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The effect of dipping with Assyrian plum extract and potassium sulfate and temperature storage on the storability of pomegranate fruits, cv. Slimmi.

Waleed Khalil Al-Jubori[1], Khaled Naji Al-Asal[2], Khaled Abdullah Al-Sahar[3]
[1,2]*College of Agriculture/Tikrit University/ Iraq*
[3]*College of Agriculture / Samarra University/ Iraq.*

** Corresponding author: E-mail: w.aljubori1982@gmail.com,*

ABSTRACT

The storage experiment is carried out in Al-Mustafa's refrigerated warehouses in Balad District in Salah al-Din Governorate for the agricultural season 2022-2023, where pomegranate fruits (*Punica granatum* L.). The response of pomegranate fruits to immersion in Assyrian plum extract and potassium sulfate, storage at different temperatures, and storability, fruits are immersed for three minutes in Assyrian plum extract at three concentrations: 0, 1, and 2%. The fruits are immersed in potassium sulfate at three concentrations: 0, 1.5, and 3%. The fruits are stored at different temperatures in refrigerated warehouses (normal room temperature, 5 and 7 °C). The study is carried out using a completely randomized design (CRD) as a factorial experiment with three factors and three replications. The Immersion with Assyrian plum extract at a concentration of 2% had a significant effect, the highest peel thickness, amounting to 3.50 mm, the highest percentage of juice, amounting to 53.80%, with the highest vitamin C content of 2.766 mg per 100 gm juice^{-1}, and a higher acidity percentage of 1.01%. As for immersion in potassium sulfate at a concentration of 0%, it had a significant effect, the highest percentage of juice of 53.66%, the lowest percentage of dissolved solids of 14.42%, and the highest content of Vitamin C amounted to 2.767 mg per 100 g juice^{-1}, and the acidity rate is 1.01%. While the 3% concentration of potassium sulfate gave the lowest percentage of microbial damage, which amounted to 4.01%. While the storage temperature of 5°C had a significant effect that led to reducing the percentage of weight loss in the fruits, which amounted to 5.10%, reducing the percentage of microbial damage, which amounted to 3.94%, and maintaining the thickness of the peel, which amounted to 3.62 mm, and the percentage of juice, which amounted to 53.99%, with the lowest percentage of solids. The soluble content reached 14.46%, and the highest vitamin C content reached 2.737 mg per 100 gm juice^{-1}, and the highest acidity reached 1.02%.

KEYWORDS: pomegranate; Assyrian plum; potassium sulfate; temperature; storage.

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تأثير التغطيس بمستخلص البمبر وكبريتات البوتاسيوم ودرجة الحرارة في القابلية الخزنية لثمار الرمان صنف سليمي

وليد خليل احمد الجبوري[1]، خالد ناجي عبد العسل[2]، خالد عبد الله السهر[3]
[2،1]قسم البستنة وهندسة الحدائق، كلية الزراعة، جامعة تكريت، العراق
[3]كلية الزراعة / جامعة سامراء.

الملخص

نفذت التجربة الخزنية في مخازن المصطفى المبردة في قضاء بلد في محافظة صلاح الدين للموسم الزراعي 2022 – 2023، اذ قسمت الثمار الى عدة مجاميع وحسب معاملات الدراسة للتعرف على استجابة ثمار الرمان للغمر في مستخلص البمبر وكبريتات البوتاسيوم والخزن في درجات حرارية مختلفة والقابلية الخزنية وتم تغطيس الثمار ولمدة ثلاث دقائق بمستخلص البمبر وبثلاثة تراكيز صفر و1 و2 %. والغمر بكبريتات البوتاسيوم وبثلاث تراكيز صفر و1.5 و3 %, وخزنت الثمار على درجات حرارية مختلفة في مخازن مبردة (درجة حرارة الغرفة الاعتيادية و5 و7 مo). نفذت الدراسة باستخدام تصميم العشوائي الكامل (CRD) كتجربة عاملية بثلاث عوامل وثلاث مكررات، وحللت النتائج احصائياً حسب تحليل التباين وقورنت المتوسطات باستعمال اختبار اقل فرق معنوي (LSD) وعلى احتمال 5 %. ولُخصت النتائج بما يلي: ادى الغمر بمستخلص البمبر بتركيز 2 % قد أثر بشكل معنوي واعطى اقل نسبة تلف ميكروبي بلغت 3.94 % واعطى اعلى سمك القشرة بلغ 3.50 ملم واعلى نسبة مئوية للعصير بلغت 53.80 % وعلى اعلى محتوى من فيتامين C بلغ 2.766 ملغم 100 غم عصير$^{-1}$ ونسبة حموضة اعلى بلغت 1.01 %. اما الغمر بكبريتات البوتاسيوم بكافة بتركيز صفر% قد أثر بشكل معنوي واعطى اعلى سمك القشرة بلغ 3.66 ملم واعلى نسبة مئوية للعصير بلغت 53.66 % وعلى اقل نسبة من المواد الصلبة الذائبة بلغت 14.42 % وعلى اعلى محتوى من فيتامين C بلغ 2.767 ملغم 100 غم عصير$^{-1}$ ونسبة حموضة اعلى بلغت 1.01 %, في حين اعطى التركيز 3 % من كبريتات البوتاسيوم اقل نسبة من التلف الميكروبي والذي بلغت نسبته 4.01 %. بينما اثرت درجة حرارة الخزن 5مْ تأثيراً معنوياً ادى الى التقليل من نسبة فقدان الوزن في الثمار والتي بلغت 5.10 % وتقليل نسبة التلف الميكروبي والتي بلغت 3.94 % والمحافظة على

سمك القشرة والذي بلغ 3.62 ملم والنسبة المئوية للعصير والتي بلغت 53.99% وعلى اقل نسبة من المواد الصلبة الذائبة والتي بلغت 14.46 % وعلى اعلى محتوى من فيتامين C بلغ 2.737 ملغم 100 غم عصير$^{-1}$ وعلى اعلى نسبة حموضة بلغت 1.02 %..

الكلمات المفتاحية: الرمان، البمبر، كبريتات البوتاسيوم، درجة الحرارة، الخزن.

INTRODUCTION

Pomegranate fruits (*Punica granatum* L.) undergo various physiological and chemical changes during fruit storage, and these changes continue after harvest, leading to decreased fruit quality and high post-harvest losses. Therefore, the development and use of alternative post-harvest control options, incorporating biological agents or natural plant extracts, have become important since they are viewed as being environmentally safer and more acceptable to public health (Janisiewicz and Korsten, 2002). Using Assyrian plum extract (*Cordia myxa* L.) either by itself or in conjunction with other supplementation with antioxidants is a promising way to reduce oxidative and enzymatic degradation and thus increase the shelf life of fresh fruits and vegetables (Quezada-Gallo, 2009).

The mucous ripe fruit extract includes mucilage made up of anionic polysaccharides covalently linked to protein (Benhura and Chidewe, 2011). Recently, antioxidants and essential oil methods have been used as alternatives to fungicides to control post-harvest diseases of fruit, such as potassium metabisulfite (KMS) also known as E224 used as a food additive as it forms sulfur dioxide (SO2) gas, and acts as an antifungal agent. It is an effective antioxidant, so it is used to prevent most microorganisms from growing, and to protect the color and delicate flavors of wine. It is also an inhibitor of the polyphenol oxidase enzyme (Sivakumar *et al*., 2002), where it has been used as a preservative in fruits and fruit products. Therefore, the application of KMS at 250 ppm on rambutan fruits, storing under 13.5°C, effectively controlled diseases, color and maintained eating quality of fruits for up to 21 days. Storage temperature is considered one of the most important environmental factors affecting fruit aging, because it regulates the rate of physiological and biochemical processes and plays an important role in prolonging the shelf life of many fruits and vegetables while maintaining their quality during storage. For countries that are not economically developed (Al-Bahnasawy, 2013).

MATERIALS AND METHODS

The storage experiment is carried out in Al-Mustafa warehouses in Balad district in Salah al-Din governorate for the agricultural season 2022-2023, where pomegranate fruits (*Punica granatum* L.) of the cv. Salimi are used, which are harvested from one of the orchards in Hawija district in Kirkuk governorate on 10/15/2022. Which have reached the stage of maturity, they are carefully harvested, choosing the fruits free of pathological, physiological and mechanical defects, removing impurities and dust stuck to them, and preparing them for storage study. The fruits are divided into

several groups to learn how the storage characteristics of pomegranate fruits respond to immersion in Assyrian plum extract and potassium sulfate and storage at different temperatures.

The fruits are immersed for three minutes in Assyrian plum extract at three concentrations (0, 1, and 2%). The fruits are immersed in potassium sulfate at three concentrations (0, 1.5, and 3%), and the fruits are stored at different temperatures in refrigerated warehouses (normal room temperature, 5 and 7°C).

The study is carried out using a camp-randomized design (CRD) as a factorial experiment with three factors and three replications. The results are analyzed according to analysis of variance and the means are compared using the least significant difference (L.S.D) test at the 5% probability level and are downloaded using the Genstat program (Al-Mohammadi and Al-Mohammadi, 2012).

RESULT AND DISCUSSION

Percentage of fruit weight loss (%):

Table (1) shows that immersing fruits with Assyrian plum extract had a significant effect in reducing the percentage of fruit weight loss, as the treatment with Assyrian plum extract at a concentration of 2% gave the lowest percentage of loss, amounting to 5.08%, compared to the comparison treatment, which gave the highest percentage, amounting to 5.71%. The results of the same table also showed that immersing fruits with potassium sulphate had a significant effect in reducing the loss in fruit weight, as potassium sulphate treatment with a concentration of 1.5% gave the lowest percentage, reaching 4.80%. The results of the same table showed that the storage temperature had a significant effect on reducing the loss, as the 5°C treatment gave the lowest percentage, amounting to 5.10%, compared to the highest percentage, amounting to 5.61%, in the comparison treatment (normal room temperature) .

As for the interaction of Assyrian plum extract and potassium sulphate, it had a significant effect and gave the lowest weight loss percentage of 4.98% in the treatment of Assyrian plum extract with a concentration of 2% + potassium sulphate with a concentration of 1.5%, compared to the comparison treatment, which gave the highest percentage of 6.37%. As noted in the results of Table (1), the interaction of the Assyrian plum extract and the storage temperature significantly affected the percentage of weight loss, in treatment of the Assyrian plum extract at a concentration of 2% + a storage temperature of 5 °C gave the lowest percentage of loss, amounting to 4.85%, compared to the comparison treatment, which It gave a higher percentage, reaching 5.96%. As for the interaction of potassium sulphate with storage temperature, it significantly affected the weight loss percentage of fruits, as the 1.5% potassium sulphate treatment + 5°C storage temperature gave a lower weight loss

percentage of 4.40%, compared to the highest percentage of 5.90% in the comparison treatment. The triple interaction of the study factors had a significant effect on the percentage of weight loss and gave a lower percentage of loss in the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 1.5% + a storage temperature of 5°C, which amounted to 4.74%, compared to the comparison treatment, which gave the highest percentage of weight loss. It is higher, reaching 6.91%.

Table 1. The effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the percentage of weight loss in pomegranate fruits, cv. Slimmi (%)

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
Zero	zero	6.91	5.84	6.32	6.37
	1.5	5.48	5.06	5.16	5.23
	3	5.80	5.41	5.78	5.66
1	zero	5.72	5.21	5.31	5.41
	1.5	5.29	4.84	5.08	5.07
	3	5.48	4.96	5.15	5.20
2	zero	5.32	4.94	5.14	5.13
	1.5	5.18	4.74	5.01	4.98
	3	5.31	4.88	5.04	5.08
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	zero	5.96	5.44	5.72	5.71
	1	5.56	5.01	5.18	5.25
	2	5.31	4.85	5.09	5.08
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	zero	5.90	5.58	5.75	5.74
	1.5	5.37	4.40	4.64	4.80
	3	5.56	5.32	5.60	5.49
Effect of storage temperature		5.61	5.10	5.33	
LSD 5 %					
Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.11	0.06	0.06	0.06	0.03	0.03	0.03

Percentage of microbial damage in fruits :(%)

The results of Table (2) showed that immersing fruits in Assyrian plum extract had a significant effect and reduced the percentage of spoilage in stored fruits, as the Assyrian plum extract

treatment at a concentration of 2% gave a spoilage rate of 3.94% compared to the highest spoilage percentage of 5.17% in the comparison treatment. It is noted in the same table data that immersion in potassium sulphate had a significant effect and gave the lowest percentage of damage to stored fruits, amounting to 4.01% in the potassium sulphate treatment at a concentration of 3%, compared to the highest percentage of 4.65% in the comparison treatment .

The results of Table (2) also showed that the storage temperature had a significant effect in reducing the percentage of fruit spoilage, as it reached 3.94% in the 5 °C storage temperature treatment, compared to the comparison treatment (normal room temperature), which gave the highest percentage of damage, amounting to 4.74 %. As for the effect of the interaction of immersion in the Assyrian plum extract and potassium sulfate, it had a significant effect on the percentage of microbial spoilage, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 3% gave a spoilage rate of 3.54%, compared to the highest percentage of spoilage in the comparison treatment, which is estimated at 5.37% . It is found that there is a significant effect on the percentage of spoilage in the fruits between the interaction of the Assyrian plum extract and the storage temperature, as the treatment with the Assyrian plum extract at a concentration of 2% gave the lowest percentage of spoilage, amounting to 3.25%, compared to the control treatment, which gave the highest percentage of damage to the fruits, amounting to 5.48%. It is also found that the interaction of the potassium sulphate treatments and the storage temperature had a significant effect in reducing the percentage of damaged fruits, as the potassium sulphate treatment at a concentration of 3% + a storage temperature of 5 °C gave the lowest percentage, amounting to 3.50%, compared to the comparison treatment, which gave the highest percentage, amounting to 5%. As for the triple interaction between the study treatments, it had a significant effect, as it reduced the percentage of damaged fruits, as the treatment of immersion in Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 3% + storage at a temperature of 5°C gave the lowest percentage of damage, amounting to 3.08%, compared to the comparison treatment, which It gave the highest damage rate of 5.82%.

Table 2. The effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the percentage of microbial damage in pomegranate fruits, cv. Slimi.

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
Zero	zero	5.82	5.10	5.20	5.37
	1.5	5.65	4.92	5.56	5.38
	3	4.99	4.30	4.98	4.76
1	zero	4.60	3.83	4.48	4.30
	1.5	4.39	3.64	4.27	4.10

	3	4.41	3.11	3.65	3.72
	zero	4.58	3.80	4.41	4.26
2	1.5	4.41	3.64	4.09	4.04
	3	3.82	3.08	3.71	3.54
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	zero	5.48	4.77	5.25	5.17
	1	4.28	3.80	4.08	4.05
	2	4.46	3.25	4.11	3.94
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	zero	5.00	4.25	4.70	4.65
	1.5	4.81	4.07	4.63	4.50
	3	4.41	3.50	4.11	4.01
Effect of storage temperature		4.74	3.94	4.48	

LSD 5 %						
Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.05	0.03	0.03	0.03	0.01	0.01	0.01

Percentage of peel thickness in fruits (%):

It is found in the results of Table (3) that immersing the fruits in the Assyrian plum extract had a significant effect on the thickness of the peel, as the treatment with the Assyrian plum extract at a concentration of 2% gave the highest peel thickness of 3.50 mm, compared to the lowest thickness of 3.24 mm in the comparison treatment.

As for immersing the fruits in potassium sulphate, it is noted that there is a significant difference in the thickness of the peel, as the comparison treatment gave the highest thickness, amounting to 3.66 mm. While the potassium sulphate treatment at a concentration of 3% gave the lowest thickness, amounting to 3.16 mm. It is found in the results of the same table that the storage temperature of 5 °C had a significant effect, as it gave the highest shell thickness of 3.62 mm, compared to the lowest thickness of 3.20 mm in the comparison treatment (normal room temperature).

As for the effect of the interaction between the Assyrian plum extract and the storage temperature, it had a significant effect on the thickness of the peel, as the treatment with the Assyrian plum extract at a concentration of 2% + a storage temperature of 5°C gave the highest thickness of 3.67 mm, compared to the control treatment, which gave the lowest peel thickness of 3.01 mm. While the results of the same table indicate that the interaction of the two potassium sulphate treatments and storage temperature significantly affected the peel thickness, as the potassium sulphate treatment at a

concentration of 0% + a storage temperature of 5 °C gave the highest peel thickness of 3.85 mm, compared to the potassium sulphate treatment at a concentration of 3% + storage. At normal room temperature, which gave the lowest crust thickness of 2.97%. It is also found that the triple interaction between the study factors had a significant effect on the thickness of the peel of the fruits, as the treatment with Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 0% + a storage temperature of 5°C gave the highest peel thickness of 3.90 mm, compared to the treatment with Assyrian plum extract at a concentration of 0% + Potassium sulfate at a concentration of 3% + storage temperature in the normal room, which gave the minimum thickness of 2.83 mm.

Table 3. Effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the peel thickness of pomegranate fruits, vc. Slimmi (mm).

Assyrian plum Extract Levels (%)	**Potassium sulfate levels (%)**	**Storage temperature levels (°C)**			**Effect of Assyrian plum extract with potassium sulfate**
		Normal room temperature	**5**	**7**	
Zero	Zero	2.98	3.49	3.07	3.18
	1.5	2.85	3.49	3.00	3.11
	3	2.83	3.37	3.00	3.01
1	Zero	3.28	3.79	3.35	3.47
	1.5	3.11	3.55	3.20	3.29
	3	2.99	3.41	3.08	3.16
2	Zero	3.68	3.90	3.76	3.78
	1.5	3.63	3.89	3.58	3.70
	3	3.48	3.72	3.49	3.56
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	Zero	3.01	3.54	3.16	3.24
	1	3.21	3.65	3.24	3.37
	2	3.38	3.67	3.44	3.50
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	Zero	3.52	3.85	3.60	3.66
	1.5	3.11	3.59	3.15	3.28
	3	2.97	3.42	3.09	3.16
Effect of storage temperature		3.20	3.62	3.28	

LSD 5 %

Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.06	0.03	0.03	0.03	0.02	0.02	0.02

Percentage of juice in fruits (%):

Table (4) shows that submerging the fruits with Assyrian plum extract had a significant effect on the percentage of juice, as the Assyrian plum extract treatment with a concentration of 2% gave the highest percentage of juice, amounting to 53.80%, compared to the control treatment, which gave the lowest percentage, amounting to 51.11%. It is found in the results of the same table that potassium sulfate had a significant effect on the juice percentage, as the comparison treatment gave the highest juice percentage, amounting to 53.66%, while the potassium sulfate treatment with a concentration of 3% gave the lowest percentage, amounting to 51.16%. The results of the same table also showed that the storage temperature significantly affected the percentage of juice, as the 5°C storage temperature treatment gave the highest percentage, amounting to 53.99%, compared to the comparison treatment (normal room temperature), which gave the lowest percentage, amounting to 50.98%.It is noted in Table (4) that there are significant differences as a result of the interaction of Assyrian plum extract and potassium sulphate, as it gave the highest juice percentage of 55.01% in the treatment of Assyrian plum extract with a concentration of 2% + potassium sulphate with a concentration of 0%, compared to the treatment with Assyrian plum extract with a concentration of 0% + potassium sulphate with a concentration of 3%. Which gave the lowest juice percentage of 49.91%. The interaction of the Assyrian plum extract with the storage temperature in Table (4) gave a significant effect, with the percentage of juice reaching 55.01% in the treatment of the Assyrian plum extract at a concentration of 2% + a storage temperature of 5 °C, compared to the comparison treatment, which gave the lowest percentage of juice, amounting to 49.07%.

It is noted in the results of the same table that the interaction of Assyrian plum extract and potassium sulphate had a significant effect on the percentage of dissolved solids, as it gave the lowest percentage of 14.22% in the treatment of Assyrian plum extract with a concentration of 2% + potassium sulphate with a concentration of 0%, compared to the treatment of Assyrian plum extract with a concentration of 0% + sulfate. Potassium at a concentration of 3%, which gave the highest percentage of 14.79%. As for the effect of potassium sulfate interfering with storage temperature, it is significant in the potassium sulfate treatment at a concentration of 0% + a storage temperature of 5 °C, with a juice percentage estimated at 54.79%, compared to 48.98% in the treatment of potassium sulfate at a concentration of 3% + normal room temperature. A significant effect is found in the interaction of the three study factors, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulphate at a concentration of 0% + storage temperature of 5 °C gave a juice percentage of 55.97%, compared to the treatment of Assyrian plum extract at a concentration of 0% + potassium sulphate at a concentration of 3% + temperature. The regular room, which gave the lowest percentage, reached 47.02%.

Table 4. Effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the percentage of juice of pomegranate fruits, cv. Slimmi(%) .

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
Zero	Zero	50.54	52.67	52.02	51.74
	1.5	49.66	53.04	52.34	51.68
	3	47.02	52.03	50.69	49.91
1	Zero	54.06	55.38	54.69	54.71
	1.5	52.15	55.06	54.32	53.84
	3	49.30	52.70	51.97	51.32
2	Zero	53.69	55.97	55.38	55.01
	1.5	52.39	55.68	54.97	54.35
	3	50.00	53.40	52.71	52.04
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	Zero	49.07	52.58	51.68	51.11
	1	51.84	54.38	53.66	53.29
	2	52.03	55.01	54.35	53.80
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	Zero	52.43	54.79	53.77	53.66
	1.5	51.53	54.47	54.14	53.38
	3	48.98	52.71	51.78	51.16
Effect of storage temperature		50.98	53.99	53.23	

LSD 5 %						
Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.06	0.03	0.03	0.03	0.02	0.02	0.02

Percentage of total dissolved solids in juice (%):

The results of Table (5) showed that immersing fruits with Assyrian plum extract had a significant effect on the percentage of total soluble solids, as the treatment with Assyrian plum extract at a concentration of 2% maintained the lowest percentage of dissolved solids, which amounted to 14.38%, compared to the comparison treatment, which gave a high percentage of soluble solids. The total amounted to 14.68% .

also indicated that immersing fruits in potassium sulfate had a significant effect on the percentage of total dissolved solids, as the comparison treatment gave the lowest percentage, estimated at 14.42%, compared to the potassium sulfate treatment at a concentration of 3%, which

gave the highest percentage, amounting to 14.66%. The results of Table (5) showed that the storage temperature significantly affected the percentage of total dissolved solids, as the 5°C treatment gave the lowest percentage of dissolved solids, amounting to 14.46%, compared to the highest percentage of 14.65% in the comparison treatment (normal room temperature). The results of the interaction of the Assyrian plum extract with the storage temperature also had a significant effect, as the treatment with the Assyrian plum extract at a concentration of 2% + a storage temperature of 5 °C gave the lowest percentage of dissolved solids, amounting to 14.28%, compared to the highest percentage, amounting to 14.72%, in the comparison treatment.

Also, the results of the same table showed that the interaction of potassium sulphate and storage temperature had a significant effect on this characteristic, as the treatment of potassium sulphate at a concentration of 0% + storage temperature of 5°C gave the lowest significant percentage of 14.33%, compared to the treatment of 3% of potassium sulphate + room temperature. The regular one gave the highest rate of 14.79%. It is also found in the results of Table (5) that the triple interaction of the study factors had a significant effect on the percentage of total dissolved solids, where the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 0% + temperature of 5°C gave the lowest percentage, estimated at 14.09%, compared to the treatment. Assyrian plum extract at a concentration of 0% + potassium sulfate at a concentration of 3% + normal room temperature, which gave the highest percentage of 14.99%.

Table 5. Effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the percentage of total soluble solids in pomegranate fruits, cv. Slimi (%)

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
Zero	Zero	14.79	14.42	14.58	14.60
	1.5	14.92	14.47	14.73	14.71
	3	14.99	14.61	14.76	14.79
1	Zero	14.52	14.37	14.41	14.43
	1.5	14.87	14.36	14.71	14.65
	3	14.88	14.58	14.74	14.73
2	Zero	14.22	14.09	14.21	14.17
	1.5	14.26	14.13	14.26	14.22
	3	14.39	14.26	14.34	14.33
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	Zero	14.72	14.62	14.69	14.68
	1	14.68	14.48	14.58	14.58
	2	14.54	14.28	14.32	14.38
					Effect of potassium sulfate
	Zero	14.48	14.33	14.45	14.42

The effect of potassium sulfate interfering with storage temperature	1.5	14.63	14.47	14.52	14.54
	3	14.79	14.58	14.62	14.66
Effect of storage temperature		14.65	14.46	14.53	

LSD 5 %						
Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.10	0.06	0.06	0.06	0.03	0.03	0.03

Vitamin C content of juice (mg/100g juice):

The results of Table (6) showed that the Assyrian plum extract had a significant effect on the vitamin C content of the juice, as the treatment with the Assyrian plum extract at a concentration of 2% gave the highest content of 2.766 mg. 100 gm juice^{-1}, compared to the control treatment, which gave the lowest vitamin C content, amounting to 2.541 mg. 100g juice^{-1}. While the results of the same table showed that potassium sulfate had a significant effect on the content of vitamin C, as the comparison treatment gave the highest content of 2.767 mg. 100 gm juice^{-1}, compared to the 3% potassium sulfate treatment, which gave the lowest content of 2.568 mg. 100g juice^{-1}. The effect of storage temperature is significantly affected, as a storage temperature of 5 °C gave the highest vitamin C content, amounting to 2.737 mg. 100 gm juice^{-1}, compared to the control treatment (normal room temperature), whose vitamin C content is 2.594 mg. 100g juice^{-1}. It is also found that the interaction of the factors of Assyrian plum extract and potassium sulfate had a significant effect, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 0% gave the highest vitamin C content of 2.836 mg. 100 gm juice^{-1}, compared to the treatment of Assyrian plum extract with a concentration of 0% + potassium sulfate with a concentration of 3%, which gave a content of 2.431 mg. 100g juice^{-1}. It is also noted in the results of this table that the interaction of the factors of Assyrian plum extract and storage temperature on this characteristic had a significant effect, as it is found that treatment of Assyrian plum extract with a concentration of 2% + storage temperature of 5°C gave a content of 2.839 mg. 100 gm juice^{-1}, compared to the control treatment, which gave a content of 2.451 mg. 100g juice^{-1} .

As for the interaction of the two factors of potassium sulphate with temperature, it had a significant effect, as the potassium sulphate treatment with a concentration of 0% + storage temperature of 5°C gave the highest content of 2.824 mg. 100 gm juice^{-1}, compared to the potassium sulfate treatment at a concentration of 3% + the normal temperature, which gave a lower content of 2.491 mg. 100g juice^{-1}. The results of Table (6) showed that the triple interaction of the study factors

had a significant effect on the content of vitamin C, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 0% + a storage temperature of 5°C gave the highest vitamin C content of 2.889 (mg/100g juice) , compared to the treatment of Assyrian plum extract with a concentration of 0% + potassium sulfate with a concentration of 3% + normal room temperature, which gave the lowest content of 2.340 (mg/100g juice).

Table 6. The effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the vitamin C content of pomegranate fruit juice (mg. 100 g juice^{-1})

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
Zero	Zero	2.546	2.692	2.653	2.630
	1.5	2.485	2.610	2.596	2.564
	3	2.340	2.487	2.466	2.431
1	Zero	2.768	2.884	2.850	2.834
	1.5	2.670	2.823	2.782	2.758
	3	2.565	2.690	2.663	2.639
2	Zero	2.751	2.889	2.867	2.836
	1.5	2.686	2.848	2.813	2.782
	3	2.575	2.707	2.672	2.651
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	Zero	2.451	2.598	2.574	2.541
	1	2.656	2.774	2.753	2.727
	2	2.677	2.839	2.783	2.766
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	Zero	2.687	2.824	2.792	2.767
	1.5	2.604	2.768	2.725	2.699
	3	2.491	2.618	2.594	2.568
Effect of storage temperature		2.594	2.737	2.704	

LSD 5 %						
Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.024	0.014	0.014	0.014	0.008	0.008	0.008

Percentage of acidity (%):

The results of Table (7) showed that the Assyrian plum extract had a significant effect on the percentage of acidity, as the Assyrian plum extract treatment with a concentration of 2% gave the highest percentage of acidity, amounting to 1.013%, compared to the control treatment, which gave

the lowest percentage of acidity, amounting to 0.961. As for the effect of potassium sulphate, it had a significant effect, as the comparison treatment gave the highest acidity percentage of 1.016%, compared to the potassium sulphate treatment with a concentration of 3%, which gave the lowest percentage of 0.967%. While the storage temperature affected the percentage of acidity significantly, as the 5°C storage temperature treatment gave the highest percentage, amounting to 1.025%, compared to the comparison treatment (normal room temperature), which gave the lowest percentage, estimated at 0.952%. It is noted in the results of Table (7) that the interaction of the two treatments of Assyrian plum extract and potassium sulfate had a significant effect on the acidity percentage, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulfate at a concentration of 0% gave a percentage estimated at 1.034%, compared to the treatment of Assyrian plum extract at a concentration of 0% + potassium sulfate at a concentration 3%, which gave a percentage of 0.948%.

The results of the same table showed that the interaction of Assyrian plum extract and storage temperature had a significant effect on the acidity percentage, which amounted to 1.041% in the treatment of Assyrian plum extract at a concentration of 2% + storage temperature of 5°C, compared to the lowest percentage of 0.928% in the comparison treatment .

It is found in the data in Table (7) that the interaction of the two potassium sulphate treatments and the storage temperature had a significant effect on the acidity percentage, as it gave the highest percentage of 1.047% in the potassium sulphate treatment with a concentration of 0% + storage temperature of 5 °C, compared to the potassium sulphate treatment with a concentration of 3%. + Normal room temperature, which gave a percentage of 0.936%. In the three-way interaction of the study factors, it had a significant effect, as the treatment of Assyrian plum extract at a concentration of 2% + potassium sulphate at a concentration of 0% + storage temperature of 5°C gave the highest acidity rate of 1.073%, compared to the treatment of Assyrian plum extract at a concentration of 0% + potassium sulfate at a concentration of 3% + temperature the regular room gave 0.909%.

Table 7. The effect of immersion in Assyrian plum extract, potassium sulfate, and storage temperature on the percentage of acidity in the juice of pomegranate fruits,cv. Slimi (%)

Assyrian plum Extract Levels (%)	Potassium sulfate levels (%)	Storage temperature levels (°C)			Effect of Assyrian plum extract with potassium sulfate
		Normal room temperature	5	7	
	Zero	0.951	1.013	0.981	0.987
Zero	1.5	0.920	0.990	0.975	0.964
	3	0.909	0.986	0.953	0.948
	Zero	0.983	1.033	1.013	1.013
1	1.5	0.945	1.017	0.995	0.985
	3	0.933	1.004	0.975	0.970
2	Zero	0.986	1.073	1.032	1.034

	1.5	0.981	1.047	1.038	1.022
	3	0.965	1.019	1.005	0.991
					Effect of Assyrian plum extract
The effect of Assyrian plum extract interfering with storage temperature	Zero	0.928	0.994	0.963	0.961
	1	0.954	1.034	0.998	0.995
	2	0.983	1.041	1.026	1.013
					Effect of potassium sulfate
The effect of potassium sulfate interfering with storage temperature	Zero	0.978	1.047	1.015	1.016
	1.5	0.950	1.025	1.007	0.996
	3	0.936	1.004	0.963	0.967
Effect of storage temperature		0.952	1.025	0.992	

LSD 5 %

Interaction of Assyrian plum extract, potassium sulfate, and storage temperature	Interaction of Assyrian plum extract and potassium sulfate	Assyrian plum extract interferes with storage temperature	Potassium sulfate interferes with storage temperature	Storage temperature	Potassium sulfate	Assyrian plum extract
0.019	0.011	0.011	0.011	0.006	0.006	0.006

From the results of tables (1, 2, 3, 4, 5, 6, and 7), it is found that immersion with Assyrian plum extract had a significant effect on the characteristics of weight loss, microbial damage to the fruit, thickness of the peel and juice, total dissolved solids in the juice, vitamin C, and acidity. This is due to the edible plant extracts used in immersing the fruits, including Assyrian plum extract, which have reduced the processes of respiration, metabolism, and transpiration by closing the stomata and lenticels in the fruits, which reduces moisture loss, decreases the consumption of acids, and reduces their percentage, thus reducing the weight loss of the stored fruits and maintaining the highest The percentage of juice and reducing the oxidation of vitamin C increased its content in the juice, and also reduced respiration and gaseous exchange between the peel of the fruit and the external environment, thus inhibiting the production of ethylene, which is considered the main cause of accelerating the ripening of fruits and then their spoilage (Elham and Sawsan, 2013 and Badawy and *et al*., 2011 and Al-Ansari, 2005), and it is also due to the fact that most plant extracts, including Assyrian plum extract, contain chemical compounds that inhibit the growth of bacteria and fungi on stored fruits, such as tannins, alkaloids, essential oils, and other chemical substances (Al-Haider, 2002). The Assyrian plum closed the stomata and lenticules, which reduced the respiratory process and thus decreased the consumption of acids and reduced their percentage (Fateh and Al-Jabbari, 2017). The results of Tables (4) also showed that potassium sulfate at a concentration of 3% had a significant effect on the percentage of microbial damage to fruits. The reason is that sulfur and its derivatives are considered oxidizing substances, as they act as preservatives for some products from microbial

spoilage, as well as inhibiting the activity of molds (Sgroppo *et al*., 2010), and in the results of tables (1, 2, 3, 4, 5, 6, and 7), the comparison treatment affected all storage characteristics except for the microbial spoilage characteristic .

The results of the same tables also showed that a temperature of 5°C significantly affected the characteristics of weight loss, bacterial spoilage of fruits, thickness of the peel and juice, total dissolved solids in the juice, vitamin C, and acidity. This is due to the fact that the low temperature has reduced the processes of respiration, transpiration and ripening, and the transformation of complex substances into simpler ones, thus reducing the percentage of dissolved solids in the juice and decreasing the process of oxidation of vitamin C, thus increasing its content in the juice and reducing the acidity in the juice, as well as reducing the ability of the stored air to It carries amounts of water vapor, metabolism, biological activities, and catabolism, thus delaying the ripening of stored fruits, as well as inhibiting the growth of bacteria and fungi, thus increasing the fruits' resistance to damage and reducing moisture loss from the peel (Ramezanian *et al*., 2018, Hadi and Al-Shammari, 2013).

CONCLUSION

Immersion with pepper extract led to positive results in most storage characteristics, especially the concentration of 2%. Storage at the cold storage temperature led to positive effects on the storage characteristics of the fruits, especially the storage temperature of 5 °C.

The dual interaction between the study factors, whether the interaction between the bomber extract and potassium sulphate, or the bomber extract and the storage temperature of the potassium sulphate, especially the high level of the bomber extract and the zero level of potassium sulphate and the storage temperature of 5 °C, led to the improvement of the storage characteristics of the fruits. The triple interaction between the study factors led to improving the storage qualities of the fruits.

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