Recommendations for Maintaining Postharvest Quality

Keri L. Morrelli and Adel A. Kader
Department of Plant Sciences, University of California, Davis

MATURITY INDICES
Degree of fullness of the fingers, i.e. disappearance of angularity in a cross section. Specialty bananas are harvest mature-green and are ripened upon arrival at destination markets.

QUALITY INDICES
- Maturity (the more mature, the better quality when ripe)
- Finger length (dependent on cultivar)
- Freedom from defects, such as insect injury, physical damage, scar and decay
- As specialty bananas ripen, their starch content is converted into sugars (increased sweetness)
- Other constituents that influence flavor include acids and volatiles

OPTIMUM TEMPERATURE (VARIES AMONG CULTIVARS)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Petite’ and ‘Yangambi’</td>
<td>11°C (52°F) for up to 7 days</td>
</tr>
<tr>
<td>‘Red Macabu’</td>
<td>10°C (50°F) for up to 7 days</td>
</tr>
<tr>
<td>‘Petite’ and other cultivars</td>
<td>12.5-14°C (54.5-57.2°F) for longer than 7 days</td>
</tr>
</tbody>
</table>

OPTIMUM RELATIVE HUMIDITY
90-95%

RATES OF RESPIRATION

<table>
<thead>
<tr>
<th>Temperature</th>
<th>10°C (50°F)</th>
<th>12.5°C (54.5°F)</th>
<th>14°C (57.2°F)</th>
<th>20°C (68°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ml CO₂/kg·hr &lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>12-17</td>
<td>22-45</td>
<td>24-53</td>
<td>79-170</td>
</tr>
</tbody>
</table>

<sup>1</sup> Low end for mature-green bananas and high end for ripening bananas.
<sup>2</sup> To calculate heat production, multiple ml CO₂/kg·h by 440 to Btu/ton/day or by 122 to get kcal/metric ton/day.

RATES OF ETHYLENE PRODUCTION (PETITE CULTIVAR)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>10°C (50°F)</th>
<th>12.5°C (54.5°F)</th>
<th>14°C (57.2°F)</th>
<th>20°C (68°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ul C₂H₄/kg·hr &lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.09-0.16</td>
<td>0.2-0.9</td>
<td>0.2-0.7</td>
<td>1.1-2.0</td>
</tr>
</tbody>
</table>

<sup>1</sup> Low end for mature-green bananas and high end for ripening bananas.
RESPONSES TO ETHYLENE

Most commercial cultivars of bananas require exposure to 100-150 ppm ethylene for 24-48 hours at 15-20°C (59-65°F) and 90-95% relative humidity to induce uniform ripening. Carbon dioxide concentration should be kept below 1% to avoid its effect on delaying ethylene action. Use of a forced-air system in ripening rooms assures more uniform cooling or warming of bananas as needed and more uniform ethylene concentration throughout the ripening room.

RESPONSES TO CONTROLLED ATMOSPHERES (CA)

- Optimum CA: 2% O₂ and 5-10% CO₂ (dependent on cultivar)
- CA delays ripening, reduces respiration and ethylene production rates

PHYSIOLOGICAL AND PHYSICAL DISORDERS

**Chilling Injury.** Symptoms include peel browning, dull or smoky peel coloration, subepidermal vascular browning, abnormal ripening, and in severe cases, failure to ripen. Chilling sensitivity varies among cultivars. Chilling injury results from exposure of ‘Petite’ bananas to temperatures lower than or equal to 10°C (50°F) for 7 or more days of storage or below 12.5°C (54.5°F) for 21 days of storage. ‘Yangambi’ bananas are subject to chilling injury when stored at temperatures less than or equal to 10°C (50°F) for 7 days. ‘Red Macabu’ bananas are subject to chilling injury when stored for 5 days at temperatures below 10°C (50°F). Chilled fruit are more sensitive to mechanical damage and postharvest decay.

**Skin Abrasions.** Abrasions result from skin scuffing against other fruit, surfaces of handling equipment, or shipping boxes. When exposed to low (<90%) relative humidity conditions, water loss from scuffed areas is accelerated and peel color turns brown and in severe cases, black. This symptom is similar to severe peel browning associated with chilling injury.

**Impact bruising.** Dropping of bananas may induce browning of the flesh with or without damage to the skin. In some cases, damaged areas may become infected with fungal growth.

PATHOLOGICAL DISORDERS

**Crown Rot.** This disease is caused by one or more of the following fungi: *Thielaviopsis paradoxa, Lasiodiplodia theobromae, Colletotrichum musae, Deightonialla torulosa*, and *Fusarium roseum*, which attack the cut surface of the hands. From the rotting hand tissue the fungi grown into the finger neck and with time, down into the fruit.

**Anthracnose.** Caused by *Colletotrichum musae*, becomes evident as the bananas ripen, especially in wounds and skin splits.

**Stem-end rot.** Caused by *Lasiodiplodia theobromae* and/or *Thielaviopsis paradoxa*, which enter through the cut stem or hand. The invaded flesh becomes soft and water-soaked.

**Cigar-end rot.** Caused by *Verticillum theobromae* and/or *Trachyspaera fructigena*. The rotted portion of the banana finger is dry and tends to adhere to fruits (appears similar to the ash of a cigar).

CONTROL STRATEGIES

Minimizing bruising; prompt cooling to 14°C (57°F); proper sanitation of handling facilities; hot water treatments [such as 5 minutes in 50°C (122°F) water] and/or fungicide (such as Imazalil) treatment to control crown rot.
POSTHARVEST PHOTO GUIDE

MATURITY AND QUALITY

PETITE RIPENESS CHART

ETHYLENE EFFECTS

DISORDERS

PETITIE CHILLING INJURY
It is the policy of the University of California not to engage in discrimination against or harassment of any person, employed by or seeking employment with the University, or in any of its programs or activities, on the basis of race, color, national origin, religion, sex, gender, gender expression, gender identity, pregnancy, physical or mental disability, medical condition (cancer-related or genetic characteristics), genetic information (including family medical history), ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services, as well as state military and naval service. This policy is intended to be consistent with the provisions of applicable state and federal laws and University policies. University policy also prohibits retaliation against any employee or person seeking employment for bringing a complaint of discrimination or harassment pursuant to this policy. This policy also prohibits retaliation against a person who assists someone with a complaint of discrimination or harassment, or participants in any manner in an investigation or resolution of a complaint of discrimination or harassment. Retaliation includes threats, intimidation, reprisals, and/or adverse...

In addition, it is the policy of the University of California to undertake affirmative action, consistent with its obligations as a Federal Contractor, for minorities and women, for persons with disabilities, and for covered veterans. The University commits itself to apply every good faith effort to achieve prompt and full utilization of minorities and women in all segments of its workforce where deficiencies exist. These efforts conform to all current legal and regulatory requirements, and are consistent with University standards of quality and excellence. In conformance with Federal regulations, written affirmative action plans shall be prepared and maintained by each campus of the University of California, by the Lawrence Berkeley National Laboratory, by the Office of the President, and by the Division of Agriculture and Natural Resources. Such plans shall be reviewed and approved by the Office of the President and the Office of the General Counsel before they are officially promulgated. Inquiries regarding the University’s equal employment opportunity policies may be directed to the Affirmative Action Contact, University of California, Agriculture and Natural Resources, 2801 Second Street, Davis, CA 95618 (530) 750-1318.