Root, Tubers & Bulbs

A	B	C
Rutabaga	Sunchoke	Cassava
Carrots	Horseradish	Sweetpotato
Radish	Celeriac	Yam
Beet	Salsify	Taro
Onion	Parsnip	Jicama
Garlic	Turnip	Potato

Storage Temperatures Roots, Tubers and Bulbs

- Chilling insensitive roots: 0-5°C (32-41°F)
- Chilling sensitive roots: 10-15°C (50-59°F)

Processing Baby Peeled Carrots

- Washing
- Disinfecting
- Rapid cooling
- Cut to 2 inch sections
- Mechanical Peeling
- Mechanical shaping
- Disinfection
- Cooling
- Computerized quality and color sorting
- VFS packaging

GRIMMWAY FARMS

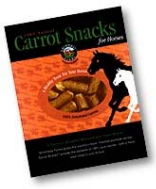
CRINKLE-CUT COINS

CARROT STICKS

SHREDDED CARROTS

There's Always Something New at Grimmway Farms!

CARROT DIPPERS™



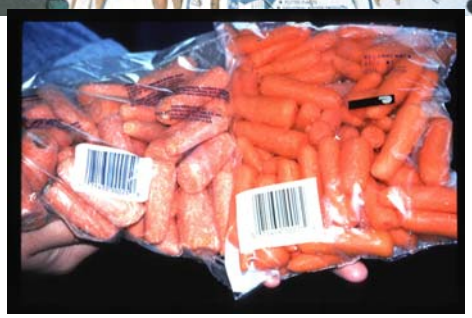
CARROT SNACKS™ for **Horses!**

CARROT CHIPS™

http://www.grimmway.com

Baby carrots

“Baby” carrots

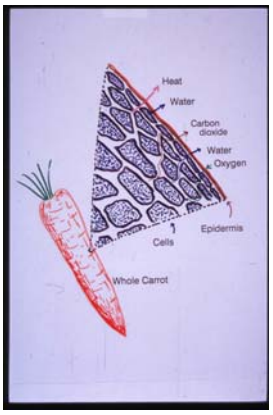


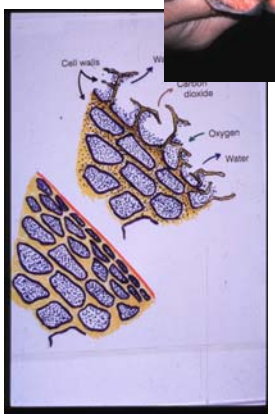
Carrot varieties

Carotene-uniformity of color
Sugar
Fiber-texture

Longitudinal cracking is highly dependent on variety

Abrasion peeling of carrots leads to fragmented cell walls that dry out and result in "white blush"; can rehydrate carrots.





Diagrams from Saltveit, UC Davis

New equipment automatically peels and then cuts the carrots; have less problem with "white blush"

White blush or chalking is Minimized at low temperature or with hygroscopic coatings

Carrots do not respond well to Modified atmospheres

Free moisture in the bag favors Decay (5°C 1 month)

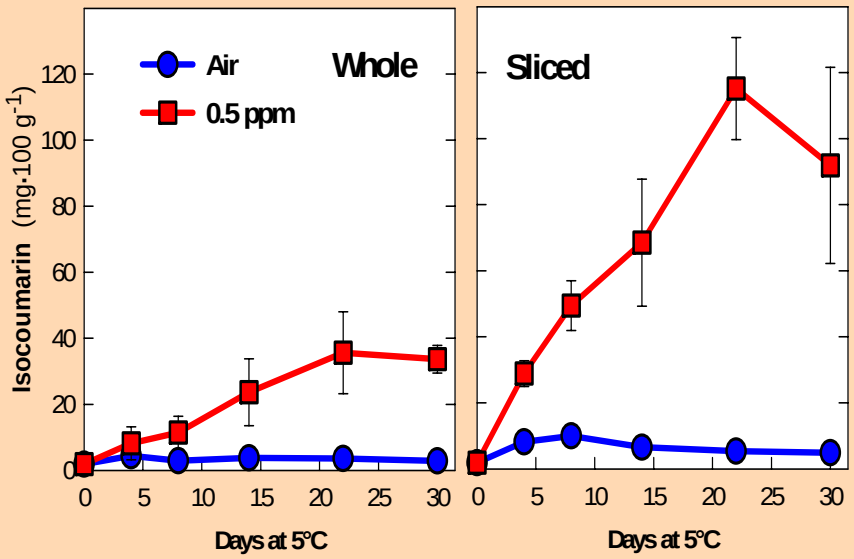
Carrot Flavor Defects

- **Harshness: Terpenes**
  - Variety
  - Growing conditions
- **Bitterness: Isocoumarin**
  - Postharvest defect
  - Ethylene exposure

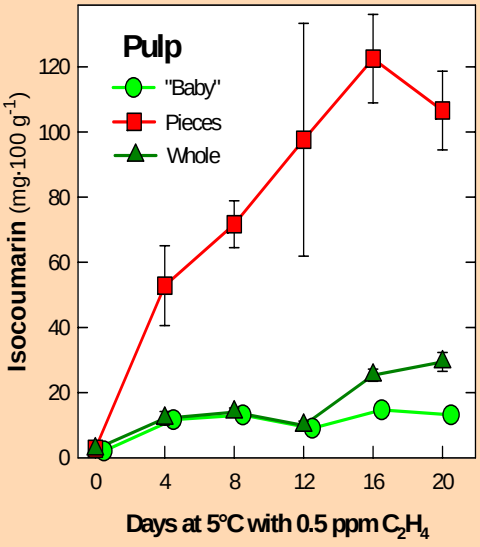
Bitterness in Carrots

- **Induced by ethylene**
- **Threshold ~0.15 ppm C_2H_4 at 0-5°C**
- **70% of isocoumarin in the peel**
- **Sliced carrots form 4X more isocoumarin**
- **Physical damage increases isocoumarin**
- **Other factors: temperature, age, variety**

Wounding increases sensitivity to ethylene



Pulp of unpeeled 5 cm pieces is very sensitive to ethylene




GILLS ONIONS
QUALITY • CONVENIENCE
About Us

Onion Handling and Storage Attributes

Attributes	Spring/summer Fresh Onions	Fall/winter Storage Onions
Storing Ability	Typically not stored, unless under controlled atmosphere or refrigeration	Designed specifically to withstand long periods of storage
Storage/Shelf-life	30 – 60 days	30 –180 days
Retail Shelf-life	30 days or less	
Temperature	Room temperature – Dry storage	
Humidity	Keep in a dry, well ventilated place	
Freezing Injury	Moderately sensitive. Highest freezing point = 30.6°F or -0.8°C	Hardier than other types. Highest freezing point = 30.6°F or -0.8°C
Odor Sensitivity	Odors will be absorbed by apples, celery and pears. Will absorb odors produced by apples and pears.	
Sweetness	Sweet/mild to slightly pungent flavors	Varies from mild to very pungent
Aroma	Mild to slightly pungent	Mildly pungent to strong
Interior Texture	Soft to medium	Medium to firm
Exterior	Thin, light colored skin	Multiple layers of thick, dark skin

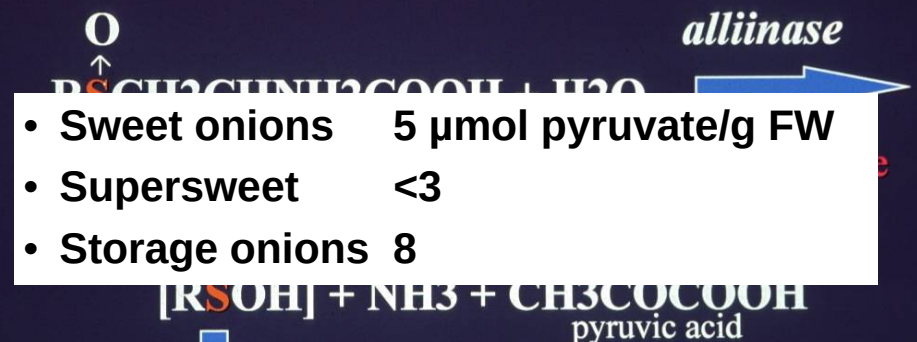
http://www.onions-usa.org

Storage Temperature:
0°C (32°F)
20°C (68°F)

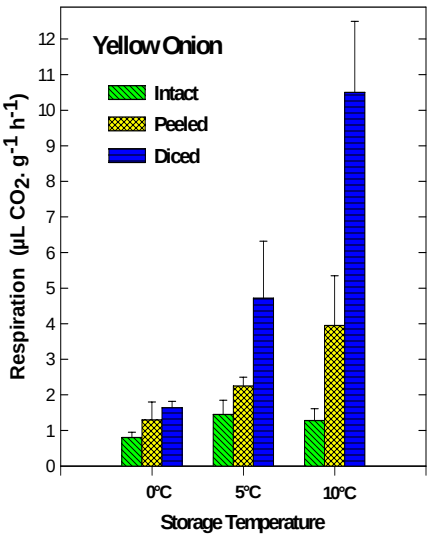
Low RH (~65-70%)

Botrytis- gray mold
Aspergillus- black mold
Sunburn
Senescence- translucency

ONION PUNGENCY



- **Sweet onions** **5 µmol pyruvate/g FW**
- **Supersweet** **<3**
- **Storage onions** **8**

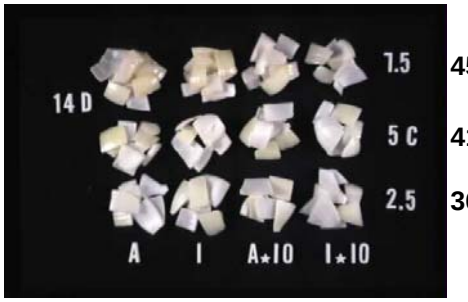


Low temperature minimizes wound response

Diced onions yellow, decay, soften and leak more than whole peeled onions

Impact of **temperature** and **controlled atmospheres** on quality of fresh-cut diced onions

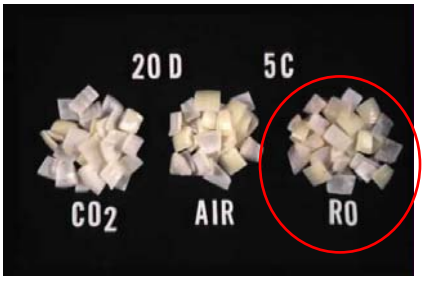
32°F **41°F** **50°F**



45°F

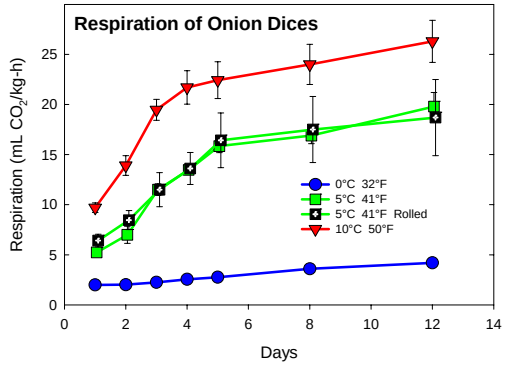
41°F

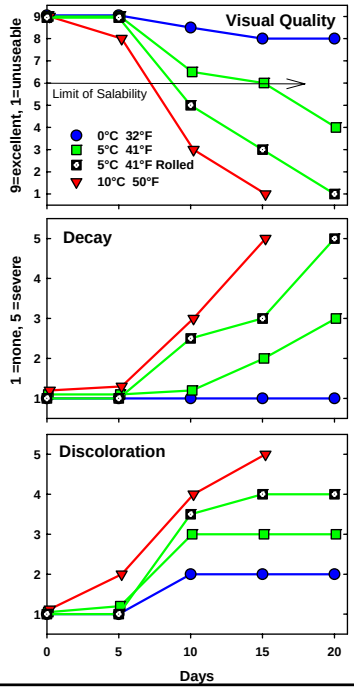
36°F



RO=rolled (damaged)

Fresh-cut Onions (dices)
Low temperature is essential
for shelf-life and quality





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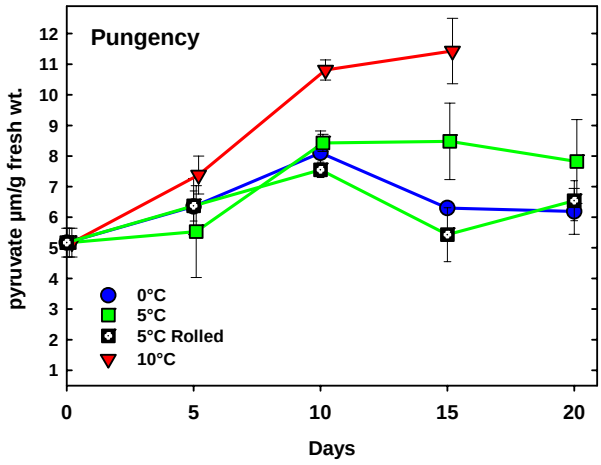
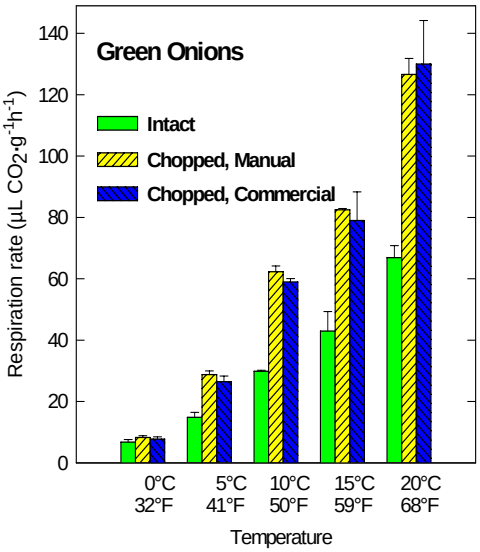


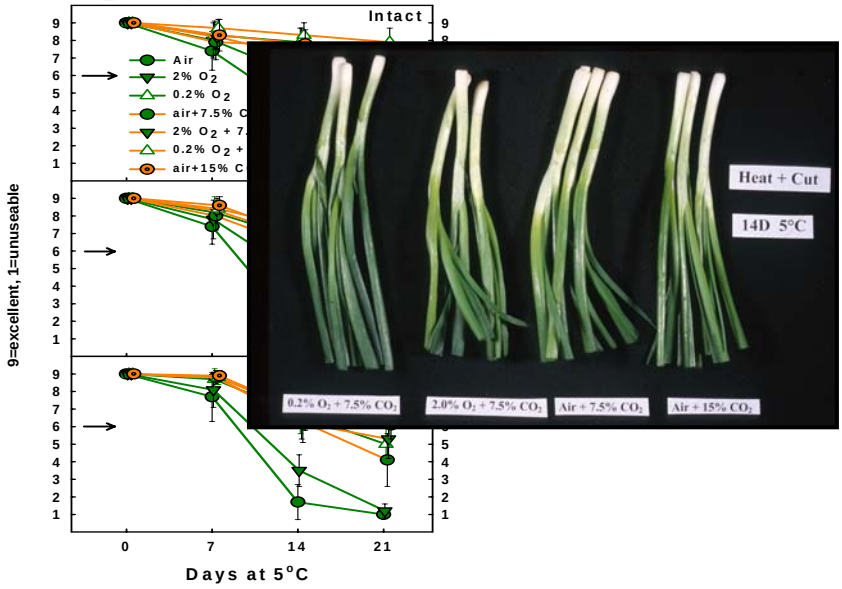


Respiration increases exponentially with increased temperature

At 10°C, chopping doubles respiration rate

At 0°C, wound response is minimized

Visual quality and CA storage



Garlic Bulb Storage

- Well cured
- Relative humidity 60-70% (reduce molds, rooting)
- -1°C to 0°C (30°-32°F) long-term
- 20°-30°C (68-86°F) 1-2 months
- 5°-18°C (41°-65°F) favor sprout growth
- Odor easily transferred to other products

Considerations for Maintaining the Quality of Fresh Peeled Garlic

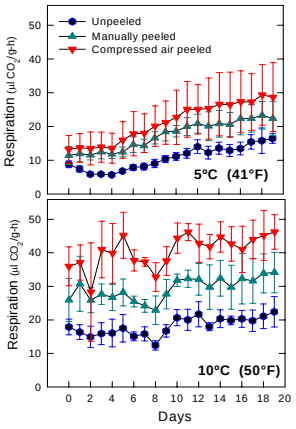
- Respiration rates; mechanical injury
- Storage temperatures
- Controlled atmospheres
- Control of sprout/root growth

Careful peeling causes a substantial increase in respiration rates.

Mechanical compressed air peeling **doubles** respiration rates.

Average Respiration Rates (µL CO_2/g-h)

	Unpeeled Cloves	Manually Peeled	Compressed Air Peeled
5°C (41°F)	10.6	17.4	21.2
10°C (50°F)	18.1	29.3	40.6



Commercially Peeled Garlic Stored 9 Days

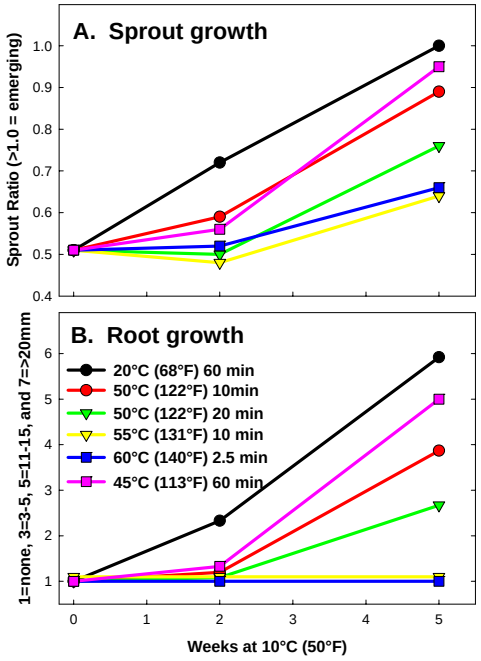
0°C 32°F	5°C 41°F	10°C 50°F	15°C 59°F

- Controlled atmospheres with 10% CO2 helped maintain visual quality of peeled garlic at 5°C (41°F) and 10°C (50°F).
- High CO2 atmospheres retarded discoloration and decay

1% O_2 + 10% CO_2
Remainder N_2

Heat treatments control Sprout growth and Root growth

Cantwell, Kang, Hong, 2000; stored at 10°C



Garlic Composition

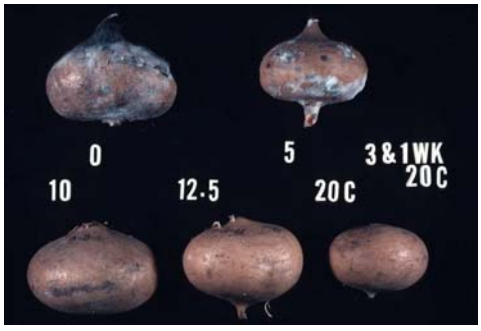
- **Alliin** is the main precursor to important flavor and potentially biological active sulfur-compounds in garlic.
- **Allicin** is the main thiosulfinate produced: provides flavor and pungency and is bioactive.

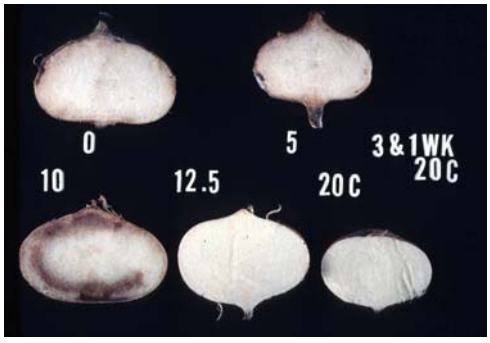
Alliin and allicin concentrations vary by:
Garlic variety
Irrigation and fertilization practices
Storage conditions and duration

Maintaining Quality of Peeled Garlic

- Reduce mechanical injury at peeling
- Store at low temperature, ~0°C (32°F)
- Use modified atmospheres with 5-10% CO_2
- Heat shock treatments retard sprout/root growth

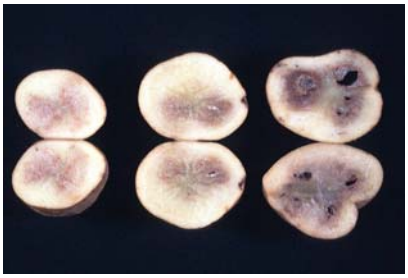
- Selection of varieties with specific qualities, high or low pungency, long dormancy, resistance to bruising and mechanical injury
- Treatments to remove “crowns” during peeling





Many root crops are chilling sensitive: Jicama as example

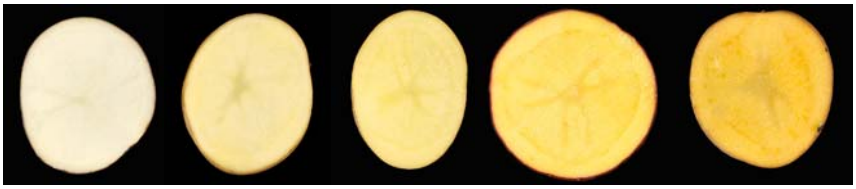
Potato stored 4-5 mo. 2°C



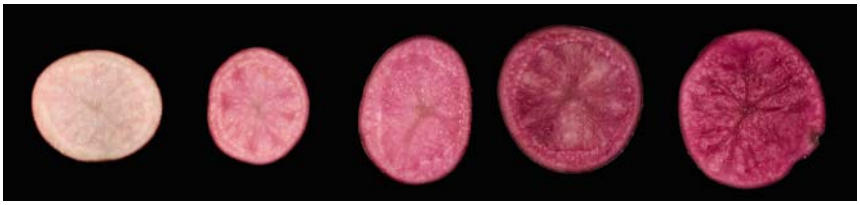
Jicama:

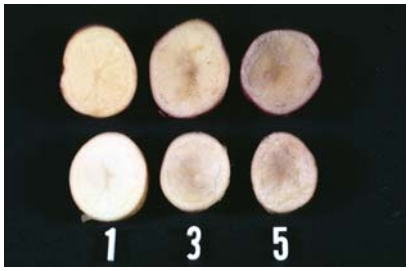
- ❖ Discoloration is problematic only at high temperatures
- ❖ Raw material quality, starch-sugar
- ❖ Surface drying

Potato Internal Color



1 2 3 4 5





Defects

1. Skinning
2. Internal deterioration
3. Cut edge discoloration

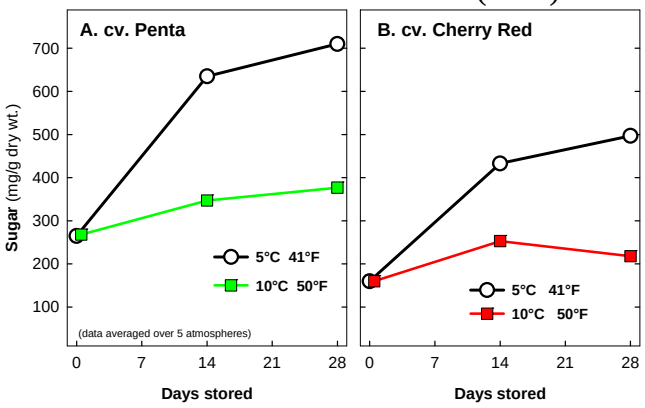
"Salad Potatoes"

Quality characteristics of '**Morning Gold' potatoes** harvested at different times and at different plant kill dates.

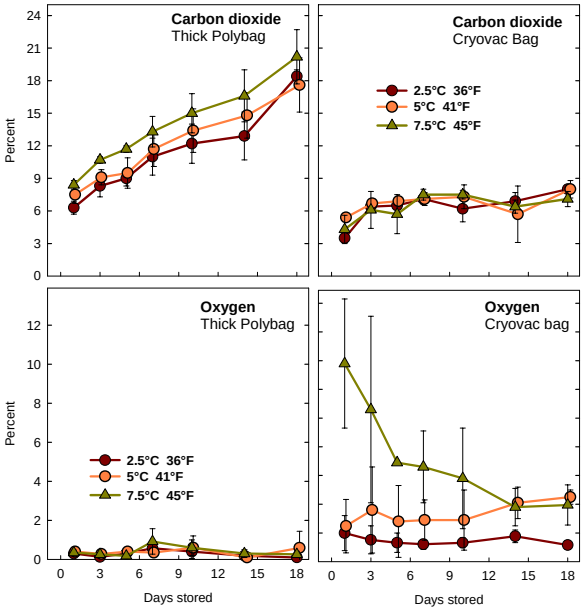
Kill Date	Harvest Date	Ave. wt. g/potato	% dry wt.	Sugar, mg/g DW	% wt loss (5d 7.5°C)	Skin Score	Torque lb-inch	Respiration µL CO_2/g-h
17 Jul	17 Jul	**21.7**	**13.8**	**132.6**	**4.1**	**2.1**	**1.2**	**6.75**
17 Jul	22 Jul	**22.5**	**13.2**	**87.5**	**3.3**	**2.0**	**1.1**	**6.75**
17 Jul	27 Jul	**21.5**	**14.6**	**65.9**	**1.2**	**2.2**	**2.8**	**7.25**
17 Jul	1 Aug	**23.4**	**14.1**	**59.1**	**1.8**	**3.9**	**4.4**	**6.30**
17 Jul	6 Aug	**21.4**	**14.3**	**46.2**	**0.5**	**4.7**	**6.2**	**4.90**
22 Jul	22 Jul	**30.0**	**15.2**	**102.6**	**4.1**	**2.0**	**1.5**	**6.00**
22 Jul	27 Jul	**34.6**	**15.5**	**66.1**	**2.5**	**2.1**	**2.7**	**6.35**
22 Jul	1 Aug	**43.5**	**15.2**	**60.2**	**2.1**	**3.2**	**3.0**	**5.60**
22 Jul	6 Aug	**38.8**	**17.7**	**29.9**	**0.6**	**3.9**	**4.3**	**4.70**
22 Jul	11 Aug	**39.0**	**15.7**	**43.5**	**0.5**	**5.0**	**--**	**5.30**
	LSD.05	**9.3**	**2.2**	**6.0**	**0.8**	**0.3**	**0.5**	**1.21**

Cantwell and Carlson, Tule Lake, CA, 2002

Storage of “new potatoes” at 5°C (41°F) in air results in significant increases in sugar concentrations, while sugar levels do not increase much at 10°C (50°F).



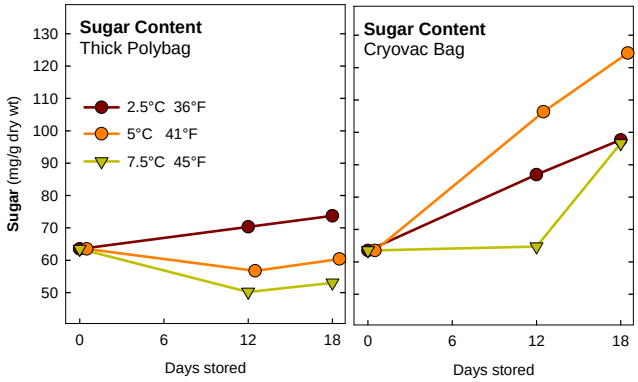
Tule Lake potatoes, 2001



The 2 bags tested created very different atmospheres.

Storage temperatures from 2.5-7.5°C (36-45°F) did not greatly affect gas concentrations

MA Test #1, Tule Lake, “new potato” cv. Penta



Sugars increased more in potatoes stored in the bag that provided higher O2 and lower CO2 concentrations.

MA Test #1, Tule Lake, "new potato" cv. Penta

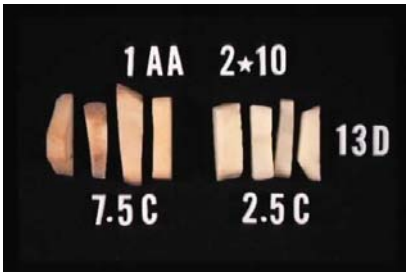
Fresh-peeled and cut Potatoes

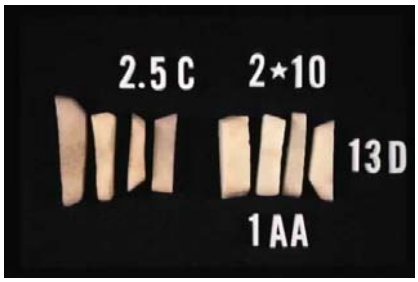
Raw material quality

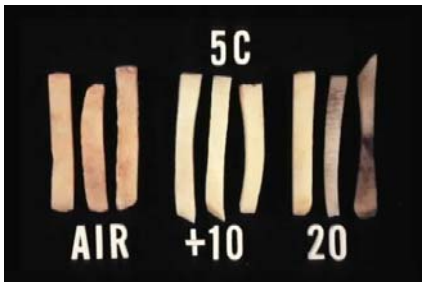
Washing and peeling, slicing (sharp)
abrasion, steam, caustic

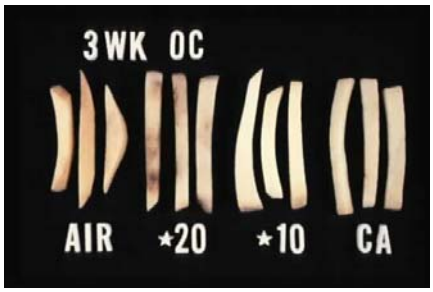
Focus on control of browning
Cultivars vary widely
Citric, ascorbic acid
Bisulfites not allowed
http://hort.cabweb.org/Postharv/Laurila.htm

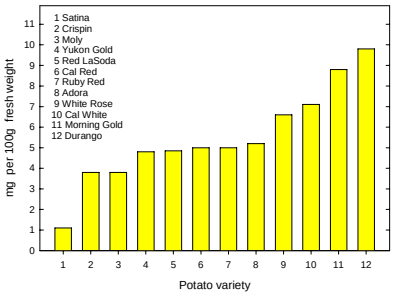
Temperatures and atmospheres
Cold
MA: high CO2 + N2





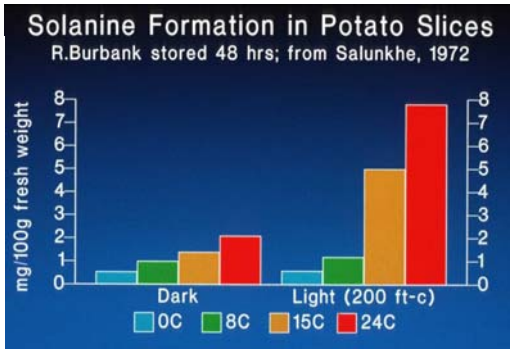




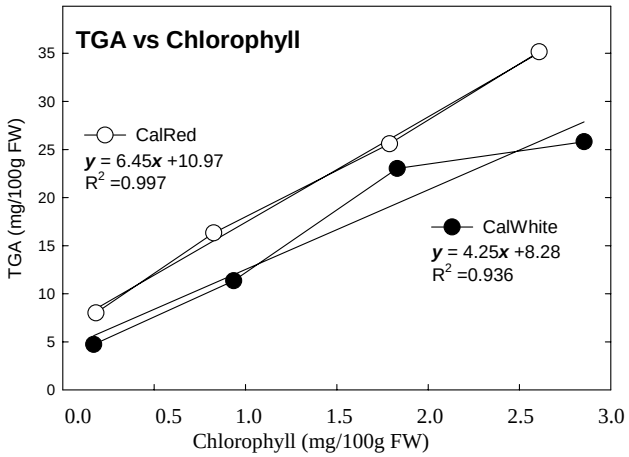


Toxic glycoalkaloid formation is closely associated with greening

Control greening & glycoalkaloids:
- **No Light- opaque packaging**
- **Low Temperature**
- **Short Duration**



Glycoalkaloids vs Chlorophyll Content



Average TGA Concentrations (mg/100g FW)

Cultivar (color)	0 time	9d dark	9d light
A94381 (r/y)	2.1	3.0	6.6
CalRed (r/w)	8.0	21.6	29.4
Durango (r/w)	4.8	6.6	9.9
VC1015 (r/y)	4.3	5.6	7.0
CalWhite (w/w)	4.7	9.9	26.7
Latona (w/y)	3.8	5.9	12.1
Satina (w/y)	2.4	4.4	10.0
Yukon Gold (w/w)	3.5	4.5	5.4