Postharvest Handling of Mango

Cultivar Differences

Tommy Atkins Mango

Kent Mango

Keitt Mango

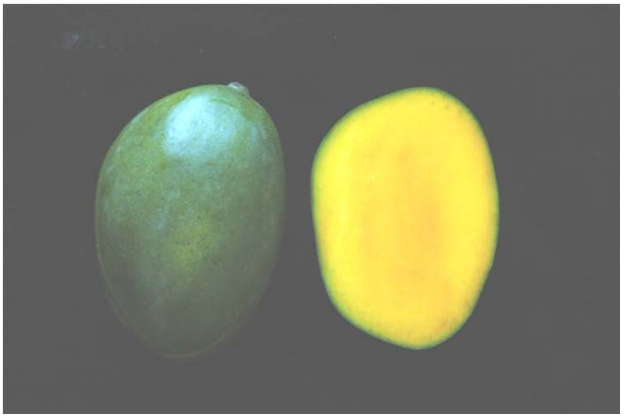
Haden Mango

Ataulfo Mango

Assessing Maturity & Eating Quality Potential

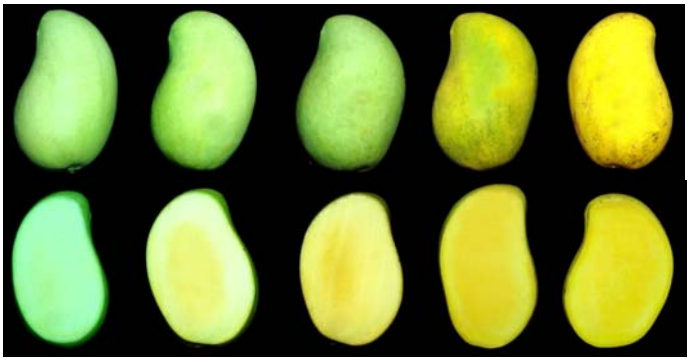
- Maturity at harvest determines eating quality potential
  - Skin color
    - Dark green to light green in some cultivars
    - Red color is not related to maturity or ripeness
  - Fruit shape
    - Fullness of cheeks
    - Shape of shoulders
  - Internal flesh color
    - Greenish-white to yellowish-orange

Skin Color



Skin color is not always related to internal color and ripeness!

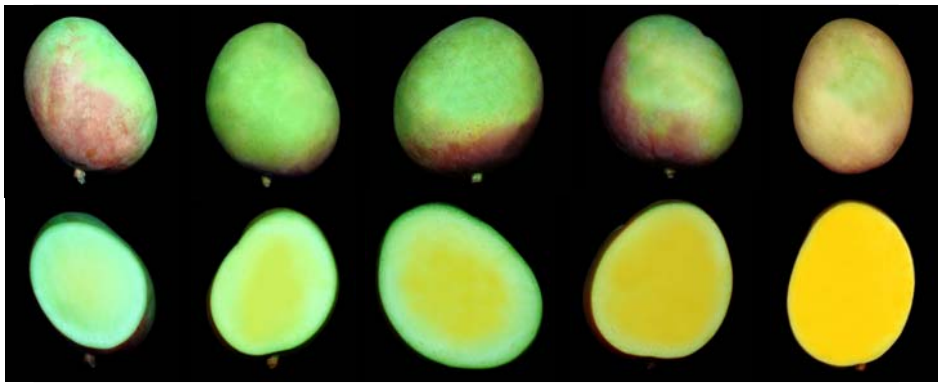
Ataulfo Color Stages



1 2 3 4 5

Fernando Mau

Tommy Atkins Color Stages

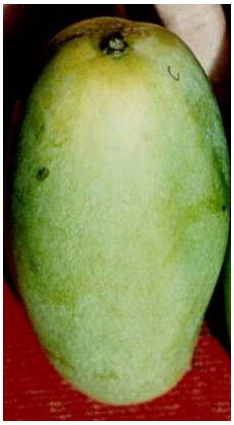


1 2 3 4 5

Fernando Mau

Fruit Shape

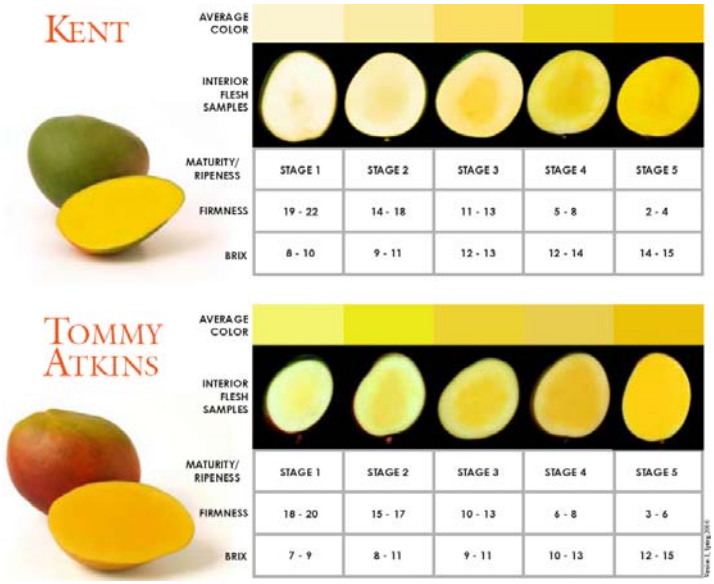
Immature



Mature

- Fullness of cheeks
- Elevation of shoulders above the stem attachment

Mango Maturity and Ripening Charts



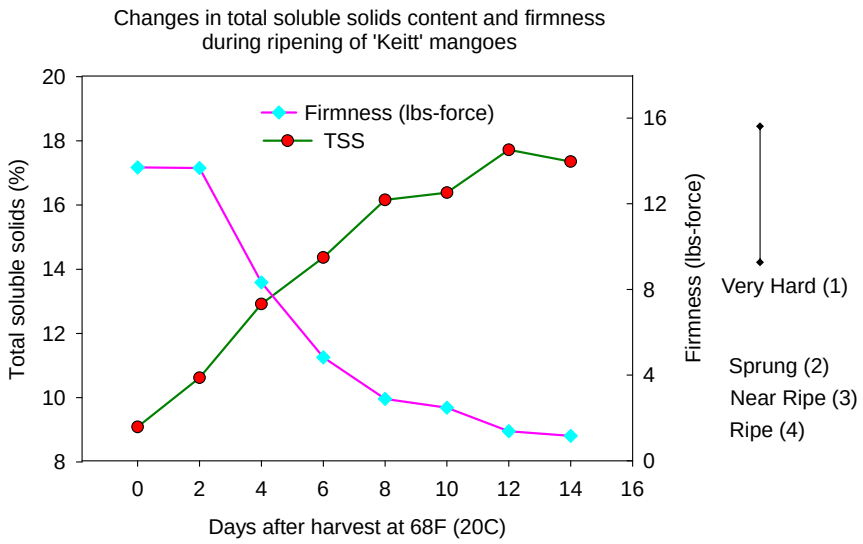
European (OECD) Standards. Mango Maturity

Not allowed	Not allowed	ALLOWED	Not allowed
			
Underdeveloped immature	Not sufficiently mature to continue ripening process	Mature Fruit	Overripe Fruit

Changes Associated with Mango Ripening

- Skin color changes from green to yellow (in some cultivars)
- Flesh color changes from greenish-yellow to yellow to orange (in all cultivars)
- Decrease in flesh firmness and increased juiciness
- Starch is converted into sugars
- Increase in soluble solids content
- Increase in carotenoids and decrease in chlorophyll content
- Increase in characteristic aroma volatiles

Changes with Ripening



Harvest

- Mangos are harvested when the fruit have reached their full size and have begun to ripen, which starts inside the fruit
- The fruit are carefully detached so that they don't fall to the ground, and are collected in plastic field crates



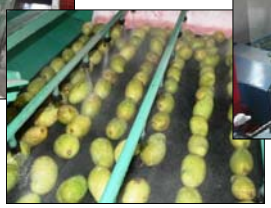


Harvest tools that allow retention of stem prevent latex staining
Angle of the hook is important to ensure snapping the fruit with stem

Mango Manila Harvest
Veracruz, Mexico
Marita Cantwell

Washing and Pre-sizing

- First the mangos are washed, then they are pre-sized according to guidelines for quarantine treatment, when required



Hot Water Quarantine Treatment

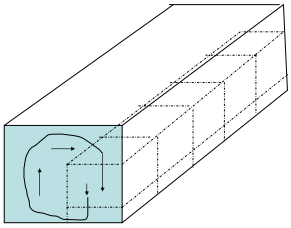
- Mangos exported to the U.S. must be immersed in 46°C/115°F water for 60 to 110 minutes depending on variety and fruit size in USDA APHIS-certified hot water treatment systems.

Hydro-cooling & Staging for Packing

- After their hot bath, the mangos are cooled in water that is no cooler than 21°C/70°F as prescribed by APHIS
  - cool enough to guard against hot water injury
  - not too cool to counteract the hot water treatment's effectiveness against fruit flies
- Fruit should be packed immediately or placed temporarily in cold room at 12C

Forced Hot Air Treatment

Heat fruit to 117F (47C), hold 20-30 min



Irradiation for Control of Fruit Flies

Common Name	Scientific Name	Min. Dose (Gy)
Oriental fruit fly	*Bactrocera dorsalis*	250
Med. fruit fly	*Ceratitis capitata*	225
Melon fly	*Bactrocera cucurbitae*	210
Caribbean fruit fly	*Anastrepha suspensa*	150
Mexican fruit fly	*Anastrepha ludens*	150
West Indian fruit fly	*Anastrepha oblique*	150
Sapote fruit fly	*Anastrepha serpentine*	150
Queensland fruit fly	*Bacterocera tryoni*	150
No common name	*Bacterocera jarvisi*	150

Packing

- The mangos may be coated with carnauba wax for appearance and for protection from water loss
- The mangos are sorted and graded to remove the fruit that are not good enough to satisfy the market
- Most mangos are hand sized as the cartons are filled






Forced-air cooling & Refrigerated Storage

- Mangos are cooled to their optimum storage and transport temperature of 12°C/54°F
- Mangos may be stored at 12°C/54°F, but only long enough to accommodate shipping schedules

Common Defects

- Latex staining (only affects appearance, not eating quality
- Hot water injury
- Decay
  - Anthracnose
  - Stem-end rot
- Chilling injury

Latex Staining




Hot Water Injury

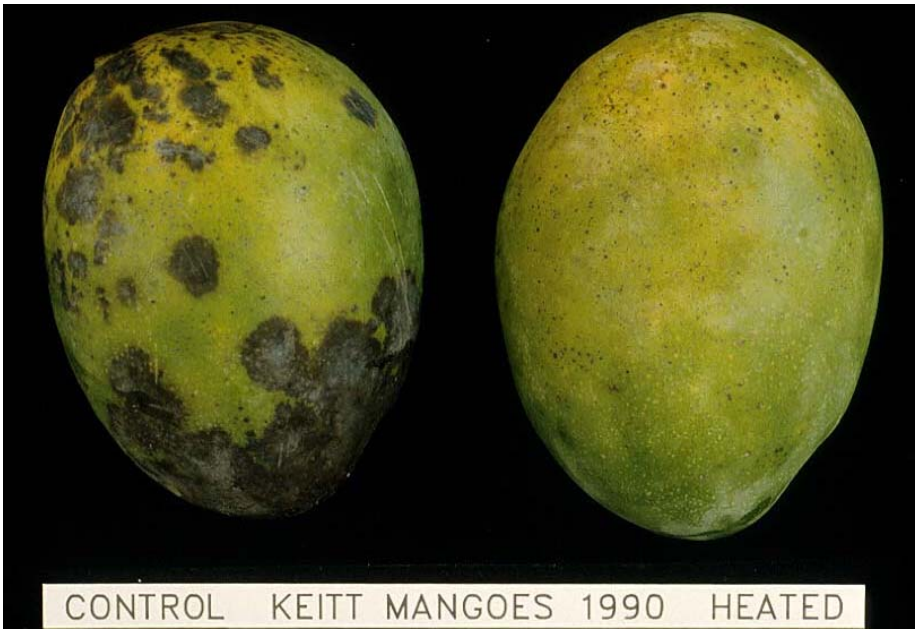



Anthracnose Decay

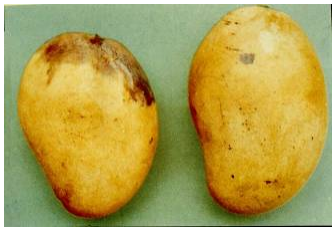
Decay Control

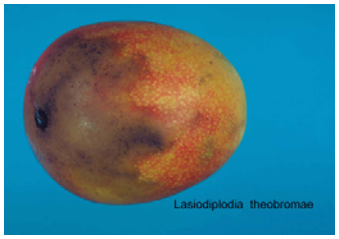
- Hot water immersion
  - 50 to 55ºC for 1 to 5 minutes
- Fungicides, may be included in hot water
- Bagging before harvest
- Irradiation not very effective at doses allowed

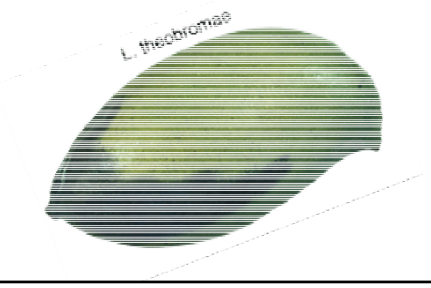
Heat Treatment Reduces Anthracnose Incidence and Severity on Mangoes



Stem-End Rot







Chilling Injury

Chilling Injury Symptoms on Mangoes

- Uneven ripening
- Poor color and flavor development
- Surface pitting
- Grayish scald-like skin discoloration
- Flesh browning in severe cases

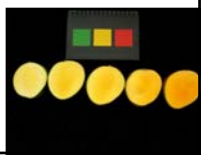
"Safe" chilling threshold temperatures* for different varieties/maturities of mangos (research is ongoing)

Variety	Maturity/Ripeness Stage**				
	1	2	3	4	5
Ataulfo**	>55°F	>55°F	>55°F	>55°F	>55°F
Keitt	55°F	50°F	45-50°F	45°F	45°F
Kent	55°F	55°F	55°F	50°F	50°F
Tommy Atkins	55°F	55°F	55°F	45-50°F	45°F

*Based on continuous exposure for 3 weeks

**Ataulfo fruit developed chilling injury at all temperatures tested; a chilling threshold temperature was not established.

Brecht et al. 2013



Mango Storage Temperatures

- Mature green mangos
  - Store/ship at 54ºF (12.2ºC)
- Ripe mangos
  - Store/ship at 46ºF (7.8ºC) to 50ºF (10ºC)

Ripening Conditions for Mangoes
Ethylene treatment accelerates ripening

Fruit temperature:	**20 to 22°C (68-72°F)**
Relative humidity:	**90-95%**
Ethylene concentration:	**100-150ppm**
Duration of exposure to ethylene:	**12-48 hours**
Carbon dioxide:	**<1%**

After ethylene treatment for 24 hours, mangos are ripe in 5-9 days at 18-22°C. Once ripe, can be held at 10-13°C for up to 1 week.

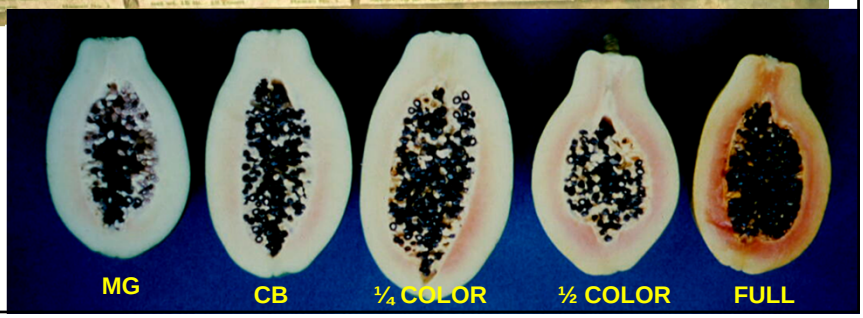
Papaya

Carica papaya

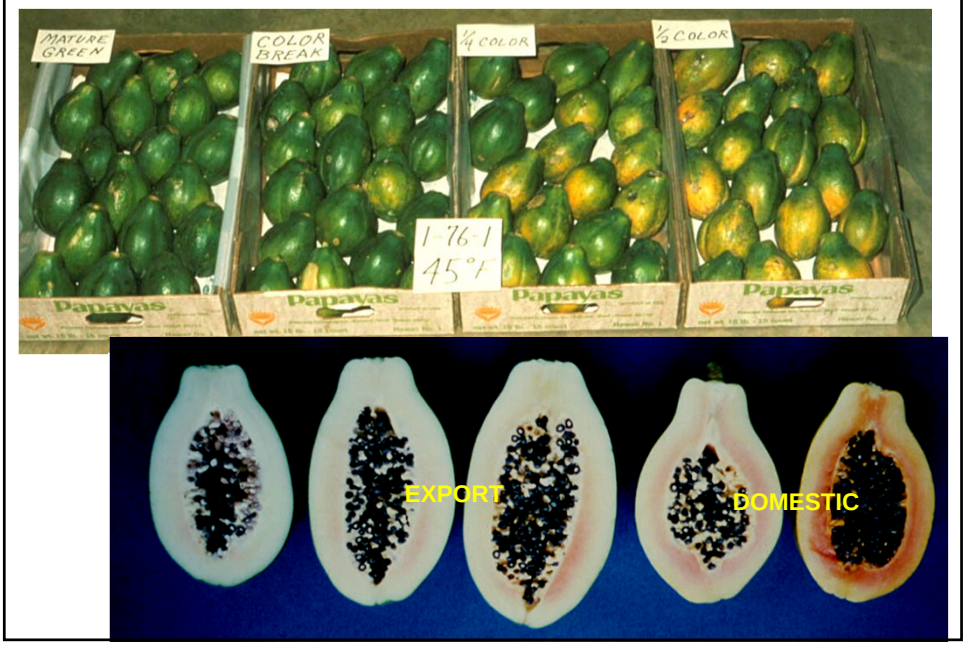
Papaya

- **Latex**
  - **In every part of plant**
  - **Contains two proteases**
    - **Papain and chymopapain**
    - **Sold as meat tenderizer**
- **Tree trained to single trunk**
- **Fruit buds form progressively higher**
  - **Oldest fruit is lowest**

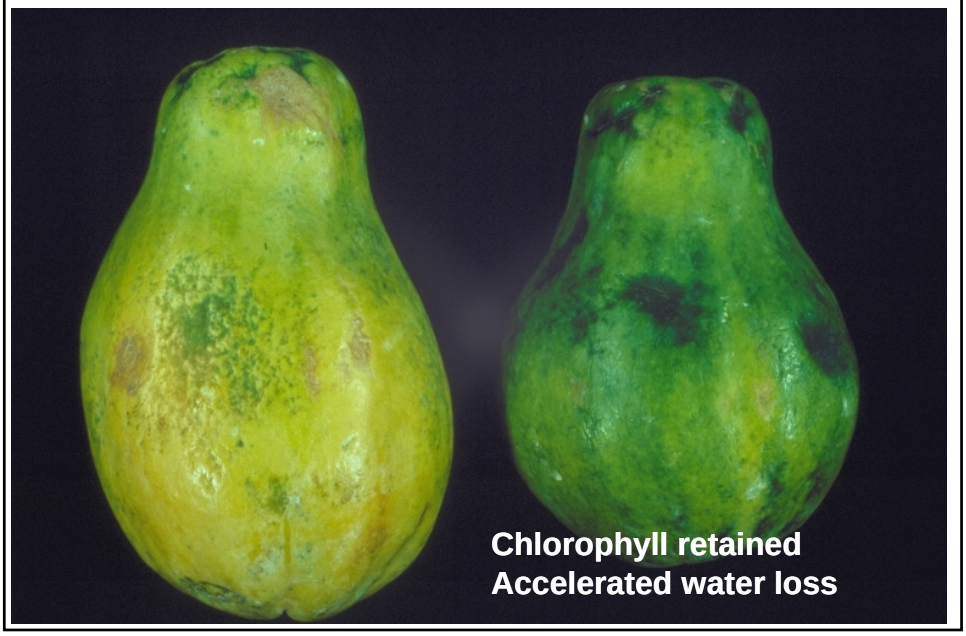
Maturity – minimum 11.5% SS = 6% color



Maturity – minimum 11.5% SS = 6% color



Green Islands from Skin Abrasions



Chilling Injury

- Mature green
  - 10 days at 2°C
  - 20 days at 7.5°C
- ½ yellow
  - 17 days at 2°C
- Preconditioning (partial ripening) reduces chilling sensitivity

Recommended Temperatures

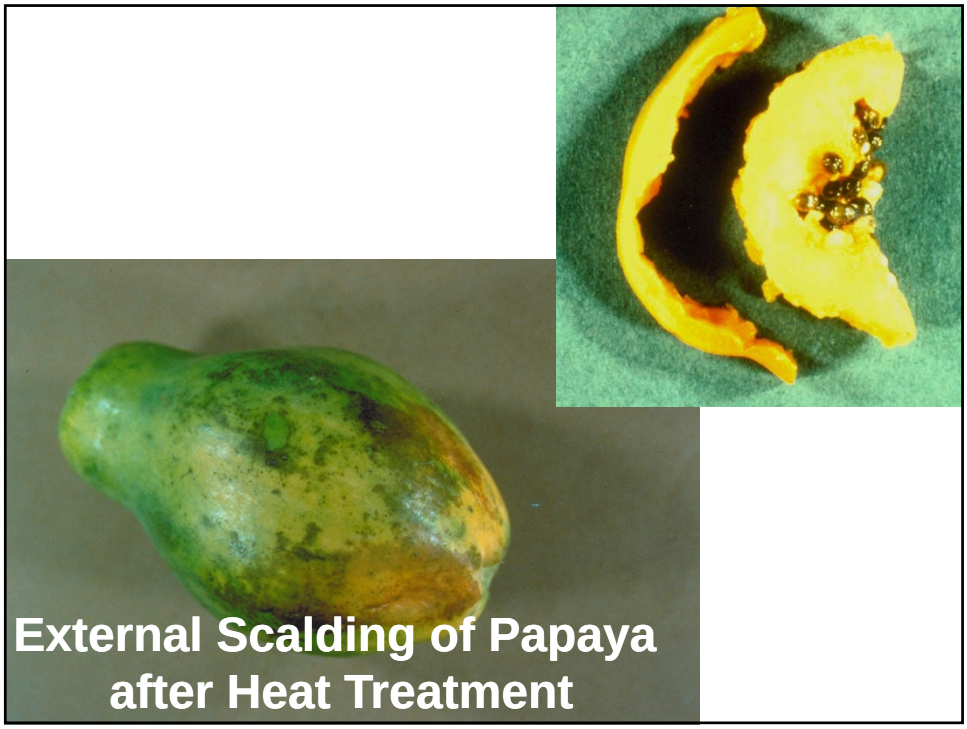
- 13°C for mature green to ¼ yellow
- 10°C for partially ripe (1/4 to ½ yellow)
- 7°C for ripe (> ½ yellow)

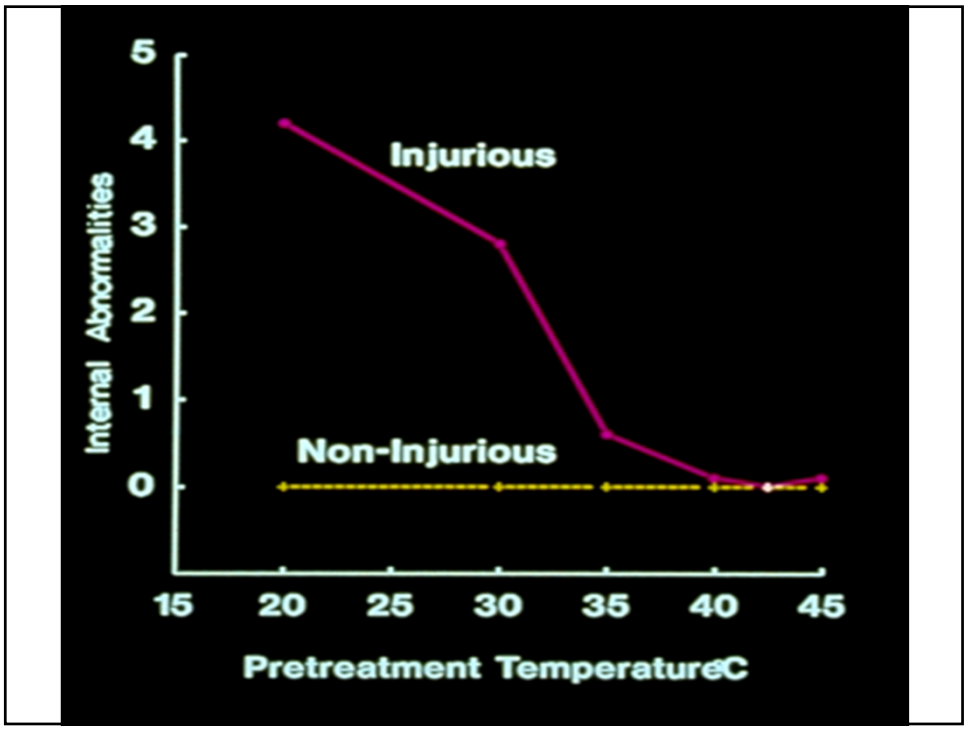
Controlled Atmosphere Storage

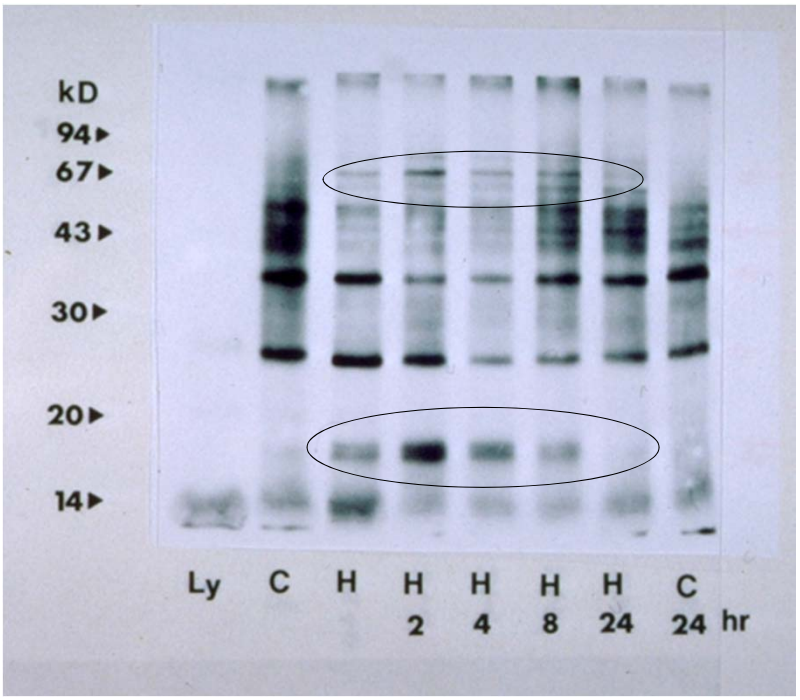
- Limited research
- Optimum 3 to 5% O_2 + 5 to 8% CO_2
- Postharvest life at 13ºC
  - 2 to 4 weeks in air
  - 3 to 5 weeks in CA
- Damaging atmospheres
  - < 2% O_2; > 8% CO_2

Quarantine Treatments

- Forced hot air
  - Multi-staged treatment
  - 48.5°C for 3 hours
- Irradiation
  - Slowed softening
  - Effect depends on fruit stage at treatment
    - MG – no effect on softening
    - 30% color – slower softening after 250 Gy


External Scalding of Papaya
after Heat Treatment


Internal Abnormalities
0
1
2
3
4
5
Injurious
Non-Injurious
15
20
25
30
35
40
45
Pretreatment Temperature C



Methods to Reduce Heat Sensitivity

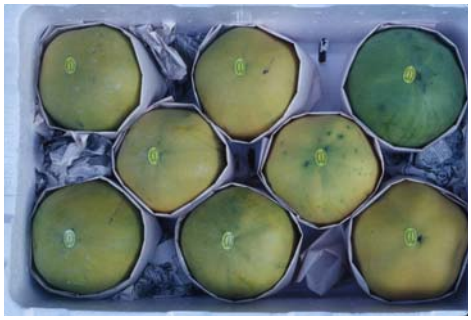
- **Continuous**
  - **Hold at temperature below 40°C for 2 to 4 hours**
- **Heat Pulse**
  - **1 hour at 38°C, wait 3 hours, then treat**
  - **30 min at 42°C, cool to 20°C, then treat**

Initial washing and sorting by maturity

Hot Water Treatment for Anthracnose Control

Marking largest fruit before hot air treatment


PAPAYAS



Questions?

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