The impact of postharvest cooling on the sensory profile of Ontario peaches

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Importance of postharvest cooling

Application of pre-cooling treatments is important in postharvest management

- Maintaining high quality product
- Lengthen shelf-life
- Reduce development of chilling injury
  - Flesh mealiness
  - Off-flavours
- Mealiness is currently best evaluated using a trained sensory panel
Temperature management

Most important factor to extend shelf-life: storage -0.5°C to 0°C, 90%-95% RH

Reducing temperature of crop as quickly as possible after harvest ➔ Precooling
• Does harvest maturity affect the sensory profiles and quality indicators of Redhaven peaches?

• Does application of pre-cooling treatment affect the sensory profiles and quality indicators of Redhaven peaches?

• Develop an analytical method to quantify flesh mealiness to the same precision as a trained sensory panel
Methods

Evaluated over 3 years 2015-2017

- *Prunus persica* L. (Batch.) Redhaven
  - Niagara-on-the-Lake, ON

- 2400 peaches obtained over two harvest dates
  - Commercial harvest: Aug 6-13
  - Physiological harvest: Aug 17 (Y1 only)

- Sorted into pre-cooling treatments by year
  1. Forced Air Cooling (FAC)
  2. Passive Room Cooling (PRC)
  3. Control Delayed Cooling (CDC)

- Storage at 0-1°C up to 3 weeks
Materials and methods

Application of forced-air cooling

- Forced-air cooling (FAC) applied in ½ serpentine formation
  - Cold storage (0 °C and 90 % RH)
  - **Cold air** travels through macro bin
  - **Warm air** is released into cold storage unit
## Application of pre-cooling treatments

**Evaluated weekly (day 7, 14, 21 postharvest)**

<table>
<thead>
<tr>
<th>Pre-cooling treatments</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced-air cooling (FAC)</td>
<td>Cold air (0 °C and 90 % RH) applied at 1.5 L/s*Kg to 0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive room cooling (PRC)</td>
<td>Passive cooling within cold storage unit to 0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control delayed cooling</td>
<td>Held at <strong>20 °C</strong> for <strong>48 hours</strong>, then <strong>forced-air cooled</strong> to 0 °C (CDC)</td>
<td>Held at <strong>20 °C</strong> for <strong>24 hours</strong>, then <strong>passively cooled</strong> to 0 °C (CDC-20)</td>
<td>Held at <strong>20 °C</strong> for <strong>24 hours</strong>, then <strong>forced-air cooled</strong> to 0 °C (CDC-F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Held at <strong>10 °C</strong> for <strong>24 hours</strong>, then <strong>passively cooled</strong> to 0 °C (CDC-10)</td>
<td>Held at <strong>20 °C</strong> for <strong>24 hours</strong>, then <strong>passively cooled</strong> to 0 °C (CDC-F)</td>
</tr>
</tbody>
</table>
Conducted weekly (0, 7, 14, and 21 days postharvest).

• Unripe
• Ripe: following ripening at room temperature
  – 2.5 days in year 2 & 3

• Evaluations:
  – Texture,
  – °Brix,
  – TA,
  – Visual mealiness,
  – Background colour,
  – Weight loss (%)
Conducted weekly (0, 7, 14, and 21 days postharvest) on ripe peaches.

- Evaluated
  - Y1: Ideal firmness range of 4.5 – 17.8 N
  - Y2 & 3: After 2.5 d at RT

- 10 of Vineland’s trained sensory panelists conducted descriptive analysis
  - Generated a lexicon of 14 attributes

Figure: Preparation of samples for sensory evaluation
### Sensory evaluation lexicon

<table>
<thead>
<tr>
<th>Modality</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma/Flavour</td>
<td>OAI-smell, citrus, tropical fruit, vegetal, OAI-taste</td>
</tr>
<tr>
<td>Taste/Mouthfeel</td>
<td>sweet, acid, bitter, astringent</td>
</tr>
<tr>
<td>Texture</td>
<td>firmness, juicy, chewy, smoothness of flesh, mealy</td>
</tr>
</tbody>
</table>
Objectives:
— Determine the effect that pre-cooling treatments have on peaches harvested at commercial and physiological maturity

Pre-cooling treatments applied
— Forced-air cooling to 0°C for storage
— Passive-room cooling to 0°C for storage
— Control delayed cooling: held at 20°C for 48hrs prior to forced-air cooling to 0°C for storage

Biggest challenge
— Limited development of mealiness

Year 1: 2015 harvest season
The effect of pre-cooling treatments on sensory profiles

Application of CDC, where fruit were pre-ripened at 20 °C, prior to cold storage, possessed:

• ↑ OAI-taste and juiciness
• ↓ firmness and mealiness

Figure: overall mean intensities of significant sensory attributes for each pre-cooling treatment applied in Year 1
Sensory profiles of Redhaven peaches are affected by harvest maturity and application of pre-cooling treatments

- Maturity differed in weight loss, sweetness and sugar : acid ratio
- Pre-cooling treatments differ in overall taste, sweetness, juiciness, mealiness and chewiness

Identified after year 1:

- Control delay cooling most suitable treatment for peaches harvested at commercial maturity
- Minimal differences between pre-cooling treatments applied at physiological ripeness
- The ratio of SSC:TA is an accurate indicator of perceivable sweetness
- Mealy texture may not have fully developed

Results from year 1
Adjustments for Year 2

• Limited development of mealiness
  — Standardized timing of ripening prior to sensory to 2.5 days

• Removed physiological ripeness treatment
  — Fruit to soft of industry packing and shipping

• Reduced controlled delay cooling to 24hrs prior to passive room cooling

• Held fruit at two different temperatures for control delayed cooling – 20°C and 10°C
Year 2 Pre-cooling treatments

2,400 Red haven peaches harvested at commercial maturity from a Niagara-on-the-Lake grower on August 6th and 9th, 2016.

1. Forced-air cooling to 0°C (32 °F) for storage
2. Passive-room cooling to 0°C for storage
3. Control delayed cooling A
   • Held at 20°C (68°F) for 24hrs prior to passive cooling to 0°C for storage
4. Control delayed cooling B
   • Held at 10°C (50°F) for 24hrs prior to passive cooling to 0°C for storage
1. Evaluate the cooling curves of applied cooling strategies

2. Determine the effect of the duration of applied control delayed treatments

3. Determine the effect of applied pre-cooling treatments at commercial maturity

4. Further investigate mealiness texture
   • Shelf-life: monitor onset
   • Comparison of evaluation techniques:
     • Vineland’s trained sensory panel
     • Visual mealiness scale (J. DeEll and L. Walker, 2015)
     • Compression test
Cooling rates

1. Evaluate the cooling curves of applied cooling strategies
Control delayed cooling duration

2. Determine the effect of the duration of applied CDC treatments

Pre-cooling treatments applied:

- CDC-A
- CDC-B

Remove from treatment application:

- 6hrs
- 12hrs
- 18hrs
- 24hrs

Cold storage for 14 days and ripened at room temperature for 2.5 days prior to evaluation

Quality measurements: firmness, juice (%), visual mealiness, background colour, compression test, °Brix, TA
## Impact of control delayed cooling

### Optimal application length

<table>
<thead>
<tr>
<th>Application length</th>
<th>Control delayed A – held at 20°C</th>
<th>Control delayed B – held at 10°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours</td>
<td>Firm, high visual mealiness</td>
<td>Firm, low visual mealiness</td>
</tr>
<tr>
<td>12 hours</td>
<td>Moderate visual mealiness</td>
<td>Firm, low juice (%), high visual mealiness</td>
</tr>
<tr>
<td>18 hours</td>
<td></td>
<td>High visual mealiness</td>
</tr>
<tr>
<td>24 hours</td>
<td>High juice (%), low visual mealiness</td>
<td>High juice (%), low visual mealiness</td>
</tr>
</tbody>
</table>
3. Determine the effect of applied cooling treatments

<table>
<thead>
<tr>
<th>Key differences</th>
<th>Pre-cooling treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forced-air</td>
</tr>
<tr>
<td>Sweetness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No perceivable difference between pre-cooling treatments</td>
</tr>
<tr>
<td>Juiciness between Day 7-14</td>
<td>↓</td>
</tr>
<tr>
<td>Mealiness at Day 14</td>
<td>Greatest</td>
</tr>
<tr>
<td>Day 21</td>
<td>↑ firmness</td>
</tr>
</tbody>
</table>
Sensory evaluation results

Comparison of sensory profiles at Day 14 postharvest

![Graph showing the comparison of sensory profiles at Day 14 postharvest. The graph uses a radar chart to display the comparison of sweet (ns), juicy, mealy, firmness, and OAI-taste. Different lines represent different samples: FAC, PRC, CDC-A, and CDC-B.]
The effect of pre-cooling on mealiness

Figure: Principal component analysis (PCA) including 8 significant sensory attributes differentiating the products in Year 2 with the overall variance accounted for by the PCA being 90.2%. Products were grouped using AHC and denoted by 'Group'.
4. Evaluation of mealiness

Methods

Monitor onset of mealiness through shelf-life evaluations

- Removed from cold storage weekly (0, 7, 14, and 21 days postharvest)
- Held at room temperature (20°C) for up to 10 days
- Daily evaluations:
  - Visual mealiness scale (J. DeEll and L. Walker, 2015)
  - Compression testing, % juice measurement

Evaluate the accuracy of the visual mealiness scale and compression testing methods compared to trained sensory panel.
Onset of mealiness

- Trained sensory panel detected mealiness 1.5 days earlier than visual scale
- Visual mealiness scale is not a reliable method
  - Earliest onset: Control delay A (20°C)
  - Latest onset: Forced-air

Onset of mealiness detected after 14 days in cold storage

<table>
<thead>
<tr>
<th>Length of room temperature storage (day)</th>
<th>Sensory evaluation</th>
<th>Visual mealiness scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td></td>
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</tr>
</tbody>
</table>

Bar graph showing the onset of mealiness detected after 14 days in cold storage.
Key findings from 2016

- Optimal application length of Control delayed cooling is 24hrs
  - High juice (%), reduced development of visual mealiness

- Application of Control delay cooling A (20 °C) is optimal
  - Juicier, greater intensity of peach taste (OAI-taste)
  - Less perceivable mealiness

- Application of Forced-air cooling is detrimental to sensory profile

- Use of trained sensory panel remains the most sensitive method when evaluating mealy texture.
Year 3 Objectives

2017

- Determine the effect of the cooling method after 24hrs of control delayed cooling at 20°C
  1. Forced-air cooling to 0°C (32 °F) for storage
  2. Passive-room cooling to 0°C for storage
  3. Control delayed cooling A: cooled to 20°C, held for 24hrs and then passively cooled to 0°C for cold storage
  4. Control delayed cooling B: cooled to 20°C, held for 24hrs and then cooled with forced-air to 0°C for cold storage
Year 3 Sensory profiles

Post harvest cooling and storage length

CI continuum
The effect of pre-cooling treatments

Conclusions from 3 years of research

- Application of CDC, applied with a holding temperature of 20 °C was deemed optimal
  - ↑ perceivable juiciness
  - ↑ characteristic peach flavour (OAI-taste)
  - Trend for ↓ mealiness development and later onset

- When control delayed cooling applied, no difference between forced air cooling or passive room cooling to 0°C
  - Key to CDC treatment is **pre-ripening at 20 °C for 24 hours**
  - CDC-treated peaches were less firm than the other pre-cooling treatments; however, firmness did not differentiate the sensory profiles of the pre-cooling treatments
Overall findings

• Does harvest maturity affect the sensory profiles and quality indicators of Redhaven peaches?
  — **YES.** Commercial maturity recommend, as physiological maturity not suitable for packing lines

• Does application of pre-cooling treatment affect the sensory profiles and quality indicators of Redhaven peaches?
  — **YES.** Control delayed cooling at 20°C for 24 hrs then cooled to 0°C creates a peach with best eating quality and lower onset of mealiness.
  — Impact on % fruit rot should be investigated

• Develop an analytical method to quantify flesh mealiness to the same precision as a trained sensory panel
  — **NO.** Sensory evaluation still the most sensitive method
Project collaboration

Ontario Tender Fruit Growers

- Ontario Tender Fruit Growers
- Vineland Research and Innovation Centre
- OMAFRA – Simcoe
- Commercial growers
- University of Guelph

- Carly Flemming completed her MSc. in Sept 2017 and is currently working at McCain foods

Figure: Poster presentation at 12th Pangborn Sensory Science Symposium, Providence, RI
Thank You

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