Berry Fruit

- Raspberry
- Strawberry
- Blueberry
- Blackberry

Berry Fruit Characteristics

- Harvest fully ripe for flavor
- Shelf life limited by decay and softening; loss of flavor
- High in antioxidants

Morphological Characteristics

- Simple fruits
  - Berries
    - Blueberry, cranberry, currant, gooseberry
    - Drupe
    - Huckleberry
  - Multiple fruits
    - Mulberry
  - Aggregate
    - Drupe
      - Blackberry, loganberry, raspberry
    - Achenes
      - strawberry

The Strawberry is an Achene Fruit

Respiration Rates and Ethylene Production

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Respiration @ 0°C</th>
<th>Respiration @ 20°C</th>
<th>Ethylene @ 5°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackberry</td>
<td>22</td>
<td>155</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Blueberry</td>
<td>6</td>
<td>68</td>
<td>0.1 to 1.0</td>
</tr>
<tr>
<td>Cranberry</td>
<td>3</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Raspberry</td>
<td>24</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td>15</td>
<td>127</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Currant</td>
<td>16</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Gooseberry</td>
<td>10</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>
Strawberries Growing on Raised Beds
Beds Covered in Plastic

Harvest, Sort, and Pack in the Field

Eight One Pound Clamshell Baskets

Nesting of Botrytis Rot
One Bad Berry can Destroy the Whole Tray

Raspberries
**Gentle Harvest by Hand**

Harvest into small containers to avoid bruising!

**Caneberry Harvest Operation**

Picking early in the day or while temperatures are cool is best

Packaging at the edge of the field

**STRAWBERRY Warming after Harvest**

- Air
- Top
- Ctr
- Shade
Packaging Area must be in the Shade!!

Blackberries

Harvest Operation
Pick, Pack, and Palletize in the Field

Two Trays are Connected with Wire Stabilizes Pallet
**Blueberries**

**Hand Harvest of Blueberries**

Reduce Handling to Maintain Waxy Bloom

Field Totes Dumped onto the Packingline

Sorting by Hand
Filling Clamshell Containers

Blueberry Packing

• Bring fruit from the field quickly
• Cool, shaded packing area
• Sorting Area: Elevated table, well lighted
• Hand sort for defects, color
• Hand or machine sort for firmness
• Pack into clamshell baskets
• Begin fruit cooling within 1 hour of harvest
**Quality Assurance**

- Monitor quality of fruit packed
  - Firmness
  - Ripeness (color)
  - Decay
  - Defects
- Training of harvest crew
- Incentives for better performance

Li, Luo and MacLean, 2012
Covered Receiving Area

Cooling and Cold Storage
Forced-Air Cooling is Best!

- Cool fruit to 0°C as quickly as possible, 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

Forced-Air Cooling of Strawberries

Postharvest Decay Organisms for Berries

Botrytis cinerea

Methods of Decay Control for Berry Fruit

- Temperature management
- CA or MA, especially elevated CO₂
- Biological control
- Irradiation
- Ozone in air – up to 0.3ppm on blackberry and blueberry
- Sulfur dioxide fumigation
Nesting of Botrytis Rot
One Bad Berry can Destroy the Whole Tray

Pallet Covers for Carbon Dioxide Treatment of Strawberries during Transport

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

Effect of Temperature and Carbon Dioxide on Growth of Botrytis cinerea

Gas Composition within Strawberry Pallet Shrouds

<table>
<thead>
<tr>
<th>At Shipping</th>
<th>Tectrol</th>
<th>Tectrol</th>
<th>CO2 West</th>
<th>PrimePro</th>
<th>PeakFresh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipment 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallet 1</td>
<td>16.5</td>
<td>11.1</td>
<td>0.1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Pallet 2</td>
<td>16.5</td>
<td>9.6</td>
<td>0.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Pallet 3</td>
<td>12.2</td>
<td>13.1</td>
<td>0.1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Shipment 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallet 1</td>
<td>9.5</td>
<td>8.5</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Pallet 2</td>
<td>16.0</td>
<td>15.4</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Pallet 3</td>
<td>NA</td>
<td>1.3</td>
<td>0.2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Shipment 3</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Pallet 1</td>
<td>12.5</td>
<td>11.9</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Pallet 2</td>
<td>10.5</td>
<td>11.6</td>
<td>0.1</td>
<td>0.3</td>
<td>0.4</td>
</tr>
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<td>11.5</td>
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</tbody>
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* Tear in bag

Temperature Change During Shipment of Strawberries

<table>
<thead>
<tr>
<th>No Bag</th>
<th>PeakFresh</th>
<th>PrimePro</th>
<th>CO2 Tech</th>
<th>Tectrol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Temperature</td>
<td>33.1</td>
<td>32.9</td>
<td>33.1</td>
<td>32.8</td>
</tr>
<tr>
<td>Arrival Temperature</td>
<td>35.4</td>
<td>38.4</td>
<td>38.7</td>
<td>36.5</td>
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<tr>
<td>Net Change</td>
<td>2.3</td>
<td>5.4</td>
<td>5.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Transit Hours</td>
<td>64</td>
<td>54</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>Temp Increase per 24 hours</td>
<td>1.0</td>
<td>2.2</td>
<td>2.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

* Tear in bag
Methods

- The fruit of two highbush blueberry varieties with desirable flavor were harvested at commercial maturity.
- Fruit in clamshells were stored for up to 6 weeks at 0°C.
- Fruit were exposed to three storage treatments:
  - Room air control
  - Modified atmosphere packaging
  - Continuous ozone gas fumigation

![Genotype 1 and Genotype 2 images](image1)

[CO₂ and O₂] during storage

<table>
<thead>
<tr>
<th>Storage time (weeks)</th>
<th>CO₂ concentration (%)</th>
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<tr>
<td>Genotype 1</td>
<td>Genotype 2</td>
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Decay Incidence

<table>
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<th>Genotype 2</th>
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<tr>
<td>O₂ concentration (%)</td>
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</tr>
<tr>
<td>Room air</td>
<td>MAP</td>
</tr>
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<td>Ozone</td>
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Refrigerated loading dock!

Center-Line Loading

Questions?