Investigating Quality and Sensory Profiles of Redhaven peaches

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Peaches are prone to developing chilling injury (CI)
  - ↓ aroma/flavour
  - Mealiness
    - Enzymatic imbalance
    - Reduced cellular adhesion
  - Flesh bleeding, browning, translucency

Figure: Redhaven peaches arriving from commercial grower
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
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
Research objectives

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 $\frac{1}{2}$ 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

<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>

Evaluuated weekly (day 7, 14, 21 postharvest)
Quality evaluations

Methods

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 (%)

Figure: Texture analyzer. XT puncture test measuring flesh firmness
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>
Year 1: 2015 harvest season

• 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
Results from 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
  – Mealy texture may not have fully developed
  – The ratio of SSC:TA is an accurate indicator of perceivable sweetness
Application of CDC, where fruit were pre-ripened at 20 °C, prior to cold storage, possessed:

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

The effect of pre-cooling treatments on sensory profiles

Figure: overall mean intensities of significant sensory attributes for each pre-cooling treatment applied in 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
Year 2 Pre-cooling treatments 2016

2,400 Red haven peaches harvested at commercial maturity from a Niagara-on-the-Lake grower on August 6\textsuperscript{th} and 9\textsuperscript{th}, 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 \textbf{20°C (68°F)} for 24hrs prior to passive cooling to 0°C for storage
4. Control delayed cooling B
   • Held at \textbf{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>
Effect of pre-cooling on sensory profiles

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>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

- sweet (ns)
- juicy
- mealy
- firmness
- OAI-taste

Graph showing comparison of sensory profiles with different varieties:
- FAC
- PRC
- CDC-A
- CDC-B
At Day 14 postharvest,

- Forced-air cooling develops greatest perceived mealiness
- Control delayed develops least perceived mealiness
The effect of pre-cooling on mealinessness

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'.

CI continuum
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.
Figure: Visual mealiness scale adapted from J. DeEll and L. Walker, 2015

- **4** – firm, juicy flesh
- **3** – juicy, flesh starting to separate
- **2** – produces juice when squeezed but doesn’t drip; juice bubbles up with flesh being ‘stringy’
- **1** – no juice produced when squeezed
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

![Bar chart showing onset of mealiness detected after 14 days in cold storage.](chart.png)
Compression testing

Methods

- Compression applied using Texture Analyzer.XT plus (Stable Micro Systems, UK)

- Juice (%) obtained

- Analysis of compression curve
  - Force at fracture
  - Compression at fracture
  - Slope
  - Force at final distance
  - Area under curve

Figure: Texture analyzer.XT compression test
Compression curves

Compression of sensory evaluation peaches

a - mealy

b - non-mealy

Compression testing
- Accuracy of 35% (8/23 peaches identified as mealy by panel possessed “mealy” curve)
- Use of trained sensory panel remains the most accurate method in evaluation of mealy texture
Key treatment findings from 2016

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

- 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.
Links between 2015 and 2016

- Application of Control delayed cooling A (20 °C) remains optimal pre-cooling treatment for peaches of commercial maturity
  - Greater intensity of peach taste and perceivable juiciness
  - Reduced development of mealiness

- Confirmation of trend identified in 2015
  - Greater intensity of mealiness in forced-air cooling and passive room cooling treatments
Determine the effect of the cooling method after 24hrs of control delayed cooling at $20^\circ C$

1. Forced-air cooling to $0^\circ C$ (32 °F) for storage

2. Passive-room cooling to $0^\circ C$ for storage

3. Control delayed cooling A: cooled to $20^\circ C$, held for 24hrs and then **passively cooled** to $0^\circ C$ for cold storage

4. Control delayed cooling B: cooled to $20^\circ C$, held for 24hrs and then **cooled with forced-air** to $0^\circ C$ 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
• 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.

• 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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### Materials and methods

#### Compression analysis

**Force (g)**

<table>
<thead>
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<th>Time (seconds)</th>
<th>Force at final distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force at fracture</td>
<td></td>
</tr>
<tr>
<td>Compression distance at fracture</td>
<td></td>
</tr>
<tr>
<td>Slope</td>
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![Graph showing force and time relationship in compression analysis]
Overall conclusions

Research objective 2

2. Examine the validity of two alternative methods of measuring mealy texture in ‘Redhaven’ peaches.

Further *refinement of easy to use alternative methods* to measure mealy texture in peaches is necessary.

- No single variable can predict perceivable mealiness
- Visual cues do not strongly relate to in-mouth perceptions
- Compression analysis was not successful in predicting perceivable mealiness
  - Further test parameter optimization
1. Does harvest maturity and the application of pre-cooling treatments affect the sensory and physicochemical profiles of ‘Redhaven’ peaches?

**Physiologically mature** fruit possessed characteristics known to be desired by consumers.
- ↓ firmness poses logistical concern
- More suitable for farm-gate sales

**Application of CDC to commercially mature** peaches is beneficial.
- Optimal pre-ripening temperature 20 °C
- ↑ characteristic peach taste (OAI-taste) and juiciness
- Trend for ↓ development and later onset of mealy texture