Factors to consider when ripening avocado

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Limitations to avocado postharvest handling

- Time after harvest (fruit age)
- Stage of ripeness - more difficult to handle “ripe” fruit
- Mismanagement at any point in the handling chain
- Fruit maturity

What we know about the avocado and why it responds to ethylene

- A climacteric fruit showing an increase in respiration and ethylene production during ripening
- Influenced by maturity, time after harvest, temperature and atmosphere

Adapted from Eaks (1978) for ‘Hass’
Susceptibility to low storage temperatures

External Chilling Injury

Internal Chilling Injury

Postharvest Diseases

Body Rot

Stem End Rot

Why Ripen Avocados?

Increase Uniformity
Decrease Checkerboarding

Relationship between dry matter (maturity) and final peel color

Final Peel Color = 3.06261 - 0.00264DW + 0.0020DW^2

where DW = Dry weight

R^2 = 0.621 ***

Untreated, fruit ripening may range from a few days to even weeks within a carton

Why Ripen Avocados?

Increase Uniformity
Decrease Checkerboarding
**Maturity and “days to ripe”**

- Ethylene hastens ripening regardless of stage of maturity.

**Time after harvest**

- Ethylene has maximum benefit within 1-2 weeks of harvest.
- Imported fruit if conventional shipment will need less time (24 hours or less).
- Imported fruit if CA shipped or 1-MCP treated may need longer treatment times.

**Hass Seasonality/Quality**

<table>
<thead>
<tr>
<th>Season</th>
<th>Ethylene Treatment</th>
<th>Best Fruit Quality</th>
<th>After Ripenfruit May Be:</th>
<th>After Ripenfruit Will Be:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Season</td>
<td>Highly Recommended (checkerboarding)</td>
<td>No shriveling</td>
<td>Not fully colored</td>
<td>Green-black to black in color</td>
</tr>
<tr>
<td>Mid Season</td>
<td>Responds well to ethylene treatment</td>
<td>Little decay except when harvested after rain</td>
<td>Watery texture</td>
<td>Creamy texture</td>
</tr>
<tr>
<td>Late Season</td>
<td>Little or no ethylene needed</td>
<td>Most tolerant of long term storage</td>
<td>Bland or grassy flavor</td>
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<td>Fruit more prone to: Decay</td>
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<tr>
<td></td>
<td>Internal disorders</td>
<td>• Difficult to store long term</td>
<td>• Black in color</td>
<td>• Creamy to dry texture</td>
</tr>
<tr>
<td></td>
<td>Most susceptible to low temperature</td>
<td>• Uneven ripening</td>
<td>• Difficult to Peel</td>
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**Time after harvest**

- Time after harvest decreases the impact of ethylene.

California 'Hass'; average of 3 harvests, 3 grower lots per harvest, 2006.
Even within lots of fruit there is variability in ripening—a way to control this is sorting by degree of ripeness into different categories.

Management Issues

Temperature
Ventilation/Air exchanges

✓ Careful Monitoring
✓ Prompt Movement of fruit
✓ What is the proper stage of ripeness?
✓ Where do you ripen the fruit?

Suggested treatment times for California 'Hass' avocados

• Early season fruit (November - February) 36 - 72 hours
• Mid-season fruit (March - June) 24 - 36 hours
• Late season fruit (July - October) 8 - 24 hours +/- ethylene

Factors under your control

Educate yourself about the potential differences between varying sources of fruit—there are differences

• Pre-ripening inspection
• Ripening management
• Post-ripening management
Ripening Management

- Uniform heating and cooling is ABSOLUTELY ESSENTIAL
- Refrigeration needs to control the heat (6000 BTU per pallet)
- Forced air ripening is critical (1000 cfm/pallet)
- Venting (preferably flow through, keep CO₂ below 1%)
- Source of Ethylene - as low as possible; physiologically you only need ~10 ppm but practically use 60 - 100 ppm
- Fruit needs to be easily accessible in ripening room for monitoring; especially if fruit is of varying arrival condition or multiple lots of fruit
- Keep good records

Can I use a banana ripening room for avocado ripening?

Some considerations

Can I use a banana room….. With some practical modifications

Refrigeration during ripening and cooling of fruit likely to be insufficient in a banana room
- Hot spots within pallet
- Uneven ripening
Do not to overload the room
Ethylene dose considerations

- Ethylene concentration
  - >20 ppm; no more than 100 ppm
- Fruit Maturity
  - Less mature; longer treatment
- Time after Harvest
  - With increasing time after harvest; shorter durations needed

Temperature Management

- Avocados have a VERY high rate of respiration during ripening = HEAT
- Efficient warming/cooling of fruit essential
- Airflow essential to maintain proper pulp temperature (20°C)

Impact of high temperatures
- Delayed/uneven ripening
- Increased decay

How much to apply?

Short exposures to ethylene can trigger ripening; threshold is believed to be around 10 ppm

Commercial application of 60 - 100 ppm is recommended

Source: I. L. Eaks, UC, Riverside

The impact of Temperature (24 or 48 hours) on ripening performance of ‘Hass’ avocado

- High temperatures are DETRIMENTAL
- The outcome is delayed or inhibited ripening and increased decay
- Keep temperatures below 21°C

No significant difference due to duration
Ripening temperature influences final peel color

Cox et al., 2004, PH Biol. Tech.

Ripening Hass at different temperatures

How long can I hold ripe or partially ripe fruit?

- Fruit continue to soften in storage
- Partially ripened fruit held at 50°F (10°C) can develop pink staining especially if held longer than 1 week
- Fruit can be successfully held at 34°F (1°C) for up to a week
- Is there a difference in eating quality?

Ripening Management
When do you turn off the gas?

- You don’t need the gas until ripe; a short duration treatment will “trigger” ripening
- Fruit may soften but may not color - maturity and other factors involved
- The best way to gauge the rate of softening is with a penetrometer...not your fingertips or buttons “popping”
- Fruit maturity is an important variable

The penetrometer is a tool to judge the relative stage of ripeness
Managing Ripe Fruit

• Decay increases with increasing ripeness; accelerates in “overripe” fruit
• Don’t hold fruit for long periods of time that are partially ripe – increased chilling injury
• Bruising increases with advancing ripeness – Protect fruit
• Peel color at “slicing” or “guacamole” ripe does not necessarily mean the fruit needs to be completely black!

These are issues wherever fruit are ripened

The outcome of “ripe” fruit

Ripe fruit at retail level has greatly increased consumption,
HOWEVER.....
• Greater challenge in temperature management
• Fruit sensitivity to damage greatly enhanced

Considerations for successful avocado ripening

• Temperature management is CRITICAL
  - Too high; ripening inhibited and increased decay
  - Too low; ripening is slowed and lose benefit
• Fruit Maturity
  - More mature; less time
• Time after Harvest
  - After storage; less time
• Avoids delays in marketing
• Minimize fruit handling

Checklist
Know the history of the fruit
Quality: don’t use stressed fruit
Standardize fruit size and maturity
Uniform warming and cooling
Careful monitoring; don’t overripen

CONSUMER/MARKET Education

Additional information

• Contact me
  mlarpaia@ucanr.edu
• UC Davis Postharvest Center website
  http://postharvest.ucdavis.edu/
• California Avocado Commission website
  http://www.californiaavocado.com/ripening-and-handling/
• General information on avocados
  www.avocadosource.com
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Sensory panel analysis
- Texture
- Flavor
- Overall acceptability

Back to the consumer - Flavor

Relationship between oil and acceptability

- Minimum acceptable taste score = 7
- Demonstrated close relationship between oil and dry matter
- HASS variety
  - Oil content = 11.2%
  - Dry weight equivalent = 22.8%

Avocado texture and acceptability

- Firm Texture
- Watery Texture
- Smooth Texture
- Creamy Texture

Taste and oil development during maturation of 'Fuerte' fruit grown at Irvine.
Avocado flavor and acceptability

Changes in key sensory attributes and “grassy” volatile content associated with increasing maturity

What is the effect of maturity on flavor and what drives these flavor changes?

Summary

1. Avocados that were most liked by our sensory panelists were described as having a creamy, smooth, buttery texture with richness, nuttiness and a minimum of grassy flavor.
2. Avocados contain aroma volatiles that likely help determine the flavor.
3. Aldehydes, such as hexanal, were clearly associated with grassy flavor.
4. Ripening led to a decline in soluble carbohydrates and in a number of aroma volatiles, hexanal being the most prominent.