SmartFresh™ and EthylBloc™ Technology:
Tools to control ripening and senescence

Presented to: Fruit Ripening and Ethylene Mgt Workshop
By: Deirdre Holcroft  Date: 28 April 2009
1-MCP (1-methylcyclopropene) prevents ethylene perception by binding with the ethylene binding site or receptor, and preventing ethylene from binding

- 1-methylcyclopropene (1-MCP) was developed by researchers at North Carolina State University
- Marketed by AgroFresh as:
The SmartFresh℠ Success Story on Apples: Crunchier apples

Results of tests on 25,000 samples of SmartFresh℠ serviced apples* compared to the controls. Apples were kept at room temperature for 14 days.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Initial Firmness</th>
<th>14 Days Firmness</th>
<th>Firmness Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gala</td>
<td>15.53</td>
<td>14.67</td>
<td>0.86</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>15.3</td>
<td>14.91</td>
<td>0.39</td>
</tr>
<tr>
<td>Jonagold</td>
<td>14.38</td>
<td>14.46</td>
<td>0.08</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>16.52</td>
<td>16.07</td>
<td>0.45</td>
</tr>
</tbody>
</table>

* SmartFresh℠ apples
• Control apples

SmartFresh℠ Quality Apples have a firmness 2–4 pounds higher than untreated control after 14 days at room temperature.
SmartFresh™ technology: Tomatoes

- Extend shelf life and marketable life by reducing:
  - rate of color change
  - rate of fruit softening
  - water loss
  - decay

- The response is affected by:
  - maturity stage when treated
  - type of tomato/variety
## Tomato maturity and color

<table>
<thead>
<tr>
<th>Maturity Stage</th>
<th>Mature Green</th>
<th>Breaker</th>
<th>Turning</th>
<th>Pink</th>
<th>Light Red</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Stage</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Hue</td>
<td>118</td>
<td>107</td>
<td>89</td>
<td>74</td>
<td>65</td>
<td>48</td>
</tr>
</tbody>
</table>

### Ideal Stage for SmartFreshSM Quality System:
USDA Stage 4
## Number of days to table ripe at 20°C/68°F ‘Bobcat’

<table>
<thead>
<tr>
<th>USDA Stage</th>
<th>Maturity</th>
<th>Control</th>
<th>SmartFresh&lt;sup&gt;SM&lt;/sup&gt; Quality System</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Breaker</td>
<td>7-8</td>
<td>17-18</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Turning</td>
<td>5-6</td>
<td>16+</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Pink</td>
<td>4</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Light Red</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
Color – USDA color chart

USDA Color Scale

Days at 20°C/68°F

Control

SmartFresh QS

Red (6)

Light Red (5)

Pink (4)
Firmness by non destructive methods

FirmTech
‘squeeze test’

Aweta Acoustic Firmness Sensor
‘acoustic test’

n=120 tomatoes
Decay incidence

![Graph showing decay incidence over time for Control and SmartFresh QS treatments.](image)

- **Control**
- **SmartFresh QS**

Days at 20°C/68°F

After 23 days

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Roma tomato held at 20°C/68°F

Treated at turning (3);
1 day at 20°C/68°F

Treated at light pink (5);
13 days at 20°C/68°F
Cherry tomato held at 20°C/68°F for 1 day
Grape Tomatoes

Day 7

SmartFresh™

Day 13

Control

Day 20

Control

AgroFresh Inc.
Tomatoes on the vine

Advantages:

- Better vine appearance
  - Greener
  - 5-10% less water loss from stems
  - Less Botrytis on the stem
- Reduced shatter, e.g. on bunched cherry tomatoes abscission was 58% in control fruit vs 14% in SmartFresh fruit (Lichter et al., 2006)

Note: Should be treated when least mature fruit is pink or light red (stage 4 or 5) to reduce variation within a bunch
Banana maturity

- **SmartFreshSM technology** is used after ripening fruit with ethylene
- **Applied at color stages 2.5 to 3.5**
Statistical analyses indicate that SmartFresh℠ technology significantly maintained overall appearance compared to untreated control fruit.
Banana color stage

Statistical analyses indicate that SmartFreshSM technology significantly delayed color development compared to untreated control fruit.
Banana color stage

Where each graph is the summary of 32 individual applications

Green diamonds = mean color stage per day

Dotted line = overall mean
Sugar spot development

Statistical analyses indicate that SmartFreshSM technology significantly delayed sugar spot development compared to untreated control fruit.
SmartFresh™ Technology: Plum

- Maintain fruit firmness
- Allow long term storage (90 days) e.g. Angeleno
- Reduce chilling injury (internal browning) in plums after long term storage e.g. Black Amber, Larry Ann

‘Fortune’ plums stored for 10 days at 32F, 7 days at 45F and 15 days at 64F
'Fortune'
10 days at 32F, 7 days at 45F and 15 days at 64F
'Owen T'

10 days at 32F, 7 days at 45F and 15 days at 64F
**SmartFresh™ Technology: Kiwifruit**

- Extend shelf life and marketable life by reducing:
  - rate of fruit softening
  - Protect from ethylene
  - Reduce shrink in the handling chain

![Graph 1: Firmness (lbf) during storage at 32°F/0°C for 3 months](image1)

![Graph 2: Firmness (lbf) during shelf life (68°F/20°C) after 3 months storage at 32°F/0°C](image2)

**Firmness (lbf) during storage at 32F/0C for 3 months**

**Firmness (lbf) during shelf life (68F/20C) after 3 months storage at 32F/0C**
Firmness of kiwifruit in the Supply Chain

Fruit stored in bins for 6 weeks prior to packing
SmartFresh™ technology: Pear
SmartFresh™ technology: Persimmon

Quality evaluation after several shelf-life periods @ 15° C (storage: 4 weeks @ -0,5° C)
Persimmon quality after 8 days of shelf-life @15° C
(storage: 4 weeks @ -0.5° C)
SmartFresh\textsuperscript{SM} technology: Mango

Shipment of ‘Kent’ mangoes to Europe at 13°C for 20 days followed by 7 days at 23°C
‘Tommy Atkins’ mango

After 13 days

Control

SmartFresh™ technology
SmartFresh™ technology: Papaya

Papaya Harvested at Maturity Stage 3 + 20 Days at 10°C

Control  SmartFresh™ technology

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# Solo Papaya

<table>
<thead>
<tr>
<th>Fruit ripeness stage (% skin yellowing)</th>
<th>Days at 22° C to full yellow</th>
<th>Control</th>
<th>SmartFresh&lt;sup&gt;SM&lt;/sup&gt; Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10%</td>
<td>7</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>20-30</td>
<td>7</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>40-50</td>
<td>6</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>60-70</td>
<td>4</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Manenoi, Bayogan, Thumdee & Paull. 2007
Postharvest Biology and Technology 44:55-62
SmartFresh℠ technology: Avocado

- Used after harvest in avocados shipped from Mexico, Chile, South Africa etc.
- Replaces CA, slows ripening and reduces internal disorders e.g. pulp discoloration and graying.

<table>
<thead>
<tr>
<th>Control</th>
<th>SmartFresh℠ technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Control" /></td>
<td><img src="image2" alt="SmartFresh℠ technology" /></td>
</tr>
</tbody>
</table>
SmartFresh℠ technology: Melons

‘Mission’ cantaloupes stored for:
20 days at 4°C/39°F and 1 and
5 days at room temp

Tuscan style melon
SmartFresh\textsuperscript{SM} technology: Vegetables

**Benefits seen on vegetables include**

- Reduced yellowing of leafy vegetables, herbs, beans and broccoli
- Reduced disorders e.g. browning and russet spotting of lettuce and spotting of beans
- Better flavor e.g. reduced bitterness in carrots
- And probably many more undiscovered benefits...
SmartFresh™ Technology: Cucumber

- ‘Sweet Marketmore’ slicing cucumbers after 10 days at 15°C/59°F
EthylBloc™ technology for ornamentals

Carnation

Rose

Control  EthylBloc

Control  EthylBloc
### Cut flowers - Carnations

After 7 days of vase life

<table>
<thead>
<tr>
<th>Variety</th>
<th>Source</th>
<th>Treatment</th>
<th>Vase life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Sim</td>
<td>California</td>
<td>Control</td>
<td>0.1 a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EthylBloc Sachet</td>
<td>12.8 b</td>
</tr>
<tr>
<td>Unknown white</td>
<td>Colombia</td>
<td>Control</td>
<td>0.1 a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EthylBloc Sachet</td>
<td>12.1 b</td>
</tr>
<tr>
<td>Unknown pink</td>
<td>Colombia</td>
<td>Control</td>
<td>0.2 a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EthylBloc Sachet</td>
<td>10.3 b</td>
</tr>
<tr>
<td>Unknown lavender</td>
<td>Colombia</td>
<td>Control</td>
<td>0.2 a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EthylBloc Sachet</td>
<td>14.2 b</td>
</tr>
</tbody>
</table>

n=150 or 200 stems/treatment; All flowers challenged with 2 ppm ethylene for 24 hours
Flowers were stored for 7 days at 36°F + 6 days at 70°F after exposure to ethylene.
Vinca ‘Cora White’

New Guinea Impatiens
Aralia

‘Parsley’
3 days in box

Control  EB sachet

‘Castor’
1 day in box

Control  EB sachet

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Thank You