Postharvest Handling
Banana & Pineapple

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UCDavis
### Intercultivar Differences in Composition of Pineapples

**Premium Select = Tropical Gold**

<table>
<thead>
<tr>
<th>Constituent (unit)</th>
<th>Champaka</th>
<th>Premium Select</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids (%)</td>
<td>16.9 ± 0.9</td>
<td>22.2 ± 0.8</td>
</tr>
<tr>
<td>Soluble solids (%)</td>
<td>12.7 ± 1.2</td>
<td>16.9 ± 0.3</td>
</tr>
<tr>
<td>Titratable acidity (%)</td>
<td>0.67 ± 0.1</td>
<td>0.54 ± 0.0</td>
</tr>
<tr>
<td>pH</td>
<td>3.60 ± 0.1</td>
<td>3.92 ± 0.0</td>
</tr>
<tr>
<td>Total ascorbic acid (mg/100g FW)</td>
<td>8.5 ± 0.7</td>
<td>30.8 ± 1.0</td>
</tr>
<tr>
<td>Beta carotene (µg/100g FW)</td>
<td>323.3 ± 94.2</td>
<td>929.9 ± 84.2</td>
</tr>
<tr>
<td>Total phenolics (mg/100g FW)</td>
<td>31.4 ± 0.9</td>
<td>63.5 ± 4.7</td>
</tr>
<tr>
<td>Antioxidant activity (DPPH) (µM/100g FW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascorbic acid equivalent</td>
<td>62.0 ± 9.8</td>
<td>217.0 ± 22.2</td>
</tr>
<tr>
<td>Trolox equivalent</td>
<td>59.4 ± 9.8</td>
<td>206.8 ± 22.2</td>
</tr>
</tbody>
</table>
Maturity and Ripeness Stages of Pineapples (Del Monte ‘Gold’ Cultivar)

Shell Color 0: Completely green fruit with no trace of yellow.
Shell Color 1: Trace of yellow beginning to show on center of eyes.
Shell Color 2: Clear color with some eyes showing some yellow color.
Shell Color 3: Majority of eyes showing partial filling with yellow color.
Shell Color 4: All eyes filled with yellow color and distinct green remains on edges of eyes.
Shell Color 5: All eyes filled with yellow color and only a trace of green on edges.
Shell Color 6: Full yellow color.

Indian Kew Pineapples and Composition at Different Stages of Ripeness

<table>
<thead>
<tr>
<th>Days from Anthesis</th>
<th>Shell Color</th>
<th>Chl mg/g</th>
<th>Dry wt. %</th>
<th>Soluble solids %</th>
<th>Titratable acidity %</th>
<th>Total sugar %</th>
<th>Vit C mg/100g</th>
<th>Sensory score*</th>
</tr>
</thead>
<tbody>
<tr>
<td>115-120</td>
<td>Green</td>
<td>0.77</td>
<td>12.97</td>
<td>7.9</td>
<td>0.66</td>
<td>6.49</td>
<td>13.7</td>
<td>3.0</td>
</tr>
<tr>
<td>135-140</td>
<td>1/8</td>
<td>0.76</td>
<td>15.26</td>
<td>12.6</td>
<td>0.74</td>
<td>8.87</td>
<td>13.9</td>
<td>4.6</td>
</tr>
<tr>
<td>141-145</td>
<td>1/4</td>
<td>0.63</td>
<td>16.09</td>
<td>18.2</td>
<td>0.77</td>
<td>11.25</td>
<td>14.4</td>
<td>5.4</td>
</tr>
<tr>
<td>146-150</td>
<td>1/2</td>
<td>0.53</td>
<td>17.65</td>
<td>18.9</td>
<td>0.77</td>
<td>11.99</td>
<td>14.9</td>
<td>6.8</td>
</tr>
<tr>
<td>151-155</td>
<td>2/3</td>
<td>0.21</td>
<td>17.76</td>
<td>18.0</td>
<td>0.83</td>
<td>12.44</td>
<td>15.3</td>
<td>6.7</td>
</tr>
<tr>
<td>156-160</td>
<td>Full</td>
<td>0.14</td>
<td>19.89</td>
<td>16.3</td>
<td>0.96</td>
<td>12.74</td>
<td>14.5</td>
<td>6.4</td>
</tr>
<tr>
<td>LSD.05</td>
<td></td>
<td>0.01</td>
<td>0.17</td>
<td>0.87</td>
<td>0.07</td>
<td>0.08</td>
<td>0.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>

* Sensory determined by panel of 10 untrained members based on nine point hedonic scale

Initial Quality Evaluation of Pineapples at the Packinghouse
Water dumping and washing pineapples

Air turbines to remove excess water

Application of chlorinated water to butt

Forced air drying

Wax application to fruit

Slides from C. Demerutis, Costa Rica
Pineapple Handling

• Importance of wax application
  – Improve fruit appearance
  – Reduce internal browning - modified atmosphere created
  – Reduce water loss
  – Reduce pathogen growth

• Importance of dry crown
  – Reduce decay
Blackheart symptoms in Hawaiian Gold (HG) and Smooth Cayenne (SC) pineapple fruit following chilling. 10 fruit were incubated at 23, 10, 6, 4, 2 and 0°C for 14 d followed by 23°C for 7 d.

Stewart et al., 2002
Fig. 1. Effect of 1-MCP on internal browning incidence (A) and intensity (B), and ripeness (C) of pineapples stored at 10°C followed by 3 days at 30°C. Asterisks indicate a significant difference between the 1-MCP treatment and the control at $P < 0.01$.

Selvarajah et al., 2001
Chen and Paull, 2001 showed removing crown had no effect, but others have shown that removing 1/3 of plant leaves reduces translucency.

Fig. 10.8. Variation in crown weight and fruit-translucency severity at different times of the year (from Paull and Reyes, 1996).

**Pineapple Defects**

- Yeast fermentation
- Thielaviopsis paradoxa (Water Blister)
- Fruitlet Core Rot: *Penicillium funiculosum* and/or *Fusarium moniliforme*
Banana

Banana Maturity Stages

Delaying harvest until the full mature-green stage results in higher yield and better eating quality when ripe.
Preparing a banana bunch for harvest

System for transporting banana bunches to packing station
Delivering Bananas to Packinghouse

Some of the banana handling slides were provided by Eduardo Kerbel

Initial Washing of Bananas at Packinghouse
Cutting and Placing Banana Hands into Water
Banana Packinghouse

Banana Packing
Surface abrasions

Internal bruising due to drops

Some common postharvest pathogens on bananas

Crown rot caused by several fungi:
Fusarium roseum, Lasiodiplodia theobromae, Thielaviopsis paradoxa, Colletotrichum musae

Lasiodiplodia stem-end rot (L. theobromae)

‘Cigar-End’ rot

http://postharvest.ucdavis.edu/PFfruits/BananaPhotos/
Weighing and Alum Spray

Banana Packaging Options

Package Type – Green Life
Polypak – thin PE (28d)
Banavac – thick PE with slight MA (47d)
- must open bags before ripening
Single fingers

Consumer packages

Bananas are usually not cooled prior to loading CA or MA often used to extend green life during transit
Break bulk and marine container shipment to markets

<table>
<thead>
<tr>
<th>Type</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavendish types</td>
<td>13-15°C (56-58°F) for storage and transport</td>
</tr>
<tr>
<td>Plantains</td>
<td>9-12°C (48-54°F) for storage and transport</td>
</tr>
<tr>
<td>Petite</td>
<td>11°C (52°F) for up to 7 days storage</td>
</tr>
<tr>
<td></td>
<td>12.5-14°C (54.5-57°F) for longer than 7 days</td>
</tr>
<tr>
<td>Red Macabu</td>
<td>10°C (50°F) for up to 7 days</td>
</tr>
<tr>
<td></td>
<td>12.5-14°C (54.5-57°F) for longer than 7 days</td>
</tr>
</tbody>
</table>

http://postharvest.ucdavis.edu; USDA handbook 66

Symptoms of Chilling Injury

- Skin discoloration (dull color)
- Browning of the inner side of peel
- Failure to ripen
- Browning of the flesh (in severe cases)
Ethylene peak precedes CO2 peak
Sugar formation very high at climacteric
(Beaudry et al. 1989. Plant Physiology 91:1436)

Ripening Conditions for Bananas

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Fruit temperature</td>
<td>14 to 18°C (58-65°F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>90-95%</td>
</tr>
<tr>
<td>Ethylene</td>
<td>100-150 ppm</td>
</tr>
<tr>
<td>Duration ethylene</td>
<td>24-28 hours</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>Adequate air exchange to prevent accumulation &gt;1%</td>
</tr>
</tbody>
</table>

**Forced air ripening rooms**
Single, double and triple tier

**Source of ethylene:**
Banana gas (ethylene in CO2)
Ethylene from catalytic generator

What is this nonuniform ripening due to?
Scheduling Ripening to Meet Retail Needs

Banana Ripening Stages

- **Stage 2**: Green, trace yellow
- **Stage 3**: More green than Yellow
- **Stage 4**: More Yellow than Green
- **Stage 5**: Yellow, Green Tips & Neck
- **Stage 6**: All Yellow, No Green Tips; slight Green on Neck
- **Stage 7**: Yellow flecked with Brown “sugar spots”
Reduce Retail Losses
Delay or Extend Ripening of Bananas

- Hold at 13°C (56°F)
- Modified atmospheres
  - 2 - 5% O₂ + 2 - 5% CO₂ at 15°C (59°F)
- Treat with 200-300 ppb 1-MCP (15°C)

After ethylene, treat with 1-MCP at 2.5-3.5 color stage

Temperature Control Retards Sugar Spots

Cantwell, 2007. Test#2 Bonita Temperature
Extending the Yellow-life of Bananas

From A.A. Kader

Extending the Yellow-life of Bananas (1-MCP)
General appearance and sugar spotting

- 1-MCP treatment was evaluated under commercial conditions at a major retailer.
- Quality was tracked over 7 days.

Questions?