Maintaining the Quality of Sweet Cherries After Harvest

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Factors Influencing Cherry Quality

- Variety
- Harvest maturity
- Handling practices
- Temperature management
- Storage temperature/atmosphere
Cherry Quality Issues

- Water loss – especially stems
- Over-ripe
- Decay
- Loss of acidity
- Excessive softening
Differences in Quality Among Cherry Varieties
Reason Consumers Preferred their Favorite Sweet Cherry Cultivar.

- Sweetness: 65%
- Tartness/Sourness: 5%
- Texture: 2%
- Skin Color: 3%
- Juiciness: 11%
- Firmness: 14%

Turner et al., 2008
Reason Consumers Disliked their Least Favorite Sweet Cherry Cultivar.

- Too tart: 27%
- Too sweet: 15%
- Lack of flavor: 31%
- Soft texture: 11%
- Not tart/sour enough: 4%
- Lack of juiciness: 5%
- Skin color: 7%

Turner et al., 2008
Harvest Maturity Influences Cherry Quality
(o) Fruit weight, (□) TSS, (●) Total acidity, (♦) Firmness.

Titratable Acidity (%) vs. Cherry Color at Harvest

- Coral
- Chelan
- Bing


At Harvest

Firmness (g)

<table>
<thead>
<tr>
<th>Untreated</th>
<th>GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
<tr>
<td>225</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td></td>
</tr>
<tr>
<td>275</td>
<td></td>
</tr>
<tr>
<td>300</td>
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</table>

Soluble Solids (%)

<table>
<thead>
<tr>
<th>Untreated</th>
<th>GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
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<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Mahogany
## Quality of ‘Sweetheart’ Sweet Cherries at Three Harvest Dates

<table>
<thead>
<tr>
<th>Harvest time</th>
<th>SSC (%)</th>
<th>Color intensity (1-7 scale)$^y$</th>
<th>Firmness (g•mm$^{-1}$)$^x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early harvest</td>
<td>19.28 a$^w$</td>
<td>2.65 a</td>
<td>303.80 a</td>
</tr>
<tr>
<td>Mid harvest</td>
<td>19.43 a</td>
<td>2.73 a</td>
<td>281.95 b</td>
</tr>
<tr>
<td>Late harvest</td>
<td>19.49 a</td>
<td>3.51 b</td>
<td>264.61 c</td>
</tr>
</tbody>
</table>

$^z$Early harvest = 3 d before commercial harvest, midharvest = commercial harvest, late harvest = 5 d after commercial harvest.

$^y$CTIFL color scale where 1 = light and 7 = dark.

$^x$FirmTech 2); 1 g•mm$^{-1}$ = 9.8100 N•m$^{-1}$.

Chauvin et al., 2009
Pearson correlations between overall acceptance and acceptance of appearance, texture, and flavor/taste of ‘Sweetheart’ cherries harvested on three dates as evaluated by a consumer panel

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Overall acceptance</th>
<th>Appearance</th>
<th>Texture</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall acceptance</td>
<td>1.00</td>
<td>0.73</td>
<td>0.23</td>
<td>0.94</td>
</tr>
<tr>
<td>Appearance</td>
<td>1.00</td>
<td>0.83</td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Texture</td>
<td></td>
<td>1.00</td>
<td>-0.13</td>
<td></td>
</tr>
<tr>
<td>Flavor/taste</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

Chauvin et al., 2009
Position of the Sensory Attributes of Early- (EH), Mid- (MH) and Late- (LH) Harvested Sweetheart Cherries as Evaluated by a Trained Sensory Panel

Chauvin et al., 2009
Cherry Handling Influences Fruit Quality
Harvest Time Effects on Fruit Firmness

- At Harvest
- 3d at 36°F
- 3d at 36°F + 1d at 68°F
- 3d at 36°F + 2d at 68°F
- 2°C + 1d at 20°C
- 2°C + 2d at 20°C

Firmness (g)

Harvest Time (h)

7 9 11 13 15 17 19
# Effect of Sun Exposure on Cherry Fruit Quality

<table>
<thead>
<tr>
<th>Time in Field</th>
<th>Evaluation Time</th>
<th>Fruit Temp. °C</th>
<th>Stem Browning</th>
<th>Firmness g/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sun</td>
<td>Shade</td>
<td>Sun</td>
</tr>
<tr>
<td>2</td>
<td>Before Storage</td>
<td>36.4</td>
<td>19.2</td>
<td>2.2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>45.6</td>
<td>21.8</td>
<td>4.4</td>
</tr>
<tr>
<td>2</td>
<td>After Storage</td>
<td></td>
<td></td>
<td>3.2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>5.0</td>
</tr>
</tbody>
</table>

Stem browning scale: 0 to 5

Kupferman 1998
Schick and Toivonen, 2000
The effect of postharvest calcium application in hydro-cooling water on tissue calcium content, biochemical changes, and quality attributes of sweet cherry fruit

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\textsuperscript{a} Department of Horticulture, Oregon State University, Mid-Columbia Agricultural Research and Extension Center, 3005 Experiment Station Dr., Hood River, OR 97031, United States
\textsuperscript{b} Oregon State University Extension, The Dalles, OR 97058, United States

Hydro-cooling with CaCl\textsubscript{2} (OptiCAL\textsuperscript{TM}) for 5 minutes
Effect of CaCl$_2$ added to hydro-cooling water at 0 °C for 5 min on calcium content of ‘Sweetheart’ cherries

Wang et al., 2014
Wang et al., 2014
Wang et al., 2014
Wang et al., 2014
Changes in Cherry Quality as Affected by Storage Practices
### Storage Temperature Effects on Decay

<table>
<thead>
<tr>
<th>Storage Temperature (°C)</th>
<th># Days until 5% Fruit Decay</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>11.8</td>
</tr>
<tr>
<td>4</td>
<td>8.1</td>
</tr>
<tr>
<td>8</td>
<td>5.9</td>
</tr>
<tr>
<td>12</td>
<td>4.3</td>
</tr>
<tr>
<td>20</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Bing Sweet Cherry
Changes in Fruit Quality During Storage

• Air Shipment = methyl bromide fumigation + 33h @ 5C + 15h @ 20C, 95% RH

• Domestic Truck Shipment = 5d @ 2C + 1d @ 20C, 60% RH

• Domestic Truck + Retail Shipment = 5d @ 2C + 5d @ 7.5C + 1d @ 20C, 60% RH
Red

Pitting (%)

Shrivel (%)

At Harvest AS DT DTR

Brown Stem (%)

Untreated GA

![Bar chart showing data for various conditions and treatments](image-url)
Cherry Color is Closely Related to Sensory Cherry Flavor and Soluble Solids Content
Sensory Quality of Coral, Chelan and Bing Cherries As Influenced by Harvest Maturity

- Each variety harvested and sorted into three color categories (light, medium and dark)
- Skin color, firmness, SSC, TA and dry matter measured
- Consumer taste test with 100 consumers per variety and color category
  - Just About Right and Liking ratings for sweet/sour, cherry flavor and firmness perception
  - Overall liking rating
- Test ability of NIR meter (F-750 Fruit Quality Meter, Felix Inc.) to measure SSC
Consumer Sensory Analyses
Just About Right (JAR) Scale

- Commonly used in consumer research to identify whether product attributes are perceived at levels that are too high, too low, or just about right for that product.
- JAR scales combine intensity and acceptability to relate the perceived strength of specific attributes to the respondent’s theoretical optimum.
- Collect intensity and hedonic information in separate scales.
- Attribute intensities regressed on the attribute liking scores.
- Determine the attribute intensity level associated with the highest attribute liking.
Scales used in the study

### Sweet/Sour Perception:

<table>
<thead>
<tr>
<th>Perception</th>
<th>Much Too Sour</th>
<th>Moderately Too Sour</th>
<th>Slightly Too Sour</th>
<th>Just About Right</th>
<th>Slightly Too Sweet</th>
<th>Moderately Too Sweet</th>
<th>Much Too Sweet</th>
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### Sweet/Sour Liking:

<table>
<thead>
<tr>
<th>Liking</th>
<th>Dislike very much</th>
<th>Like very much</th>
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### Cherry Flavor Perception:

<table>
<thead>
<tr>
<th>Perception</th>
<th>Much Too Weak</th>
<th>Moderately Too Weak</th>
<th>Slightly Too Weak</th>
<th>Just About Right</th>
<th>Slightly Too Strong</th>
<th>Moderately Too Strong</th>
<th>Much Too Strong</th>
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### Cherry Flavor Liking:

<table>
<thead>
<tr>
<th>Liking</th>
<th>Dislike very much</th>
<th>Like very much</th>
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### Firmness Perception:

<table>
<thead>
<tr>
<th>Perception</th>
<th>Much Too Soft</th>
<th>Moderately Too Soft</th>
<th>Slightly Too Soft</th>
<th>Just About Right</th>
<th>Slightly Too Firm</th>
<th>Moderately Too Firm</th>
<th>Much Too Firm</th>
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### Firmness Liking:

<table>
<thead>
<tr>
<th>Liking</th>
<th>Dislike very much</th>
<th>Like very much</th>
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### Overall Liking (all factors considered):

<table>
<thead>
<tr>
<th>Liking</th>
<th>Dislike very much</th>
<th>Like very much</th>
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Penalty Analysis

• Used to identify attributes that appear to have a strong impact on overall liking.

• Determine for each characteristic studied with the JAR scale if the JAR rankings are related to significantly different results in the liking score.

• The word “Penalty” comes from the fact that we are looking for characteristics that can penalize the consumer’s satisfaction with a product.
Just About Right and Penalty Analyses

Percentages for the JAR levels

Sweet/Sour Balance Cherry Flavor Firmness

Penalties

Sweet/Sour Balance Cherry Flavor Firmness
Just About Right and Penalty Analyses

‘Chelan’

Percentages for the JAR levels

Penalties
Just About Right and Penalty Analyses

Percentages for the JAR levels

Sweet/Sour Balance | Cherry Flavor | Firmness
---|---|---
Penalties

'Bing'

Penalties

Sweet/Sour Balance | Cherry Flavor | Firmness
---|---|---
Felix F-750 Produce Quality Meter
Felix F-750 Produce Quality Meter

Cherries Selected for Model Development
Nondestructive Prediction of TSS in Cherry

• Original data set contains 675 Spectra from 225 Cherries
  – 75 of each of 3 cultivars, including 3 color categories
  – Spectra collected at three temperatures (15, 24 and 37°C)
  – 3 spectra per cherry at each temperature
• Two spectral outliers were removed leaving 673 spectra in the global data set (all cultivars and temperatures combined)
• No TSS outliers were removed.
TSS Model Building in Cherry

• Leave-one-out cross-validation method was used to determine that 8 PLS factors was the correct size of the model (i.e. not over-fitting the data).

• Data was then randomly split:
  – Calibration set had 159 (54 Bing, 53 Chelan, and 52 Coral) cherries
  – Hold-out (Validation) set had 66 (21 Bing, 22 Chelan, and 23 Coral) cherries.
Nondestructive TSS Prediction in Cherry

Global Model
$R^2 = 0.917$

Bing Std. Error = 2.4
Chelan Std. Error = 1.6
Coral Std. Error = 1.9

Thanks to David Slaughter, UC Davis
$R^2 = 0.92$
$SEC = 1.87$
Nondestructive Prediction of TSS in Cherry

• Wavelength range was determined to be 530nm to 990nm by using the VIP statistic.
• The coefficient of determination was $R^2 = 0.917$
• Standard error of calibration was $2^\circ\text{TSS}$
• Appears we can develop one model for all three varieties. Need to collect more data to strengthen the model.
Using Chelan Model to Predict Coral TSS

Thanks to Kerry Walsh, CQ University, Australia
Thank You!

Sandra Escribano
Bill Biasi
Ashley Call

F-750 Model Development
David Slaughter - UC Davis
Kerry Walsh – CQ University, Australia
Ryan Lerud – Felix/CID Inc.