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The effect of some edible coating treatments on shelf life of pomegranate arils cultivar "Malas-e Saveh"

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ABSTRACT

Purpose: The purpose of this research was to evaluate various coatings for preserving the quality attributes of "Malas-e Saveh" pomegranate arils during storage. **Research method**: A bi-factorial experiment in frame of completely randomized design was conducted to compare eight coating treatments at two storage times (two and four weeks) with three replications. **Findings**: The highest pH and acidity was observed in the ascorbic acid treatment after four and two weeks of storage, respectively. The control after two weeks had the highest TSS and the nanosilicate container after four weeks had the highest taste index. The zero-day control had the highest vitamin C, while *Aloe vera* gel + chitosan and nanosilicate container after four weeks had the lowest. The zero-day control had the lowest total phenols but the highest total flavonoids and anthocyanins. *Aloe vera* gel, ascorbic acid and nanosilicate container after two weeks had the highest antioxidant activity, which first increased and then decreased with storage. The coatings did not significantly affect maintaining the L index or brightness of pomegranate arils. However, *Aloe vera* gel better maintained the (redness) and b (yellowness) indices. *Aloe vera* gel + ascorbic acid best preserved the sensory values closest to the zero-day control. **Research limitations**: None were found to report. **Originality/Value**: After comparing conventional coating materials with emerging options, this study revealed that *Aloe vera* gel alone or in combination with other coating materials was effective in preserving the quality of pomegranate arils during storage.

INTRODUCTION

Marketing is the final stage of the production cycle for horticultural products, including pomegranates. Improved storage and distribution techniques are needed to optimize pomegranate fruit marketing in Iran. Developing pomegranate packaging, especially for pomegranate arils, is crucial given growing global demand due to reported health benefits (Singh, 2010). Efficient aril separation techniques could generate interest by providing ready-to-eat fresh arils. Recent attention has focused on isolating and selling arils (Oz & Ulukanli, 2012). Accordingly, aril separation devices have been designed and utilized. However, extending the shelf life of arils via postharvest methods remains necessary to maintain their quality during storage and transportation.

The pomegranate (*Punica granatum* L.) is an ancient and popular fruit characterized by rounded, shiny red or yellow-green fruit that turns purple when ripe. Arils, which are separated by thin membranes within the fruit (Nikdel et al., 2016), contain juicy flesh that can be red, white, or pink depending on the cultivar. Various plant biochemicals have been extracted from pomegranate parts (peel, arils, spongy tissue, and seeds). Around 52% of the weight of a pomegranate is made up of arils, which contain 80% juice and 20% seed. The arils are composed mostly of water (85%) and contain sugars, carbohydrates, organic acids, anthocyanins, vitamins, polysaccharides, polyphenols, antioxidative phytochemicals, antimicrobial compounds, and essential minerals (Yang et al., 2022). Since the tough outer layer of the pomegranate cannot be eaten and is typically discarded, removing the fruit's arils and separating them becomes a laborious and difficult process. This can be a deterrent for people who want to consume or choose this fruit (Akhtar et al., 2015).

When pomegranate arils were packaged in a modified atmosphere, they only had a shelf life of 10 days, and the quality of their flavor and aroma could only be maintained for 7 of those days (Caleb et al., 2013). Therefore, it is necessary to find new solutions that can help decrease the number of microorganisms on pomegranate arils and slow down the deterioration of their quality. Coating treatments can be applied to fresh pomegranate arils to extend their shelf life and maintain their quality. This coating also helps to prevent moisture loss and protect the arils from damage during transport (Kawhena et al., 2020). Using biodegradable edible coatings to maintain the quality of minimally processed products after harvest is becoming an increasingly popular option. This may be because these coatings are made from natural sources and are therefore biodegradable. Additionally, consumers now expect safer and healthier food products that have excellent sensory qualities (Ncama et al., 2018).

A range of biopolymers obtained from both plants and animals are utilized to create coating materials that can be applied to food products (Singla et al., 2022). After cellulose, chitin is the second most abundant biopolymer found in nature. A study was conducted using a combination of chitosan and ascorbic acid as an edible coating to determine its effect on the shelf life of pomegranate arils. The study revealed that this coating helped to preserve the visual quality of the arils during storage and prevented bacterial and fungal growth on them (Özdemir & Gökmen, 2017). *Aloe vera* gel is rich in vitamins, minerals, and antioxidants, which can be used as a natural food preservative and coating material due to its ability to prevent the growth of microorganisms and extend the shelf life of food products. Application of coatings such as *Aloe vera* gel on pomegranate arils resulted in lower respiration rate (Martínez-Romero et al., 2013). Honey has natural antimicrobial properties and has been used as a food preservative for centuries. As far as we know, there is little available literature regarding the use of honey to maintain pomegranate arils. Polymer nanotechnology involves the manipulation of materials at the nanoscale level to create new materials with improved properties. In the food industry, this technology can be used to develop new packaging materials that offer better barrier properties, are more resistant to punctures and tears, and can extend the shelf life of food products (Silvestre et al., 2011).

Ready-to-eat fruits are uncommon in Iran. Expanding this sector, at least for export, could increase product value. Despite promising Iranian pomegranate cultivars, insufficient information exists on coating treatments' effects on quality attributes and shelf life of "Malas-e Saveh" pomegranate arils, an important Iranian export cultivar. While arils' nutritional importance is recognized, limited research has evaluated maintaining aril quality during storage. Given concerns over chemical overuse in postharvest technology and consumer demand for healthy products, research on postharvest edible coatings is warranted. This research presents a comparison between conventional coating materials, such as honey and *Aloe vera* gel, and emerging options, such as chitosan and nanosilicate containers, for maintaining the quality and shelf life of "Malas-e Saveh" pomegranate arils.

MATERIALS AND METHODS

This research was conducted at the Gorgan University of Agricultural Sciences and Natural Resources.

Fruit material

Pomegranate fruits of the "Malas-e Saveh" cultivar were harvested at the stage of commercial maturity according to native growers' experience from an orchard in Golestan province, Iran, with an altitude of 86m above sea level, latitude 37.12 N, and longitude 54.85 E. Healthy, undamaged fruit of almost uniform size were selected for the experiment and immediately transported to the laboratory.

Experimental treatments

A factorial experiment in the form of a completely randomized design was applied with two factors: coating treatment and storage time. There were eight coating treatments: *Aloe vera* gel (100%), ascorbic acid (1%), *Aloe vera* gel + ascorbic acid (1%), *Aloe vera* gel + honey (20%), *Aloe vera* gel + chitosan (1%), polypropylene nanosilicate container, control (uncoated fruits), and zero-day control (fresh untreated arils separated from fruits before storage). The fruit was stored for either two or four weeks at three replications per treatment.

Coating preparation and application

The fruits were first surface-sanitized by soaking them in 0.5% sodium hypochlorite for 5 minutes and then rinsing them with boiled water at room temperature. The fruits were then left to air dry before being cut with a sharp knife and the arils carefully separated and placed on clean paper towels. The arils were immersed in the desired treatment for 10 minutes at room temperature for coating. After coating, the arils were separated from the solution using laboratory sieves and dried on paper towels for 30 minutes. Finally, 100 grams of treated arils per treatment were placed in plastic containers with lids and stored at 4°C. The polypropylene nanosilicate containers (thickness 0.02 mm) were obtained from Nano Company (Baspar Aitech) in Tehran, Iran. The *Aloe vera* gel was prepared by washing fresh leaves with distilled water and removing the flesh with a clean knife before blending it for 5 minutes to crush it (Emamifar, 2015).

Physicochemical analyses

The weight of the arils was measured using a scale with an accuracy of 0.01 grams. To determine the percentage of weight loss, the arils for each treatment were weighed and marked. After two and four weeks of storage, the percentage of fruit weight loss was calculated. Following two and four weeks of storage, the juice was extracted from the pomegranate arils and centrifuged for 10 minutes at 2500 rpm before measuring the desired traits. The pH of the fruit juice was measured using a pH meter (pH 110 meter, EUTECH/OAKTON Instruments, USA) and the electrical conductivity was measured using a conductivity meter (Cond315iSET, made in Germany).

The amount of total soluble solids (TSS) in pomegranate juice was determined using a digital refractometer (Digital Abbe refractometer, model Quartz, Ceti, Belgium) (Feyzi et al., 2018). The acidity rate was determined by titration with sodium hydroxide (Selcuk & Erkan, 2014). The ratio of TSS to titratable acidity was calculated as a taste index. The antioxidant activity was measured according to Sun and Ho (2005) using a spectrophotometer (SQ 2800 UV/VIS, UNICO, USA). After 30 min of incubation of the prepared solution, the absorbance was measured against a blank (methanol) at 517 nm and the inhibition of free radical DPPH was calculated using the appropriate formula. The total phenolic content of the juice was measured using the Folin-Ciocalteu phenol indicator and the spectrophotometer. Total flavonoid content was measured using the method introduced by Fawole and Opara (2012) and vitamin C content was measured according to Kashyap and Gautam (2012). The differential pH method (Giusti & Wrolestad, 2001) was employed to determine the total anthocyanin content. The method involved measuring the absorbance of each sample at 510 and 700 nm in buffers at pH 1.0 and 4.5 and then calculating the difference in absorbance between the two pH values. During storage, the decay of arils is assessed through visual observations. After the emergence of symptoms such as browning and mold growth, the number of infected arils was counted and the percentage of decay was determined (Moradinezhad et al., 2023).

Color and sensory evaluation

The color of the pomegranate arils was measured using a colorimeter (Lovibond CAM-System 500), which utilizes three indices: a*, b* and L*. Sensory evaluation was conducted to assess the appearance, smell intensity, taste, and freshness of the pomegranate arils. A five-point test was used where a score of 5 represented the highest value and a score of 1 indicated the lowest value. Six trained panelists participated in the evaluation (Emamifar, 2014). Color and sensory data were collected only before storage (zero-day control) and at the end of storage (after four weeks), and analyses were conducted using a completely randomized design.

Statistical analysis

All data from this research were analyzed using SAS software. Comparison of means was performed using the least significant difference (LSD) test.

RESULTS AND DISCUSSION

Physicochemical properties

The analysis of variance showed significant interaction effects between coating treatment and storage period for various traits. Significant interaction effects ($P<0.001$) were observed for acidity, flavor index, vitamin C, total phenols, total flavonoids, total anthocyanins, antioxidant activity, and decay rate. Additionally, there were significant interaction effects ($P<0.05$) for pH and TSS. Consequently, mean comparisons were conducted for these traits based on the interaction effects. In contrast, the interaction effect for weight loss and electrical conductivity was not significant. The coating treatment had a significant ($P<0.001$) impact on weight loss and electrical conductivity, while the storage period did not. Therefore, simple effects were compared for these two traits.

The highest pH value was observed for the ascorbic acid treatment after four weeks of storage (3.443), although it was not significantly different from some other treatments. Conversely, the lowest pH value was observed after two weeks of storage for the zero-day control and some other treatments (Table 1). For most treatments, pH increased after four weeks of storage compared to two weeks, although the difference was not significant for some. Previous study by Shahi et al. (2022) also found that pH was initially low and increased over time. Ghorbani et al. (2017) showed that pH decreased from day 10 to 16 with increasing storage time of pomegranate arils. The varying results could be attributed to differences in storage periods. As fruit storage time increases, respiration and consumption of organic acids rise, causing acids to convert to sugars and higher pH (Singh, 2010). Furthermore, the relative growth of molds and yeasts during storage also leads to higher pH due to consumption of organic acids (Zivanovic et al., 2007).

The ascorbic acid treatment after two weeks of storage gave the highest acidity (0.642%), while the nanosilicate container after four weeks resulted in the lowest acidity. The control acidity increased during storage compared to the zero-day control but then decreased slightly after four weeks, though for most treatments the value was slightly lower after four weeks. The present study's findings are consistent with those of Singh et al. (2022) and Singla et al. (2022), who observed an increase in aril acidity from the first day of storage to day 15. However in this study, it followed by a further decrease due to degradation after extended storage. The reduction in fruit organic acids is attributed to their consumption during respiration, which is closely linked to metabolism (Rahemi, 2006).

The control had the highest TSS (18.03 °Brix) after two weeks; while, the *Aloe vera* gel and *Aloe vera* gel + ascorbic acid after two and four weeks and the *Aloe vera* gel + honey and ascorbic acid treatments after four weeks showed the lowest TSS values. These treatments were not statistically different from some others. These results agree with Shahi et al. (2022) and Moradinezhad (2021), who found that the control had the highest TSS. The amount of TSS remained almost constant during storage, which is consistent with the findings of Barzegar et al. (2019). However, some researchers showed that TSS decrease during storage (Hajivand-Ghasemabadi et al., 2022; Shahi et al., 2022). The nanosilicate container after four weeks and the ascorbic acid treatment after two weeks of storage had the highest and lowest taste indices, respectively. Moradinezhad et al. (2019) also reported that packaging can improve the taste index in pomegranate.

The highest amount of vitamin C was in the zero-day control (4.312 mg/100 ml) and the lowest in the *Aloe vera* gel + chitosan and nanosilicate container after four weeks. This observation is consistent with the findings of Mandegari et al. (2020), who reported a reduction in vitamin C during storage. Vitamin C damage increases with longer storage, higher temperature, lower humidity, physical damage and frost. The main reason for vitamin C reduction is oxidation in the environment; higher pH from enzymatic activity also destroys it.

The lowest amount of total phenols was observed in zero-day control, though it had the highest values for total flavonoids and total anthocyanins. The *Aloe vera* gel + ascorbic acid treatment showed the highest total phenols (22.92 mg GAE/100 ml) after four weeks of storage. Overall, total phenols increased during storage for most treatments. In another study, Ayhan and Eştürk (2009) showed that the phenolic compounds of pomegranate arils decreased initially and then increased, which is consistent with the present results, although their storage period was much shorter. Changes in phenolic compounds are likely due to changes in acidity and TSS, impacting antioxidant activity.

Table 1. The Interaction effect of coating treatments and storage period on some physicochemical characteristics of edible arils of pomegranate cultivar "Malas-e Saveh".

Coating treatments	Storage time (week)	pH	Acidity (%)	TSS (°Brix)	Taste index	Vitamin C (mg/100 ml)
		P=0.039	P<0.001	P=0.029	P<0.001	P<0.001
Zero-day control	-	3.303 b	0.338 f	17.43 ab	51.59 bcd	4.312 a
Control	2	3.323 b	0.560 b	18.03 a	32.54 ij	2.288 d
	4	3.410 ab	0.453 d	17.56 ab	42.06 efgh	1.798 e
Aloe vera gel	2	3.363 ab	0.350 ef	15.60 c	44.88 ef	2.552 c
	4	3.430 ab	0.336 f	15.77 c	46.92 cde	1.672 ef
Aloe vera gel + honey	2	3.287 b	0.455 cd	17.07 b	37.66 hi	2.288 d
	4	3.413 ab	0.359 ef	15.80 c	44.12 efg	1.584 ef
Aloe vera gel + chitosan	2	3.373 ab	0.513 bc	16.80 bc	32.76 ij	1.731 e
	4	3.440 ab	0.313 fg	16.77 bc	53.77 ab	1.320 f
Aloe vera gel + ascorbic acid	2	3.273b	0.408 de	16.13 c	39.56 fgh	2.141 d
	4	3.360 ab	0.336 f	16.00 c	47.67 bcde	1.672 e
Ascorbic acid	2	3.223 b	0.642 a	16.90 bc	26.40 j	2.053 d
	4	3.443 a	0.350 ef	16.10 c	46.00 def	1.760 e
Nanosilicate container	2	3.297 b	0.327 fg	17.33 ab	53.23 ab	2.875 b
	4	3.420 ab	0.294 fg	17.33 ab	59.10 a	1.525 f

In each column, different letters indicate significant difference (at 1 or 5% probability level, LSD).

Table 1. (*Continued*).

Coating treatments	Storage time (week)	Total phenols (mg GAE/100 ml)	Total flavonoids (mg QE/100 ml)	Total anthocyanins (mg C3GE /100 ml)	Antioxidant activity (%)	Decay rate (%)
		P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
Zero-day control	-	10.58 g	6.593 a	25.84 a	78.25 c	0.00 e
Control	2	11.69 defg	3.796 de	18.57 c	88.33 ab	4.70 e
	4	13.49 c	2.587 fg	11.34 de	59.30 e	90.48 a
Aloe vera gel	2	11.96 def	3.518 def	18.05 c	90.64 a	0.00 e
	4	11.86 def	2.724 efg	9.59 e	49.47 fg	31.29 c
Aloe vera gel + honey	2	12.44 cde	5.053 bc	21.27 bc	71.05 d	0.00 e
	4	18.95 b	2.916 efg	11.68 de	48.67 fg	29.80 cd
Aloe vera gel + chitosan	2	11.90 def	4.209 cd	18.26 c	83.73 b	0.00 e
	4	12.18 de	2.043 g	9.68 e	46.72 g	20.57 d
Aloe vera gel + ascorbic acid	2	12.55 cde	6.072 ab	25.10 a	89.10 ab	0.00 e
	4	22.92 a	2.939 efg	13.02 de	48.05 fg	41.17 b
Ascorbic acid	2	12.52 cde	5.055 bc	23.58 ab	90.46 a	0.00 e
	4	10.58 fg	3.385 def	13.49 d	50.89 fg	9.25 e
Nanosilicate container	2	12.64 cd	4.530 cd	23.78 ab	89.93 a	0.00 e
	4	10.87 fg	3.669 def	12.49 de	52.22 f	35.39 bc

In each column, different letters indicate significant difference (at 1 or 5% probability level, LSD).

Aloe vera gel + chitosan had the lowest amount total flavonoid content after four weeks of storage which was in agreement with the results of Singla et al. (2022). For total anthocyanins, both *Aloe vera* gel and *Aloe vera* gel + chitosan showed the lowest values after four weeks of storage. *Aloe vera* gel + ascorbic acid after two weeks of storage (25.10 mg cyanidin 3-glycoside per 100 ml) and the zero-day control (25.84 mg cyanidin 3-glycoside per 100 ml) had the highest anthocyanin content, although no statistical difference was observed compared to some other treatments. Factors like temperature, oxygen, storage time, moisture loss, and fruit type can reduce anthocyanins (Oz & Ulukanli, 2012). The decrease in total anthocyanins during storage is consistent with previous studies (Ghorbani et al., 2017; Mandegari et al., 2020; Shahi et al., 2022).

Table 2. Simple effect of coating treatments and storage period on weight loss and electrical conductivity (EC) of edible arils of pomegranate cultivar "Malas-e Saveh".

	Weight loss (%)	EC (mmohs/cm)
Coating treatments	P<0.001	P<0.001
Zero-day control	0.000 b	4.253 a
Control	3.000 a	4.204 a
Aloe vera gel	0.426 b	4.115 b
Aloe vera gel + honey	0.157 b	3.992 d
Aloe vera gel + chitosan	0.795 b	4.128 b
Aloe vera gel + ascorbic acid	0.393 b	4.083 bc
Ascorbic acid	0.287 b	4.042 cd
Nanosilicate container	0.412 b	4.120 b
Storage time (week)	P=0.119	P=0.453
2	0.564	4.112
4	0.804	4.122

In each column, different letters indicate significant difference (at 1% probability level, LSD).

The highest antioxidant activity was observed for *Aloe vera* gel, ascorbic acid and nanosilicate container after two weeks of storage (90.64%, 90.64% and 89.93%, respectively). The lowest activity was seen in *Aloe vera* gel + chitosan after four weeks of storage. The results showed that antioxidant activity initially increased and then decreased over time. These findings are consistent with those of with Zahran et al. (2015), who also reported that the antioxidant activity of pomegranate arils increased over time. In pomegranates, antioxidant activity is more influenced by phenolic compounds like elagitannins, and less by anthocyanins and ascorbic acid (Tehranifar et al., 2014). Some edible coatings can enhance antioxidant properties by reducing respiration and ethylene production (Ghasemnezhad et al., 2013).

The results of the present study revealed that, after 2 weeks of storage, no decay was observed in treatments except for the control, which had a decay rate of 4.70% (Table 1). The highest decay rate was observed in control after four weeks (90.48%). Among the other treatments, *Aloe vera* gel + chitosan exhibited the lowest decay rate after four weeks of storage (20.57%). Moradinezhad et al. (2023) also demonstrated that packaging treatments led to reduced decay in pomegranate arils during storage.

Table 2 presents the simple effect of coating treatment and storage period on the weight loss of edible pomegranate arils ("Malas-e Saveh" cultivar). The zero-day control had the lowest value without weight loss, while the control treatment had the highest weight loss (3%). Other coating treatments showed slight, statistically similar weight loss to the zero-day control. No significant difference in weight loss was observed between two and four weeks of storage. These results agree with Mandegari et al. (2020) and El-Beltagi et al. (2023), who also reported decreased aril weight during storage and reduced weight loss with coatings. Weight loss during storage is caused by water evaporation, membrane damage, and increased senescence. The zero-day control and control also showed the highest electrical conductivity values (4.253 and 4.204 decisiemens/meter, respectively), while the *Aloe vera* gel + honey had the lowest value, although not significantly different from the ascorbic acid treatment. No statistical difference in electrical conductivity was observed between two and four weeks of storage.

Color properties

The results of the analysis of variance showed that the coating treatments had a significant effect on the color indices a (red color) and b (yellow color) of the pomegranate arils. However, they did not significantly affect the maintenance of the L index or brightness. This finding is consistent with that of Mandegari et al. (2020), who also showed that 5 µM nitric oxide did not affect the L index.

According to the results, the zero-day control and *Aloe vera* gel produced the highest values for index a (50.11 and 46.87, respectively), while the control and *Aloe vera* gel + ascorbic acid produced the lowest values (Table 3). In other words, the intensity of the arils' redness (an index) decreased over time, but the *Aloe vera* gel coating helped maintain this color. The other treatments were less effective, although there were minor differences. These results agree with Mandegari et al. (2020) and Moradinezhad et al. (2023), who demonstrated that this index decreases over time and that 5 and 10 µM nitric oxide best preserved it. The reduction in red color at the end of storage may be due to anthocyanin degradation (Varasteh et al., 2012). Additionally, the zero-day control had the highest b index value (38.27), while the control and ascorbic acid treatments produced the lowest. During storage, the intensity of the arils' yellowness (b index) decreased which was in agreement with Moradinezhad et al. (2023). As with redness (an index), the *Aloe vera* gel coating better maintained this index compared to other treatments, which were less effective. Fruit color is an important quality characteristic for consumers, as appropriate color makes the fruit appear appetizing and directly impacts marketability. Chemical changes during storage often reduce fruit pigments (Varasteh et al., 2012).

Sensory properties

The results of the analysis of variance indicated that there were statistically significant differences between the coating treatments for the sensory evaluation attributes, including appearance, smell intensity, taste, and freshness.

The sensory evaluation results revealed that consumers preferred the natural taste of the fresh pomegranate arils in the zero-day control, which received the highest scores (Table 4). However, the control had the lowest appearance value (2.3), while the control and *Aloe vera* gel + chitosan had the lowest smell intensity values (both 3.3). The *Aloe vera* gel and *Aloe vera* gel + chitosan had the lowest taste values (both 2.5), and the control and nanosilicate container received the lowest freshness values (1.8 and 2.5, respectively). Appearance is the most important indicator in sensory evaluation (de Resende et al., 2008), as any signs of contamination or decay will reduce marketability. Thus any factor that slows aging and prevents decay signs will better preserve appearance and sensory appeal. In this study, most coating treatments better maintained the arils' appearance compared to the control, which is consistent with the findings of Mandegari et al. (2020).

Table 3. The effect of coating treatments on color properties in edible arils of pomegranate cultivar "Malas-e Saveh".

Coating treatments	*L*	*a*	*b*
	P=0.065	P<0.001	P<0.001
Zero-day control	35.39	50.11 a	38.27 a
Control	41.36	36.42 c	8.86 c
Aloe vera gel	40.09	46.87 a	27.34 ab
Aloe vera gel + honey	36.22	41.06 b	20.75 bc
Aloe vera gel + chitosan	35.24	39.54 bc	18.62 bc
Aloe vera gel + ascorbic acid	32.18	36.48 c	16.85 bc
Ascorbic acid	36.98	38.52 bc	13.56 c
Nanosilicate container	36.85	39.88 bc	21.14 bc

In each column, different letters indicate significant difference (at 1% probability level, LSD).

Table 4. The effect of coating treatments on sensorial properties in edible arils of pomegranate cultivar "Malas-e Saveh".

Coating treatments	Appearance	Aroma	Taste	Freshness
	P<0.001	P<0.001	P<0.001	P<0.001
Zero-day control	5.0 a	5.0 a	5.0 a	5.0 a
Control	2.3 e	3.3 c	3.2 bc	1.8 d
Aloe vera gel	3.0 cd	4.0 b	2.5 c	3.0 cd
Aloe vera gel + honey	3.5 bc	4.0 b	3.0 bc	3.0 cd
Aloe vera gel + chitosan	2.7 de	3.3 c	2.5 c	3.2 bcd
Aloe vera gel + ascorbic acid	3.7 b	4.0 b	3.5 b	3.8 b
Ascorbic acid	3.0 cd	4.5 ab	3.2 bc	3.5 bc
Nanosilicate container	2.5 de	4.0 b	3.3 b	2.5 d

In each column, different letters indicate significant difference (at 1% probability level, LSD).

CONCLUSION

In recent years, there has been a growing trend to separate and sell fresh pomegranate arils in the market. However, after harvesting and separation from the fruit, pomegranate arils undergo a series of enzymatic and biochemical reactions that may lead to quality deterioration during storage. Therefore, certain precautions should be taken to minimize these changes. This study aimed to investigate the effectiveness of various food coatings in preserving the quality of "Malas-e Saveh" pomegranate arils during storage. The results showed that the coating treatments and storage time had a significant interaction or simple effect on acidity, flavor index, vitamin C, total phenols, total flavonoids, total anthocyanins, antioxidant activity, TSS, and weight loss. All coatings were effective in preventing weight loss. Nanosilicate containers largely maintained TSS content during storage. *Aloe vera* gel + ascorbic acid were effective in preserving total phenols, total flavonoids, total anthocyanins, and antioxidant activity. *Aloe vera* gel was most effective at maintaining aril color. *Aloe vera* gel + ascorbic acid had the greatest impact on maintaining sensory evaluation attributes including appearance, smell intensity, taste, and freshness. Further research is suggested to investigate the effects of edible coatings and nano packaging containers on the storage of edible pomegranate arils across different cultivars.

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Conflict of interest
The authors have no conflict of interests to declare.

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