (T0) and (T5), which gave the lowest content of vitamin C and reached 93.87 and 96.71 mg / 100 g, respectively, for fruits stored at 4 ° C ± 2 ° C. The refrigerated storage treatment for the fruits (P0) gave the highest value amounted to 133.33 mg / 100 g, while the fruits stored for (P25) gave the lowest content of vitamin C, reaching 44.98 mg / 100 g. The stored fruits (S1) gave the highest content of vitamin C and reached 101.27 mg / 100 g, compared with fruits (S2) which gave the lowest average, which was 95.93 mg / 100 g. Either the bi- interaction between the treatments and the storage period (T2P0) gave the highest content of vitamin C, which was 133.33 mg / 100 g, while the decreased concentrations in the interaction treatment (T0P25) and (T5P25) were 33.87 and 41.33 mg / 100 g, respectively. The bi- interaction between the fruit cultivar and the storage period(S1P0) gave the highest vitamin C content and it reached 138.13 mg / 100 g, compared to the interaction between (S1P25) and (S2P25) the lowest vitamin C content, which were 44.06 and 45.87 mg / 100 g, respectively. As for the interaction between the cultivar of fruits and the treatments with antioxidants, the triple interaction between the cultivar of fruits, the treatments, and the storage period did not significantly affect them .It is noticed that the fruit content of vitamin C is decreased continuously during the storage period. The reason may be due to an increase in weight loss, as well as an increase in the speed of respiration as a result of being affected by light. This is consistent with what they found (29), (26) and (28) It turned out that the fruits treated with ascorbic acid retained the largest amount of vitamin C. The reason can be due to the role of ascorbic acid in reducing bio processes inside the cell and reducing oxidative activities, as well as enhancing the primary antioxidants that are phenolic substances respectively, the activity of enzymes decreases as a result of their interaction with free radicals and the formation of stable and ineffective products, in accordance with what he found (27) and (2).

Table (2) The effect of antioxidants and the storage period, the interaction between them in The fruit's vitamin C content is mg / 100 g of the two Jujube fruits (Al-Tuffali and Al-Armouti) stored at a temperature of 4 ° C ± 2

Interaction	**Storage period/ day**						**Treatments**	**Storage type**
S*T	P25	P20	P15	P10	P5	P0	T	**S**
97.07	33.07	69.33	94.93	117.33	129.60	138.13	T0	**S1**
103.73	50.13	78.40	100.80	122.13	132.80	138.13	T1	
106.40	57.07	82.67	102.40	123.73	134.40	138.13	T2	
99.82	41.60	72.00	97.60	119.47	130.13	138.13	T3	
101.16	43.73	74.13	98.13	121.07	131.73	138.13	T4	
99.02	38.93	70.93	96.53	118.93	130.67	138.13	T5	
100.36	42.13	72.53	99.20	120.00	130.13	138.13	T6	
101.07	43.20	73.07	99.73	120.53	131.73	138.13	T7	
102.84	46.93	77.33	100.27	121.60	132.80	138.13	T8	
90.67	34.67	63.47	89.07	108.80	119.47	128.53	T0	**S2**
98.58	51.73	77.87	97.60	113.07	122.67	128.53	T1	
101.07	55.47	81.60	100.80	115.73	124.27	128.53	T2	
95.11	44.80	73.60	93.87	110.40	119.47	128.53	T3	
95.91	45.33	74.13	94.93	111.47	121.07	128.53	T4	

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94.40	43.73	72.53	93.33	109.33	118.93	128.53	T5	
95.38	44.27	73.07	94.93	110.93	120.53	128.53	T6	
95.38	44.80	73.60	94.40	110.40	120.53	128.53	T7	
96.89	48.00	74.67	96.00	112.00	122.13	128.53	T8	
N.S	N.S							**LSD**
Average S								
101.27	44.09	74.49	98.84	120.53	131.56	138.13	S1	**S*P**
95.93	45.87	73.84	94.99	111.35	121.01	128.53	S2	
0.892	2.185							**LSD**
Average T								
93.87	33.87	66.40	92.00	113.07	124.53	133.33	T0	**T*P**
101.16	50.93	78.13	99.20	117.60	127.73	133.33	T1	
103.73	56.27	82.13	101.60	119.73	129.33	133.33	T2	
97.47	43.20	72.80	95.73	114.93	124.80	133.33	T3	
98.53	44.53	74.13	96.53	116.27	126.40	133.33	T4	
96.71	41.33	71.73	94.93	114.13	124.80	133.33	T5	
97.87	43.20	72.80	97.07	115.47	125.33	133.33	T6	
98.22	44.00	73.33	97.07	115.47	126.13	133.33	T7	
99.87	47.47	76.00	98.13	116.80	127.47	133.33	T8	
1.892	4.634							**LSD**
	44.98	74.16	96.92	115.94	126.28	133.33	**Average P**	
	1.545						**LSD**	

3- Effect on carotene pigment

The results in the statistical analysis of Table (3) indicate that the treasury treatments had a significant effect on the content of the fruit peel of the carotene pigment, where the treatment (T0) and (T3) gave the highest average, reaching 0.89 and 0.86 mg / 100 g, respectively, compared with the treatment (T2) that gave the lowest average was 0.72 mg / 100 g. As for the storage period (P25) gave the highest average and reached 1.63 mg / 100 g, while the fruits stored for (P0) gave the lowest average, at 0.24 mg / 100 g. The fruit cultivar also had a significant effect, where the (S2) cultivar recorded the highest average at 0.88 mg / 100 g, while the (S1) cultivar recorded the lowest average, which was 0.71 mg / 100 g. As for the interaction between treatments and storage period, (T0P25) gave the highest amount, which was 1.74 mg / 100 g, while (T2P0) gave the lowest amount, which was 0.24 mg / 100 g. Also, the bi-interaction between fruit cultivar and storage period(S2P25) gave the highest quantity, at 1.74 mg / 100 g, while (S1P0) the lowest amount was recorded, which was 0.23 mg / 100 g. With regard to the bi-interaction between the fruits cultivar and the treatments with antioxidants and the triple interaction between the fruits cultivar and the treatments with antioxidants, the storage period did not significantly affect. The summary of the results of the study of this trait turned out that the storage period is the most influential factor among the other factors as there is a positive increase with the extension of the storage period. The reason may be due to the degradation of the chlorophyll pigments when ripening progresses, the appearance of pigments that were hidden such as carotenoids, and the transformation of the chloroplasts in the peel fruits into coloured plastids as the ripening of the fruits progressed (3) and these results are consistent with what was mentioned (25) and (5) The control treatment fruits retained a higher

percentage of carotene pigments compared to fruits treated with ascorbic and citric acids. The reason for this may be due to the role of antioxidants in preserving the components of fruits and preserving them from deterioration as well as reducing the bioactivities, and this is consistent with (15) and (5) It is noticed that the apple variety contains less pigments than the Al-Armouti cultivar and It may be due to the nature of the genetic traits of each cultivar.

Table (3) The effect of antioxidants and the storage period, the interaction between them in carotene pigment (mg / 100g fresh weight) of the two Jujube fruits (Al-Tuffali and Al-Armouti) stored at a temperature of 4 ° C ± 2

Interaction S*T	**Storage period/ day**						**Treatments**	**Storage type**
	P25	P20	P15	P10	P5	P0	T	**S**
0.81	1.63	1.15	0.87	0.58	0.36	0.23	T0	
0.65	1.42	0.90	0.62	0.47	0.26	0.23	T1	
0.63	1.39	0.87	060	0.42	0.25	0.23	T2	
0.74	1.54	1.06	0.78	0.54	0.32	0.23	T3	
0.67	1.49	0.93	0.63	0.45	0.27	0.23	T4	**S1**
0.76	1.57	1.08	0.80	0.55	0.33	0.23	T5	
0.73	1.55	1.01	0.73	0.52	0.32	0.23	T6	
0.69	1.54	0.96	0.68	0.49	0.27	0.23	T7	
0.67	1.45	0.92	0.66	0.48	0.27	0.23	T8	
0.97	1.83	1.56	1.18	0.61	0.33	0.25	T0	
0.84	1.70	1.27	0.89	0.59	0.33	0.25	T1	
0.80	1.62	1.25	0.87	0.52	0.30	0.25	T2	
0.92	1.79	1.40	1.02	0.68	0.38	0.25	T3	
0.86	1.72	1.34	0.96	0.54	0.37	0.25	T4	**S2**
0.94	1.79	1.49	1.11	0.67	0.36	0.25	T5	
0.86	1.75	1.34	0.96	0.56	0.31	0.25	T6	
0.85	1.72	1.33	0.90	0.55	0.33	0.25	T7	
0.83	1.70	1.29	0.89	0.54	0.33	0.25	T8	
N.S	N.S							**LSD**
Average S								
0.71	1.51	0.99	0.71	0.50	0.29	0.23	S1	**S*P**

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0.88	1.74	1.36	0.97	0.58	0.34	0.24	S2	
0.015	0.037							**LSD**
Average T								
0.89	1.74	1.36	1.02	0.60	0.35	0.24	T0	
0.75	1.57	1.09	0.76	0.53	0.30	0.24	T1	
0.72	1.51	1.07	0.74	0.48	0.28	0.24	T2	
0.84	1.67	1.23	0.90	0.61	0.35	0.24	T3	
0.77	1.61	1.14	0.80	0.50	0.32	0.24	T4	**T*P**
0.86	1.69	1.29	0.96	0.61	0.34	0.24	T5	
0.79	1.65	1.18	0.85	0.54	0.32	0.24	T6	
0.78	1.64	1.14	0.79	0.53	0.31	0.24	T7	
0.76	1.58	1.11	0.77	0.51	0.30	0.24	T8	
0.032	0.079							**LSD**
	1.63	1.18	0.85	0.55	0.32	0.24	**Average P**	
	0.026						**LSD**	

4- Effect on total phenols%

The results in Table (4) showed that the fruits of treatment (T2) gave the highest percentage, reaching 1.18%, while the fruits of treatment (T0) and (T3) gave the lowest percentage, reaching 0.92% and 1.00%, respectively, for the fruits of refrigerated storage. The highest average was 1.29%, As for the fruits of cultivar (S2), they gave the lowest percentage, which amounted to 0.81%. Fruits stored for (P0) gave the highest percentage, reaching 1.71%, while the fruits stored (P25) gave the lowest percentage, which amounted to 0.31%. As for the interaction between the treatments and the storage period (T2P0), the highest percentage was 1.71%, while the interaction (T0P25) gave the lowest percentage for phenolic substances, reaching 0.19%. The interaction between fruit cultivar and storage period(S1P0) gave the highest percentage, which was 1.99% compared to (S2P25) fruits, the lowest percentage of phenolic substances was 0.24%.With regard to the bi-interaction between the cultivar and the treatments with antioxidants, and the triple interaction between the cultivar , the treatments of antioxidants, and the storage period, they had no significant effect. The fruit's retention of a high percentage of phenolic substances, when treated with ascorbic and citric acids, is due to the role of the two acids in reducing the action of the enzyme polyphenol oxider by affecting the pH function, especially ascorbic acid, and thus stopping or inhibiting the enzyme action (6),As well as the role of ascorbic acid in enhancing the effectiveness of primary antioxidants such as phenolic compounds, and thus it has an important mechanism of action where it interacts with free radicals and active oxygen factions and inhibits its action (22), (2) and (26). The decrease in the proportion of phenols with the increase in storage time may be due to The oxidation processes conducted by the enzyme polyphenol oxidase, peroxidase

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enzyme, and phenolase enzyme for phenolic compounds and their reduction to quinones that are unstable and low persistence and this is consistent with what he found (23), (2) and (30).

Table (4) The effect of antioxidants and the storage period, the interaction between them in the percentage of phenolic substances of the two Jujube fruits (Al-Tuffali and Al-Armouti) stored at a temperature of 4 ° C ± 2

Interaction S*T	**Storage period/ day**						**Treatments**	**Storage type**
	P25	P20	P15	P10	P5	P0	T	**S**
1.13	0.22	0.44	0.95	1.51	1.72	1.99	T0	
1.39	0.48	0.93	1.28	1.79	1.84	1.99	T1	
1.42	0.58	0.97	1.35	1.78	1.84	1.99	T2	
1.23	0.35	0.62	1.02	1.67	1.76	1.99	T3	
1.28	0.39	0.78	1.02	1.68	1.81	1.99	T4	**S1**
1.26	0.29	0.74	1.00	1.70	1.81	1.99	T5	
1.27	0.32	0.76	0.99	1.74	1.81	1.99	T6	
1.28	0.36	0.76	1.00	1.71	1.83	1.99	T7	
1.33	0.39	0.78	1.22	1.79	1.81	1.99	T8	
0.70	0.16	0.28	0.57	0.96	1.07	1.44	T0	
0.87	0.29	0.57	0.70	0.92	1.31	1.44	T1	
0.95	0.41	0.64	0.81	1.00	1.39	1.44	T2	
0.78	0.19	0.42	0.61	0.81	1.20	1.44	T3	
0.81	0.21	0.43	0.67	0.85	1.24	1.44	T4	**S2**
0.67	0.18	0.38	0.58	0.79	1.18	1.44	T5	
0.77	0.21	0.42	0.61	0.78	1.17	1.44	T6	
0.79	0.24	0.44	0.66	0.78	1.18	1.44	T7	
0.81	0.27	0.47	0.69	0.81	1.19	1.44	T8	
N.S	N.S							**LSD**
Average S								
1.29	0.38	0.76	1.09	1.71	1.80	1.99	S1	**S*P**
0.81	0.24	045	0.65	0.83	1.22	1.44	S2	
0.017	0.043							**LSD**
Average T								
0.92	0.19	0.36	0.76	1.10	1.39	1.71	T0	
1.13	0.39	0.75	0.99	1.36	1.57	1.71	T1	
1.18	0.49	0.80	1.08	1.39	1.61	1.71	T2	
1.00	0.27	0.52	0.81	1.24	1.48	1.71	T3	
1.04	0.29	0.61	0.84	1.27	1.53	1.71	T4	**T*P**
1.01	0.24	0.57	0.76	1.25	1.49	1.71	T5	
1.02	027	0.59	0.81	1.26	1.49	1.71	T6	
1.03	0.30	0.59	0.83	1.25	1.51	1.71	T7	
1.07	0.33	0.62	0.95	1.29	1.51	1.71	T8	
0.037	0.091							**LSD**
	0.31	0.60	0.88	1.27	1.51	1.71	**Average P**	
	0.030						**LSD**	

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5- The effect on protein percentage

Table (5) results show that some Storage treatments affected in the protein content of fruits, where treatment (T2) achieved the highest average, reaching 3.46%. While the treatment (T0) gave the lowest average, at 3.03%.The storage period of fruits affected the amount of proteins. Fruits stored for (0P) gave the highest average of 4.73%, while fruits stored (P25) gave the lowest average, reaching 1.69%.Either the effect of the fruit cultivar had a significant effect, where (S1) fruits excelled them, reaching 3.47%, while (S2) fruits gave the lowest average of proteins, reaching 2.95%.With regard to the bi-interaction between the cultivar of fruits and the storage period, (0S1P) gave the highest percentage, at 5.01%, while (S2P25) the lowest average was 1.44%.With regard to the bi-interaction between the cultivar of fruits and the treatments with antioxidants, the interaction between the storage period and the antioxidant treatments had no significant effect, as well as the triple interaction between the cultivar of fruits, the antioxidant treatments and the storage period did not significantly affect, It is noted from this study that the percentage of protein is constantly decreasing the period of storage, and the reason may be due to the biological processes that occur inside the fruit cells that lead to the degradation of the protein and this is consistent with what he mentioned that all fruits suffer from a decrease in protein during storage (10) and (4) . The fruits treated with ascorbic acid and citric acid maintained a high percentage of protein compared to the rest of the treatments. The reason may be the role of antioxidants in stabilizing the protein inside the fruit cells, reducing its loss and preventing its degradation, where ascorbic acid works on Capturing hydrogen peroxide H2O2 and protects enzymes and proteins from oxidation (16) and agrees with findings (2) and (7).

Table (5) The effect of antioxidants and the storage period, the interaction between them in the percentage of protein of the two Jujube fruits (Al-Tuffali and Al-Armouti) stored at a temperature of 4 ° C ± 2.

Interaction S*T	**Storage period/ day**						**Treatments**	**Storage type**
	P25	P20	P15	P10	P5	P0	T	**S**
3.27	1.54	2.39	3.05	3.62	4.03	5.01	T0	
3.53	2.00	2.75	3.32	3.88	4.20	5.01	T1	
3.77	2.40	3.01	3.55	4.03	4.59	5.01	T2	
3.36	1.68	2.48	3.11	3.67	4.19	5.01	T3	
3.48	2.03	2.66	3.28	3.70	4.24	5.01	T4	**S1**
3.34	1.77	2.40	3.07	3.63	4.11	5.01	T5	
3.40	1.89	2.52	3.13	3.67	4.18	5.01	T6	
3.44	2.04	2.66	3.12	3.68	4.14	5.01	T7	
3.64	2.25	2.88	3.32	3.88	4.47	5.01	T8	
2.79	1.12	1.86	2.53	3.16	3.62	4.45	T0	
3.03	1.51	2.23	2.85	3.37	3.81	4.45	T1	
3.14	1.78	2.40	2.91	3.40	3.92	4.45	T2	
2.83	1.27	1.93	2.54	3.13	3.67	4.45	T3	
3.06	1.57	2.23	2.86	3.39	3.83	4.45	T4	**S2**
2.78	1.19	1.89	2.52	3.09	3.53	4.45	T5	
2.96	1.48	2.11	2.74	3.27	3.73	4.45	T6	
2.97	1.43	2.15	2.73	3.28	3.76	4.45	T7	

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2.99	1.59	2.22	2.82	3.21	3.70	4.45	T8	
N.S	N.S							**LSD**
Average S								
3.47	1.96	2.64	3.22	3.75	4.24	5.01	S1	**S*P**
2.95	1.44	2.11	2.72	3.26	3.73	4.45	S2	
0.049	0.120							**LSD**
Average T								
3.03	1.33	2.12	2.79	3.38	3.83	4.73	T0	**T*P**
3.28	1.76	2.48	3.08	3.62	4.01	4.73	T1	
3.46	2.09	2.71	3.23	3.71	4.25	4.73	T2	
3.09	1.48	2.21	2.83	3.40	3.93	4.73	T3	
3.27	1.80	2.45	3.07	3.55	4.04	4.73	T4	
3.07	1.48	2.15	2.79	3.36	3.82	4.73	T5	
3.18	1.69	2.32	2.93	3.48	3.96	4.73	T6	
3.21	1.74	2.40	2.93	3.48	3.95	4.73	T7	
3.32	1.91	2.55	3.07	3.55	4.08	4.73	T8	
0.104	N.S							**LSD**
	1.69	2.37	2.97	3.51	3.98	4.73	**Average P**	
.	0.085						**LSD**	

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