Correct packaging retained phytochemical, antioxidant properties and increases shelf life of minimally processed pomegranate (Punica granatum L.) arils Cv. Mridula

K Bhatia 1, R Asrey 1* and E Varghese 2

1 Division of Post Harvest Technology, New Delhi-110 012, India
2 Indian Agricultural Statistics Research Institute, New Delhi-110 012, India

Received 9 September 2013; revised 26 November 2014; accepted 28 December 2014

This study investigated the effect of packaging materials (Poly propylene, low density poly ethylene and KPA bags) with different water and gas transmission rate on minimally processed ‘Mridula’ pomegranate arils stored at 5 ± 2 ºC and 85 ± 5 % RH for 15 days. During course of storage, phytochemical and antioxidant properties of minimally processed arils were determined at 3 days interval. The results indicated that packaging material influenced ascorbic acid, phenols, anthocyanins, antioxidant and sensory score of minimally processed arils. Arils packed in PP bags retained better total phenols, anthocyanins and antioxidant compared to LDPE and KPA packed arils. PP packed arils maintained higher acceptance score over the recommended commercial acceptance level (above 6.0) up to the 15 days of storage.

Keywords: Punica granatum L., Minimal processing, Packaging, Phytochemical, Shelf-life

Introduction

Recently, the demand for the fresh and minimally processed pomegranate products has greatly increased (18th most popular fruit world over) due to consumer health awareness and its nutritional properties. Pomegranate aril juice is rich in pigments (anthocyanins) and minerals (Ca, Fe, S and Mg) which are known for their chemopreventive properties anti-oxidation, anti-mutagenic activity, anti-hypertension and reduction of hepatic injuries. With increasing demand for fresh and natural products without addition of harmful chemicals, packaging film seems to be an ideal tool for preservation of minimally processed fruits, being cheap and easy to apply. Varietal response to various packaging material has also shown varied results in retention of fruit functional quality and shelf-life during storage. The pomegranate arils of ‘Mollar’ variety washed with chlorinated water and antioxidant solution, packed in polyethylene film and stored at 1ºC, maintained good quality and appearance for 7 days. Likewise, previous researcher have reached similar conclusion when studying minimal processing of pomegranate arils. These findings hinted that there is a need of variety specific studies in relation to packaging material, storage temperature, functional properties and shelf life.

Materials and methods

Plant material and experimental design

Physiologically mature (total soluble solids ranging from 11 to 12 Brix) pomegranate fruits of Mridula cultivars were harvested from experimental orchard of Mahatma Phule Agricultural University, Rahuri, Maharashtra and immediately transported to the postharvest handling laboratory and kept at 5 ± 2 ºC and 85 ± 5 % relative humidity (RH) until the next day. Pomegranates with defects were discarded and healthy ones uniform in size and appearance were selected for minimal processing. Thereafter 100 g of minimally processed arils were packed in three different packaging films made up of polypropylene (PP), low density poly ethylene (LDPE) and KPA (Nylon based laminate pouches, Cryovac India). The thickness, water vapour transmission rate (WVTR) and oxygen transmission rate (OTR) of three packaging material used in present study are presented in Table 1. Packaged samples were stored at 5 ± 2 ºC and 85 ± 5 % RH for 15 days and data were recorded on 0, 3, 6, 9, 12 and 15 days of storage.
Ascorbic acid was quantitatively determined by 2,6 dichlorophenolindophenol-dye method. Results were expressed as mg 100 g⁻¹ on aril weight basis.

Total phenols
The phenolics content was determined by the Folic-Ciocalteu method using gallic acid as standard. Total phenols was expressed in microgram of gallic acid equivalent per gram of aril weight (µg gallic acid equiv. g⁻¹).

Total anthocyanins
Total anthocyanins content was determined by the pH-differential method. The pigment content was expressed as milligrams equivalent cyanidin-3-glucoside 100 g⁻¹ aril fresh weight.

Antioxidant activity
Antioxidant activity was measured by cupric reducing antioxidant capacity (CUPRAC) method and results were expressed as µmol equivalent trolox g⁻¹.

Sensory evaluation
Sensory evaluation of minimally processed pomegranate arils obtained from ‘Mridula’ cultivars packed in three different packaging material was performed during storage using 9-point hedonic scale with 1, dislike extremely; 2, dislike very much; 3, dislike moderately; 4, dislike slightly; 5, neither like nor dislike; 6, like slightly; 7, like moderately; 8, like very much and 9, like extremely. Scores of above 6 were considered as acceptable for commercial purposes. The evaluated parameters were colour, taste, texture, juiciness and overall acceptability.

Statistical analyses
Data for the analytical determination were pooled and subjected to two-way analysis of variance (ANOVA) by taking packaging material and storage days as the two sources of variations. Further, it was subjected to multiple range comparison procedure to identify the pair-wise significant difference between the effects. Results were given as mean ± standard deviation of three independent determinations. Differences were considered to be significant at P ≤ 0.05 (95% confidence level). All analyses were performed with SAS software package, version 9.3 (SAS Institute, North Carolina, U.S.A.).

Results and Discussion

Ascorbic acid
Effect of packaging material on ascorbic acid content of minimally processed pomegranate arils during storage was found to be significant (Fig. 1). Irrespective of packaging material ascorbic acid content showed progressive declining pattern during entire storage. Declining trend of ascorbic acid was much pronounced in KPA packed arils. Packaging of arils in PP may cause the better control over pack in atmospheric conditions and resulted in the higher ascorbic acid. The declining trend of ascorbic acid attributed to water loss, cell wall damage, temperature, humidity, and packaging environment. Similar declining trend of ascorbic acid was also reported in minimally processed pomegranate arils during storage.

Table 1—Thickness, water vapour transmission rate (WVTR) and oxygen transmission rate (OTR) of selected films used for packaging of minimally processed pomegranate arils

<table>
<thead>
<tr>
<th>Packaging Material</th>
<th>Thickness (µm)</th>
<th>WVTR (cm³/m²/24h)</th>
<th>OTR (cm³/m²/24h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP</td>
<td>40</td>
<td>1.4</td>
<td>2701.73</td>
</tr>
<tr>
<td>LDPE</td>
<td>50</td>
<td>5.6</td>
<td>6313.761</td>
</tr>
<tr>
<td>KPA</td>
<td>90</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>

1PP: Polypropylene, LDPE: Low density polyethylene, KPA: Nylon based laminate pouches, Cryovac India

Fig. 1—Effect of packaging material on ascorbic acid (mg 100⁻¹ g) of minimally processed pomegranate arils during cold storage (5 ± 2 ℃ and 85 ± 5% RH)
Total phenols

The effect of packaging material, storage days and their interaction on total phenol content was found to be significant (P ≤ 0.05). Arils packed in PP showed highest phenolics content compared to LDPE and KPA during entire course of storage (Table 2). Irrespective of packaging material, progressive increase in total phenol content was observed till 12th day followed by onward declining pattern during storage. Stress response to wounding (production of stress alleviating phyto-chemicals) during minimal processing operations is well known phenomenon. Decrease in aril phenol content during later phase of storage (12th day onward) may be attributed to water loss, changes in acidity and TSS content. These changes could have affected total anthocyanins and antioxidant activity and finally resulted into varied phenols content during storage.

Total anthocyanins

Total anthocyanin content was found to be significantly (P ≤ 0.05) affected by packaging material, storage days and their interaction (Table 2). It was observed that there was gradual decrease in total anthocyanins with the advancement of storage period. Arils packed in PP bags showed highest average anthocyanin content (20.79 mg equiv. cyanidin-3-glucoside 100 g−1) followed by LDPE (19.73 mg equiv. cyanidin-3-glucoside 100 g−1) and KPA (18.66 mg equiv. cyanidin-3-glucoside 100 g−1). The relative amounts anthocyanin in coloured fruits and vegetables depend on the pH and anthocyanin structure. The declining trend of anthocyanin content was reported in minimally processed pomegranate arils during storage.

Antioxidant Activity

Effect of packaging material, storage days and their interaction on antioxidant activity of minimally processed pomegranate arils was found to be significant (P ≤ 0.05). Among the packaging materials, PP packed arils retained the highest antioxidant activity followed by LDPE and KPA (Fig. 2). Irrespective of packaging material, antioxidant activity of minimally processed pomegranate arils increased till 9th day followed by declining pattern during entire storage. Higher antioxidant content in PP packed arils could be due to higher retention of anthocyanin pigment and phenolics content. Antioxidant capacity in fresh cut grape increased up to seven days followed by declining pattern till end of storage period. Appreciation in antioxidant activity may be due to wound induced response during minimal processing operations. With prolonged aril storage, decrease in antioxidant capacity may attribute to the O2-promoted oxidation of the constitutive phenolic compounds.

Table 2—Effect of packaging material and storage on total phenols (µg gallic acid equiv. g−1) and total anthocyanins (mg equiv. cyanidin-3-glucoside 100 g−1) of minimally processed pomegranate arils during cold storage (5 ± 2 °C and 85 ± 5% RH)

<table>
<thead>
<tr>
<th>Storage days</th>
<th>Packaging Material</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenols</td>
<td>PP</td>
<td>LDPE</td>
</tr>
<tr>
<td>0</td>
<td>152.93 k</td>
<td>152.93 k</td>
</tr>
<tr>
<td>3</td>
<td>166.35 h</td>
<td>161.82 i</td>
</tr>
<tr>
<td>6</td>
<td>171.89 f</td>
<td>169.27 g</td>
</tr>
<tr>
<td>9</td>
<td>176.88 ef</td>
<td>173.58 ef</td>
</tr>
<tr>
<td>12</td>
<td>187.24 a</td>
<td>180.61 a</td>
</tr>
<tr>
<td>15</td>
<td>179.26 bc</td>
<td>172.51 ef</td>
</tr>
<tr>
<td>Mean</td>
<td>172.42 a</td>
<td>168.45 b</td>
</tr>
<tr>
<td>Total anthocyanins</td>
<td>PP</td>
<td>LDPE</td>
</tr>
<tr>
<td>0</td>
<td>23.07 a</td>
<td>23.07 a</td>
</tr>
<tr>
<td>3</td>
<td>22.59 ab</td>
<td>21.57 abc</td>
</tr>
<tr>
<td>6</td>
<td>21.54 abc</td>
<td>21.22 abcd</td>
</tr>
<tr>
<td>9</td>
<td>20.68 bcd</td>
<td>19.42 def</td>
</tr>
<tr>
<td>12</td>
<td>19.58 cde</td>
<td>17.39 fg</td>
</tr>
<tr>
<td>15</td>
<td>17.26 g</td>
<td>15.57 gh</td>
</tr>
<tr>
<td>Mean</td>
<td>20.79 a</td>
<td>19.73 b</td>
</tr>
</tbody>
</table>

1PP: Polypropylene, LDPE: Low density polyethylene, KPA: Nylon based laminate pouches, Cryovac India
Means with same superscript are homogeneous.
Sensory evaluation

Sensory score above 6 out of 9 is the limit of acceptance in terms of product attributes such as aril colour, texture, sweetness and juiciness. The sensory evaluation performed during storage showed that arils packed in PP bags scored highest point with respect to colour, crispness, sweetness, juiciness and overall acceptance as compared to LDPE and KPA packed arils (data not shown). The reasons for higher score of arils packed in PP bags attributed to lower water loss, better colour retention and organoleptic quality. The sensory score for crispness and overall acceptance for arils packed in KPA bags were lower than the commercial acceptance level score of above 6 on 12th day, limiting its acceptance to 9 days. Minimally processed arils packed in PP and LDPE scored above the limit set for commercial acceptance on 15th day of storage period. The shelf life of minimally processed pomegranate arils from late harvested and early harvested fruits as 10 days and 14 days respectively.

Conclusions

Packaging film had the most significant impact on the phytochemical retention antioxidant properties and shelf-life of pomegranate arils cultivar (cv. ‘Mridula’) and these properties were significantly higher with PP bags even up to 15 days. This finding highlights the significance of selecting of right kind of packaging films for minimally processed fresh produce handling with special reference to pomegranate cultivar ‘Mridula’.

References