



Almond Shelf Life

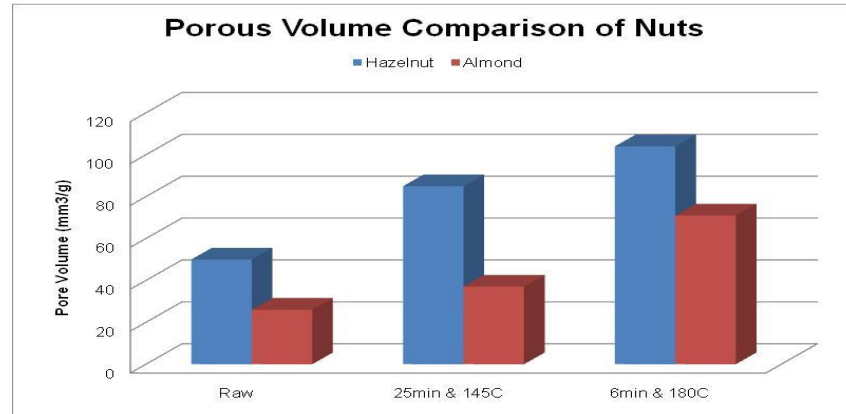
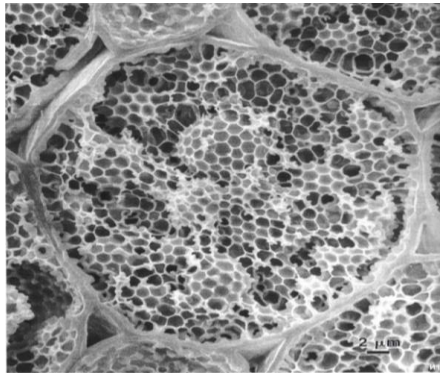
Almond Property
Quality Change Over Storage
Shelf-life Determination
Recommendations

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Unique Physical and Chemical Properties Lead to Great Shelf-life Potential

- Low water content: < 6% (no bacteria and mold growth)
- Right fatty acid profile: high in mono-unsaturated and low in poly-unsaturated (S:M:P = 8:66:26)
- High natural antioxidant content: vitamin E in flesh and flavonoids in skins
- Tight cellular structure: less porous



Adapted from Perren presentation to ABC 2007

Almond Properties, Storage Temperature and Humidity, and Packaging Affect Shelf-life Potential

Product Characteristics

- Composition: unsaturated fat and vitamin E levels, moisture/ water activity, initial quality
- Forms: natural/blanched, whole/cut, raw/roasted
- Roasted: dry/oil, roast level

Environment

- Temperature
- Humidity
- Oxygen
- Processing conditions
- Insects, pests, microorganisms

Package

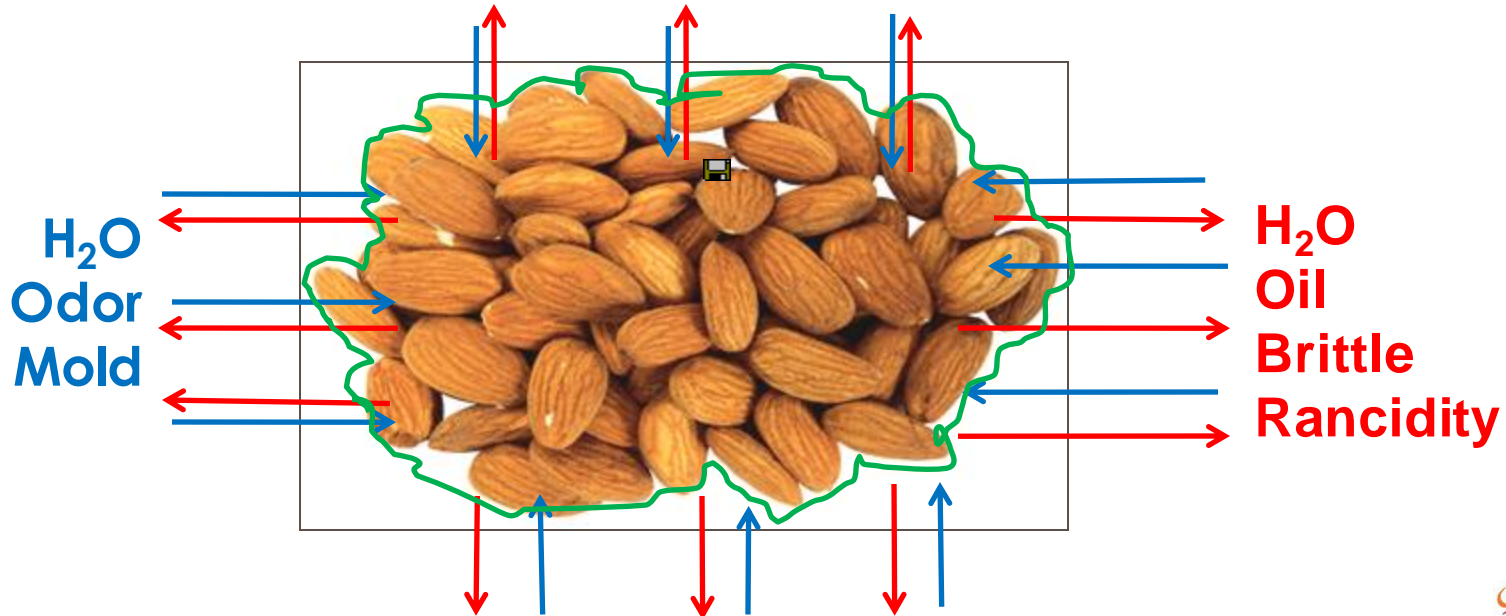
- Physical protection (film thickness)
- Moisture barrier (water vapor transmission rate)
- Oxygen barrier (gas transmission rate)
- Nitrogen-flush or vacuum packing

Quality Changes Over Storage

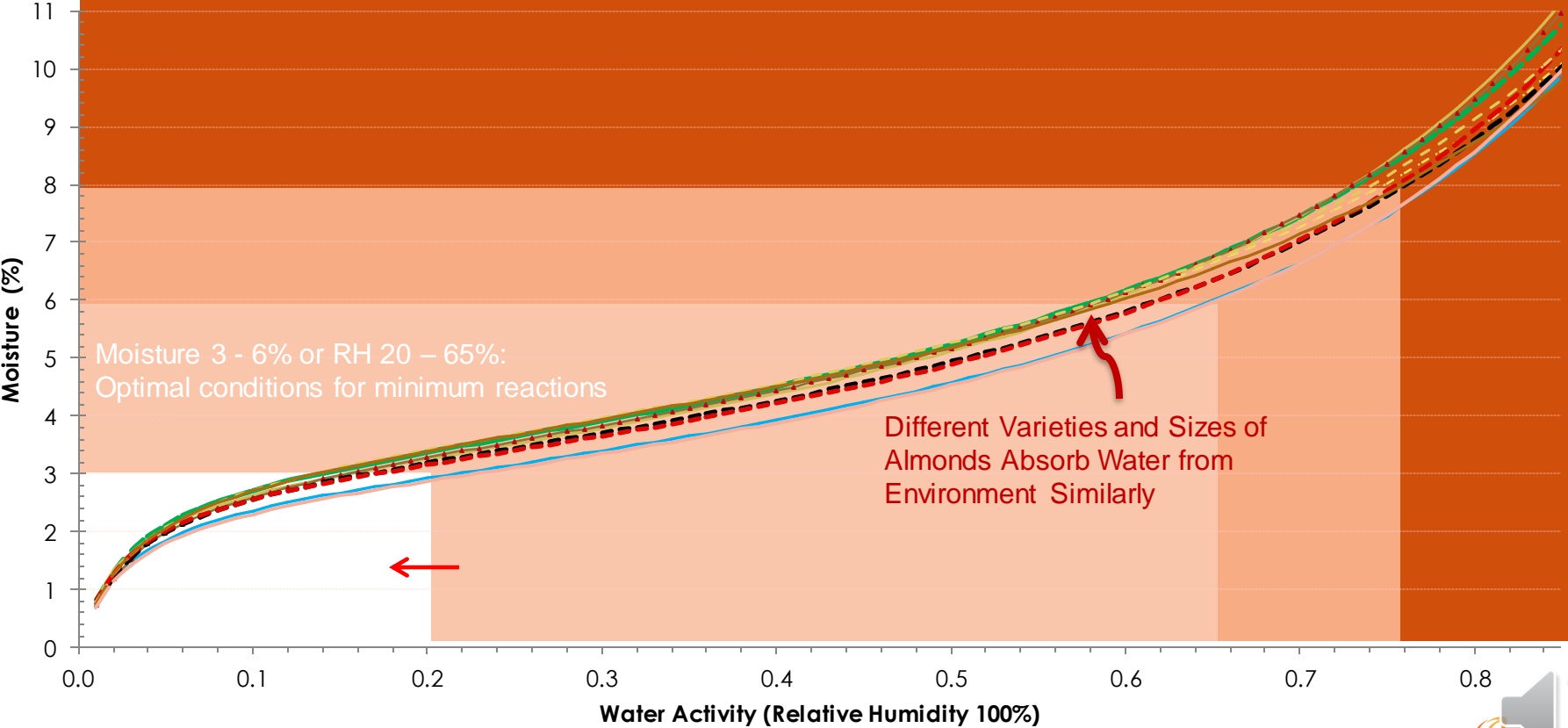
Almond Properties Changes with Environmental Conditions

Temperature, humidity, packaging, processing conditions affect quality (oil migration, water migration, flavor fading, etc.)

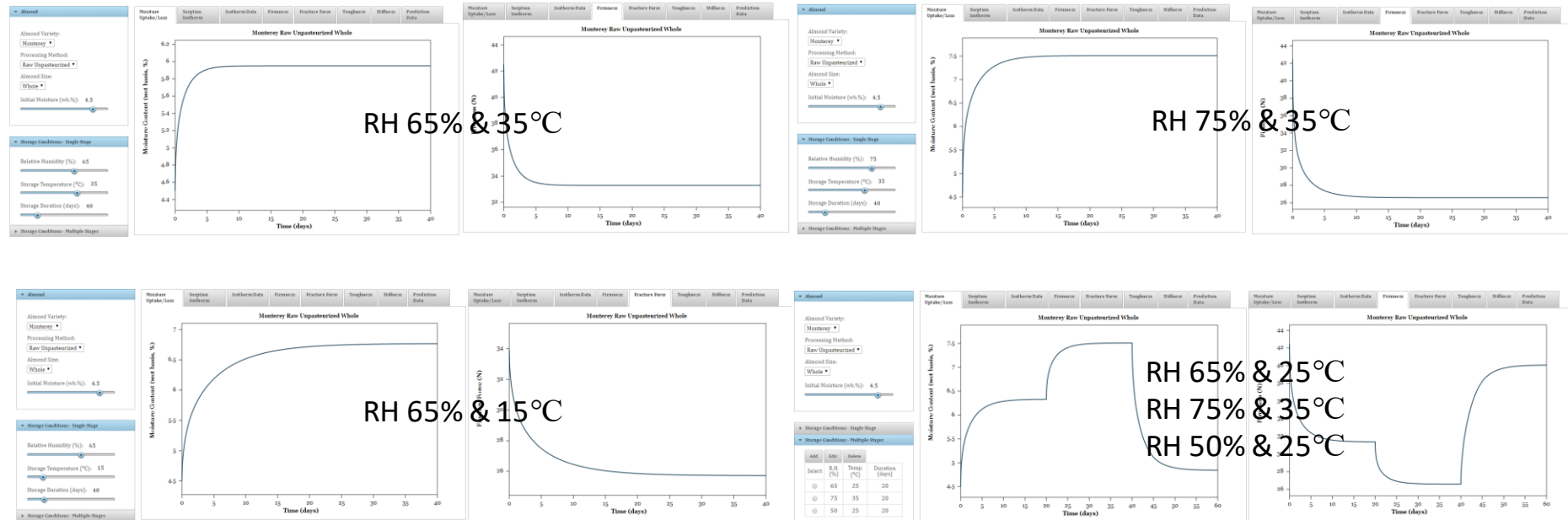
Environment: Temperature ↓ ↑ Humidity ↑ ↓



Relative Humidity (Water Activity) Affect Product Moisture

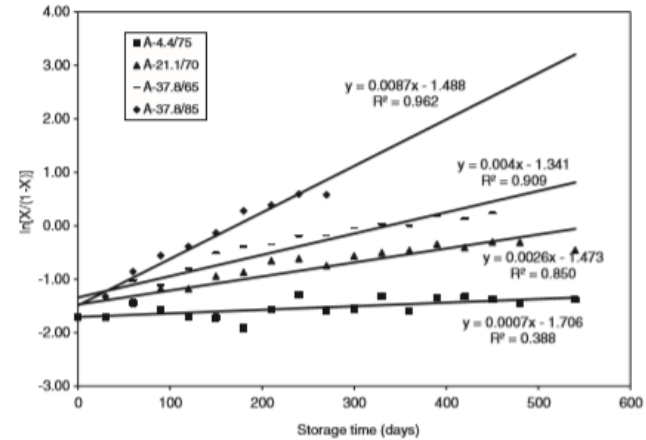
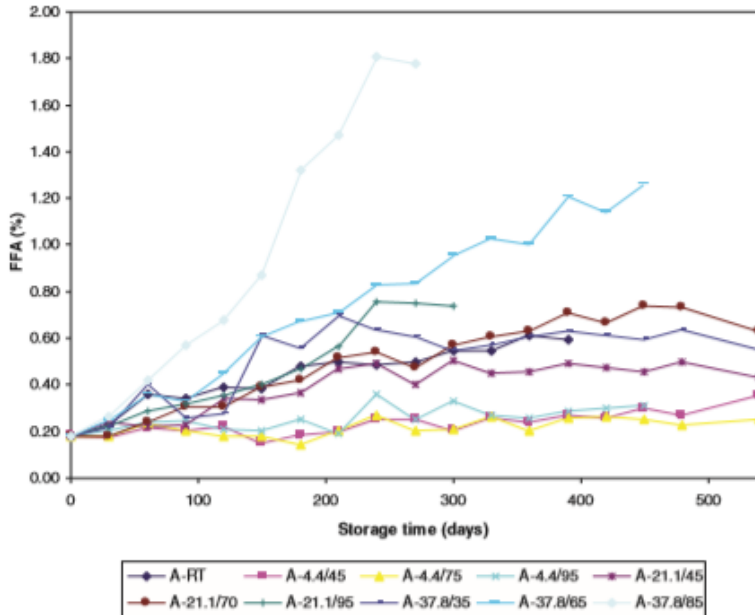


Temperature and Humidity Affect Moisture and Texture (Online Tool)



[Almond \(almonds.com\)](http://Almond(almonds.com))

Elevated Moisture Leads to Release of Fatty Acids (Impact of Temperature and Humidity on FFA)



$$C = C_0 e^{kt} = C_0 e^{k_0 e^{-E_a/R T} t}$$

R-gas constant
C-FFA concentration
T-absolute temperature

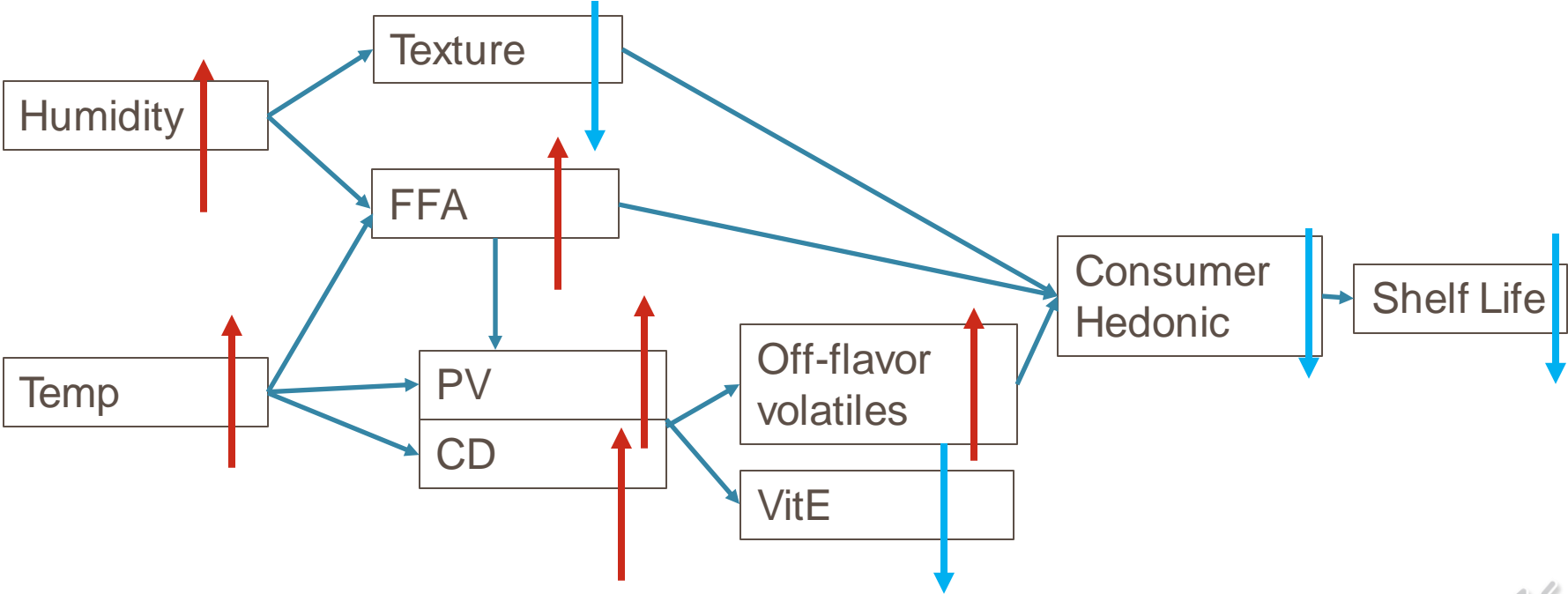
Table 5—Temperature dependence of FFA formation rates.

	Low RH	Medium RH	High RH
K_0	2.64×10^{-1}	1.75×10^5	8.43×10^5
E_a (Cal/Mol)	3.01×10^3	9.32×10^3	1.12×10^4

Shelf Life Determination



Humidity and Temperature Affect Shelf-life Parameters

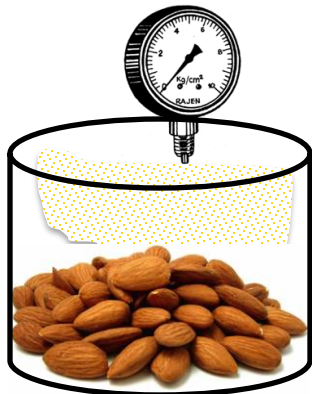


Moisture and Texture are two Common Physical Parameters for Shelf-life Evaluation

- The rate of chemical reactions in foods depends on temperature and moisture



Moisture Content
Weight of water in food
compared to total weight
Range: 0 to 100 gH₂O/100g



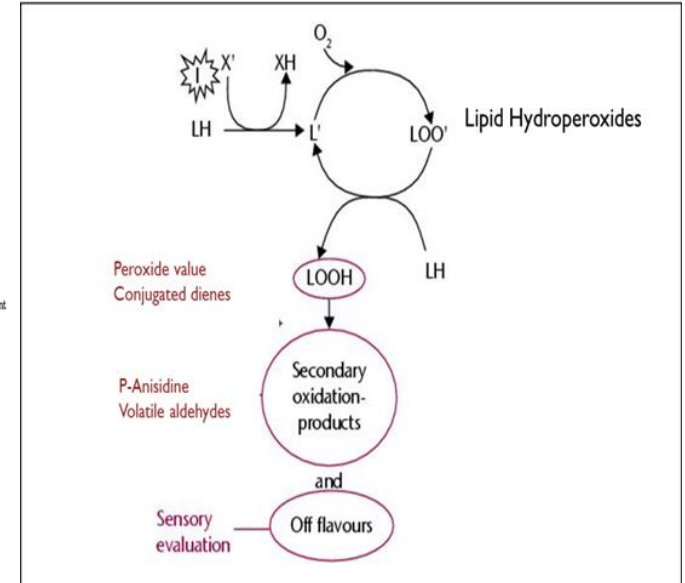
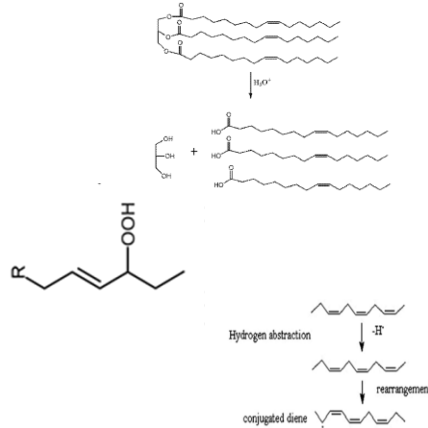
Water Activity
Related to number of water
molecules
Measured by vapor pressure
Range: 0 to 1



The fracturability
of whole almonds
can be evaluated
using the texture
analyzer with a
compression disk.

Analytical Parameters for Oil Oxidation Measurements

- Hydrolytic Rancidity
 - Free Fatty Acids
- Oxidative Rancidity
 - Peroxide Value
 - Conjugated Dienes
- Vitamin E
 - Tocopherols
- Head Space Volatiles
- Sensory Measures
 - Consumer Hedonic Analysis



TWO YEAR SHELF LIFE STUDY OF RAW AND ROASTED NONPAREIL ALMONDS

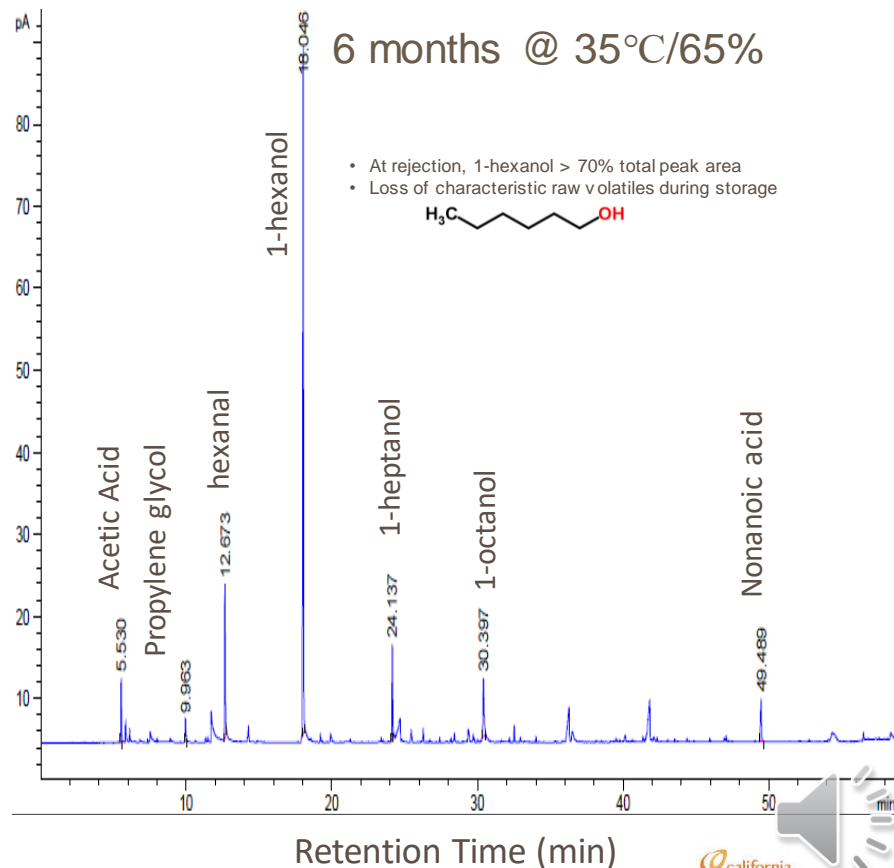
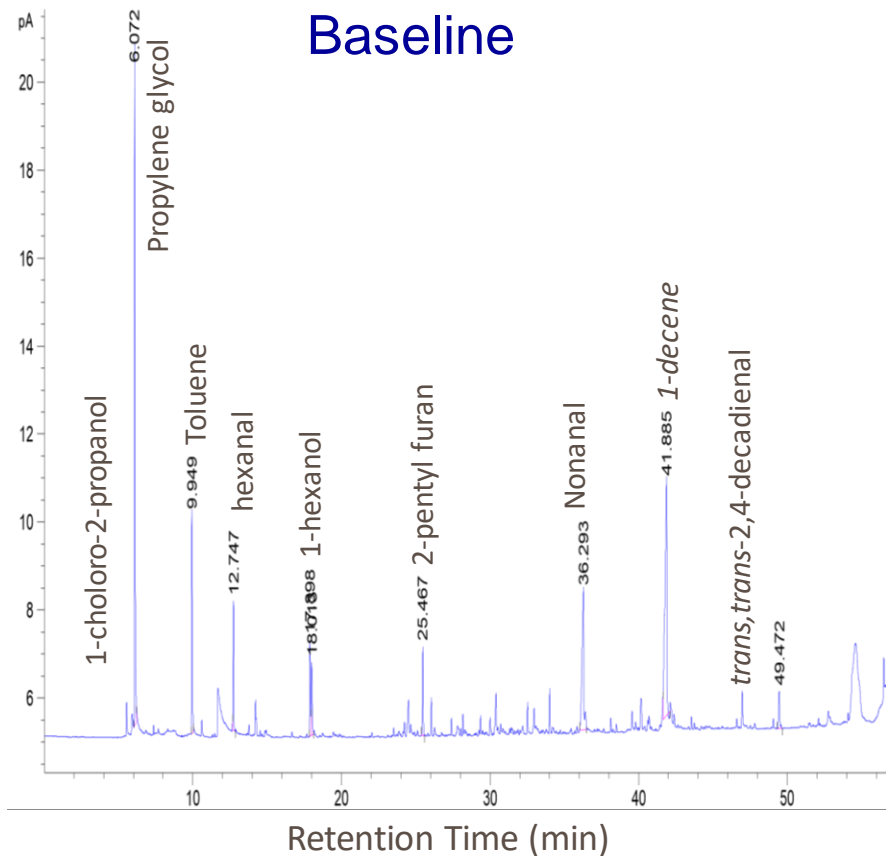


Temp: 4, 15, 25, 35°C
RH: 50 & 65%



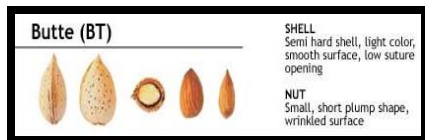
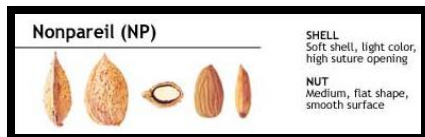
Temp: Temp: 4, 15, 25, 35°C

Flavor Volatiles in Raw Almonds Fade Away Over Time



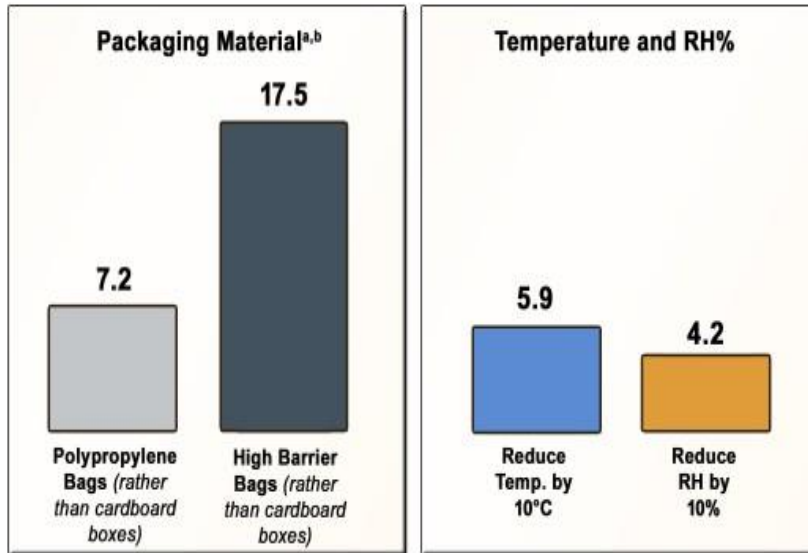
TWO YEAR SHELF LIFE STUDY OF RAW INSHELL AND SHELLED NONPAREIL AND BUTTE ALMONDS

Control (10°C/65%), 15°C/55%, 15°C/70%, 25°C/55%, 25°C/70%,
Reference (4°C/No RH Control), CA ambient, GA ambient



Lowering Storage Temperature and Relative Humidity, Packages or Inshell Extend Shelf Life

Approximate Increases (in months) until Expected Sensory Failure^{2,4}



Months until sensory failure =
 $49 - .59(^{\circ}\text{C}) - .42(\text{RH}\%)$

Inshell – Shelled >> 4-8 months

Nonpareil > Butte (Shelled)
Nonpareil \approx Butte (Inshell)

Sensory failure = Rejection by 25% or more panelists



Storage Recommendations for Raw Almonds

- Store under cool and dry conditions (<15°C/59°F and <60% relative humidity)
- Maintain almond moisture at 3 to 5.5% for optimal stability
- Use packages with good barrier properties against water and air transmission, and prevent infestation, to maximize shelf life when affordable and feasible
- Avoid exposure to light and adjacent materials with extraneous odors



Thanks for listening!

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