Effects of Preharvest Applications of AVG on Ripening of ‘Bartlett’ Pears With and Without Cold Storage

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Abstract. Application of 400 ppm aminoethoxyvinylglycine (AVG) to pear trees 6 and 2 weeks before harvest resulted in marked but variable inhibition of postharvest ripening at 20°C. AVG amplified the usual nonuniformity in the initiation of ripening exhibited by freshly harvested fruit. Prolonged storage of the fruit at 0 to 2°C counteracted the inhibitory effects with resultant rapid and uniform ripening upon transfer to 20°C. However, a physiological nonuniformity as reflected by wide differences in internal C₂H₄ concentration persisted well beyond the time when threshold levels for the initiation of ripening had been reached by all fruit. Probable relationships between AVG effects, cold storage, and C₂H₄ are illustrated diagrammatically.

Control of fruit ripening with aminoethoxyvinylglycine (AVG), an inhibitor of ethylene synthesis, loomed promising following the observations of Lieberman et al. (5). Postharvest treatment of pears with AVG has been shown since to inhibit ethylene production and delay ripening (8, 10). Of more immediate interest are the recent reports (1, 2, 11) that preharvest applications of AVG will suppress the ripening of apples.

We tested the effects of 400 ppm AVG + 0.1% Tween 20 applied to 12-year-old ‘Bartlett’ pear trees as a drenching spray 6 weeks and again 2 weeks before harvest. Two trees were used for each treatment. The fruit were harvested at 7.3–8.2 kg (16–18 lb.) firmness, placed in cold storage (0 to 2°C), and then randomly selected for experiments. The effects of AVG were highly variable, and further experimentation is needed to assess time, concentrations, carrier, and other parameters that may yield more uniform results. However, certain aspects of the variability in postharvest behavior of AVG-treated fruit were distinctive and informative.

It is well-known that ‘Bartlett’ pears will commence to ripen at varying times unless ripening is induced and thereby synchronized by prior cold treatment (4, 6, 9). This is illustrated by the disparity in the number of days before control fruit, placed at 20°C 4 days after harvest, reached the respiratory or C₂H₄ climacteric peak (solid lines, Fig. 1). However, upon transfer to 20°C after 2 months storage at 0 to 2°C, ripening was rapid and uniform in both control and AVG-treated fruit.

![Fig. 1. CO₂ and C₂H₄ production by individual control (——) or AVG-treated (-----) ‘Bartlett’ pear fruit transferred to 20°C after 4 days or after 59 days storage at 0 to 2°C. CO₂ was determined with the method of Claypool and Keefer (3). Vertical lines represent the range of values for the 6 fruits in each treatment.](image)

Table 1. Internal ethylene concentrations of control and AVG-treated ‘Bartlett’ pear fruits.

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Control ppm internal C₂H₄ (range)</th>
<th>AVG-treated ppm internal C₂H₄ (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.084 (0.07–0.1)</td>
<td>0.074 (0.06–0.74)</td>
</tr>
<tr>
<td>52</td>
<td>56.1 (15.5–106)</td>
<td>42.6 (3.9–88.3)</td>
</tr>
<tr>
<td>59</td>
<td>232 (130–437)</td>
<td>164 (57–357)</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.055 (0.050–0.060)</td>
<td>0.06 (0.05–0.07)</td>
</tr>
<tr>
<td>14</td>
<td>0.073 (0.041–0.123)</td>
<td>0.10 (0.038–0.173)</td>
</tr>
<tr>
<td>28</td>
<td>9.08 (2.02–19.6)</td>
<td>0.685 (0.024–2.33)</td>
</tr>
<tr>
<td>42</td>
<td>55.7 (17.4–90.8)</td>
<td>37.7 (15.7–78.2)</td>
</tr>
</tbody>
</table>

*Fruit transferred to 0°C immediately after harvest. Internal C₂H₄ was sampled using the vacuum-immersion technique (7). Given are the average and range of internal C₂H₄ of 10 individual fruit (1980) or 6 fruit (1981). In 1981, the preharvest sprays were applied 4 and 2 weeks before harvest.

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treated fruit, although \( \text{C}_2 \text{H}_4 \) production by the latter was suppressed by more than 50%. Cold storage not only synchronized the ripening of control fruit but also counteracted the ripening restraints of prior AVG treatment. A less pronounced normalizing effect of cold storage was obvious after 18 and 35 days of storage (data not shown). These observations are in concert with the recent findings of Bramlage et al. (2). There was, however, no discernible change in firmness in either the control or AVG-treated pears throughout the period of cold storage.

Internal \( \text{C}_2 \text{H}_4 \) levels were negligible when measured 4 days after harvest but increased with time in storage until they were well in excess of threshold levels for the initiation of ripening in both control and AVG-treated fruit (Table 1). Of note is the persistence of a large disparity in internal \( \text{C}_2 \text{H}_4 \) levels of individual fruit throughout the prolonged cold storage.

Nonuniformity in the AVG effect could be the result of uneven uptake or distribution, but that seems unlikely with the 2 drenching sprays employed. We suggest that in lowering \( \text{C}_2 \text{H}_4 \) production rates, AVG simply inhibits \( \text{C}_2 \text{H}_4 \) synthesis by a feedback mechanism.

Fig. 2. How the physiological nonuniformity among freshly harvested pear fruit may remain unaltered while seemingly amplified by AVG and counteracted by cold storage. Although the time span (A) for all control fruit to have reached the threshold \( \text{C}_2 \text{H}_4 \) level (T) for induction of ripening is much less than for AVG-treated fruit (B), (re: Fig. 1) the actual disparity (proportionality) in the extreme rates of \( \text{C}_2 \text{H}_4 \) accumulation within the control (a1, a2) and AVG-treated (b1, b2) group may be unaltered; i.e., 

\[
\frac{a_1}{a_2} = \frac{b_1}{b_2}.
\]

After a sufficient period of time at 20°C (X, or 13 days for fruit in Fig. 1), all control fruit will have experienced threshold levels of \( \text{C}_2 \text{H}_4 \) and thus begin to ripen. Eventually (Y2, or ca 45 days in Fig. 1) AVG-treated fruit will have done so as well. If held at 0°C for a sufficient period of time (Y1, or 59 days in Fig. 1), all fruit will have reached or passed “T” and ripening will be uniform upon transfer to 20°C. However, internal \( \text{C}_2 \text{H}_4 \) levels were negligible when measured 4 days after harvest but increased with time in storage until they were well in excess of threshold levels for the initiation of ripening in both control and AVG-treated fruit (Table 1). Of note is the persistence of a large disparity in internal \( \text{C}_2 \text{H}_4 \) levels of individual fruit throughout the prolonged cold storage.

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Friction discoloration of pears is a skin browning that occurs after injury of epidermal cells from mechanical friction during packing and is commonly referred to as “brush burn” or “scuffing.” Phenolic compounds, especially chlorogenic acid, leak from the injured epidermal cells and are enzymatically oxidized to form unstable quinone compounds. The quinones react with amino acids and proteins to form complex brown polymers that discolor the fruit surface (2, 3, 4). Treatment of pears with ascorbic acid or sodium bisulfite has reduced the amount of friction discoloration of ‘Bartlett’, but not ‘d’Anjou’, due to brush friction. Fruits also were subjected to a return flow belt for 5 minutes to simulate the sorting sequence during packing. Fresh-Cote substantially reduced the susceptibility of both ‘Bartlett’ and ‘d’Anjou’ pears to peel discoloration due to belt friction.

In-line Application of Porous Wax Coating Materials to Reduce Friction Discoloration of ‘Bartlett’ and ‘d’Anjou’ Pears1,2

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Additional index words. Pyrus communis, brush burn, beltburn, packing line

Abstract. ‘Bartlett’ and ‘d’Anjou’ pears (Pyrus communis L.) were passed through several brushrollers during washing, rinsing, and drying sequences of a simulated packing process. In-line application of Fresh-Cote, a wax coating formula with porosity, to the pear surface at washing location of the packing line reduced peel discoloration of ‘Bartlett’, but not ‘d’Anjou’, due to brush friction. Fruits also were subjected to a return flow belt for 5 minutes to simulate the sorting sequence during packing. Fresh-Cote substantially reduced the susceptibility of both ‘Bartlett’ and ‘d’Anjou’ pears to peel discoloration due to belt friction.

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4Professor, Assistant Professor, and Biological Technician, respectively.


