Effect of Irradiation on Fruit Quality and Nutritional Value

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Outline

• Effects of phytosanitary irradiation on fruit
  • Intrinsic factors
  • Effect on post harvest physiology
  • Extrinsic factors
  • Nutritional value

• Research next steps
• Cold treatment
• Phytosanitary doses are low!
Benefits

• Efficacy
• Treatment
• Non-thermal/ non-chemical process
• Facilitates trade
Quality dependent on

Intrinsic factors:
• Fruit
• Variety
• Climacteric versus non-climacteric
• Maturity stage
• Composition

Extrinsic factors:
• Dose
• Temperature
• Atmosphere/Packaging
• Handling
• Initial microbial load
Fruit with high tolerance to phytosanitary doses

- Apples
- Blueberries
- Cherries
- Dragon fruit
- Figs
- Grapes
- Guava
- Longan
- Lychees
- Mangoes
- Papaya
- Peaches
- Pitaya
- Pomegranates
- Rambutan
But tolerance depends on variety
Radiation is a type of stress...

- Temperature
- Wounding
- Radiation
- Atmospheric Change
- Hormones
- Chemicals

Reactive Oxygen Species (ROS)

- Oxygen: $O_2$
- Superoxide anion: $\cdot O_2^-$
- Peroxide: $\cdot O_2^{-2}$
- Hydrogen Peroxide: $H_2O_2$
- Hydroxyl radical: $\cdot OH$
- Hydroxyl ion: $OH^-$
Irradiation → ROS → Membrane Damage → ↑↓ key enzymes

- Respiration
  - Carbohydrates/Acids → Flavor
- Ethylene
  - Ripening enzymes
- PAL
  - Phenylpropanoid metabolism
    - Soluble phenolics → Antioxidant capacity
- Membrane Damage
  - Electrolyte leakage
  - Lipid oxidation
  - Browning/Pitting/scald
- Macromolecules
  - Texture Flavor
- Signaling pathways and gene expression
  - Key enzymes
- Texture Color Aroma Flavor
- Ripening enzymes
  - Phenylpropanoid metabolism
Oxidative Stress

Robards et al. (1999); Toivonen (2004)
Climacteric

- Apples
- Figs
- Guava
- Mangoes
- Papaya
- Peaches

Non-climacteric

- Blueberries
- Cherries
- Dragon fruit
- Grapes
- Longan
- Lychees
- Pitaya
- Pomegranates
- Rambutan
Respiration Rate

Gala apples

CO₂ (mL/Kg*h)

Days

Control
250 Gy
500 Gy
N-DPA Granny Smith apples

![Graph showing ethylene and respiration rate over days for different treatments.](image-url)
Delayed ripening

Wall 2012
Accelerated ripening
Maturity stage
Temperature

Control

400 Gy

Fumigated
Handling

Day 1 after irradiation

3 weeks

4 weeks

Control 150 Gy 1000 Gy

Doi: 10.1016/j.scienta.2017.01.029
Handling

Navel oranges after 28-day storage

- Control
- 0.2KGY
- 0.4KGY
- 0.6KGY

commercial storage

stored at 3°C

http://dx.doi.org/10.1016/j.postharvbio.2013.06.018
Packaging

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<th>Irr</th>
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<th>MAP</th>
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Doi: 10.1002/jsfa.7648
Effect on spoilage organisms

Control  Irradiated  Fumigated

Scientia Horticulturae 201: 109-117.
Effect on pathogens

![Graph showing the effect on pathogens over time. The x-axis represents days from harvest, and the y-axis represents log_{10} CFU/g. Graph includes data for Listeria (Control), Listeria (IRR), Salmonella (Control), and Salmonella (IRR). Doi: 10.1002/jsfa.7648]
Effect of irradiation on nutrients

• Fruit is a good source of potassium, vitamin C, folic acid, vitamin C, phytonutrients, fiber

• PI dose is too low to impact macronutrients
• Fat Soluble: Vitamin E < carotene < A < D < K
• Water soluble: Vitamins B1 < C < B6 < B2 < Folate < B3 < B12
Kishu mandarins

http://dx.doi.org/10.1016/j.foodchem.2017.02.126
Low Dose Gamma Irradiation Does Not Affect the Quality or Total Ascorbic Acid Concentration of •Sweetheart• •Passionfruit (Passiflora edulis)
- Phenolic biosynthesis

http://www.mdpi.com/2077-0472/2/3/259/htm
Total phenolic content (mg GAE/L) vs. Storage (days)

http://dx.doi.org/10.1016/j.foodchem.2017.02.125
Chemical and sensory quality of fresh pomegranate fruits exposed to gamma radiation as quarantine treatment

http://dx.doi.org/10.1016/j.foodchem.2013.08.052
• Establish quality standards
  • Best varieties
  • Maturity at harvest/treatment for non-climacteric fruit
  • Climacteric stage
  • Package configuration

• Effect of commercial conditions of distribution and storage

• For sensitive fruit, mitigate quality impacts
  • Modified atmosphere technology
Anderson Melo
Nasim Kheshti
Alan Baquero
Thank you

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