Postharvest Handling Update
Cool Season Vegetables

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UCCE Vegetable Pest Management and Postharvest Issues
Santa Maria, June 9, 2010
Produce Facts

- Harvest indices
- Quality indices
- Temperature and RH
- Freezing point/damage
- Respiration rates
- Ethylene production
- Effects of ethylene
- Effects of modified atmospheres
- Physiological disorders
- Postharvest diseases
- Mechanical injury
- PHOTOS

140
Fruits
Vegetables
Flowers
Causes of Quality & Postharvest Losses

Leafy Vegetables

- Lettuces
- Spinach
- Cabbage
- Chard
- Broccoli
- Celery
- Herbs
- Endives
- Asparagus
- Green Onions

- Water loss
- Mechanical damage
- Loss of chlorophyll and other nutrients
- Respiration rates
- Microbial growth
- Sensitivity to ethylene
Fresh Produce Deterioration

- Metabolic changes:
  - respiration, ethylene,
  - texture, aroma, etc.
- Growth and development
- Transpiration
- Mechanical injury
- Physiological disorders
- Decay; microbial growth

Temperature Affects All Causes of Deterioration
Postharvest Handling Update
Cool Season Vegetables

• Broccoli
  – Iced to iceless product; firmness and water loss
• Specialty Brassicas
  – Compare postharvest performance to broccoli
• Fresh-cut and modified atmospheres
  – Response of broccoli and sugar snap peas
• Cauliflower -- needs postharvest work
• Cabbage Quality and Temperature
• Lettuce Varieties
  – Fresh-cut performance
Storage temperature
Days (to initiate yellowing)

Broccoli Shelf-life & Temperature
cv. Legacy

Fresh appearance
Green florets
Tender stem
No discoloration
No breakage
No decay
No off-odors
Broccoli Compositional Quality and Storage Temperature

Chlorophyll

Carotenoids

Ascorbic Acid

Sugars

(limit of salability)

Cantwell, unpublished
Loss of green color by mature and immature Kale leaves stored at 4 temperatures for up to 18 days.
1-MCP=1-methyl-cyclopropene, SmartFresh™, AgroFresh
Broccoli and Temperature and 1-MCP (no ethylene exposure)

A. Chlorophyll

B. Sugar

A. Vitamin C (AA + DHA)

B. Glucoraphinin

Glucoraphin produces Sulforaphane – potent Phase 2 Enzyme Inducer, inhibit cancer
### Specialty Brassicas Comparative Study

**Gai-lan**

**Choi-sum**

**Broccoli raab, rapini**

**Broccolini**

![Specialty Brassicas Image]

<table>
<thead>
<tr>
<th>Component</th>
<th>Florets</th>
<th>Stem Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>5C, 8d</td>
</tr>
<tr>
<td>Total sugars, mg/gFW</td>
<td>5.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Ammonia, μmole/100gFW</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Antioxidant activity mg Trolox/100gFW</td>
<td>117</td>
<td>100</td>
</tr>
<tr>
<td>Vitamin C, mg/100g FW</td>
<td>235</td>
<td>176</td>
</tr>
</tbody>
</table>

Changes in ammonia and GS activity in Spinach

Changes in ammonia in spinach at 4 temperatures over 18 days

6 days, data of Eghle Catalano, 2007
A. Ethanol

B. Acetaldehyde

C. Ammonia

D. Sugars

Test #2
18 days at 5°C (41°F)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3+7</td>
<td>3+12</td>
<td>3+18</td>
<td>10+12</td>
<td>Air</td>
</tr>
</tbody>
</table>

DAMAGING

Air=Best quality
Broccoli Storage Conditions

- 0°C with very high humidity
- MA: 5-8% O2 + 7-10% CO2

Iceless Broccoli
Temperature-yellowing
Moisture loss-softening
Table 1. Broccoli head firmness and compactness scoring and the relationship to firmness measurements on texture analyzer. This table based on preliminary 2009 data.

<table>
<thead>
<tr>
<th>Subjective score</th>
<th>Description</th>
<th>Objective firmness N compression force*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Heads hard, very tight and firm</td>
<td>65-100N</td>
</tr>
<tr>
<td>4</td>
<td>Heads firm, a few outer florets may be loosened</td>
<td>50-80</td>
</tr>
<tr>
<td>3</td>
<td>Heads moderately firm, with some florets loosened**</td>
<td>40-60</td>
</tr>
<tr>
<td>2</td>
<td>Heads moderately soft, with most florets loosened</td>
<td>25-40</td>
</tr>
<tr>
<td>1</td>
<td>Heads soft, with extensive loosening of florets</td>
<td>10-25</td>
</tr>
</tbody>
</table>

*Heads compressed with a flat disc to a depth of 7.5 mm

**A score of 3 is likely the limit of marketability at retail.
A. % Weight Loss

Curve 1, \( y = 1.55x + 0.34; R^2 = 0.98 \)
Curve 2, \( y = 1.72x + 0.36; R^2 = 0.98 \)

B. % Firmness Loss

- Minimize delay from harvest to cooling
- Use plastic liners to reduce water loss
- Keep it cold
14 days 5°C (41°F)

- 5% O₂
- 5% O₂ + 7.5% CO₂
- 5% O₂ + 15% CO₂
14d 5°C

Air                        1%O₂ +15% CO₂

Quality Problems
Graying
Loss of fluid
Off-odor
Cauliflower Quality

- color is cream white
- freedom from mechanical injury
- freedom from decay
- overall attractive appearance
- no discoloration on cut edges
- minimal number of small pieces; good integrity of cut florets
- good aroma and odor as fresh or microwaved food
- retain high content of sugars and Vitamin C

RESEARCH TO DO

- Evaluate the performance of cultivars for quality of fresh market and fresh-cut product
- Evaluate the impact of initial postharvest handling on the shelf-life and quality of fresh-cut cauliflower florets.
- Evaluate the impact of production conditions (seasonability, fertilization, irrigation) on the quality and shelf-life of cauliflower florets
Napa or Chinese cabbage
Black Speck Disorder
Black Speck Disorder on Chinese Cabbage

- Black speck development on Napa cabbage stored in air or in ethylene is the same.
- PAL enzyme levels similar; 1-MCP does not reduce black speck.
- Cultivars vary greatly in their susceptibility to black speck.

Black speck index = black speck score multiplied by % extension.
Cabbage Quality and Temperature

CDFA WIC Stores Small Farm Program Project
Shermain Hardesty, Lucia Kaiser, and Advisors

• Retail handling—good to poor conditions
• Impact on marketability and nutritional value—conditions to retain 80% original nutrition
• Vitamin C, Antioxidant Activity, Carotenoids
• Wide range of temperatures (0-29°C; 32-84°F)
• Cabbage performs well over temp range—should be available in all WIC stores
Fresh-cut Lettuces
Varieties of Iceberg, Romaine and Crosses

- Performance as fresh-cut product
  - Visual quality score
  - Discoloration
  - Decay

- Respiration rates

- Phenolics and phenolic enzymes (PAL, PPO)

- Composition
  - Number leaves per head
  - % dry weight
  - Sugars
  - Chlorophyll and carotenoids
  - Vitamin C
  - Ammonia
Discoloration Rating Scale for Romaine

1 3

2

3

4

5
Romaine lettuce

Leaf position (after trimming)

Total sugars (mg/g fwt.)

<table>
<thead>
<tr>
<th>Leaf Position</th>
<th>0 days</th>
<th>7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Inner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midsize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full size Outer</td>
<td></td>
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LSD.05

Total sugars

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LSD.05

Vitamin C (Total Ascorbic Acid)

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<td></td>
<td></td>
</tr>
<tr>
<td>Full size Outer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LSD.05

Leaf Position

Romaine lettuce
Development of Russet Spot Disorder on Iceberg and Romaine Lettuces. Intact heads were stored in 5ppm ethylene at 5°C (41°F) plus 1 week in air.

<table>
<thead>
<tr>
<th>Variety</th>
<th>1=Sonoma</th>
<th>2=Spreckles</th>
<th>3=Salinas 521</th>
<th>4=Raider</th>
<th>5=Salinas 517</th>
<th>6=Buena Vista</th>
<th>7=Stinger</th>
<th>8=Van Sal 210</th>
<th>9=Salinas</th>
<th>10=Ace</th>
<th>11=Champ</th>
<th>12=Salinas 88</th>
<th>13=Ridgemark</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Iceberg Lettuces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety</th>
<th>1=Paris Island Cos</th>
<th>2=Romo</th>
<th>3=Red Eye Cos</th>
<th>4=Gx800</th>
<th>5=Corazon</th>
<th>6=Red Hot Cos</th>
<th>7=Nero</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Romaine Lettuces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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Cantwell, UC Davis, unpublished
Is Temperature a Quality Issue or a Food Safety Issue?

✓ Prevention of Contamination is most important
✓ Time and Temperature are Amplifiers of Risk
10 Basic Postharvest Principles

1) Harvest at correct maturity
2) Reduce physical handling
3) Protect product from sun
4) Keep packingline 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