Effect of Arabic Gum Application on the Storage Potential of Two Jujube Fruit *Ziziphus mauritiana* Lam Varieties Tufahee and Malasi

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Abstract

The study was done on mature jujube fruits of the Tufahee and Malasi varieties collected on February 3, 2025, from a private orchard in the Hamdan area of the Abu Al-Khasib district south of Basra. This statement moved to materials and methods part.with three concentrations of Arabic gum (0%, 2%, and 4%). The fruits were put in 250gm containers and stored in a refrigerated incubator at 4°C for eight weeks. The experiment was performed as a factorial design with a fully randomized design (CRD), with three replicates for each treatment and three variables. The first factor was a treatment with Arabic gum at three concentrations (0%, 2%, and 4%), a second factor covered two varieties of jujube fruit (Tufahee and Malasi), and the last factor was the storage period, which included four periods (after two weeks, four weeks, six weeks, and eight weeks). The difference between means was assessed using the least significant difference (LSD) test at a 5% probability threshold [13], and the data was analyzed using the Genstate software,The results showed that the 4% Arabic gum treatment beat the other treatments in both spoilage and weight loss decrease, as well as flavor and appearance change, whereas the 2% treatment increased acidity and total soluble solids. In most qualities, Tufahee beat Malasi. As storage time rose, spoilage, weight loss, and total soluble solids increased but total acidity reduced.

Keywords: Arabic gum, Jujube fruits, storage temperature, Storage potential

Introduction

One of the edible fruits noted in the Holy Quran and other religious books is the jujube tree (*Ziziphus mauritiana* Lam). It is listed as one of the plants of Paradise and is part of the Rhamnaceae family. It forms an evergreen fruit tree.

The Rhamnaceae family is one of the the largest plant families, in 55 genera and over 950 species. With 170 species, the Rhamnaceae family's most famous genus is Ziziphus. These species live in warm temperate, tropical, and subtropical zones world. The cultivated varieties 'Pumpawi' and 'Malasi' falls on the species Z. spina-christi, and the cultivated types like 'Olive' and 'Apple' be classified in the species Z. mauritiana. The variety is important in Iraq, and its cultivation mainly common in the central and southern regions of Iraq. The jujube tree gets a lot of attention recent years due to its exceptional flexibility to many soils and tolerance to drought conditions [25]. Jujube cultivation is common in southern and central Iraq. Several commercially viable types with early yields and high quality exist, including Armouti,Tufahee, and Red Malasi varieties

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[14,6].Arabic gum is a biodegradable material available to all living organisms, thus representing a renewable resource with no negative impact on human health or the environment. This plant material is characterized by its predominant carbohydrate composition, consisting of repeated monosaccharides. Furthermore, its production cost is significantly lower compared to that of synthetic materials [23]. Based on the above, efforts can be made to encourage the cultivation of gum-rich plants and to explore new sources of these materials, given their diverse applications in the food and pharmaceutical industries [27]. They may also be able to compete with imported commercial gums at higher prices. Arabic gum is considered a modern material used in various processes. Post-harvest treatment, such as immersion in a solution, has been shown to preserve fruit quality by slowing down ripening and extending shelf life [9].This study aims to improve the storability of jujube fruit (Tufahee and Malasi varieties) after treatment with Arabic gum and its storage duration under refrigeration.

Materials and Methods

This study was done on matured jujube fruits of the Tufahee and Malasi varieties collected on February 3, 2025, from a private orchard in the Hamdan area of the Abu Al-Khasib district south of Basra. The fruits were sent to the Horticulture and Landscape Engineering Department's Care and Storage Laboratory, They were washed with distilled water to remove dirt and dust. The rest were treated with Arabic gum at 0, 2, and 4%. Small, sick, and mechanically damaged fruits. The fruits were later placed in 250g containers and stored in a refrigerated incubator at 4°C. for eight weeks to study the effect of Arabic gum treatment on the storability, quality, and chemical and physical properties of the fruits.

Studied Characteristics

1- damaged fruits%
The damaged fruits%, whether infected with pathogens or fully ripe, was calculated as follows:

$$\text{Percentage of Damaged Fruits} = \frac{\text{Number of Damaged Fruits}}{\text{Total Number of Fruits}} \times 100$$

2- of weight loss%
The fruits' weight loss was evaluated weekly as a percentage , over a period of eight weeks. An electronic scale was used to evaluate the percentage of weight loss based on a specific equation:

Weight Loss% = (Weight of Sample After Storage - Weight of Sample Before Storage) / (Weight of Sample Before Storage) x 100

3- Sensory Evaluation

The fruits were sensory-evaluation by a group of experts to determine the extent of change in color and flavor. The results were divided according to the following table:

	10-40%: Not acceptable	50-60%: Acceptable	60-70% Good	80-90%: Very good
Color				
flavor				

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4- Total Dissolved Solids (TSS) %

The percentage of total dissolved solids in the fruit was calculated using a method defined in [1]. It included mixing 5 g of soft fruit pulp with 5 ml of distilled water, filtering the juice, and put one or two drops of the clear juice on a table-type refractometer (2WAJ—made in China). Subsequent to each reading, the instrument's lens was thoroughly cleaned and dried prior was zeroed with distilled water to obtain a new readings. The readings were then adjusted to 23°C by formulas presented [20].

5- Titrable acidity %

The total acidity of the jujube fruit was given as a percentage using the [28] method. This involved crushing 5 g of fresh fruit every time with 20 ml of distilled water, blending for five minutes with an electric blender, and filtering through cheesecloth. Ten ml of the filtrate were collected and used as an indicator with phenolphthaleinThe sample was then neutralized with 0.1 N sodium hydroxide until neutralization occurred, as confirmed by the persistence and pinkish color on spinning.The total acidity % was found based on the citric acid level in the fruit juice [1], using the following equation:

$$\text{Total acidity} = \frac{(\text{Naturality of base} \times \text{Quantity} \times 0.064 \times \text{Final volume of solution})}{(\text{Volume of filtered solution} \times \text{Weight of sample})} X100$$

Experimental Design and Analysis

The experiment was performed as a factorial design with a fully randomized design (CRD), with three replicates for each treatment and three variables. The first factor was a treatment with Arabic gum at three concentrations (0%, 2%, and 4%), a second factor covered two varieties of jujube fruit (Tufahee and Malasi), and the last factor was the storage period, which included four periods (after two weeks, four weeks, six weeks, and eight weeks). The difference between means was assessed using the least significant difference (LSD) test at a 5% probability threshold [13], and the data was analyzed using the Genstate software.

Results and Discussion

1- Damaged fruit %

Table (1) shows the results of the effect of Arabic gum treatment, variety, storage duration, and their interaction on the percentage of total spoilage of jujube fruit. It was shown that treatment with Arabic gum at 4% Significantly decreased the overall spoilage percentage, with the lowest possible spoilage rate at 6.33% with a high total spoilage rate at 24.33% in the control group. Applying Arabic gum stops post-harvest deterioration and protects the nutritional quality of ponkan fruit during cold storage [21]. Similar results were reported by [16], indicating that natural materials used as edible coatings, including Arabic gum, inhibit the growth of pathogenic fungi that cause fruit spoilage.

In regard to variety effect, the Tufahee variety was the lowest percentage of all rot (8.06%), which was significantly lower than the Malasi variety, whereas the Malasi variety was the highest percentage of total spoilage (21.72%). The lower spoilage rate

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for the Tufahee variety may be due to its superior storage quality and thicker skin compared to the Malasi variety. The table shows that long storage periods lead to a greater rate of all spoil. The maximum damage percentage for jujube fruits was 38.90% after 8 weeks of storage, but the rate of damaged fruits was 3.82% after the first two weeks of storage. This may be due to the rapid ripening process and the damage of certain fungi [31]. The interaction effect between Arabic gum treatment and variety, the results show that the Tufahee variety treated with 4% Arabic gum reduced the overall spoilage rate for 4.08%, while the Malasi variety fruits treated with 0% Arabic gum was the highest spoilage rate, 37.25%.

The results also showed a significant link between Arabic gum treatment and storage duration. The fruits treated with 4% Arabic gum was the lowest spoiling rate (15.22%) at the end of the 8-week storage period.After 8 weeks of storage, fruits treated with 0% Arabic gum show the highest overall damage rate (51.22%).

The relation between variety and storage duration is a significant effect on overall spoil rate. The Tufahee variety was the lowest ratio of damaged fruits at 20.78% at a 8-week storage period, while the Malasi variety showed highest percentage at 44.78% at a similar period. Weeks. The interaction affect between the three factors — treatment with Arabic gum, variety, and storage length – was significant. At the conclusion of the 8-week storage period, the fruit of the Tufahee variety treated with 2% Arabic gum showed the lowest percentage for the total loss (11.67%). The Malasi variety's fruit, given 0% Arabic gum, showed highest total decay percentage at end of the 8-week storage period (75.00%).

Table (1) Effect of treatment with Arabic gum, variety and storage period on jujube fruits in terms of percentage of spoilage and interaction between them

Treatment with Arabic gum	**Variety**	**Storage period (weeks)**					**Arabic Gum *variety**
		Before storage	**2**	**4**	**6**	**8**	
0%	Tufahee	**0.00**	**3.33**	**5.67**	**12.67**	**35.33**	**14.25**
	Malasi	**0.00**	**10.67**	**25.00**	**38.33**	**75.00**	**37.25**
%2	Tufahee	**0.00**	**0.33**	**2.00**	**5.67**	**15.33**	**5.83**
	Malasi	**0.00**	**5.33**	**11.67**	**21.67**	**46.67**	**21.33**
%4	Tufahee	**0.00**	**0.33**	**1.33**	**3.00**	**11.67**	**4.08**
	Malasi	**0.00**	**3.33**	**5.67**	**5.67**	**12.67**	**6.58**
							Average effect of arabic gum treatment
ArabicGum * storage	**0%**	**0.00**	**6.56**	**14.33**	**25.22**	**51.22**	**24.33**
	% 2	**0.00**	**2.67**	**6.33**	**13.78**	**32.89**	**13.92**

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	% 4	**0.00**	**1.67**	**3.44**	**5.00**	**15.22**	**6.33**
							Average impact of the variety
Variety*Storage period	Tufahee	**0.00**	**1.33**	**3.00**	**7.11**	**20.78**	**8.06**
	Malasi	**0.00**	**6.44**	**14.11**	**21.56**	**44.78**	**21.72**
Average storage period			**3.82**	**8.41**	**14.52**	**38.90**	
The lowest significant difference was adjusted at the 0.05 level.							
Treatment with Arabic gum	**variety**	**Storage period**	**Treatment with Arabic gum and variety**	**Treatment with Arabic gum and storage period**	**Type and storage period**	**Triple interference**	
0.79	**0.79**	**0.93**	**1.43**	**1.65**	**1.65**	**2.86**	

1- Weight Loss(%)

Table (2) shows the effect of Arabic gum treatment, variety, Storage period and interaction effects on the percentage of weight loss in the fruits of the Jujuba cultivars, Tufahee and Malasi, kept at 4°C. The usage of Arabic gum significantly reduced weight loss, with the lowest percentage at 3.78% for fruits treated with a 4% concentration, while the highest percentage was 6.70% for fruits treated with Arabic gum. At a concentration of 0%. The results are consistent with those obtained by [34], on strawberries treated with 5% Arabic gum under refrigerated storage conditions. They confirmed that the thin layer of gum on the fruit formed a barrier against water loss and reduced the respiration rate, causing a weight loss. This act might be caused by the fact that Arabic gum provides a semi-permeable layer for the flow of oxygen, carbon dioxide, and moisture, thus reducing respiration rate, water loss, and oxidation [26]. Arabic gum acts as a barrier, slowing water flow and protecting the fruit's outer surface from mechanical damage. Also, it covers small wounds, delaying drying [29].

Regarding the effect of variety, the highest weight loss was observed at 5.75% for the Malasi variety, while the lowest weight loss was 4.56% for the Tufahee variety. This may be as the Tufahee variety is thicker skin than the Malasi variety. Fruit's water content is a significant storage asset that must be maintained. Water loss occurs due to a decrease in turgor pressure, leading to a loss of weight and shine, and consequently, symptoms of wilting and shriveling.

The storage period had a clear impact, as the table shows that The percentage of weight loss increases with length of storage. The highest weight decrease, 8.42%, was after 8 weeks of storage, and a weight loss of 2.20% in the first and second weeks. This may be explained by the fact that weight loss rises with longer storage durations

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owing to the depletion of the fruit's nutritional reserves by internal processes such as transpiration, which removes water from the fruit's surface [22]. When jujube fruits were kept at 5°C for 12 weeks, Tembo et al. (2008) showed that weight loss increased with storage length. It confirms the study findings of [30], which showed that weight loss in jujube fruits increased with long storage period at 4°C over 25 days. In addition, it agrees with a study in [30] that weight loss increased with extended storage durations when jujube fruits underwent storage at 5°C for 5 weeks. However, the combination between Arabic gum treatment and variety yielded the minimal percentage of weight loss. The Tufahee variety fruits treated with 4% Arabic gum exhibited a weight loss of 3.03%, whilst the Malasi variety fruits treated with 0% Arabic gum saw the largest weight loss of 7.56%. Additionally, the findings indicated a significant interaction impact between Arabic gum treatment and storage period. After 8 weeks of storage, fruits treated with 4% Arabic gum exhibited the least weight loss (6.02%), and fruits treated with 0% Arabic gum saw the most weight loss (11.37%).

The results showed a significant interaction result between variety and storage duration. The minimum weight loss was 7.81% for Tufahee variety fruits after 8 weeks of storage, whilst the maximum weight loss was 9.04% for Malasi variety fruits after identical period. The fruits of the Tufahee variety treated with a concentration of 4% Arabic gum at the end of the storage period of 8 weeks showed the highest percentage of weight loss (12.44%) while the three factors—treatment with Arabic gum, variety, and storage period—interacted.

Table (2) Effect of treatment with Arabic gum, variety and storage period on jujube fruits in terms of percentage of weight loss and the interaction between them

Treatment with Arabic gum	**Variety**	**Storage period (weeks)**					**Arabic Gum *variety**
		Before storage	**2**	**4**	**6**	**8**	
0%	Tufahee	**0.00**	**2.72**	**4.34**	**7.43**	**10.54**	**6.26**
	Malasi	**0.00**	**3.21**	**5.66**	**8.95**	**12.44**	**7.56**
%2	Tufahee	**0.00**	**1.48**	**3.39**	**5.18**	**7.54**	**4.40**
	Malasi	**0.00**	**2.75**	**4.29**	**6.43**	**8.26**	**5.43**
%4	Tufahee	**0.00**	**1.04**	**2.51**	**3.20**	**5.35**	**3.03**
	Malasi	**0.00**	**2.23**	**3.74**	**4.62**	**6.43**	**4.25**
							Average effect of arabic gum treatment
ArabicGum * storage	**0%**	**0.00**	**2.75**	**4.80**	**7.89**	**11.37**	**6.70**
	% 2	**0.00**	**1.99**	**3.84**	**5.82**	**7.84**	**4.87**
	% 4	**0.00**	**1.64**	**3.25**	**4.21**	**6.02**	**3.78**

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							Average impact of the variety
Variety*Storage period	Tufahee	**0.00**	**1.75**	**3.41**	**5.27**	**7.81**	**4.56**
	Malasi	**0.00**	**2.73**	**4.56**	**6.66**	**9.04**	**5.75**
Average storage period			**2.20**	**3.98**	**5.97**	**8.42**	
The lowest significant difference was adjusted at the 0.05 level.							
Treatment with Arabic gum	**variety**	**Storage period**	**Treatment with Arabic gum and variety**	**Treatment with Arabic gum and storage period**	**Type and storage period**	**Triple interference**	
0.06	**0.06**	**0.07**	**0.12**	**0.14**	**0.14**	**0.24**	

1-Sensory Characteristics

Table 3 shows the effect of Arabic gum treatment, variety, and storage period on the sensory characteristics of the Tufahee and Malasi jujube fruits.

Regarding the Tufahee variety fruits treated with Arabic gum, The judges gave the following ratings at the end of the 8-week storage period: 5 % Very good. 10% Good, 30% Acceptable, and 55% Unacceptable.

For the Malasi variety fruits treated with Arabic gum, the judges gave the following ratings: 2% Very Good, 3% Good, 35% Acceptable, and 60% Unacceptable.

For the control treatment (date kernel powder packaged in plastic containers), the judges gave the following ratings: 35% Very Good, 2% Good, 3% Acceptable, and 60% Unacceptable.

Regarding the Tufahee variety fruits treated with 2% Arabic gum at the end of the 8-week storage period, the judges gave the following ratings: 10% Very Good, 65% Good, 15% Acceptable, and 10% Unacceptable.

The judges gave the following ratings: For the Malasi variety fruits treated with 2% Arabic gum, the judges gave the following ratings: 5% Very Good, 50% Good, 25% Acceptable, and 20% Unacceptable.

For the Tufahee variety fruits treated with 2% Arabic gum, the judges gave the following ratings: 7% Very Good, 55% Good, 23% Acceptable, and 17% Unacceptable.

During the 8-week storage period, the judges gave the Tufahee variety fruits treated with 4% Arabic gum the following ratings: 15% Very Good, 60% Good, 20% Acceptable, and 5% Unacceptable.For the Malasi variety fruits treated with 4% Arabic gum, the judges gave the following ratings: 10% Very Good, 55% Good, 25% Acceptable, and 10% Unacceptable.

For the Tufahee variety fruits treated with 4% Arabic gum, the judges gave the following ratings: 12% Very Good, 58% Good, 23% Acceptable, and 7% Unacceptable.

It was observed that the Arabic gum treatment resulted in the highest percentage

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improvement in sensory characteristics. This is because the date kernel powder delayed fruit ripening, thus preserving quality characteristics in terms of color, taste, and aroma compared to the control treatment.

Regarding the effect of variety, it was observed that the Tufahee variety was more resistant than the Malasi variety.

The color and aroma of the fruit change during extended storage due to increased biological processes within the fruit, such as respiration and transpiration, and increased activity of the polyphenol oxidase enzyme, which oxidizes and darkens phenolic compounds, and increased activity of the chlorophyll enzyme, which breaks down chlorophyll pigments and changes their color [19].

This is consistent with the findings of [33], Storing jujube fruits at 5°C for 12 days led to a color change when the storage period. This aligns with [3],which found that storing jujube fruits for 20 days led to a change in the color of the fruits with time. It is also consistent with what [24], found when storing jujube fruits for 15 days, where a change in the color and flavor of the fruits was observed as the storage period continued.

Table (3) Effect of treatment with Arabic gum, variety and storage period on the sensory characteristics of jujube fruits

Treatment with arabic gum	**Variety**	**End of storage period (8 weeks)**				
		Excellent	**Very good**	**Good**	**Acceptable**	**Unacceptable**
0%	**Tofahee**	**0%**	**5%**	**10%**	**30%**	**55%**
	Malasi	**0%**	**2%**	**3%**	**35%**	**60%**
2%	**Tofahee**	**0%**	**10%**	**65%**	**15%**	**10%**
	Malasi	**0%**	**5%**	**50%**	**25%**	**20%**
4%	**Tofahee**	**0%**	**15%**	**60%**	**20%**	**5%**
	Malasi	**0%**	**10%**	**55%**	**25%**	**10%**

1- TSS(%)

Table (4) shows the results of the effect of Arabic gum treatment, variety, storage duration, and their interaction on the percentage of total dissolved solids in jujube fruits of the Tufahee and Malasi varieties stored at 4°C. Treatment with Arabic gum decreased total dissolved solids to the lowest percentage (15.19%).for fruits treated with 4% Arabic gum with the highest percentage (16.86%) for fruits treated with 0 Arabic gum.Tufahee jujube fruits had the lowest ratio (14.19%), and Malasi fruits had the highest percentage (16.83%). This may be due to the lower water loss in the fruit of the Tufahee variety compared to the Malasi variety. Alternatively, It may be due to the fruit's low juice and moisture content [17].

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Table indicates that the percentage of TSS increases as the storage time increases, which is a positive consequence. The maximum percentage, 18.33%, was The highest scale, 12.87%, was found after 8 weeks of storage, and the lowest percentage was seen in the first and second weeks. This might be due to an increase in total soluble solids when the fruit's water content drops. The rise in solids content in advanced ripening fruits occurs as they approach the last stages of ripening [11]. In addition, jujube fruits are spore-forming, with total soluble solids accumulating as the fruit matures [18].

Numerous rapid chemical changes occur throughout the ripening process, especially enzyme-controlled activities that raise the fruit's sugar content, which is reflected in its total soluble solids content. This research aligns with [10, 8]. Findings match with those of [30], who found that storage jujube fruits at 5°C for 5 weeks resulted in an increase in the percentage of total dissolved solids with time. They align with the findings of [30]. When jujube fruits were stored at 4°C for 25 days, the total soluble solids (TDS) content augmented with extended storage period. It agrees with [35], who noted an analogous increase in TDS levels upon 30 days of jujube fruit storage.About the correlation between Arabic gum treatment and variety, jujube fruits treated with 2% Arabic gum was the lowest TDS level (14.14%), which was not significantly different from the 14.18% seen in jujube fruits treated with 4% Arabic gum. Conversely, the highest TDS content (18.50%) was observed in jujube fruits treated with 0% Arabic gum. The table also illustrates the interaction between Arabic gum treatment and storage duration. After 8 weeks of storage, jujube fruits treated with 4% Arabic gum was the lowest percentage of total soluble solids (TDS), at 17.69%. At the conclusion of the storage period, jujube fruits treated with 0% Arabic gum was the highest level of TDS (18.91%), which was not significantly different from the percentage of 18.90% for fruits treated with 2% Arabic gum.
The interaction between variety and storage duration significantly shaped the percentage of TDS. The lowest TDS percentage was 16.34% for Tufahee type jujube fruits at 8 weeks of storage, while maximum was 20.20% for Malasi variety fruits at the conclusion of the storage period. The results further showed the effects of the interaction of the three factors: treatment with Arabic gum, variety, and storage period. The minimum solid percentage found was 16.13% for the Tufahee variety of Jujuba fruit subjected to a 4% Arabic gum concentration over an 8-week storage period, which did not much differ a similar variety treated with the same concentration of Arabic gum. During the storage period, the total percentage of solids for Malasi Jujuba fruit treated with 4% Arabic gum was 20.32%, which did not significantly vary from that of Malasi fruit treated with 2% Arabic gum.

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Table (4) Effect of Arabic gum treatment, variety, and storage period on jujube fruit in terms of the percentage of total soluble solids and the interaction between them

Treatment with Arabic gum	Variety	Storage period (weeks)					ArabicGum*variety
		Before storage	2	4	6	8	
0%	Tufahee		12.02	12.18	16.02	16.75	18.50
	Malasi		12.08	16.00	16.30	20.04	16.10
2%	Tufahee		12.13	12.26	16.05	16.13	14.14
	Malasi		12.25	16.06	16.25	20.25	16.20
4%	Tufahee		12.25	12.32	16.03	16.13	14.18
	Malasi		16.08	16.18	20.20	20.32	18.19
							Average effect of arabic gum treatment
ArabicGum * storage	0%		14.88	16.16	17.50	18.91	16.86
	%2		12.20	15.54	17.48	18.90	16.03
	%4		12.11	14.78	16.18	17.69	15.19
							Average impact of the variety
Variety*Storage period	Tufahee		12.13	12.25	16.03	16.34	14.19
	Malasi		13.47	16.08	17.58	20.20	16.83
Average storage period			12.87	14.53	16.87	18.33	

The lowest significant difference was adjusted at the 0.05 level.

Triple interference	Type and storage period	Treatment with Arabic gum and storage period	Treatment with Arabic gum and variety	Storage period	variety	Treatment with Arabic gum
0.09	0.09	0.10	0.15	0.18	0.18	0.31

1- Percentage of Total Neutralizable Acidity

Table (5) shows the results of Arabic gum treatment, variety, storage duration, and their interaction on the percentage of total neutralizable acidity in Jujuba fruits of the

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Tufahee and Malasi varieties stored at 4°C. It is observed that Arabic gum treatment had a significant effect on maintaining the percentage of total neutralizable acidity, with the highest percentage (1.24%) at a 4% concentration, while the lowest percentage (0.90%) was recorded in the control treatment.

Regarding the effect of variety, the highest value for total neutralizable acidity was 1.07% for Malasi fruits, while Tufahee fruits yielded the lowest percentage (0.92%). The higher acidity of the Malasi variety may be attributed to its acidic taste compared to the sweet taste of the Tufahee variety. The data also shows that the storage duration is a significant effect Total neutralizable acidity. The total neutralizable acidity percentage decreased with long storage at 4°C, reaching a low level of 0.52% after 8 weeks, while a peak total acidity percentage was 1.46% at the beginning of storage. The reason for a decrease in the fruit's total acidity content with longer storage duration may be that it is consumed by respiration or converted into sugars [17]. The reason could be related to the steady drop in the total neutralizable acidity over the storage period, resulting from physiological and chemical changes occurring within the fruit. Alternatively, it may be due to the fruit's advanced ripening until it reaches maturity and is converted into sugars, making it suitable for consumption. The decrease may also be due to its consumption through respiration [4,17]. This finding aligns with that of [33], who observed a decrease in The full acidity of jujube fruit at 12 weeks of storage at 5°C. It also agrees with [30], finding that the total neutralizable acidity of jujube fruit decreases with increasing storage time at 5°C for 5 weeks, and with [35], who found that the total acidity of jujube fruit decreases with increasing storage time, Specifically, after thirty days.The interplay between the Arabic gum treatment and the variety had an important effect on the total neutralizable acidity, the fruits of the Malasi variety treated with 4% Arabic gum exhibited the highest acidity level at 1.41%, while the fruits of the Tufahee variety treated with 0% Arabic gum recorded the lowest acidity level at 0.80%.

The results also showed a significant relationship between Arabic gum treatment and storage duration. At 8 weeks of storage, the fruits treated with 4% Arabic gum was a highest acidity level of 0.75%. The control group fruits was the lowest acidity level of 0.48% at the end of the 8-week storage period.The interaction effect between variety and storage duration was significant at the 5% level of significance. The Malasi variety was highest acidity level at 0.63% after 8 weeks of storage, and the Tufahee variety showed the lowest acidity level at 0.51% at the end of the storage duration.This shows the effect of the interaction of three factors (treatment with Arabic gum, variety, and storage duration) on the total neutralizable acidity percentage. The highest acidity percentage recorded was 0.76% for the Malasi variety fruits treated with a 4% concentration of Arabic gum after 8 weeks of storage, and the lowest acidity percentage was 0.46% for the Tufahee variety fruits treated with a 0% concentration of Arabic gum.

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Table (5) Effect of treatment with Arabic gum, variety and storage period on jujube fruits in total neutralizable acidity and the interaction between them

Treatment with Arabic gum	**Variety**	**Storage period (weeks)**					**Arabic Gum *variety**
		Before storage	**2**	**4**	**6**	**8**	
0%	Tufahee	**1.80**	**1.17**	**0.89**	**0.68**	**0.46**	**0.80**
	Malasi	**1.80**	**1.28**	**1.03**	**0.71**	**0.50**	**0.88**
%2	Tufahee	**1.80**	**1.33**	**1.06**	**0.73**	**0.46**	**0.89**
	Malasi	**1.80**	**1.57**	**1.18**	**0.97**	**0.64**	**1.09**
%4	Tufahee	**1.80**	**1.46**	**1.28**	**0.90**	**0.60**	**1.06**
	Malasi	**1.80**	**1.78**	**1.36**	**1.13**	**0.76**	**1.26**
ArabicGum * storage	**0%**	**1.80**	**1.32**	**1.05**	**0.75**	**0.48**	**0.90**
	% 2	**1.80**	**1.56**	**1.21**	**0.91**	**0.61**	**1.07**
	% 4	**1.80**	**1.73**	**1.40**	**1.09**	**0.75**	**1.24**
							Average impact of the variety
Variety*Storage period	Tufahee	**1.80**	**1.32**	**1.07**	**0.77**	**0.51**	**0.92**
	Malasi	**1.80**	**1.54**	**1.19**	**0.93**	**0.63**	**1.07**
Average storage period		**1.80**	**1.46**	**1.15**	**0.87**	**0.52**	
The lowest significant difference was adjusted at the 0.05 level.							
Treatment with Arabic gum	**variety**	**Storage period**	**Treatment with Arabic gum and variety**	**Treatment with Arabic gum and storage period**	**Type and storage period**		**Triple interference**
0.01	**0.01**	**0.01**	**0.02**	**0.02**	**0.02**		**0.04**

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