Loss of Flavor Precedes Loss of Appearance Quality

Marita Cantwell
Mann Lab, Dept. Plant Sciences, UC Davis
mcantwell@ucdavis.edu

2010 Dietary Guidelines for Americans

FOODS TO INCREASE
- Half the plate should be fruits and vegetables
- Switch to fat-free or low-fat (1%) milk.

BALANCE CALORIES
- Enjoy your food, but eat less.
- Avoid oversized portions.

FOOD TO DECREASE
- Eat foods with lower sodium
- Drink water instead of sugary drinks.


General Principles

- Consumers judge quality of products on basis of appearance and freshness at time of purchase
- Satisfaction for eating quality (texture and flavor) affects repeat purchases
- Consumers also interested in nutritional quality and safety

Factors that influence U.S. Consumers’ Produce Purchases

References: Flavor-life and Shelf-life


General Principles

- Fresher the product (time), better the flavor
  - True for vegetables
  - More complicated for fruits that require ripening
- Adhering to storage and handling guidelines results in better flavor
- Postharvest treatments may extend shelf-life but not preserve flavor
Quality Definitions

- Quality is the degree of excellence or superiority
- Quality is the totality of features and characteristics of a product that affect ability to satisfy
- Quality is any feature that makes something what it is
- Quality if the state of being free from defects, deficiencies, significant variations

Modified from slides of Kader and Mitcham, UC Davis

Flavor-Life vs Shelf-life

- Definitions are difficult: Everyone has own criteria
- Acceptability; below certain limit, product is rejected
- Shelf-life is the time before the product attributes drop below the acceptance limit
- Flavor-life is the time........
- Consumer integrates all sensory inputs (appearance, texture, taste, aroma, off-flavors) for a final judgement


Flavor life

- Flavor quality is a complex assessment.
- Loss of flavor or end of flavor-life is associated with losses in sugars, acids and aroma volatiles (especially esters)
- Loss of flavor may also be due to development of off-flavors (fermentative metabolism or odor transfer)

Why don't we routinely evaluate flavor life when evaluating shelf-life?

- Flavor analysis is complex
  - Sugars, acids
  - Volatiles; which impact flavor; threshold
- Sensory work can be difficult for fresh fruits and vegetables
  - Sensory perception of flavor affected by texture
- Use physical and chemical measurements to approximate flavor and sensory evaluations

How are objective/subjective evaluations related to sensory quality?
Do they approximate sensory quality?

Quality Changes in Cilantro During Storage

<table>
<thead>
<tr>
<th>Storage temp.</th>
<th>10 days</th>
<th>14 days</th>
<th>18 days</th>
<th>22 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32°F (0°C)</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>41°F (5°C)</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>45°F (7.5°C)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>% Green Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32°F (0°C)</td>
<td>96</td>
<td>94</td>
<td>92</td>
<td>87</td>
</tr>
<tr>
<td>41°F (5°C)</td>
<td>95</td>
<td>92</td>
<td>87</td>
<td>81</td>
</tr>
<tr>
<td>45°F (7.5°C)</td>
<td>48</td>
<td>25</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>Aroma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32°F (0°C)</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>41°F (5°C)</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>45°F (7.5°C)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

Challenges for Melon Quality
Fresh-cut products

| APPEARANCE QUALITY |
| COLOR |
| FIRMNESS |
| FLAVOR; EATING QUALITY |

Maturity: sugars vs firmness
Taste-life vs Shelf-life

Sugar loss in fresh-cut cantaloupe at 5°C may be considerable, but Soluble solids do not change much; Sugar loss typically is not as extreme as in this example.

Relative Importance of Temperature and Modified Atmospheres for Fresh-cut melon

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Atmosphere</th>
<th>Visual Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5°C (45°F)</td>
<td>Air CA 3% O2 + 10% CO2</td>
<td>10 days</td>
</tr>
<tr>
<td>5°C (41°F)</td>
<td>Air 1% O2</td>
<td>10 days</td>
</tr>
<tr>
<td>2.5°C (36°F)</td>
<td>Air + 10% CO2</td>
<td>10 days</td>
</tr>
</tbody>
</table>

Fresh-cut Cantaloupe: Temperature and Atmosphere

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Atmosphere</th>
<th>Visual Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5°C (45°F)</td>
<td>Air CA 3% O2 + 10% CO2</td>
<td>10 days</td>
</tr>
<tr>
<td>5°C (41°F)</td>
<td>Air 1% O2</td>
<td>10 days</td>
</tr>
<tr>
<td>2.5°C (36°F)</td>
<td>Air + 10% CO2</td>
<td>10 days</td>
</tr>
</tbody>
</table>
Sensory Fresh-cut melon altered after 4 days at 4°C
Visual appearance acceptable up to 10 days

A = Air + 1% CO₂
B = 5% O₂ + 5% CO₂
C = 10% O₂ + 5% CO₂


Fresh-cut green pepper stored in air and CA.

Flavor and texture affected before declines in visual quality

Fresh-cut Fruits
Flavor vs Shelf-life

- Freshcut honeydew melon stored in air at 5°C for 6 days: good appearance but lacked acceptable texture and had flat flavor
- Fresh-cut pineapple stored at 4°C had excellent visual appearance
- after 7 to 10 days, but off flavors associated with microbial fermentation.
- Fresh-cut orange segments at 4°C had acceptable appearance after 14 days, but unacceptable flavor quality after 5 days
- Sliced watermelon had good appearance and odor after 7 days at 5°C, but flavor not acceptable.

Examples from Forney 2008 and Barrett et al. 2010.

Grape Tomatoes stored 18 days at 5°C in air or CA

Aroma and flavor change after about 12 days at 5°C under all atmospheres

A = Air + 1% CO₂
B = 5% O₂ + 5% CO₂
C = 10% O₂ + 5% CO₂

Stewart Postharvest Review, June, 2008
Shelf-life/Handling and Flavor Quality
Tomato as Example

- Ripe fruit appearance acceptable and fruit marketable
- 40 cm drop during ripening; internal bruising affected chemical composition of locule and pericarp tissues (decrease acids, Vit C, carotenoids)
- Panelists could distinguish flavor of bruised and unbruised fruit when red (bruised were 'bland')
- Internal bruising affects aroma volatile profiles in tomato; changes in synthesis from lipid, carotenoid and amino acid pathways due to bruising

Moretti et al. 1998. J. ASHS 123: 656

CA and 1-MCP treatments maintain firmness in stored apples
- Storage conditions and time result in decreased aroma volatile production
- Consumers prefer crispy less aromatic apples over softer, more aromatic apples

Moretti et al. 1998. J. ASHS 123: 656

Do these fresh-cut fruits taste as good as they look?

Apples Flavor Quality and Storage

- CA and 1-MCP treatments maintain firmness in stored apples
- Storage conditions and time result in decreased aroma volatile production
- Consumers prefer crispy less aromatic apples over softer, more aromatic apples

CA and 1-MCP treatments maintain firmness in stored apples
- Storage conditions and time result in decreased aroma volatile production
- Consumers prefer crispy less aromatic apples over softer, more aromatic apples

Fellman et al. 2003. Flavor regeneration after CA storage of apples. PH Biol. Tech. 27: 39

Based on Appearance (Visual Quality)

- CA and 1-MCP treatments maintain firmness in stored apples
- Storage conditions and time result in decreased aroma volatile production
- Consumers prefer crispy less aromatic apples over softer, more aromatic apples

CA and 1-MCP treatments maintain firmness in stored apples
- Storage conditions and time result in decreased aroma volatile production
- Consumers prefer crispy less aromatic apples over softer, more aromatic apples

Fellman et al. 2003. Flavor regeneration after CA storage of apples. PH Biol. Tech. 27: 39

Do these fresh-cut fruits taste as good as they look?

AA Kader, UC Davis