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Effect of Aloe Vera Gel and Active Modified Atmosphere Packaging (A-MAP) on the Quality of Pomegranate Arils Ready-To-Eat

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Abstract : In this study, the effect of an edible coating based on natural Aloe vera (AV) gel (0, 50, and 75% v/v) and modified atmosphere packaging (MAP-1: 5 KPa O_2, 15 KPa CO_2, 80KPa N_2; MAP-2: 80KPa O_2, 5KPa CO_2, and 15 KPa N_2) and packaging with air condition (21 KPa O_2 and 0.03 KPa CO_2) investigated on postharvest quality of ready-to-eat pomegranate arils at 0, 6, 12, and 18 days of storage at 5℃. These results demonstrate that AV gel in combination with A-MAP is proved to be the most effective treatment to maintain the quality of pomegranate arils for 18 days of storage.

Keywords: Aloe vera gel, Edible coating, MAP, Pomegranate arils,Postharvest quality, Ready to eat.

Introduction

Pomegranate fruit is one of the most popular fruits around the world; which is probably native to Iran or northern Turkey. Iran is known as the land of pomegranate fruit, which is mainly consumed fresh or as juice(1,2).

Minimum-processed pomegranate arils are a rich source of bioactive and phytochemical compounds and provide health for the consumers. However, maintaining thepostharvest quality of pomegranate aril is a major challenge(3). Thus, the research on the design and implementation of methods to maintain the quality of freshly processed fruits has greatly increased(2).

Recently, the use of high oxygen atmosphere has been shown as an appropriate alternative to thelow O_2 atmosphere, for inhibition of microbial growth and enzymatic degradation and maintaining overall quality(3).

However, the modified atmosphere and low-temperature maintenance alone are not enough to increase the useful life of fresh-cut products, because of high physical damage and increased microbial sensitivity; since it reduces the shelf life of freshly cut products due to cutting operations(4).

To the best of our knowledge, there is no report demonstrating the extension of the shelf life of ready-to-eat pomegranate arils using a combination of both technologies including barrier edible coatings and modified activated atmosphere packaging. Therefore, the development of more efficient processing and packaging technologies for fresh-cut pomegranate is required to ensure quality and value after longer storage times. The objective of the present study is to evaluate combinations of edible coatings (AV) and modified atmosphere treatments to maintainthe shelf life of ready to eat pomegranate arils beyond day18 at 5℃.

Material preparation

Preparation of ready-to-eat pomegranate

Pomegranate fruit (*P. granatum L., cv. Bejestoni*) was supplied from a plot located in Bajestanand immediately transported to the laboratory. Pomegranates arilswere separated manually and using a sharp knife and then mixed together to ensure uniformity (5).

Freshly AV gel was prepared according to Navarro et al. (6). The gel diluted with distilled water (50:50 or 25:75 v/v) was used for the AV 50 and 75% treatments, respectively. Pomegranate arils were dipped for 5 minutes in a solution of AV 50 and 75 % or water (control) and then were removed by filtration.

After coating treatments, arils (130 g) were placed directly in an80 µm-thickthree-layer plastic bag (PE/PA/PE). Gas mixtures including MAP-1: (5 KPa O_2+15 KPa CO_2+80KPa N_2), MAP-2: (80KPa O_2+5KPa CO_2+15 KPa N_2), and air (21 KPa O_2, 0.03 KPa CO_2) were used to treat the samples.

All treatments were stored at 5℃ and RH= 90 for 18 days and analyses were carried out on days 0, 6, 9, 12, and 18 in triplicate.

Gas composition

The gas composition was measured inside each packaging by measuring the CO_2 and O_2 concentrations. The composition of the gas inside the packageswas determined using a gas analyzer (Gases Analysers, Model Oxybaby, WITT Company Germany) before opening the packages on the sampling days.

pH, Total soluble solids, and titratable acidity

Pomegranate arils in each package were juiced separately using a manual juicer. Then, the juice was directly used for pH and total soluble solid (TSS) and titratable acidity(TA) measurements using a pH meter (Metrohm 691) and digital refractometer expressed as Brix (PR-101, Otago, Tokyo, Japan), respectively. Titratable acidity (TA) was measured by titration to an endpoint of pH 8.2 using a Metrohm 691 compact titrosampler.

Total anthocyanin content

The content of total anthocyanin was assessed according to the method of Caleb et al. (7) by the pH-differential method. Total anthocyanin was calculated as cyanidin-3-glucoside according to the following equation:

$$\text{Total anthocyanin}\left(\text{mgL}^{-1}\right)=\left[\left(A\times MW\times DF\times 1000\right)\div\varepsilon\times L\right] \quad (1)$$

$$A=\left(A_{520}-A_{700}\right)pH_{1.0}-\left(A_{520}-A_{700}\right)pH_{4.5} \quad (2)$$

MW: molecular weight of cyanidin-3-glucoside (449.2 g mol^{-1}), DF: dilution factor, ε: molar extinction coefficient (26900), and L: path length in cm.

Antioxidant activity

The Antioxidant activitywas assessed according to the method ofAyhanandEştürk(5). Total antioxidant activity was calculated according to the following equation:

$$\text{Total antioxidant activity}\left(\%\right)=\left[\left(A_{sample(517nm)}/A_{control(517nm)}\right)\times 100\right] \quad (3)$$

Firmness

The tissue firmness of pomegranate arils was measured using a texture analyzer(TA-Plus) according to the method of Calbe et al. (7). A cylindrical probe with a diameter of 35mm was used. A test speed of 1.0 mm s^{-1} and distance of 9.5 mm were used and results were expressed as N. A total of 10 arils were measured per treatment.

Statistical Analysis

Experiments were performed according to a factorial analysis of variance (ANOVA) with SPSS software package v. 16.0 for windows. Draw charts with Excel software and Mean comparison was performed using Tukey's test at a 95% confidence level ($P \leq 0.05\%$).

Results and discussion

Gas composition

Inside the package headspace, the concentrations of CO_2 increased and O_2 decreased significantly over time(Fig. 1A-1B)($P<0.05$).Highest CO_2 concentration was found for arils treated with water (control) in thehigh O_2 atmosphere and the lowest for those treated with AV 75% v/v in thelow O_2 atmosphere.However, the gas composition of O_2 observed in this study (20–36 kPa) in thehigh O_2 modified atmosphere was above the council level of 2–5 kPa O_2(8).

Fig. 1. Gas composition at (a) low MAP and (b) high MAP of ready-to-eat pomegranate arils stored at 5 °C (MAP-1: 15 kPa CO_2+ 5 kPa O_2; MAP-2: 5 CO_2+80 kPa O_2) during storage. Dot, Dashed and solid lines represent the AV coated with 50 and 75% v/v and the uncoated (water-dipped) samples, respectively.

Total soluble solids content, titratable acidity, and pH

For all treatments, the TSS decreaseswith the storage time($P<0.05$). Results showed that there was no significant effect of modified atmosphere packaging and AV coating on TSS until the storage time of 18th d ($P>0.05$) (Fig. 2A). Storage time had asignificant effect on TA at all treatments ($P<0.05$) and significantly decreased in all treatments until day 18 of storage (Fig. 2B). This decrease might be attributed to the use of organic acids due to metabolic activities during pomegranate storage(5). Although there was nosignificant effect of MAP application and AV coating on the pH, it significantly increased during storage time (Fig. 2C).

Fig. 2. (A) Total acidity (%), (B) pH and (C) Total solid solution of ready-to-eat pomegranate arils stored in different modified atmospheres packaging at 5 ◦C. (MAP-1: 15 kPa CO2+ 5 kPa O2; MAP-2: 5 CO2+80 kPa O2; Control: atmospheric conditions) during storage. Dashed, dot and solid lines represent the AV coated with 50 and 75% v/v and the uncoated (water-dipped) samples, respectively.

Total antioxidant capacity

Total antioxidant capacity increased until 6 days and then decreased under air condition packed and low-oxygen atmospheres (MAP-1) at all concentrations of AV coatings and uncoated samples (Fig. 3)($P<0.05$); On the other hand, the total antioxidant capacity of pomegranate arils packed in high-oxygen atmospheres (MAP-2) increased until 12 days and then decreased; however, total antioxidant capacity of pomegranate arils packed in high-oxygen atmospheres combined with 75% v/v AV gel was significantly higher than other packaging and concentration of coatings. Furthermore, antioxidant activity increased compared to its initial level at the end of the storage period (18 day).

Fig. 3. Total antioxidant content of ready-to-eat pomegranate arils stored in different packaging at 5 °C. (MAP-1: 15 kPa CO_2+ 5 kPa O_2; MAP-2: 5 CO_2+80 kPa O_2; Control: atmospheric conditions) during storage.

Total anthocyanin content

Total anthocyanin content fluctuated with storage in various treatments; however, at the end of storage time, all treatments were significantly reduced($P<0.05$).Pomegranate arils treated with AV gel (75% v/v) combine with low O_2 concentration (MAP-1) had the greatest total anthocyanins content than of other treatments and untreated sample.While,the lowest anthocyanin values were observed in sample at high O_2 concentration (MAP-2) and also 0% AV after 18 days of storage (Fig. 4). The anthocyanin increased during cold storage may be due to the continued biosynthesis of these compounds after harvest(10).

Fig. 4. Total anthocyanin content of ready-to-eat pomegranate arils stored in different packaging at 5 °C. (MAP-1: 15 kPa CO_2+ 5 kPa O_2; MAP-2: 5 CO_2+80 kPa O_2; Control: atmospheric conditions) during storage.

Firmness

Regardless of treatment, the firmness values of the pomegranate arils decrease during storage time($P<0.05$). Arils stored under high-oxygen concentration (MAP-2) combined with the AV gel coating (50 and 75% v/v) showed the highest firmness compared to those treated with low oxygen concentration (MAP-1), air treatment, and the uncoated AV (control) in all treatments (Fig. 5). However, no significant differences were observed among AV treatments. Therefore, the greatest reduction in firmness was observed in the control arils, while a significant delay in aril softening was seen in samples treated with AV alone (50 or 75% v/v) or in combination with MAP.

Fig. 5. Firmness (N) of ready-to-eat pomegranate arils stored in different packaging at 5 °C. (MAP-1: 15 kPa CO_2+ 5 kPa O_2; MAP-2: 5 CO_2+80 kPa O_2; Control: atmospheric conditions) during storage.

Conclusion

The AV coatings combined with active MAP allowed a good preservation of the TSS, titratable acidity, firmness, and total antioxidant activity. Nevertheless, total anthocyanin content was higher in the AV+high O_2 modified atmosphere. Thus, further studies have to be done on the effects of high-oxygen atomic in combination with AV coatings.

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