

Effect of gum arabic of tunisian origin coating on physicochemical characteristics and preservation performance of arbutus

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Abstract

Arbutus is an important climacteric fruit that exhibits short shelf life at ambient conditions. Due to short shelf life, marketing and subsequent storage of arbutus is difficult. Therefore, some treatments that can extend shelf life and conserve quality of arbutus fruits are required. In the present work, edible coatings of gum Arabic of Tunisian origin (GA) (5%) were assessed as potential postharvest treatments to protect the quality of fresh arbutus when stored at 5°C for up to 20 days. Then, physicochemical qualities of arbutus were evaluated. The results indicated that the weight loss, acidity, infection percentage, and ascorbic acid of coated arbutus fruits were significantly reduced as compared to control ($p < 0.05$). Besides, Total soluble solid (TSS) of all samples increased significantly with storage time ($p < 0.05$). Therefore, we can suggest the use of Tunisian gum Arabic as a novel edible coating extends the shelf-life of Arbutus fruits on postharvest.

Keywords: Tunisian acacia gum, coating; arbutus, storage period, quality attributes

Introduction

Arbutus unedo L. (the strawberry tree) is a common Mediterranean plant (Messaadia *et al.*, 2020).^[12] It belongs to the Ericaceae family and the Ericales order (Kachkoul *et al.*, 2019).^[7] In Tunisia, it grows in mountains in North West, Tunisian Dorsal Mountain, and the Cap Bon area (Masmoudi *et al.*, 2020).^[11] Arbutus contains many bioactive compounds such as flavonoids, polyphenols, and sterols as well as dietary fiber (Masmoudi *et al.*, 2020).^[11] So far, fresh strawberry tree fruits have almost been absent in the market due to their short consumption period, fragility, and short shelf life (Fazenda *et al.*, 2019).^[5] Producers store fruits in traditional packs like paper and/or plastic materials (El-Gioushy *et al.*, 2022).^[4] To prolong the storage life of arbutus and prevent its early deterioration, fruits are generally harvested at less maturation level and stored to reduce postharvest losses (Botelho *et al.*, 2015).^[3] The indicators of Postharvest losses are the loss of weight, total soluble solids, and the reduction in aromatic compounds (Zhu *et al.*, 2019).^[20]

To preserve the quality of fruits suitable postharvest technology is used like cold storage and edible coating by creating a semi-permeable barrier to gases, water vapor, volatile compounds, and exterior microorganisms (Jiang *et al.*, 2019).^[6] Mohamed *et al.*, (2020)^[13] reported that eco-friendly materials such as polysaccharides like gum arabic, starch, chitosan, cellulose, and other plant-derived are explored in forming edible films. In fact, gum Arabic (GA) is the most used polysaccharide for fruit edible coatings (Anjum *et al.*, 2020).^[2]

The purpose of this study was to apply gum Arabic of Tunisian origin in the storage of postharvest arbutus and evaluate its physicochemical qualities after twenty days of storage.

Materials and methods

1. Plant exudate collection

The samples of Acacia gum were collected from the region

of Sidi Bouzid located in the center of Tunisia and more precisely in the Bouhedma National Park. Raw gum was dried, purified, and crushed to obtain a fine powder, and stored in a sealed container at ambient temperature until further use.

2. Preparation of coating solution and coating

For the preparation of film, 5g of gum arabic powder was dissolved in 100 mL of distilled water. The solution was stirred at 40°C for 30 min then vacuum filtered to remove impurities. After cooling to 20°C, Glycerol Monostearate was added as a plasticizer to improve the strength and flexibility of the coating solutions. The pH of the solutions was maintained at 5.6 using 1N NaOH.

Selected arbutus of the same color and at the same stage of maturity showing no physical lesions or fungal infections were used during this study. Before applying the treatment, the fruits were immersed in a solution of sodium hypochlorite (0.05% (w/w)) for 3 min and dried at room temperature (20°C). Seventy arbutus were soaked in the coating solution (5%) for 2-3 min and the solution was applied evenly over the entire surface. The control fruits were immersed in distilled water.

Then, the fruits were dried at room temperature for 1 hour and then they were packed in cardboard boxes (5 to 8 fruits per box), and stored at a temperature of 5°C for 20 days. Data were recorded before treatment (day 0) and every 2 days during storage.

3. Physico-chemical characterization during storage

3.1 Infected percentage

The presence of mold was examined visually. A fruit is considered infected when a visible lesion is observed. The results were expressed as the percentage of infected fruits. The percentage of infection of coated and uncoated fruits was calculated as the number of infected fruits, divided by the initial number of all arbutus samples, multiplied by 100 according to Ali, (2009).^[1]

3.2 Weight loss

The variation in weight of arbutus during the storage period was measured daily. The measurements were carried out on 5 fruits from each batch. Weight loss was calculated as the percentage loss from baseline weight.

3.3 Titratable acidity

Titrate acidity was determined according to the AOAC (1995) method, using 10 g aliquots of fruit puree in 90 mL of distilled water, and the titration was carried out with a 0.1 N NaOH solution to a pH equal to 8.1. Titratable acidity was expressed as grams of citric acid per 100 of fruit.

3.4 Total soluble solids (TSS)

Total soluble solids (TSS) content was determined by refractometry. A hand refractometer was used and the reading was direct in percentage of sucrose.

3.5 Ascorbic acid content

The vitamin C content was determined according to the method of AOAC (1995), using 5 g aliquots of fruit pure in 20 mL of iodine, and the titration was carried out with a solution of sodium thiosulfate $\text{Na}_2\text{S}_2\text{O}_3$.

4. Statistical analyses

Statistical analyses were performed using SPSS version 18 software. The One-Way ANOVA test was used for the analysis of variances and the Tukey' HSD test to compare the fruit analysis results over time. In addition, the comparison between the coated and uncoated fruits was carried out using a student test. Some statistical analysis tables are presented in the appendix.

Results and discussion

1 Use of gum Arabic for coating arbutus

1.1 Infection percentage of fruit

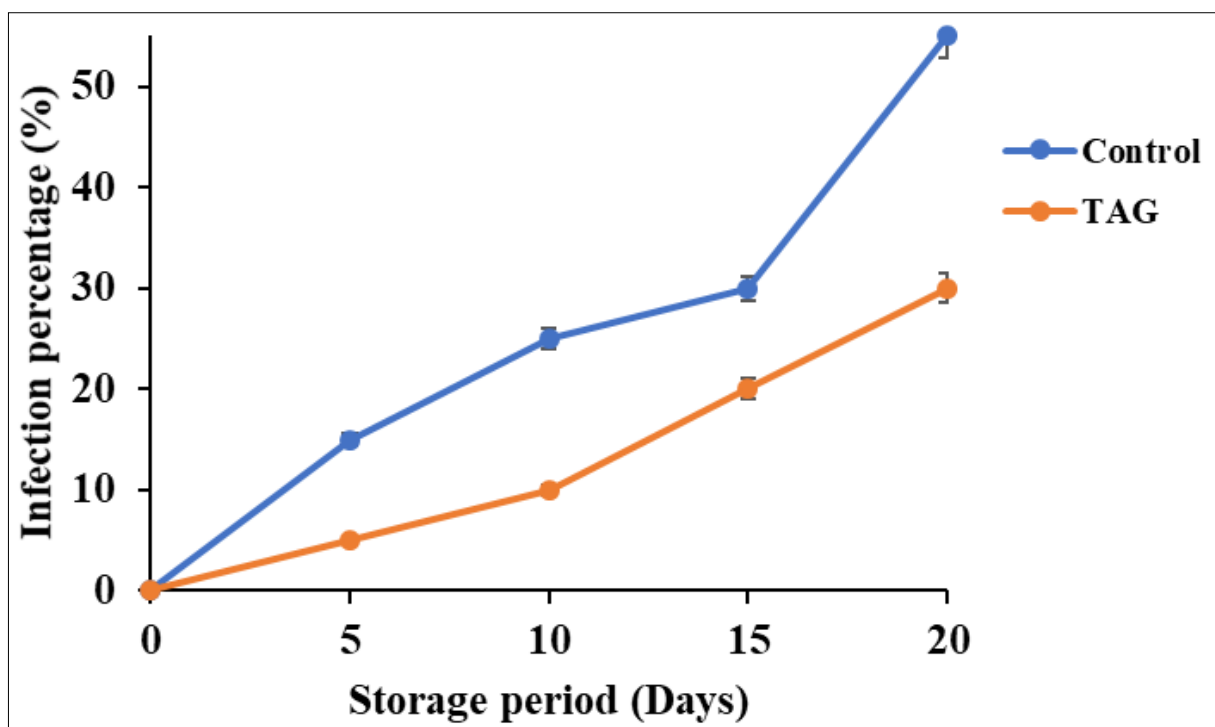


Fig 1: Percentage of infection of coated and uncoated fruits over time

The variation in the percentage of infected fruits over time is shown in Figure 1. The percentage of infection increased significantly ($p < 0.05$) up to 30% for treated arbutus and up to 55% for untreated arbutus. In addition, the statistical analysis showed that there is a significant difference ($p < 0.05$) in the percentage of infection between coated and uncoated arbutus, and this difference appears from the 2nd day of storage. On the other hand, arbutus coated with a solution of gum arabic (5%) did not show fungal degradation during the first 2 days of storage. For the uncoated arbutus, the percentage of infection increased more and more from the first day to reach 20 days a value of 50% which is a higher value than that of the coated fruits (almost 30% of infection during 20 days of storage). This is explained by the fact that arbutus are fruits that have a very short post-harvest life, and the loss of quality of these fruits is mainly due to their relatively high metabolic activities and

their susceptibility to fungal attack. El-Gioushy *et al.* (2022) [4] realized that the application of gum Arabic (10%) and moringa extract (10%) enhanced the shelf-life period of guava fruit. In reality, edible coatings have barrier features that decrease a fruit's surface permeability to oxygen and carbon dioxide, resulting in a change in internal gas composition that reduces oxidative metabolism and increases the fruit's shelf life.

1.2 Weight loss

The weight loss percentages of coated and uncoated arbutus are shown in Figure 2.

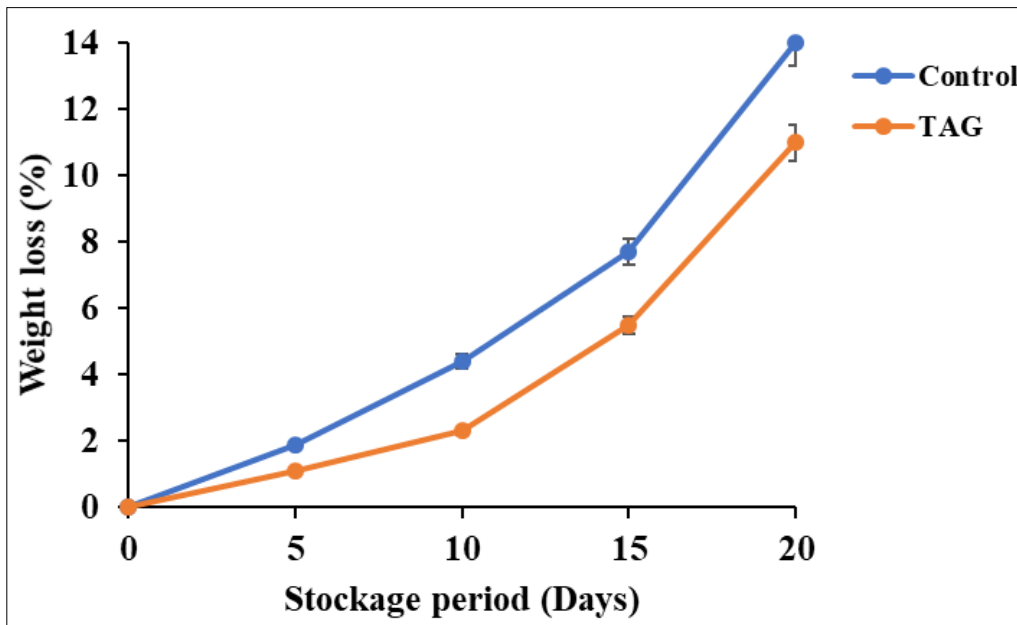


Fig 2: Variation in weightloss of coated and uncoated fruits over time

The weightloss of arbutus increased significantly over time. However, the weight loss was greater in the uncoated fruits. Indeed, the statistical analysis showed that there is a significant difference ($p < 0.05$) in the percentage of weight loss between the coated and uncoated arbutus, and this difference appears from the 2nd day of storage.

Coating with gum Arabic (5%) reduced the weight loss of arbutus compared to control fruits. The weight loss percentage of uncoated fruits increases with storage time and reaches a value of 14% after 20 days at a temperature of 5°C. While this percentage was lower (almost 10%) for coated fruits. This is because gum Arabic acts as a barrier against water loss. The water vapor transmission is correlated with weight loss. In addition, the lower oxygen transmission coefficient and higher carbon dioxide transmission coefficient during coating create a better microenvironment with high carbon dioxide and low oxygen to reduce fruit respiration rate and further delay

senescence. Fruit weight loss is affected by many conditions outside the preservation film on the fruit surface (temperature, relative humidity, etc) and film properties (pore size and homogeneity of the film) (Zhu *et al.*, 2019).^[20] The weight loss ratio of cherry tomatoes packaged by bilayer films based on pea starch/poly lactic acid gradually increased with lengthening storage time (Zhou *et al.*, 2019).^[19] After storage for 9 days, the weight loss rate of strawberries was 36.17%, significantly higher than that of the treatment groups. The fruits coated with 4% cellulose nanocrystals-based film has the lowest weight loss percentage, which is 13.97% (Kang *et al.*, 2021a).^[8] Kang *et al.*, (2021b)^[9] demonstrated that the weight loss rate of raspberries in the control group was more than twice that of the film-treated groups after 4 days of storage.

1.3 Variation in titratable acidity of fruits

Variations in acidity values of arbutus are shown in Figures 3.

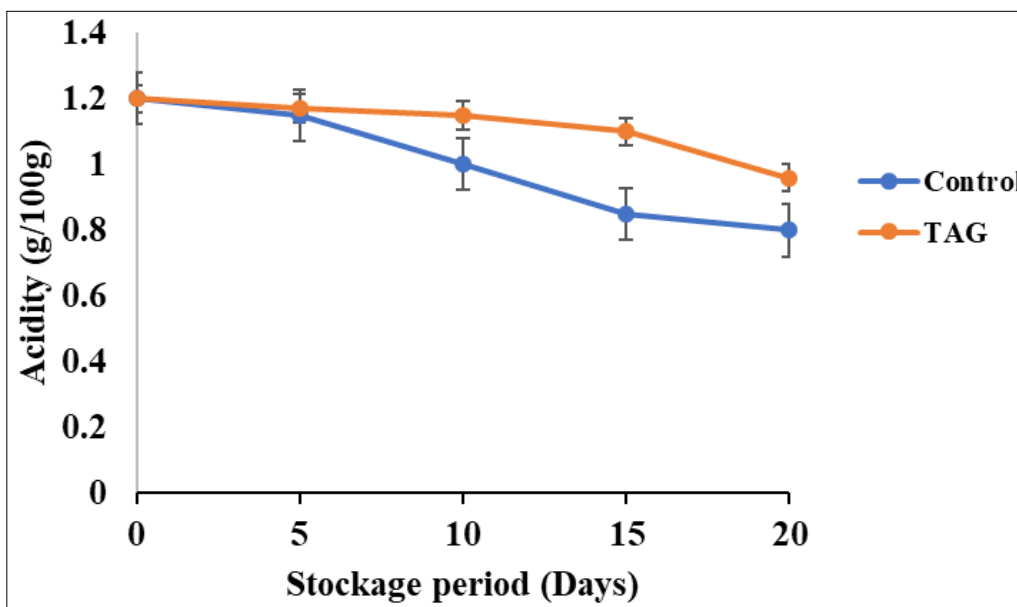


Fig 3: Variation in acidity of coated and uncoated fruits over time

The titratable acidity is an important index for fruits which is essential to the mouthfeel. The statistical study revealed that there is an effect of time on the evolution of acidity in the case of coated and uncoated arbutus. The acidity decreased significantly ($p < 0.05$) from the 15th day for coated arbutus and from the 5th day for uncoated arbutus. Acidity decreases from 1.2g/100g to 0.8g/100g for untreated groups and reaches 0.96g/100g for treated groups. The reason for the reduction in acidity was that the composite films had a suitable permeability to reduce the O_2 rate in the microenvironment of films which retard the respiratory

speed of the fruits during storage, minimizing the consumption of organic acids such as citric and malic acid (Yan *et al.*, 2020).^[17] Besides, the decrease in acidity over time seems more pronounced in uncoated bananas compared with the group treated with the chitosan/gum Arabic/ZnO coating (La *et al.*, 2021).^[10]

1.4. Total soluble solids (TSS)

The variation in total soluble solids (TSS) during the storage period is shown in Figure 4.

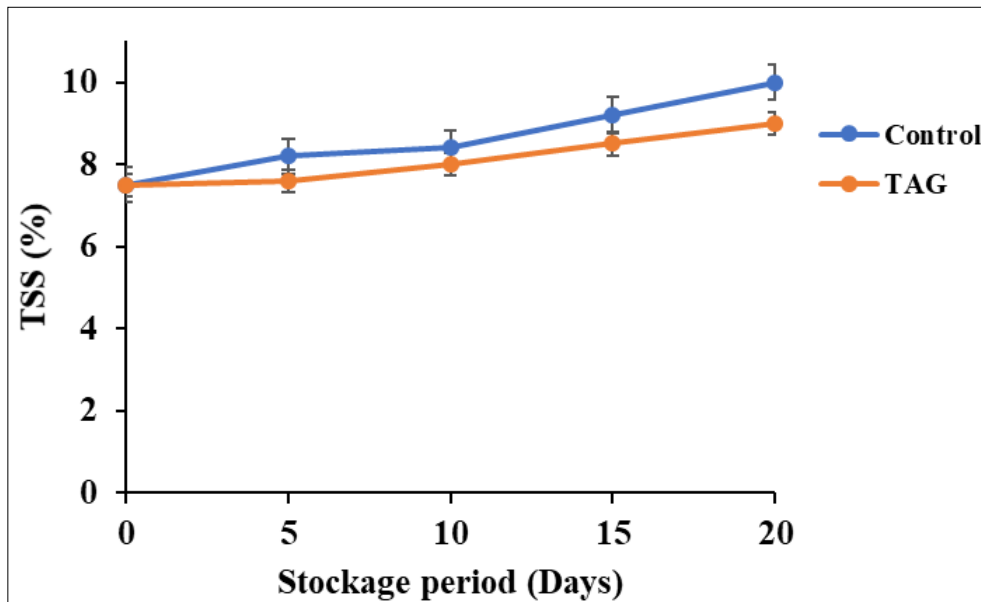


Fig 4: Variation in total soluble solids of coated and uncoated fruits over time

Total soluble solids (TSS) reflect the flavor quality and ripeness of fruits. TSS increases gradually in both coated and uncoated arbutus during the storage period. It was higher in the control fruits than in the coated group. A possible explanation for this situation is that the weight loss for the control fruits has the highest value. The more water lost, the more raise of solid concentration in fruits and the more increment of TSS rate (Xin *et al.*, 2017).^[16] This content increases from 7.5 to 10% at the end of the storage period for uncoated arbutus. In contrast, TSS reaches 9% for coated

arbutus. This is due to that films have good barrier properties which inhibit the respiration of fruits, reducing the consumption of nutrients (sugars and others) (Nguyen *et al.*, 2020).^[10] These results are in agreement with those found by (Kang *et al.*, 2021b; Kang *et al.*, 2021a).^[9, 8]

1.5 Teneur en acide ascorbique

The variation in ascorbic acid content over time is shown in Figure 5.

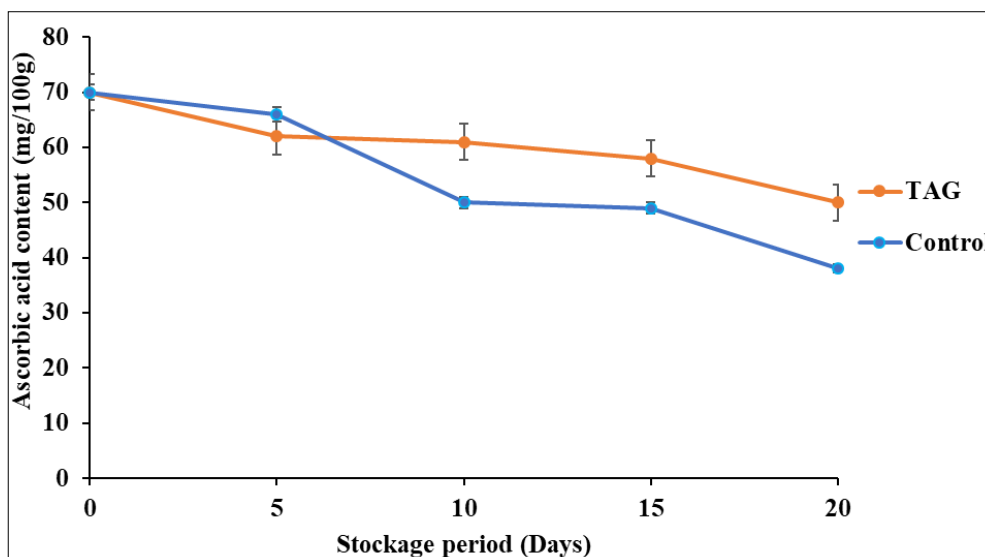


Fig 5: Variation in ascorbic acid content of coated and uncoated fruits over time

Vitamin C content decreased significantly ($p < 0.05$) from the 5th day for the untreated arbutus and from the 7th day for the coated fruit. For the uncoated arbutus, ascorbic acid decreased from 68 to 38 mg/100 g at the end of the storage period. But, for coated arbutus, the ascorbic acid content was 50 mg/100 g on the 19th day. This result maybe due to advanced fruit maturity, senescence, and oxidative breakdown (Anjum *et al.*, 2020).^[2] These results colluded with those reported by Suresh *et al.*, (2022)^[15] and Zhou *et al.*, (2021).^[18]

Conclusion

The work provided a reference for people to investigate the application of gum Arabic-based polysaccharide material in food preservation. The ability of gum Arabic to form a semi-permeable film on the surface of the strawberries proportionally delays the change in the initial characteristics of the fruits such as the reduction in the content of ascorbic acid and the content of soluble dry residues. Moreover, this film maintains the color of strawberries during the storage period.

Abbreviations

GA: Gum Arabic.

TAG: Tunisian Acacia Gum.

TSS: Total soluble solids.

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Compliance with ethical standards

Conflict of interest: No potential conflict of interest was reported by the authors.

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