Guar and Eremurus Edible Coatings Enhance Postharvest Quality of Pomegranate Fruits

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Summary

One effective method for extending the shelf life of harvested fruits is through the application of edible coatings. This study investigates the effect of edible guar (0.5%, 1%, and 2%) and eremurus (0.5%, 1%, and 1.25%) coatings on the storage life of pomegranate fruits cv. 'Rababe Neyrize Fars'. The fruits were treated with different concentrations of the edible coatings. After drying, the fruits were stored in a roofed storage at the orchard with a temperature of 6 °C and relative humidity of 45% for three months. Fruits were taken out of the storage every month and various characteristics were measured. The results of the study demonstrate that the use of guar and eremurus coatings significantly reduced weight loss, and the highest weight loss (16.78%) was observed in uncovered pomegranates. Fruits covered with different concentrations of guar had higher antioxidant capacity and taste index compared to the control samples. The highest vitamin C (16.44 mg 100 mL^{-1}) and phenol (268.61 mg 100 mL^{-1}) were observed in 1% guar coating treatment, while the lowest amount was observed in the control samples. Higher TA was recorded in fruits treated with different concentrations of eremurus compared to uncovered pomegranates. Using 1.25% eremurus coating maintained the appearance quality of the fruits and 1% guar treatment also obtained the highest scores in terms of taste, juiciness and overall evaluation of the fruit. In conclusion, the results of the study suggest that guar and eremurus coatings are effective in increasing the postharvest life of pomegranate fruits

Key words

edible coating, eremurus, guar, pomegranate, postharvest life, *Punica granatum* L.

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Introduction

The pomegranate (*Punica granatum* L.), is a fruit indigenous to Iran and belongs to the *Punicaceae* family. This semi-tropical fruit has a long history of medicinal use and is considered effective in reducing the risk of chronic ailments such as cancer, arteriosclerosis, blood pressure, diabetes, and other diseases (Hasanzadeh et al. 2016). Pomegranate fruit storage life varies across different cultivars and can reach up to five to six months, providing opportunities for preparation, grading, packaging, marketing and preparation of conversion products (Nikdel et al. 2015).

However, during harvesting, processing and storage, about 25% of the product is lost as waste due to various factors (Nikdel et al. 2015), particularly in late summer to early fall when the fruit is harvested but faces damage or price reduction due to inadequate storage conditions (Selahvarzi and Tehranifar 2012). Factors contributing to fruit losses include frostbite, fungal rots, high respiration, weight loss, drying and browning of the fruit skin (D'Aquino et al. 2010). While the use of high temperatures to prevent frost damage may lead to fungal contamination and increase waste (Selahvarzi and Tehranifar 2012), the use of chemicals to control fungal contamination may pose risks to consumers' health and the environment. Therefore, the production of healthy products is crucial in reducing the consumption of chemicals (Jalili-Moghadam et al. 2018) and non-chemical and safe methods, such as the use of edible coatings, should be considered in order to maintain the fruit quality, reduce respiration and water loss and enhance resistance to pathogenic factors (Ramazanian 2014). In addition, the research has demonstrated that plant extracts and essential oils can replace chemical poisons in the control of fungal infections (Selahvarzi and Tehranifar 2012). Malekshahi and ValizadehKaji (2021) found that the use of chitosan and thymol presented a promising alternative for extending the shelf life of pomegranate fruits.

Guar (*Cyamopsis tetragonoloba* (L.) Taub.) gum is composed of di-galactose and di-mannose (Tahir et al. 2019). This high molecular weight polysaccharide is extracted from plant seeds' endosperm and can be used as an edible coating due to its long polymer chain, high solubility in water and antibacterial activity. This gum is effective in reducing fruit juice loss by reducing the rate of respiration and oxidation reactions, as expressed by Dong and Wang (2018), Naeem et al. (2018), and Tahir et al. (2019), in improving the quality of 'Valencia' oranges, 'Roma' tomatoes and sweet cherries post-harvesting. Furthermore, due to its physicochemical properties and non-toxicity, this compound has found utility in a range of packaging and pharmaceutical industries (Huang et al. 2019).

The *Eremurus persicus* (Jaub. & Spach) Boiss. plant species, known locally as 'Serish', is extensively cultivated mainly in Central, Western and Middle Eastern Asia including Afghanistan, Iran, Tajikistan and Lebanon (Hakemi Vala et al. 2011). The roots of this plant serve as a natural adhesive, while the leaves are traditionally used to relieve constipation, diabetes, liver and stomach ailments (Hakemi Vala et al. 2011). This plant extract exhibits significant antibacterial activity against several bacteria and anticancer properties due to its phenolic compounds and antioxidant activity (Tuzcu et al. 2017). Based on the findings of researchers, the application of the edible coating of *Eremurus* can prevent fruit weight loss (Esmaili et al. 2022).

Considering the importance of maintaining the quality of pomegranate fruit, for export and off-season supply in domestic markets, the need is felt to increase the storage life of the fruit. Research has been conducted to explore the impact of different techniques on enhancing the quality of stored pomegranate fruit, and these methods include low temperature (Rahimi et al., 2015), heat treatment (Abedi et al., 2018), chitosan (Candir et al., 2018), pectin (Hosseini and Moradi-Nejad, 2014), polyethylene (Chamani-Asghari et al., 2016), wax application (Opara et al., 2015), and the use of plant essential oils (Ghafouri et al., 2014). Cold storage of pomegranate fruits increases their shelf life and reduces product waste. However, in addition to frost damage, there are usually no industrial cold storages in most of the pomegranate growing areas, and keeping the product in traditional orchards and warehouses without observing the necessary conditions will reduce the quality of the fruit as well as its shelf life. Based on this, it is necessary to use treatments to increase the life after harvesting and maintain the quality of the fruit. Therefore, this research aims to use edible coatings in order to increase the shelf life of fruit and is recommended as an alternative to chemical coating materials in order to ensure the health of the consumer.

Materials and Methods

The current study was conducted during the fall and winter of 2019 in a covered warehouse situated in an orchard in Taft city, which is located in the southwestern region of Yazd province, Iran. The average temperature during this time period was 6 °C, with a relative humidity of 45%. The research comprised of nine treatments, including concentrations of 0.5%, 1%, and 2% of guar gum and three concentrations of *Eremurus* (0.75%, 1%, and 1.25%) and their interaction effect. To prepare guar gum concentrations of 0.5, 1, and 2 %, respectively, 15, 30 and 60 g of guar gum were added to 3000 cc distilled water. In addition, to prepare three liters of *Eremurus* treatment at each concentration, respectively, 22.5, 30 and 37.5 g of *Eremurus* powder were added to 3000 cc distilled water, and thus treatments with concentrations of 0.75, 1, and 1.25% were prepared. An electric stirrer was used to homogenize the solution. To investigate the interaction effect of the guar gum and *Eremurus*, 1000 cc of each treatment were mixed with 1000 cc of the other treatment and mixed with an electric stirrer to obtain a uniform treatment. Distilled water was also considered as a control treatment. Each treatment was replicated three times with five fruits and distilled water being used as controls for each replication. Desired traits were measured at 30-day intervals. The research commenced at the beginning of November with the harvesting of 450 pomegranate fruits of the 'Rababe Neyrize Fars' cultivar. These fruits were selected based on their healthy and pest-free characteristics, while also being free of any damage, such as cracks or sunburn. The fruits were then stored in a roofed storage inside the orchard for the application of treatments. The pomegranate fruits were treated using the immersion method for three minutes with varying concentrations, while the control samples were treated with distilled water. Following the drying process, the treated fruits were placed in single-row plastic baskets and transferred to the storage.

Then, the fruits were weighed with a digital scale. At the onset of the investigation and subsequently for three consecutive periods of 30 days, the pomegranate fruits were extracted from the storage for measuring characteristics. The traits measured were weight loss, juice of 100 arils, titratable acidity (TA), soluble solids content (SSC) with a refractometer and taste index that was computed utilizing the correlation between SSC divided by TA and decay and browning index. The pH of the fruit juice samples from different treatments was determined by directly measuring it using a pH meter in the laboratory (Mokhtarizadeh Naeini et al., 2018).

The total phenol in fruit juice was conducted by Folin reagent (Bakran et al. 2017). In order to determine the quantity of vitamin C in fruits, the titration method with 6,2-dichlorophenol-indophenol was implemented (Kashyap and Gautam 2012). The antioxidant activity was assessed using DPPH free radical neutralization property through a spectrophotometer at a wavelength of 517 nm, as outlined by Sun and Ho (2005). The Bradford method was employed to measure the total protein content in this study. To construct the standard curve, 5 mg of a standard protein was dissolved in 5 ml of 50 mM sodium phosphate buffer with pH 7. Different volumes (5, 10, 20, 30, 40, 50, 60, and 70 microliters) of the standard protein solution were added to separate test tubes containing 3 mL of Bradford reagent. After thorough mixing, the absorbance at 595 nm was measured using a spectrophotometer. Test tubes with zero microliters of standard protein were used to calibrate the instrument to zero.

To determine the protein content in the samples, 35 microliters of pomegranate juice was mixed with 3 milliliters of Bradford reagent in a test tube. The absorbance at 595 nm was then measured using a spectrophotometer. The protein content in each sample was calculated using equation (1) (Bradford, 1976).

Equation (1):

$$y = 0.003x + 0.0141$$

To determine the degree of decay of fruits through scoring, the fruits were divided into four categories and the scoring was as follows: 1: Fruits without decay; 2: Fruits with decay less than one-third of the fruit surface; 3: Fruits with decay between one-third and two-thirds of the fruit surface and 4: Fruits with decay of more than two-thirds of the fruit surface were examined. The decay index was calculated using equation 3 and expressed as a percentage (Jalili-Marandi, 2011).

Equation (2):

$$\text{Decay index} = \frac{\Sigma\ (\text{Number of decayed fruits per bunch} \times \text{bunch score})}{4 \times \text{Fruits number per replication}} \times 100$$

To evaluate the browning index of the peel of the fruits, a scoring method was used with a scale of zero to four (zero: no browning, one: browning in one-fourth of the peel, two: browning in half of the peel, three: browning in three-fourths of the peel, and four: browning in all peels), which was calculated using equation 3 (Ehteshami et al., 2020).

Equation (3):

$$\text{Browing index} = \frac{\Sigma\ (\text{Number of brown fruits per bunch} \times \text{bunch score})}{4 \times \text{Fruits number per replication}} \times 100$$

Furthermore, the scoring method was utilized to evaluate the appearance characteristics of the fruits. The grading criteria encompassed color uniformity and fruit decay, with grades ranging from 1 to 5: 1 for poor, 2 for average, 3 for good, 4 for very good, and 5 for excellent (Ebrahimi et al. 2018).

At the end of the experiment (day 90 of storage) in order to check the marketability of the fruits from the point of view of the consumer, a panel test was conducted in which the person in question, without knowing the type and amount of coating material used on the fruits, answered the questions asked in the question form or gave answers by letter. For this purpose, fruits from each treatment were randomly selected and after separating the arils from the peel, they were poured into the container. The numbered containers were arranged in a mixed manner. Next, the questionnaires were given to 9 people between the ages of 30 and 60 (4 women and 5 men) and they were asked to answer the questions after observing, examining and eating each of the fruits (Martinez Romero et al., 2013).

Statistical Analysis

This research was designed as a completely randomized factorial design and data analysis was accomplished through SAS 9.1 software. Mens were separated by Duncan's multiple range test at $P < 0.05$ significance level.

Results and Discussion

Weight Loss

One of the most significant challenges in storing pomegranate fruit is the reduction in fruit weight. Transpiration and water loss are the primary contributors to this phenomenon, while respiratory activity plays a minor role (Khademi et al. 2016). During storage, the decrease in pomegranate fruit weight is more closely related to the loss of peel moisture than the effect of aril moisture. The thick peel of the pomegranate fruit is characterized by numerous pores that accelerate water loss and reduce fruit weight (Meighani et al. 2015). Studies have shown that the loss of fruit weight increases with storage temperature and time. The use of edible coatings as a barrier against moisture loss and by adjusting gas concentration (reducing respiration by lowering oxygen absorption from the environment) can help preserve fruit juice (Opara et al. 2015; Fawole and Opara 2013; Artes et al. 2000).

The results of this research indicate that the weight loss of both covered and uncovered pomegranate fruits increased during storage. Nevertheless, the control samples showed the greatest amount of weight loss. In fruits coated with different concentrations of guar gum (0.5%, 1%, and 2%) compared to different levels of the coating (0.75%, 1%, and 1.25%), a lower amount of weight loss has been observed. (Table 1). The lowest weight loss in the first and second months was related to the pomegranates treated with level 3 guar and *Eremurus* (2% guar + 1.25% *Eremurus*) and in the third month in the fruits coated with 1% guar (Table 2). As time passes and evaporation and transpiration intensify due to the non-uniformity of water vapor pressure in intercellular spaces of the tissues and the atmosphere surrounding the fruit, as well as increased respiratory processes, weight loss during storage becomes a natural occurrence (Mokhtarizadeh Naeini et al. 2020).

Ramzanian et al. (2016) found that edible coatings, particularly chitosan, significantly prevented weight loss of 'Rabab-e-Neyriz-e-Fars' pomegranate arils. The treatment with chitosan 1.5% showed the lowest weight loss of arils. Selahvarzi and Tehranifar (2012) observed that the use of plant essential oil significantly reduced the weight loss of pomegranate fruit after five months of storage.

Table 1. Effect of edible coatings on weight loss, TA, SSC and taste index of pomegranate

Treatment	Taste index	Soluble solids content (°Brix)	Titratable acidity (%)	Weight loss (%)
0.5% guar	8.99[bc]	15.2[b]	1.71[e]	13.9[d]
1% guar	8.4[cd]	15.4[ab]	1.88[cde]	12.76[e]
2% guar	13.09[a]	16.55[a]	1.43[f]	14.13[d]
0.75% eremurus	7.92[de]	15.51[ab]	2.06[abc]	15.2[bc]
1% eremurus	7.32[ef]	15.52[ab]	2.19[ab]	15.87[ab]
1.25% eremurus	6.84[f]	14.9[b]	2.22[a]	16.08[ab]
0.5% guar + 0.75% eremurus	9.11[bc]	15.5[ab]	1.84[de]	14.83[cd]
1% guar + 1% eremurus	8.09[de]	15.59[ab]	1.95[cd]	11.65[f]
2% guar + 1.25% eremurus	9.26[b]	16.08[ab]	1.76[e]	11.28[f]
Control	8.13[de]	15.6[ab]	2.01[bcd]	16.78[a]

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Black cumin essential oil treatment showed the lowest weight loss. Although the mechanism of the protective effect of medicinal plant essential oils against fruit weight loss is yet to be determined, weight loss is correlated with the increase in fungal decay. Thus, it is possible that the inhibiting effect of plant essential oils against the growth of fungi and other microorganisms may prevent weight loss in coated fruits.

Abolfathi et al. (2014) have reported that the application of aloe vera gel as a coating on 'Malase Saveh' pomegranate fruit can effectively prevent fruit weight loss. Their study has revealed that the treatment with 50% aloe vera gel coverage has shown the least water loss among the different levels of aloe vera gel treatments (25%, 50%, and 100%). This reduction in water loss has been found to be significantly different from the control fruits.

Ebrahimi and Rastegar (2020) have documented that the use of guar and aloe vera edible coatings on mango fruit, stored at 25 °C for 3 weeks, can prevent fruit weight loss by reducing respiration.

Dong and Wang (2018) have investigated the effect of a combination of two extracts of guar gum and ginseng extract on maintaining the quality of cherry fruit at 20 °C and a relative humidity of 70-75%. Their findings suggest that this combination has a significant effect in reducing fruit weight loss.

Juice of 100 g Arils

According to Figure 1, the lowest fruit juice of 100 g arils (64.05 mL) was observed in the control fruits and the highest amount (67.72 mL) was observed in the fruits coating with 0.75% *Eremurus*. Varasteh et al. (2017) showed that during the storage period of pomegranate fruit, the percentage of arils and juice of arils increased.

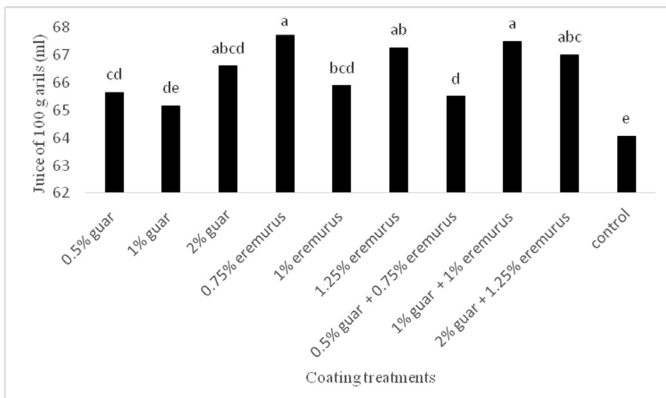

Figure 1. Effect of edible coating treatments on juice of 100 g arils of pomegranate

Titratable Acidity (TA)

The determination of fruit quality is significantly influenced by the measure of acidity. The conversion of organic acids into sugars and their utilization in the metabolic processes of fruits result in a decrease in titratable acidity (Tahri et al. 2018). Respiration uses organic acids as a source of energy. The combination of organic acids and sugars in fruits is what creates their sour or sweet taste (Jalili-Marandi 2011).

The increase in ambient temperature accelerates the reduction of organic acids due to enhanced respiration rates. The reduction of organic acids can be prevented by decreasing oxygen or increasing carbon dioxide in the environment (Mokhtarizadeh Naeini et al. 2020).

Table 2. Effect of edible coatings and storage time on weight loss (%) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	15.39[def]	13.99[efghi]	12.34[ijk]
1% guar	13.16[ghij]	13.84[efghi]	11.27[k]
2% guar	17.26[bc]	12.56[hijk]	12.58[hijk]
0.75% eremurus	17.54[bc]	12.59[hijk]	15[def]
1% eremurus	20.29[a]	11.77[jk]	9.08[l]
1.25% eremurus	17.67[bc]	15.55[de]	13.62[fghi]
0.5% guar + 0.75% eremurus	14.09[efghi]	14.34[defgh]	11.27[k]
1% guar + 1% eremurus	14.83[defg]	15.19[def]	12.63[hijk]
2% guar + 1.25% eremurus	16.15[cd]	11.08[k]	6.61[m]
Control	20.32[a]	18[b]	17.44[bc]

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Based on the results obtained, the titratable acidity of the fruit decreased during the storage period, with the lowest amount recorded on the 90th day of storage. The impact of edible coatings on fruit juice acidity was also significant. Fruits coated with varying concentrations of *Eremurus* had a higher amount of titratable acidity than the control samples, while pomegranates with other coatings had lower acidity than the control samples. The findings of the 90th day of storage indicated that all treatments, except for fruits coated with 2% guar and one level of guar and *Eremurus* (0.5% guar + 0.75% *Eremurus*), had higher TA than control pomegranates (Table 1). In the first month, the acidity of the fruit juice was the highest in pomegranates coated with different concentrations of *Eremurus* (0.75, 1, and 1.25%), which had a significant effect compared with the control samples. In the second month, the highest acidity was observed in the control fruits. The results of the third month showed that all the treatments, except for the fruits covered with 2% guar and 1 level of guar and *Eremurus* (0.5% guar + 0.75% *Eremurus*), were more acidic than the control pomegranates (Table 3).

The decrease in the level of titratable acidity in uncoated fruits is associated with an increase in respiration rate during storage, leading to a reduction in organic acid levels. Organic acids, such as citric and malic acids, are major respiration substrates (Saberi et al. 2018).

Dong and Wang (2018) explored the impact of guar gum and ginseng extract coatings on the quality of cherry fruit at 20 °C and relative humidity of 70-75%. They reported that the combination of these two extracts significantly affected changes in respiration rate and slowed down the titratable acidity of fruit juice. Saberi et al. (2018) observed that the use of guar gum edible coating on Valencia oranges for four weeks at 5 and 20 degrees Celsius maintained titratable acidity during fruit storage. The investigation conducted by Hosseini and Moradinezhad (2014) examined the efficacy of aloe vera and pectin edible coatings, with concentrations of 50% and 75% and 0.75% and 0.375%, respectively, on the pomegranate arils of the 'Shishe-cap ferdows'. The fruit was packaged in plastic containers and stored at 5 °C in the refrigerator. The results indicated that the use of both types of edible coatings had a positive impact on the preservation of the titratable acidity of fruit juice during the storage period.

Ghafouri et al. (2014) investigated the use of thyme essential oil as a coating for pomegranate fruits, at four different concentration levels (0, 500, 1000, and 1500 mg L^{-1}) and three distinct time levels (1, 2, and 3 months of storage), at a temperature of 6 °C and relative humidity of 85%. Their findings demonstrated that the application of thyme essential oil prevented the reduction of titratable acidity and the breakdown of sugars during storage.

Soluble Solids Content (SSC)

Most of the soluble solids content in fruits are composed of sugars, alongside a small proportion of organic acids, amino acids, vitamins, and minerals. These compounds significantly impact the taste of the fruit, with their effect increasing during the fruit's ripening process (Jalili Marandi, 2013). As a result, fruits that are harvested later tend to contain more soluble solids at both the time of harvesting and the end of their storage period. This increase in soluble solids content can be attributed to the concentration of sugars caused by water loss (Dong and Wang, 2018).

The experiment's findings reveal that the highest amount of soluble solids content of the fruit can be traced back to the 90th day of storage, with no significant difference noted in the first and second months. In pomegranates, the amount of soluble solids significantly increased with the rise in storage time, especially when coated with different guar concentrations. The highest SSC was observed in the fruits coating with 2% guar (Table 1).

Table 3. Effect of edible coatings and storage time on TA (%) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	2.04^{defgh}	1.54^{klm}	1.56^{klm}
1% guar	1.65^{ijkl}	1.83^{e-k}	2.17^{cdef}
2% guar	1.14^{n}	1^{n}	2.14^{cdefg}
0.75% eremurus	1.81^{ghijk}	1.61^{jkl}	2.77^{a}
1% eremurus	1.82^{f-k}	1.93^{e-j}	2.82^{a}
1.25% eremurus	1.98^{d-i}	2.06^{defgh}	2.63^{ab}
0.5% guar + 0.75% eremurus	1.26^{mn}	1.97^{d-i}	2.29^{cd}
1% guar + 1% eremurus	1.77^{hijkl}	2.17^{cdef}	1.91^{e-j}
2% guar + 1.25% eremurus	1.62^{jkl}	1.65^{ijkl}	2.01^{defgh}
Control	1.46^{lm}	2.41^{bc}	2.17^{cde}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Kawhena et al. (2022) found that pomegranate fruits treated with gum arabic showed the highest total soluble solids content, compared to uncoated fruits. The lowest amount of soluble solids was observed in pomegranates coated with 0.5% guar in the first month and the highest amount was observed in fruits coated with 2% guar in the third month of storage. On the 30th day of storage, the content of soluble solids in control samples was higher than that in guar-coated fruits (0.5, 1, and 2%) and pomegranates coated with *Eremurus* (0.75, 1, and 25 1.0 %) had lower values. In the second and third months of storage, the highest and lowest amounts of solids were observed in the 2% guar and 1.25% *Eremurus* treatments, respectively (Table 4).

Table 4. Effect of edible coatings and storage time on SSC (°Brix) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	17.27^{ab}	14.97^{b-i}	13.37^{i}
1% guar	16.43^{abcde}	16.03^{a-g}	13.73^{ghi}
2% guar	17.93^{a}	16.44^{abcde}	15.27^{b-i}
0.75% eremurus	15.47^{b-i}	14.87^{c-i}	16.2^{a-f}
1% eremurus	15.37^{b-i}	14.53^{efghi}	16.67^{abcde}
1.25% eremurus	15.33^{b-i}	13.67^{hi}	15.7^{a-h}
0.5% guar + 0.75% eremurus	16.6^{abcde}	14.1^{fghi}	15.8^{a-h}
1% guar + 1% eremurus	17.1^{abcd}	14.8^{d-i}	14.87^{c-i}
2% guar + 1.25% eremurus	17.13^{abc}	15.27^{b-i}	15.83^{a-h}
Control	15.37^{b-i}	16.13^{a-f}	15.3^{b-i}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

In their investigation of the effect of guar gum and ginseng extract coatings on the preservation of cherry fruit quality at a temperature of 20 °C and a relative humidity of 70-75%, Dong and Wang (2018) discovered that the combination of these two extracts had a significant impact on the preservation of the material content.

Abolfathi et al. (2014) reported that the application of bitter almond oil on 'Malase Saveh' pomegranate fruit after 4 months of storage in cold storage was the best treatment for preserving the soluble solids of the fruit.

Taste Index

The ripening coefficient, also known as the taste index, holds a significant influence on the flavor of fruit. It is determined by the ratio of soluble solids to organic acids present in the fruit and serves as a first-class indicator for determining the harvest of pomegranates. (Jalili-Marandi 2011; Esnaashari and Zakai khosroshahi 2017).

During the storage period, the fruit flavor index was found to increase. The highest value of this index was recorded on the 90th day of storage. The primary factor influencing the taste of fruit during storage is the change in sugar and organic acid levels. As the soluble solids increase and the titratable acidity decreases, the taste index also rises (Fawole and Opara 2013; Meighani et al. 2016).

Research findings indicate that fruits covered with guar (0.5, 1, and 2 %) exhibits a higher taste index than the control samples. Conversely, pomegranates covered with *Eremurus* (0.75, 1, and 1.25 %) show lower values than the control. The taste index reached its highest level in the guar samples at 2% (Table 1). The highest taste index was observed in the treatment with 2% guar on the 60th day of storage, and the lowest in the coating with 0.75% guar in the first month. In the first month, the highest amount of guar was 2% and the lowest amount was in the cover with *Eremurus* (0.75%, 1%, and 1.25%). Thus, in the first and third months, the fruits coated with different concentrations of *Eremurus* had a lower taste index compared to the control pomegranates. In the second month, the taste index in the control samples was lower than that in the other treatments (Table 5).

Ebrahimi et al. (2018) have reported that the application of aloe vera gel (20%) as a coating for mango fruit after four weeks of storage at 12 °C results in the highest taste index. As per Ramazanian et al.'s research (2016) on the effect of edible coatings of chitosan, nano-chitosan, methyl-cellulose and pectin on the storage of 'Rababe Neyrize Fars' pomegranate arils, the taste index of arils tends to increase during storage. The pectin coating has been found to result in the highest increase in taste index.

pH

Based on the test results, it was observed that in the first month, pomegranates coated with guar (0.5, 1, and 2%) had the highest pH values, while those coated with *Eremurus* (0.75, 1 and 1.25%) had the lowest pH values. Throughout the storage period, pomegranates coated with topaz (0.75, 1, and 1.25%) showed an increase in pH levels (Table 6).

Chamani-Asghari et al. (2016) conducted a study to examine the impact of storage duration on the qualitative characteristics of 'Malase Saveh' pomegranate fruit. The fruit was stored at a temperature of 4 degrees Celsius and a relative humidity of 85% for 90 days. The researchers concluded that the pH levels of the fruit increased during the storage period.

In another study by Nikdel et al. (2015), the effect of various treatments, including coating (polyethylene and paper), chemical (calcium chloride and wax) and temperature (ambient temperature

Table 5. Effect of edible coatings and storage time on taste index of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	8.57^{defgh}	9.8^{cd}	8.59^{defgh}
1% guar	10.01^{cd}	8.82^{def}	6.37^{ij}
2% guar	15.74^{a}	16.35^{a}	7.18^{ghij}
0.75% eremurus	8.62^{defg}	9.29^{cde}	5.87^{j}
1% eremurus	8.49^{defgh}	7.56^{fghi}	5.91^{j}
1.25% eremurus	7.76^{efghi}	6.79^{ij}	5.96^{j}
0.5% guar + 0.75% eremurus	13.27^{b}	7.17^{ghij}	6.9^{ij}
1% guar + 1% eremurus	9.72^{cd}	6.82^{ij}	7.73^{efghi}
2% guar + 1.25% eremurus	10.61^{c}	9.29^{cde}	7.87^{efghi}
Control	10.62^{c}	6.73^{ij}	7.04^{hij}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Table 6. Effect of edible coatings and storage time on pH of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	2.99ghi	3.28a-f	3.37abcd
1% guar	3.36abcde	3.13c-i	3.26b-g
2% guar	3.41abc	3.54a	3.23b-h
0.75% eremurus	3.37abcd	3.13c-i	2.96hi
1% eremurus	3.3a-f	3.17c-i	2.93i
1.25% eremurus	3.12d-i	3.15c-i	3.05fghi
0.5% guar + 0.75% eremurus	3.48ab	3.08efghi	3.12d-i
1% guar + 1% eremurus	3.21b-i	3.12d-i	3.14c-i
2% guar + 1.25% eremurus	3.47ab	3.3a-f	3.17c-i
Control	3.35abcde	3.17c-i	3.16c-i

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

and refrigerator), was investigated during a four-month storage period of 'Shirine Kolbad' pomegranate fruit. The study found that the control samples had the lowest pH compared to the other treatments.

Overall, the pH levels of pomegranate fruit can be influenced by factors such as coating materials, storage duration and storage conditions, as observed in the mentioned studies.

Antioxidant Capacity

An antioxidant is a substance that plays an important role in combating mutagenic or carcinogenic substances by preventing the oxidation of the substrate or delaying its oxidation (Babalar et al. 2017; Mehrabian et al. 2017). Pomegranate fruit has a high antioxidant capacity due to compounds such as polyphenols, anthocyanins and ascorbic acid (Khademi et al. 2016; Fawole and Opara 2013). According to research results, antioxidant capacity gradually decreases during storage (Adiletta et al. 2019; Fawole and Opara 2013).

The obtained results showed that the maximum amount of antioxidants in the fruit was in the second month and in the third month antioxidants decreased, so that it reached the lowest amount during the storage period. Also, the highest amount of antioxidants was observed in guar-coated fruits (0.5, 1, and 2%) and the lowest in the control and level two treatments of guar and *Eremurus* (1% guar + 1% *Eremurus*). The fruits with the *Eremurus* coating (0.75, 1 and 1.25%) also had a higher antioxidant capacity than the control samples (Table 7). In the first and second months of storage, there were no significant differences between the different coatings and the control. In the third month, fruits covered with guar and *Eremurus* level 2 (1% guar + 1% *Eremurus*) and guar and *Eremurus* level 3 (2% guar + 1.2% *Eremurus*) had lower antioxidant levels than the control samples. However, other treatments had higher antioxidant capacities than the control. The highest antioxidant capacity was observed on the 90th day of storage in guar-coated pomegranates (0.5, 1, and 2%) (Table 8).

Ebrahimi and Rastegar (2020) investigated the effect of edible coatings of guar and aloe vera on the quality of mango fruit stored at 25 °C for 3 weeks and reported the amount of antioxidant activity in the coated fruits. The amount of antioxidants was significantly higher with guar compared to other treatments.

Saberi et al. (2018) reported that the antioxidant capacity of Valencia orange fruits coated with guar gum was higher than other uncoated samples after 4 weeks of storage at 5 and 20 °C.

Selahvarzi and Tehranifar (2012) reported the application of black cumin and peppermint essential oil with a concentration of 1000 ppm on pomegranates stored for 5 months at a temperature of 5 °C and a relative humidity of 85-90%. It increased the antioxidant capacity of fruit juice compared to control samples.

The results of experiments conducted by Abolfathi et al. (2014) in the study of the effect of aloe vera gel coating on 'Malase Saveh' pomegranate fruit showed that the antioxidant activity of pomegranate juice in fruits coated with aloe vera gel was more in comparison to uncoated fruits.

Anthocyanins

According to the results obtained from the experiment, pomegranates without cover (control) and fruits covered with *Eremurus* (0.75, 1 and 1.25%) had more anthocyanin content than fruits covered with guar (0.5, 1 and 2 %). The lowest amount of anthocyanin was observed in fruits with 3 levels of guar and serise (2% guar + 1.25% *Eremurus*) (Table 7). The highest anthocyanin was related to pomegranates covered with 2% guar on the 30th day of storage, which significantly decreased on the 60th and 90th

Table 7. Effect of edible coatings on antioxidant capacity, anthocyanin, vitamin C and total phenols of pomegranate

Treatment	Total phenol (mg gallic acid mL^{-1})	Vitamin C (mg 100 mL^{-1})	Anthocyanin (absorption)	Antioxidant capacity (%)
	211.87^{ef}	14.33^{bc}	1.11^{d}	37.91^{a}
0.5% guar	268.61^{a}	16.44^{a}	1.23^{bc}	38.1^{a}
1% guar	235.66^{cd}	15.39^{ab}	1.09^{d}	37.71^{ab}
2% guar	266.62^{a}	12.93^{cd}	1.38^{a}	36.53^{b}
0.75% eremurus	232.16^{d}	13.99^{bcd}	1.37^{a}	37.58^{ab}
1% eremurus	225.56^{de}	14.7^{b}	1.31^{ab}	37.13^{ab}
1.25% eremurus	250.55^{b}	14.69^{b}	1.21^{c}	36.49^{b}
0.5% guar + 0.75% eremurus	247.28^{bc}	13.99^{bcd}	1.23^{bc}	34.38^{c}
1% guar + 1% eremurus	260.89^{ab}	12.59^{d}	1.06^{d}	34.79^{c}
2% guar + 1.25% eremurus	208.37^{f}	10.13^{e}	1.35^{a}	34.7^{c}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Table 8. Effect of edible coatings and storage time on antioxidant capacity (%) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	40.23^{a}	38.2^{a-f}	35.29^{ghi}
1% guar	40.41^{a}	39.01^{abcd}	34.87^{hi}
2% guar	38.44^{abcde}	38^{a-f}	36.69^{defgh}
0.75% eremurus	35.26^{ghi}	38.5^{abcd}	35.82^{fgh}
1% eremurus	37.1^{c-h}	38.89^{abcd}	36.74^{defgh}
1.25% eremurus	35.76^{fgh}	39.63^{ab}	36^{efgh}
0.5% guar + 0.75% eremurus	33.17^{i}	39.37^{abc}	36.92^{c-h}
1% guar + 1% eremurus	26.74^{k}	38.91^{abcd}	37.49^{b-g}
2% guar + 1.25% eremurus	29.15^{j}	37.61^{b-g}	37.61^{b-g}
Treatment	30.67^{j}	36.86^{defgh}	36.57^{defgh}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

days of storage. On the 60th day of storage, control samples had more anthocyanins than other treatments. On the 90th day of storage, the highest amount of anthocyanin was observed in fruits with 0.75% *Eremurus*. On the 60th and 90th days of storage, less anthocyanin was observed in guar coated pomegranates (0.5, 1 and 2%) compared to the control samples (Table 9).

The results of Nikdel et al.' (2015) in investigating the effects of coating (polyethylene coating and paper), chemical (calcium chloride and wax) and temperature (ambient temperature and refrigerator) treatments on the storage of 'Shirin Kolbad' pomegranate fruit showed that pomegranates without coating after four months of storage, had the highest amount of anthocyanin, which can be due to the high concentration of carbon dioxide under the fruit cover.

Table 9. Effect of edible coatings and storage time on anthocyanin (absorption) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	1.27defgh	1.05jk	1.01k
1% guar	1.2fghij	1.25efgh	1.25efgh
2% guar	1.03jk	1.07ijk	1.09ghijk
0.75% eremurus	1.45abc	1.19fghij	1.49ab
1% eremurus	1.26defgh	1.39bcde	1.45abc
1.25% eremurus	1.25efgh	1.11hijk	1.56a
0.5% guar + 0.75% eremurus	1.23efghi	1.05jk	1.36bcdef
1% guar + 1% eremurus	1.32cdefg	1.19fghij	1.19fghij
2% guar + 1.25% eremurus	1.08ijk	1.05jk	1.04jk
Treatment	1.31cdefg	1.43abcd	1.3cdefg

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Vitamin C (Ascorbic Acid)

Vitamin C is one of the most abundant vitamins in fruits and it increases during fruit growth and decreases after harvesting due to the activity of ascorbic acid oxidase enzyme. This composition decreases with increasing temperature during storage. Also, mechanical damage to the fruit due to the oxidation of ascorbic acid in the vicinity of oxygen causes a decrease in the amount of vitamin C (Jalili Marandi 2011; Esnaashari and Zakai Khosroshahi 2017).

The results of the effect of edible coatings showed that the highest and lowest levels of vitamin C were found in fruits coated with 1% guar and pomegranates without coating, respectively (Table 7). During the storage period, vitamin C in coated pomegranates was higher than that of non-coated fruits (control). So the highest vitamin C content was seen on the 30th, 60th and 90th days of storage in fruits coated with 1% guar and the lowest in control pomegranates (Table 10).

Ramazanian et al. (2016) reported the use of edible coatings of chitosan (1.5%), nanochitosan (3%), methylcellulose (3%) and pectin (3%) on pomegranate arils of the Rabab cultivar that were stored at 5 °C for 16 days significantly prevented the reduction of vitamin C in arils.

Candir et al. (2018) by investigating the effect of chitosan coating on the storage of "Hikaznar" pomegranate fruit at 6 °C and 90% relative humidity after 6 months of storage, concluded that the use of this edible coating prevented the decrease of vitamin C during storage.

Chamani-Asghari et al. (2016) investigated the effect of the storage period on the qualitative characteristics of 'Malase Saveh' pomegranate fruit at a temperature of 4 °C and a relative humidity of 85% after 90 days of storage and reported that the fruits had the highest vitamin C at the time of harvest, which decreases during storage.

Total Phenols

The synthesis of phenolic compounds in plants is contingent upon both biotic and abiotic stresses, such as high levels of ultraviolet radiation, food deprivation, low temperature, pest and disease infestations and horticultural practices (Fawole and Opara 2013; Meighani et al. 2015). The deterioration of phenolic compounds during storage can be attributed to the degradation of cellular structure due to aging and the oxidation of phenolic compounds by the polyphenol oxidase enzyme. Furthermore, as secondary metabolites in plants, phenolic compounds are effective in eliminating oxygen free radicals, which leads to their oxidation. Therefore, the reduction in these compounds during storage can be attributed to an increase in oxygen free radicals during the aging process (Selcuk and Erkan 2015). Kulkarni and Aradhya (2005) demonstrated that the highest concentration of phenolic compounds was present in 20-day-old pomegranates. This research revealed that the total phenol content in fruit decreased during storage, with the lowest level observed in the third month, yet no significant difference was observed in the first and second months of storage. Additionally, the highest amount of phenol content was observed in pomegranates coated with 1% and 0.75% guar, whereas the lowest amount was observed in the control treatment (Table 7). Phenol in the control samples increased during storage, reaching the highest level on the 90th day of storage compared with the other treatments. In addition, in fruits coated with different concentrations of *Eremurus*, phenol content increased in the second month and decreased in the third month. The lowest phenol content was observed in the guar treatment (2 %) in the first month, which increased in the second month and again decreased in the third month. According to the results of the test, the highest amount of phenol was recorded in the treatments of levels 1, 2, and 3 of guar and *Eremurus* in the first month, which was significantly different from the control pomegranates; however, at the end of storage, its amount decreased to a lower amount than the control samples (Table 11).

Table 10. Effect of edible coatings and storage time on vitamin C (mg 100 mL^{-1}) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	11.53^{def}	15.73^{ab}	15.73^{ab}
1% guar	15.73^{ab}	16.8^{a}	16.8^{a}
2% guar	15.73^{ab}	14.7^{abc}	15.73^{ab}
0.75% eremurus	11.53^{def}	13.63^{bcd}	13.63^{bcd}
1% eremurus	12.6^{cde}	13.63^{bcd}	15.73^{ab}
1.25% eremurus	12.6^{cde}	14.7^{abc}	16.8^{a}
0.5% guar + 0.75% eremurus	13.63^{bcd}	14.7^{abc}	15.73^{ab}
1% guar + 1% eremurus	12.6^{cde}	13.63^{bcd}	15.73^{ab}
2% guar + 1.25% eremurus	10.5^{ef}	11.53^{def}	15.73^{ab}
Treatment	9.43^{f}	9.43^{f}	11.53^{def}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Table 11. Effect of edible coatings and storage time on total phenol (mg gallic acid mL^{-1}) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	208.92^{ijklm}	221.34^{hijkl}	205.34^{jklm}
1% guar	191.73^{mn}	208.45^{ijklm}	237.1^{efghi}
2% guar	247.84^{defgh}	281.5^{bc}	177.65^{n}
0.75% eremurus	230.65^{fghij}	306.57^{ab}	262.64^{cde}
1% eremurus	210.36^{ijklm}	256.91^{cdef}	229.22^{f-k}
1.25% eremurus	196.75^{lmn}	244.26^{defgh}	235.66^{efghi}
0.5% guar + 0.75% eremurus	245.45^{defgh}	206.06^{jklm}	300.13^{ab}
1% guar + 1% eremurus	201.28^{cde}	221.34^{hijkl}	319.23^{a}
2% guar + 1.25% eremurus	262.17^{cde}	251.9^{defg}	268.61^{cd}
Treatment	323.05^{a}	245.69^{defgh}	224.92^{g-l}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Dong and Wang (2018) investigated the preservation of cherry fruit quality at a temperature of 20 °C and a relative humidity of 70-75% through the use of guar gum and ginseng extract coatings. The combination of these two extracts had a significant effect on preserving the phenolic compounds of the fruit. Similarly, Ebrahimi and Rastegar's (2020) research on the effect of guar and aloe vera on the quality of mango fruit stored at 25 °C for 3 weeks revealed that the amount of phenol in fruits treated with guar was significantly higher than that in other fruits.

Meighani et al. (2015) reported that chitosan and carnauba wax coating treatments significantly prevented the decrease in the amount of total phenolic content of 'Malase Torshe Saveh' pomegranate fruit during the storage period of 120 days. Additionally, Selahvarzi and Tehranifar (2012) research demonstrated that the use of black cumin and peppermint essential oil on pomegranate fruit after 5 months of storage at 5 °C and relative humidity of 85-90% prevented the reduction of phenolic compounds in fruit juice.

Total Proteins

Based on the results obtained, the total protein content of pomegranate fruit increased during the storage period and reached its highest level on the 90th day of storage. The fruits coated with 2% levels of guar and *Eremurus* (1% guar + 1% *Eremurus*) exhibited the highest protein content, while the lowest protein content was observed in fruits coated with 0.5% guar. The protein content in the treatments with 2% guar and *Eremurus* (1% guar + 1% *Eremurus*), as well as 1% and 1.25% *Eremurus*, was higher than the control samples, whereas in other treatments it was lower than the control (Table 12).

Rouhani et al. (2019) conducted a study on kiwi fruit and reported that the expression of certain proteins increased with the lengthening of the storage period. These proteins play a significant role in the breakdown of cell wall polysaccharides and the softening of the fruit. The results of their research indicated a significant increase in the protein content of the fruit, especially after 90 days of storage.

In summary, the protein content of pomegranate fruit can be influenced by the storage period, with longer storage durations generally leading to higher protein levels. This finding is consistent with the research conducted on kiwi fruit by Rouhani et al. (2019).

Decay and Browning Index

After 90 days of storage, the percentage of pomegranates covered with high levels of *Eremurus* and guar was less and most decay was observed in the control pomegranates and the pomegranates treated with low levels of guar (Fig. 2). In the research conducted on the improvement of pomegranate storage, the effect of edible coating in reducing decay has been confirmed (Ghafouri et al. 2014; Abolfathi et al. 2014).

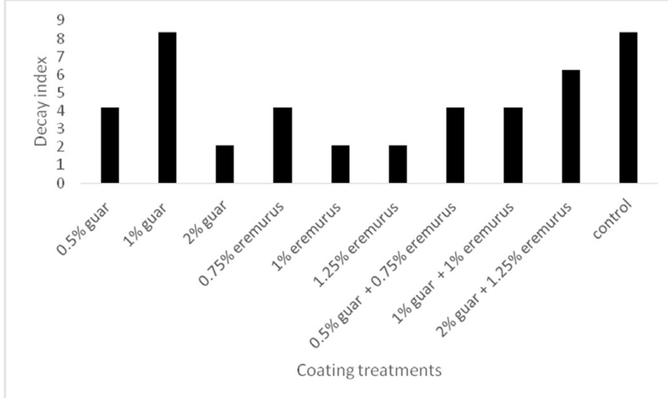

Figure 2. Effect of edible coating treatments on decay index of pomegranate

The obtained results showed that fruit browning increased during storage in all treatments. The highest browning was observed in the untreated treatments (control), which reached the highest level on the 90th day of storage. At the end of storage, the lowest amount of browning was related to pomegranates covered with 1.2% guar and 1.25% *Eremurus* (Fig. 3).

The research has shown that the formation of brown spots increases during storage and low temperatures usually aggravate it. This complication includes surface browning of the peel, which is caused by the oxidation of phenolic compounds by the polyphenol oxidase enzyme. The peroxidase enzyme is also effective in the browning of the fruit, it can quickly oxidize the phenolic compounds and cause stains on the fruit (Zhang and Zhang 2008).

Table 12. Effect of edible coatings and storage time on total protein (mg 100 g^{-1}) of pomegranate

Treatment	Storage time (day)		
	90	60	30
0.5% guar	46.8^{i-n}	38.62^{n}	41.13^{lmn}
1% guar	52.94^{ghijk}	43.63^{jklmn}	50.14^{ijklm}
2% guar	60.96^{defgh}	53.63^{f-k}	45.95^{i-n}
0.75% eremurus	55.13^{efghi}	43.61^{jklmn}	40.13^{mn}
1% eremurus	63.3^{cdef}	67.47^{bcd}	41.94^{lmn}
1.25% eremurus	73.13^{abc}	53.47^{f-k}	46.3^{i-n}
0.5% guar + 0.75% eremurus	75.3^{ab}	51.13^{hijkl}	43.14^{klmn}
1% guar + 1% eremurus	79.63^{a}	50.63^{ijklm}	53.96^{fghij}
2% guar + 1.25% eremurus	72.96^{abc}	61.46^{defg}	36.46^{n}
Treatment	67.13^{bcd}	64.29^{cde}	40.51^{mn}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

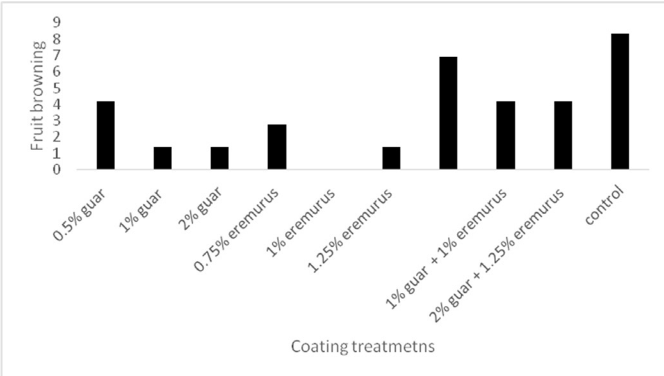

Figure 3. Effect of edible coating treatments on fruit browning of pomegranate

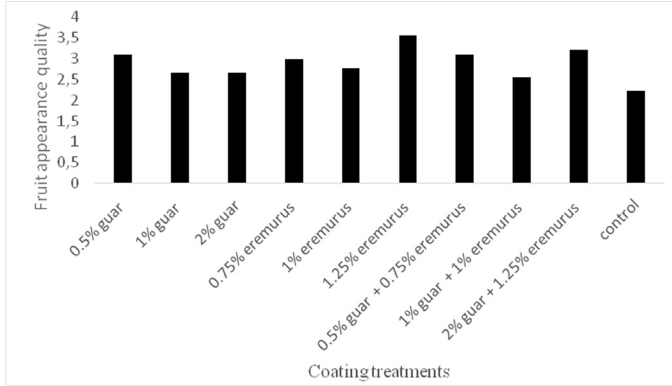

Figure 4. Effect of edible coating treatments on fruit appearance quality of pomegranate

Appearance Quality of the Fruit

Based on the obtained results, the appearance quality of the fruit decreased during the storage period and the highest score was given to the pomegranates coated with 1.25% and the lowest score to the control samples. The reason for the higher appearance quality in pomegranates with 1.25% crown cover compared to the control samples can be due to the reduction of decay (Fig. 4).

These results in terms of the higher appearance quality of the coated fruits compared to the control pomegranates were consistent with the results of Mokhtarizadeh Naeini et al. (2020).

Esmaili et al. (2022) reported that the use of astragalus and *Eremurus* edible coatings in four concentrations of 0, 7.5, 10 and 12.5 g L^{-1} improved the appearance quality of the cherry fruit of the cv. 'Takdane Mashhad' compared to the control. According to Abolfathi et al.'s research (2014), the best appearance quality of 'Malase Saveh' pomegranate fruit after 4 months of cold storage was observed in the treatment of bitter almond oil as fruit coating. Khanian and Ghanbarian (2015) reported that the application of 1% chitosan coating at a temperature of 4 °C for 105 days of storage preserved the appearance quality of pomegranate fruit compared to the control samples.

Panel Test

From the perspective of consumers, several factors are considered important in determining fruit quality. These factors include fruit appearance (size, shape, and color), texture, taste, and nutritional value (Mokhtarizadeh Naeini et al., 2020). Therefore, in the evaluation of fruit marketability, various aspects such as peel and aril color, aroma, taste, texture, fruit juiciness, appearance quality and customer satisfaction were investigated.

Based on the sensory evaluation results, pomegranates coated with a 0.75% *Eremurus* received the highest score in terms of consumer satisfaction regarding skin color, aroma, taste and fruit texture. Additionally, pomegranates treated with a 0.5% guar received the highest score in terms of aril color, appearance quality and consumer decision to buy. Pomegranates treated with a 1% guar received high marks for taste, texture, juiciness and overall evaluation.

Table 13. Effect of edible coatings on peel color, aril color, taste, flavor and texture of pomegranate

Treatment	Texture	flavor	Taste	Aryl color	skin color
0.5% guar	4.22^{a}	4^{abc}	4.55^{a}	4.55^{a}	4^{ab}
1% guar	4.55^{a}	4.44^{a}	4.11^{abc}	4^{ab}	3^{bcd}
2% guar	3.78^{ab}	2.67^{cd}	3.67^{abc}	4.11^{ab}	3.22^{bcd}
0.75% eremurus	4.55^{a}	4.22^{a}	4.55^{a}	4.11^{ab}	4.55^{a}
1% eremurus	4.33^{a}	4.11^{ab}	4.11^{abc}	4.11^{ab}	4.44^{a}
1.25% eremurus	4.44^{a}	3.33^{abcd}	4.44^{ab}	4.33^{a}	3.67^{abc}
0.5% guar + 0.75% eremurus	2.67^{c}	3.22^{abcd}	3.44^{bc}	3^{b}	3.33^{bcd}
1% guar + 1% eremurus	2.67^{c}	2.55^{d}	3.11^{c}	2.89^{b}	2.67^{cd}
2% guar + 1.25% eremurus	$3b^{c}$	3.33^{abcd}	4^{abc}	3.67^{ab}	2.33^{d}
Treatment	3.11^{bc}	2.78^{bcd}	4^{abc}	4.11^{ab}	3.78^{ab}

Note: Means followed by different letters in each column indicate significant differences at $P < 0.05$ (Duncan's multiple range test)

Overall, the different concentrations of the treatment had a significant impact on the taste, texture, appearance quality and general evaluation of pomegranate fruit compared to the control samples (Table 13).

In a study by Mokhtarizadeh Naeini et al. (2020), it was reported that the treatment of 5.7 g L^{-1} of Katira had a significant effect on aril color, smell, taste, texture, purchase decision and overall evaluation of 'Malase Yazdi' pomegranate fruit. This treatment received the highest scores from consumers compared to other treatments.

Conclusion

Based on the findings of the investigation, the utilization of guar and *Eremurus* edible coatings resulted in a reduction in fruit weight loss. Specifically, the control pomegranates displayed the highest weight loss, while the least amount of weight loss was observed in the fruits coated with different concentrations of guar and *Eremurus* (2% guar + 1.25 % *Eremurus*). Furthermore, the fruits coated with varying amounts of guar exhibited higher antioxidant capacity and taste index in comparison to the control. Notably, the pomegranates coated with 1% guar demonstrated the highest amount of vitamin C and phenol, whereas the control samples showed the lowest amount. Fruits treated with different concentrations of *Eremurus* displayed a greater amount of titratable acidity than untreated pomegranates. In general, it is apparent that various edible coatings yield different effects on the quantitative and qualitative traits of the fruit. Additionally, different concentrations of these coatings can enhance certain qualities in the fruit's postharvest state.

CRediT Authorship Contribution Statement

Maryam Majidi: Implementation, Conduction, and Data collection. **Azam Jafari:** Study planning, Manuscript writing, English translation, Original draft preparation. **Jalal Gholamnezhad:** Data analysis. **Mohammad Reza Vazifeshenas:** Manuscript editing.

Declaration of Competing Interest

The authors declare no known competing financial interests or personal relationships to influence the work reported in this manuscript.

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