QUALITY OF IRRADIATED TROPICAL FRUIT

Marisa Wall
U.S. Pacific Basin Agricultural Research Center, Hilo, HI
Hawaii: Irradiation treatments approved for export to U.S.

**Fruit**
- Abiu
- Atemoya
- Banana
- Breadfruit
- Dragon fruit
- Guava
- Jackfruit
- Longan
- Lychee
- Mango
- Mangosteen
- Melon
- Papaya
- Pineapple
- Rambutan
- Sapodilla
- Star fruit

**Vegetable**
- Bell pepper
- Eggplant
- Long bean
- Moringa
- Squash
- Sweet potato
- Tomato
Regulations key to the adoption of irradiation as a quarantine treatment

- FDA approved irradiation doses up to 1000 Gy for preservation and disinfestation of fresh fruits and vegetables (1986).

  150 Gy tephritid fruit flies
  400 Gy all insects except Lepidoptera
Irradiation tolerance of fresh commodities

The effective irradiation dose for quarantine treatment may be very close to the phytotoxic limit.
Possible adverse effects of irradiation on fruit quality

- Softening
- Altered ripening
- Pitting, darkening, discoloration, scalding
- Loss of flavor or aroma
- Higher disease incidence
- Lower vitamin C and organic acids
Research objectives: Determine postharvest quality at potential maximum irradiation doses to ensure fruit quality while providing quarantine security.

Factors that influence fruit tolerance:

- Cultivar
- Harvest season
- Fruit maturity
- Initial quality
- Dose
Hawaii Pride

- E-beam source converted to X-ray irradiation
- Designed for fresh produce
- Low dose uniformity ratio
Dosimetry

For fruit quality research, extensive dose mapping provides low dose uniformity ratios (1.05 to 1.15).

<table>
<thead>
<tr>
<th>Dosimetry Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCN Number: 20040584</td>
</tr>
<tr>
<td>Processing Facility: Hilo</td>
</tr>
<tr>
<td>Customer: Hawaii Pride</td>
</tr>
<tr>
<td>SPSA: HP01</td>
</tr>
<tr>
<td>Product: Papaya - 10 lb Net</td>
</tr>
<tr>
<td>Lot(s): 329-P1</td>
</tr>
<tr>
<td>Cases: 30</td>
</tr>
<tr>
<td>Date Processed: 11/24/2004</td>
</tr>
<tr>
<td>Date Read: 11/24/2004</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitoring DSM Position</th>
<th>DSM Pack. Number</th>
<th>Absorbance Reading (mODU)</th>
<th>Average Absorbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD</td>
<td>853</td>
<td>0.816</td>
<td>0.820</td>
</tr>
<tr>
<td>STANDARD</td>
<td>829</td>
<td>0.796</td>
<td>0.799</td>
</tr>
<tr>
<td>Correlated Dmin, Gy</td>
<td>478</td>
<td>464</td>
<td>655</td>
</tr>
<tr>
<td>Correlated Dmax, Gy</td>
<td>853</td>
<td>829</td>
<td></td>
</tr>
</tbody>
</table>

Commercial Max/Min Ratio
Tropical fruit = 1.5
Sweet potato = 2.0
Irradiation research: Multiple variables measured to determine postharvest quality at a range of irradiation doses.

- Initial maturity
- CO$_2$ & C$_2$H$_4$ rates
- Firmness (peel and flesh)
- Weight loss
- Color (peel and flesh)
- Disease incidence
- Injury rating
- Days to ripe; shelf life
- Composition
Irradiation of mixed fruit boxes

Single commodity vs. Mixed commodity

Doses: 0, 400, 800 Gy
Is tropical fruit quality affected when mixtures of fruit are irradiated?

Mixed fruit

Single fruit types
Expt. 1: single vs. mixed fruit boxes

Banana, Mango, Lychee, Papaya

BML, BPL, BMP, PML
Expt. 1: Tropical fruit irradiated, stored, ripened, and evaluated

Irradiation
0, 400, & 800 Gy

Storage
1 week at 10°C

Ripening
22°C

Quality analyses: days to ripe, weight loss, color, firmness, disease, scald, soluble solids, acidity
Irradiated single vs. mixed fruit treatments

No differences for:
- days to ripe
- weight loss
- quality rating
- disease rating
- firmness
- soluble solids
- acidity
Fruit mixture impacts peel injury rating

Banana

Mango

Banana 0 Gy

BPL 800 Gy

Mango 0 Gy

BPM 800 Gy
Irradiation dose impacts peel injury & flesh firmness

Scald rating:
1 = 1-20%
3 = 41-60%
5 = 81-100%

Fruit type
Banana Papaya Mango Lychee

Scald rating
0 Gy 400 Gy 800 Gy

Flesh firmness (N)
0 Gy 400 Gy 800 Gy
Irradiation dose and final quality rating

<table>
<thead>
<tr>
<th>Fruit type</th>
<th>0 Gy</th>
<th>400 Gy</th>
<th>800 Gy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papaya</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mango</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lychee</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Denotes significant difference.
Expt. 2: single vs. mixed fruit boxes

- Dragon fruit
- Pineapple
- Longan
- Papaya

PiPD  PiPL  PiDL  PDL
Dragon fruit tolerate irradiation at 800 Gy
Papayas tolerate irradiation at 800 Gy.

Some fruit at all doses developed stem-end rot.
Longan: some peel darkening after irradiation

0 Gy vs. 400 Gy

0 Gy vs. 800 Gy

* Darkening may vary with harvest maturity.
Pineapple: variable response to dose

Less mature fruit may have improper ripening after 800 Gy treatment.

Bract damage at 800 Gy
Conclusions: irradiating fruit mixtures

- Tropical fruit have similar irradiation tolerance when treated as single or mixed fruit boxes.
- Exception: banana scald at 800 Gy + greater with papaya & lychee - lower with papaya & mango
Conclusions: irradiating fruit mixtures

- Most tolerant fruit types: dragon fruit, papaya, mango
- Need to test this mixture.
- Lower doses for: banana, longan, pineapple
- Use 150 Gy generic dose for less tolerant fruit.
- Other fruit & combinations?
Considerations for irradiation treatment:

- Dose uniformity
- Cultivar
- Fruit maturity or stage of ripeness
- Fruit condition at harvest
- Postharvest and storage conditions
- Mode of transport
Mahalo!