The Effect of 1-MCP on Internal Browning Incidence of Asian Pear (Pyrus serotina Rehd.)

N. Yazdani¹,a, K. Arzani², Y. Mostofi³ and M. Shekarchi⁴
¹ Assistant Professor of Postharvest Physiology, Department of Horticulture. Abouraihan Compus, University of Tehran, Tehran, Iran
² Professor of Pomology, Department of Horticultural Science, Tarbiat Modares University, Tehran, Iran.
³ Associate Professor of Postharvest Physiology, Department of Horticultural Science. Faculty of Agriculture Science & Engineering, College of Agriculture & Natural Resources, University of Tehran, Karaj, Iran.
⁴ Department of Research and Development, Food and Drug Lab Research Center, Ministry of Health, Tehran, Iran

Keywords: Asian pear, 1-MCP, internal browning, antioxidant enzymes, storage disorder

Abstract
This study was conducted in order to determine the effect of 1-MCP treatment on ‘KS6’ Asian pear fruit in relation to internal browning development after long-term storage. Fruit were harvested on the commercial basis and the experiment was arranged base on completely randomized design (CRD) with factorial arrangement. Fruit were treated with 0 and 2 µL L⁻¹ 1-MCP. Treated fruit were stored in 0.5°C for 120 days. There was no significant difference between control and treated fruit for fruit ripening and quality parameters at harvest time. 1-MCP treatment delayed ripening and prolonged storage life as indicated by delayed loss of firmness, TA and delayed surface color changes. 1-MCP did not significantly affect SSC levels. Total phenolic compounds increased over time in fruit flesh but, were retarded or delayed in 1-MCP treated fruit. Ascorbic acid concentrations determined from fruit samples taken around fruit core area were diminished during storage time but, 1-MCP relatively turned down this decreasing rate. Higher catalase activity was observed in 1-MCP treated fruit versus control fruit. However, the effects of 1-MCP on superoxide dismutase activities in fruit flesh were not significant. Polyphenoloxidase activities and internal browning index increased simultaneously but, 1-MCP significantly retarded this increasing rate. Results indicated that internal browning index in ‘KS6’ in 1-MCP treated fruit was significantly less than control after 120-day cold storage, although this disorder was not completely controlled.

INTRODUCTION
In most cases, the end of storage life of the Asian pear is due to the onset of physiological disorders, especially internal browning. The occurrence of browning results from the enzymatic oxidation of phenolic compounds by polyphenoloxidase (PPO) to o-quinones. Moreover, peroxidases (POD) are able to oxidize phenols to o-quinones using H₂O₂ as co-substrate (Nicolas et al., 1994). In contrast L-ascorbic acid (l-AA) can also convert o-quinones back to diphenols (Franck et al., 2007). Moreover, phenolic compounds are the primary molecules responsible for the antioxidant capacity of fruits.

Since PPO located in cytoplasm and its phenolic substrates are located in plastids and vacuole, hence enzymatic browning is a direct consequence of membrane disintegration (Nicolas et al., 1994).

The objective of this study was to investigate the influence of 1-MCP treatment on individual phenolics and the antioxidant activity of Asian pear (Pyrus serotina Rehd.) during storage in at 0.5°C for 120 days.

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a n.yazdani@ut.ac.ir

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MATERIALS AND METHODS

Fruit were harvested at the commercial maturity stage on July 15, about 89 days after full bloom (DAFB). Fruit were divided into two groups, each with three replications. One group was packed in commercial boxes and kept at 1°C for up to 120 days storage (non-treated controls). The other group was treated with 2 µL L⁻¹ 1-MCP for 20 h at 25°C and then packed in the commercial boxes, and also kept at a cold temperature (1°C) for up to 120 days.

Flesh firmness was monitored with a penetrometer. Values are expressed as Newtons. Soluble solid content (SSC) was estimated on 10 fruit using a temperature-compensated refractometer. Titratable acidity (TA) was determined by titration. Fruit skin color was measured with a colorimeter and reported as hue angle (\( h° = \tan^{-1} \left( \frac{b^*}{a^*} \right) \)).

Extraction and measurement of total ascorbic acid AA concentrations was determined according to the dinitrophenylhydrazine (DNPH) method (Terada et al., 1978).

The amount of total phenolic compounds in pear flesh tissues were determined by the method of Folin-Ciocalteu reaction. CAT, SOD, PPO activities were measured according to Yazdani et al. (2011). Assessment of browning was conducted after each removal and expressed as an index. The browning index is the sum of the browning-score of the ten pears divided by 30, and multiplied by 100%, and 0, I, II, and III refer to the number of pears in the various browning classes (Veltman et al., 2000).

\[
\text{Browning index} = \left[ \frac{I + 2II + 3III}{3(0 + I + II + III)} \right] \times 100.
\]

RESULT AND DISCUSSION

1-MCP treatment delayed ripening and prolonged storage life as indicated by delayed loss of firmness, TA and delayed surface color changes. In contrast, 1-MCP did not significantly affect SSC levels (Table 1; Figs. 1 and 2). Effects of 1-MCP on inhibition of flesh softening and chlorophyll degradation of Asian pear were similar to its already reported effects on European and Japanese pears (Spotts et al., 2007; Itai and Tanahashi, 2008).

Total phenolic compounds increased over time in fruit flesh but were retarded or delayed in 1-MCP treated fruit (Table 2). Also, polyphenoloxidase activities and internal browning index increased simultaneously but, 1-MCP significantly retarded this increasing rate (Fig. 6).

Ascorbic acid concentrations determined from fruit samples taken around fruit core area were diminished during storage time but, 1-MCP relatively turned down this decreasing rate (Fig. 3).

Moreover, higher catalase activity was observed in 1-MCP treated fruit versus control fruit. However, the effects of 1-MCP on superoxide dismutase activities in fruit flesh were not significant (Figs. 4 and 5).

Overall, our result indicated that internal browning index in ‘KS₆’ in 1-MCP treated fruit was significantly less than control after 120-day cold storage, although this disorder was not completely controlled.

Literature Cited


### Tables

Table. 1. Soluble solid content and titratable acidity of ‘KS₆’ Asian pears flesh tissues either untreated or treated with 2 µl L⁻¹ 1-MCP.

<table>
<thead>
<tr>
<th>Time after harvest</th>
<th>Soluble solid content (ºBrix)</th>
<th>Titratable acidity (ºBrix)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>1-MCP</td>
</tr>
<tr>
<td>0</td>
<td>11.5</td>
<td>11.5</td>
</tr>
<tr>
<td>20</td>
<td>16.8</td>
<td>16</td>
</tr>
<tr>
<td>40</td>
<td>16.2</td>
<td>16</td>
</tr>
<tr>
<td>60</td>
<td>16.2</td>
<td>16.5</td>
</tr>
<tr>
<td>80</td>
<td>16.3</td>
<td>16</td>
</tr>
<tr>
<td>100</td>
<td>16.2</td>
<td>17.4</td>
</tr>
<tr>
<td>120</td>
<td>16.5</td>
<td>17.8</td>
</tr>
</tbody>
</table>

LSD (P=0.05) 1.463 0.127

Regression a L*** NS L** L***

a L = linear.
NS, **, *** represent non-significant or significant at P≤0.01 and P≤0.001, respectively.

Table. 2. Total phenolics and polyphenol oxidase activity of ‘KS₆’ Asian pears flesh tissues either untreated or treated with 2 µl L⁻¹ 1-MCP.

<table>
<thead>
<tr>
<th>Treatment time after harvest</th>
<th>Total phenols (mg gallic acid/100 g f.w.)</th>
<th>PPO activity (Δ absorbance 410 nm min⁻¹ mg protein⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>1-MCP</td>
</tr>
<tr>
<td>0</td>
<td>47.6</td>
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<tr>
<td>20</td>
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<td>53.3</td>
</tr>
<tr>
<td>120</td>
<td>55.9</td>
<td>54.4</td>
</tr>
</tbody>
</table>

LSD (P=0.05)

Regression a L*** NS L*** L***

a L = linear.
NS, *** represent non-significant or significant at P≤0.001.
Figures

Fig. 1. Color of ‘KS₉’ Asian pears either untreated or treated with 2 µl L⁻¹ 1-MCP.

Fig. 2. Firmness (N) of ‘KS₉’ pears either untreated or treated with 2 µl L⁻¹ 1-MCP.
Fig. 3. Total ascorbic acid (AA) concentration of ‘KS₆’ Asian pears either untreated or treated with 2 µl L⁻¹ 1-MCP.

Fig. 4. Catalase activity of ‘KS₆’ Asian pears flesh tissue either untreated or treated with 2 µl L⁻¹ 1-MCP.
Fig. 5. Superoxide dismutase activity of ‘KS₆’ Asian pears flesh tissue either untreated or treated with 2 μl L⁻¹ 1-MCP.

Fig. 6. Internal browning index of ‘KS₆’ pears either untreated or treated with 2 μl L⁻¹ 1-MCP.