Postharvest Quality Considerations for Blackberries

Overview Berry Composition
CDFA Berry Irrigation Project
Postharvest Handling Resources

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Caneberry Meeting
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Fruit Composition & Flavor

SWEET  HIGH FLAVOR
Low Acid  High Acid
BLAND  TART
Low Sugar

Measuring Sugar Concentrations

✓ Both °Brix and % soluble solids can be measured by a refractometer
✓ °Brix is a measurement of solids in a pure sucrose solution
✓ % soluble solids is an estimate of sugars because a juice solution contains sugars, but also other soluble constituents: organic acids, amino acids, soluble pectins and other soluble compounds.
✓ A fruit juice sample is composed of various sugars and soluble components; therefore “% soluble solids” should be used.

Composition of ‘Seascape’ Strawberries

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Concentration (%)</th>
<th>Percent of SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sugars</td>
<td>5.28</td>
<td>57.3</td>
</tr>
<tr>
<td>Total acids</td>
<td>0.97</td>
<td>10.6</td>
</tr>
<tr>
<td>Others</td>
<td>2.95</td>
<td>32.1</td>
</tr>
<tr>
<td>Total Soluble solids</td>
<td>9.20</td>
<td>100.0</td>
</tr>
</tbody>
</table>

What are the Other Constituents?

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Contribution to refractometer reading</th>
<th>% of TSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthocyanins</td>
<td>1.95</td>
<td>21.2</td>
</tr>
<tr>
<td>Soluble pectins</td>
<td>0.60</td>
<td>6.5</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>0.21</td>
<td>2.3</td>
</tr>
<tr>
<td>Phenolics</td>
<td>0.19</td>
<td>2.1</td>
</tr>
<tr>
<td>Total</td>
<td>2.95</td>
<td>32.1</td>
</tr>
</tbody>
</table>

Relative Sweetness of Sugars

• 15% solutions
• Sucrose = 100
• Fructose = 150-160
• Glucose = 70-80

Pancorbo & Junk. 1940, Handbook of sugars. AVI
### Range of reported composition of 4 berries (from Talcott, S. 2007. Berry Fruit Ch. 2)

<table>
<thead>
<tr>
<th>Berries</th>
<th>Phenolic compounds</th>
<th>Flavonoids mg/g FW</th>
<th>Anthocyanins mg/g FW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilberry</td>
<td>Vaccinium myrtillus</td>
<td>525</td>
<td>44</td>
</tr>
<tr>
<td>Blackberry</td>
<td>Rubus fructicosus</td>
<td>486</td>
<td>276</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Vaccinium corymbosum</td>
<td>261-585</td>
<td>50</td>
</tr>
<tr>
<td>Lingonberry</td>
<td>Vitis vitis-idea</td>
<td>652</td>
<td>74</td>
</tr>
<tr>
<td>Raspberry</td>
<td>Rubus idaeus</td>
<td>121</td>
<td>6</td>
</tr>
<tr>
<td>Red currant</td>
<td>Ribes rubrum</td>
<td>1490</td>
<td>22</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Fragaria x ananassa</td>
<td>313</td>
<td>54</td>
</tr>
</tbody>
</table>


### Phenolic compounds in berry fruits.

![Phenolic compounds in berry fruits.](image)

### Anthocyanins

![Anthocyanins](image)

### California Berry Crops: Improving Water-Use Efficiency While Maintaining Crop Quality

- Shermain Hardesty PI, UCCE Ag Econ Nat. Res. UC Davis
- Elizabeth Mitcham, UCCE Postharvest specialist, UC Davis
- Marita Cantwell, UCCE Postharvest specialist, UC Davis
- Larry Schwankl, Irrigation specialist, KAC
- Aziz Baameur, UCCE Santa Clara County
- Mark Gaskell, UCCE Santa Barbara County
- Manuel Jimenez, UCCE Tulare County
- Ramiro Lobo, UCCE San Diego County
- Cooperating growers
- 2011-2014, Blackberry, blueberry, strawberry
- 4 irrigation regimes, 50, 75, 100, 125% CIMIS
- Field performance and yields, marketable quality, composition, postharvest quality, consumer sensory

### Vitamin C and Antioxidant Activity

- **Vitamin C**
  - A specific vitamin required by humans
  - Active forms are sum of ascorbic acid and dehydroascorbic acid
  - 90% of Vitamin C comes from fruits and vegetables
  - Needed for cell repair; protects against oxidative stress
  - Is a labile vitamin (degrades easily)
  - Often measured in storage studies of fruits and vegetables
- **Antioxidant activity**
  - With aging, there is increase in oxidative damage
  - Antioxidants can reverse early stages of oxidation
  - In fruits and vegetables, many constituents provide antioxidant activity (phenolics, Vitamin C, Vitamin E, carotenoids and others)
  - Various assays can estimate total activity of antioxidant compounds in fruits and vegetables

### Total phenolics, flavonoids and anthocyanins of selected berries.

<table>
<thead>
<tr>
<th>Berries</th>
<th>Scientific name</th>
<th>Phenolics mg/g FW</th>
<th>Flavonoids mg/g FW</th>
<th>Anthocyanins mg/g FW</th>
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</thead>
<tbody>
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<td>276</td>
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<td>Vaccinium corymbosum</td>
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<td>25-495</td>
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Irrigation Project
Composition of Berries

- **Soluble solids** (refractometer)
- **pH and titratable acidity** (pH meter, titration)
- **Sugars** (individual sugars by HPLC)
- **Acids** (individual acids by HPLC)
- **Vitamin C** (ascorbic + DHAA by HPLC)
- **Anthocyanins** (total by spectrophotometry)
- **Phenolics** (total by spectrophotometry)
- **Antioxidant Activity** (FRAP, spectrophotometric assay)

Berries harvested during peak of production
Berries harvested at typical commercial maturity
Berries were of marketable quality, no defects

Blackberry Irrigation Project
2012 and 2013 Samples

**Sugars and Acids**

Blackberry, acids are 40% citric, 30% malic and 30% tartaric

Blackberry, sugars are about 50% glucose, 50% fructose

In blackberry, acids are 40% citric, 30% malic and 30% tartaric

In blackberry, sugars are about 50% glucose, 50% fructose

In blackberry, acids are 40% citric, 30% malic and 30% tartaric

Blackberry Irrigation Project
2012 and 2013 Samples

**Anthocyanins and Phenolics**

Blackberry Irrigation Project
2012 and 2013 Samples

**Fruit weight, % Dry weight**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50% ET</td>
<td>7.04</td>
<td>6.95</td>
<td>7.12</td>
<td>7.08</td>
<td>7.47</td>
<td>7.32</td>
<td>7.14</td>
<td>7.08</td>
<td>7.47</td>
<td>7.32</td>
<td>7.14</td>
<td>7.08</td>
</tr>
<tr>
<td>75% ET</td>
<td>8.26</td>
<td>8.09</td>
<td>8.37</td>
<td>8.22</td>
<td>8.93</td>
<td>8.77</td>
<td>8.53</td>
<td>8.37</td>
<td>8.93</td>
<td>8.77</td>
<td>8.53</td>
<td>8.37</td>
</tr>
<tr>
<td>Average</td>
<td>8.50</td>
<td>8.35</td>
<td>8.61</td>
<td>8.45</td>
<td>9.12</td>
<td>8.91</td>
<td>8.72</td>
<td>8.51</td>
<td>9.12</td>
<td>8.91</td>
<td>8.72</td>
<td>8.51</td>
</tr>
</tbody>
</table>

LSD.05: n.s. n.s. n.s.

**Soluble solids vs Sugars**

Analysis from separate sets of berries (postharvest and composition)
Berry Irrigation Project

Conclusions to date - composition

• For blackberry, berry weight not affected by irrigation regimes
• Only in 1 of 4 blackberry trials were sugars and acids affected by irrigation regimes
• Variation from location to location much greater than for irrigation regimes
• 1 more year of data to obtain

Berry Quality Resources

• UC Postharvest website  
  http://postharvest.ucdavis.edu/libraries/publications/
  http://www.ba.ars.usda.gov/hb66/contents.html

Causes of Quality & Postharvest Losses

Fruits

- Mechanical damage
- Maturity, immature, overmature
- Poor ripening, conditioning
- Softening, texture loss
- Changes in composition
- Water loss
- Chilling injury
- Microbial growth

Composition of Ripe Strawberry

Harvested at different stages; held at 70°F (21°C)

<table>
<thead>
<tr>
<th>Maturity</th>
<th>% SS</th>
<th>% Acid</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>25% color</td>
<td>4.28</td>
<td>0.80</td>
<td>5.35</td>
</tr>
<tr>
<td>50% color</td>
<td>4.56</td>
<td>0.79</td>
<td>5.77</td>
</tr>
<tr>
<td>75% color</td>
<td>4.98</td>
<td>0.68</td>
<td>7.32</td>
</tr>
<tr>
<td>100% color</td>
<td>5.48</td>
<td>0.59</td>
<td>9.28</td>
</tr>
</tbody>
</table>

Flavor determined by maturity at harvest
Flavor declines with storage time

Example of strawberry is true for all berries

What do all these fruits have in common?
Higher respiration rates are generally correlated with shorter postharvest life.

**Cooling and Cold Storage**

**Forced-Air Cooling is Standard for Berries**

- Cool fruit to 0°C as quickly as possible
  - Cool within 2 hours of harvest
- When cooled, 90 – 95% RH
  - Reduce water loss
  - Reduce decay
  - Reduce respiration rate and extend postharvest life
- Maximum postharvest life
  - Strawberry – 2 to 3 weeks
  - Raspberry and blackberry – 1 week
  - Blueberry – 4 weeks

**Effect of Temperature and Carbon Dioxide on Growth of Botrytis cinerea**

1) Harvest at correct maturity
2) Reduce physical handling
3) Protect product from sun
4) Keep packingline or area simple and clean; ensure good worker hygiene
5) Select, classify, and pack carefully
6) Align cartons, strap pallet
7) Cool as soon as possible
8) Know market and product requirements
9) Coordinate efficient & rapid handling
10) Train and compensate workers adequately