**Banana, Plantain**

**Recommendations for Maintaining Postharvest Quality**

_Keri L. Morrelli and Adel A. Kader_
_Department of Plant Sciences, University of California, Davis_

### Maturity Indices

Maturity can be judged by the angularity of the fingers. Plantains are harvested mature-green and may or may not be ripened upon arrival at destination markets since plantains are eaten both at the mature-green stage and when fully yellow.

### Quality Indices

Finger size (minimum length of 22 cm = 9 inches). Freedom from mechanical damage, scars, insect damage, disease and chemical residues.

### Optimum Temperature

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Optimum Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2–10°C (45-50°F) for up to 7 days</td>
<td>90-95%</td>
</tr>
<tr>
<td>10–12°C (50-54°F) for longer than 7 days</td>
<td></td>
</tr>
</tbody>
</table>

### Rates of Respiration

<table>
<thead>
<tr>
<th>Temperature</th>
<th>13°C (56°F)</th>
<th>15°C (59°F)</th>
<th>18°C (65°F)</th>
<th>20°C (68°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ml CO₂/kg·hr¹,²</td>
<td>10-30</td>
<td>12-40</td>
<td>15-60</td>
<td>20-70</td>
</tr>
</tbody>
</table>

¹Low end for mature-green plantains and high end for ripening plantains.

²To calculate heat production multiply ml CO₂/kg·hr by 440 to get BTU/ton/day or by 122 to get kcal/metric ton/day.

### Rates of Ethylene Production

<table>
<thead>
<tr>
<th>Temperature</th>
<th>7.2°C (45°F)</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>µl C₂H₄/kg·hr¹</td>
<td>0.01-0.05</td>
<td>0.01-0.26</td>
<td>0.01-0.11</td>
<td>0.01-0.12</td>
<td>0.01-2.58</td>
</tr>
</tbody>
</table>

¹Low end for mature-green plantains and high end for ripening plantains.

### Responses to Ethylene

Ethylene stimulates ripening of plantains. Thus, plantains that are marketed mature-green should be protected from exposure to ethylene. Plantains that are marketed ripe should be ripened with bananas (exposure to 100-150 ppm ethylene for 24-48 hours at 15-20°C = 59-68°F and 90-95% relative humidity).
## RESPONSES TO CONTROLLED ATMOSPHERES (CA)

- **Optimum CA:** 2% O₂ and 5-10% CO₂
- CA delays ripening, reduces respiration and ethylene production rates, and maintains overall appearance of the fruit.
- CA may decrease the occurrence of subepidermal browning at marginally low temperatures.

## PHYSICAL DISORDERS

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

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

## PHYSIOLOGICAL DISORDERS

- **Chilling Injury.** Symptoms include peel browning, dull or smoky peel coloration, subepidermal vascular browning, abnormal ripening (possible acceleration); and in severe cases failure to ripen. Chilling injury results from exposure of plantains to temperatures less than or equal to 7.2°C (45°F) for 7 or more days, depending on cultivar, maturity, and temperature. Chilled fruit are more sensitive to mechanical damage and postharvest decay.

## 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 grow 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 *Verticillium theobromae* and/or *Trachysphaera fructigena*. The rotted portion of the plantain finger is dry and tends to adhere to fruits (appears similar to the ash of a cigar).

- **Control strategies.** Minimizing bruising; prompt cooling to 12°C (54°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

- RIPENING VARIABILITY
- RIPE AND GREEN PLANTAINS

DISORDERS

- CHILLING INJURY SYMPTOMS
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.