MAXIMIZING ALMOND QUALITY AND SHELF LIFE
Managing Humidity and Temperature to Preserve Almond Quality
Today

1. Almond Physical and Chemical Properties
2. Interactions with Environmental Factors
3. Findings from Shelf Life Studies
4. Simple Means to Preserve Quality

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Almond Board of California
Physical and Chemical Properties of California Almonds

- Low water content: < 6% (no bacteria and mold growth)
- Tight cellular structure: less porous
- 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

Adapted from Perrein presentation to ABC 2007
Almond Interactions with Environment

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

Environment: Temperature $\downarrow$ $\uparrow$ Humidity

- H$_2$O
- Odor
- Mold
- H$_2$O
- Oil
- Brittle
- Rancidity
Moisture >8% or relative humidity >75%:
Stimulate biological activities and texture changes
Accelerate lipid oxidation, enzymatic activities, non-enzymatic browning

Moisture 6 - 8% or relative humidity 65-75%:
High temperatures (>20°C) may promote lipid oxidation, enzymatic activities and non-enzymatic browning

Moisture 3 - 6% or RH 20 – 65%:
Optimal conditions for minimum reactions

Moisture <3% or relative humidity < 20%:
Concerns for lipid oxidation increase

Different Varieties and Sizes of Almonds Absorb Water from Environment Similarly

Labuza, 2009, UMN, unpublished data
Water Sorption Isotherm of Processed Almonds – Impact of Relative Humidity on Moisture

- Pasteurization (PPO & Steam) was not found to impact moisture sorption
- Roasting & blanching were found to reduce moisture sorption
- Varieties & sizes have little impact on moisture sorption

Labuza, 2009, UMN, unpublished data
Dynamics of Shelf Stability Parameters

- Temp
- Humidity
- Texture
- FFA
- PV
- CD
- Off-flavor volatiles
- VitE
- Consumer Hedonic
- Shelf Life
Impact of Temperature and Humidity on Moisture and Texture of Almonds (Online Tool)

Impact of Temperature and Humidity on FFA in Whole Almonds

Lin et al., J. Food Science, 2012, 77(6), 583-593
Major Findings from Almond Shelf Life Study (University of Georgia, 2015)

<table>
<thead>
<tr>
<th>Package Type</th>
<th>Raw NP</th>
<th>Light Roasted NP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined carton (UCs) (600 ± 5 g)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Polypropylene bag (PPBs) (300 ± 5 g)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>High barrier bag (HBBs) (300 ± 5 g)</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

- Bags were flushed with food-grade N₂ and sealed, providing a “pillow-pack” design. The headspace was analyzed in multiple samples, and the initial O₂ level was < 0.5%.

- Kernel acceptability or rejection by consumers is complex,
  - No single chemical indicator or sensory attribute leads to sample rejection
- For raw kernels, texture changes (due to moisture migration) had much more influence on consumer panel rejection than did odor or flavor changes
- For roasted kernels, flavor (most important) and texture (but not odor) were significant predictors of overall acceptability
## Shelf Life and Packaging Extension (month)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Raw NP(^1)</th>
<th>Roasted NP(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp ( °F)</td>
<td>rH (%)</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>59</td>
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<tr>
<td></td>
<td>95</td>
<td>50</td>
</tr>
</tbody>
</table>

1, 2 Samples not rejected by consumer panel at the end of storage of 24 months for raw and 16 months for roasted
3 Samples removed from study before rejection due to storage cabinet failure
Summary – Shelf Life Preservation Recommendations

• Current Recommendation: Storage for all almond forms in cool and dry conditions (<50°F/<10°C and <65% relative humidity).
• Lower humidity (< 60%) will ensure longer stability due to lower moisture (<5.5%).
• With proper packaging, product can have longer stability even slightly higher humidity such as ~65%.
• A cool temperature of <50°F/<10°C is optimal, but a higher temperature that does not stimulate insect activity may work as well to control moisture migration (<59°F/<15°C).
• Almonds are a shelf-stable nut that can have more than two years of shelf life when stored at the recommended conditions.
Thank You!

Any Questions?
Maximizing Almond Quality and Shelf Life: CPG Manufacturer Perspective

Mark Kline, Sr. Manager, Nut & Energy Sourcing, Global Commodities

December 4th, 2018

The Almond Conference
Supplier Quality Expectations Manual

https://www.thehersheycompany.com/en_us/shared-goodness/shared-business/responsible-sourcing.html#tab1

“Give them quality. That’s the best kind of advertising in the world.”
HERSHEY SUPPLIER APPROVAL PROCESS

• Assess suppliers Food Safety and Quality Management System
  - Global Food Safety Initiative (GFSI) certification & compliance
• Conduct site visit & facility audit
• Evaluation of product/test loads
Hershey’s Preferred Almond Requirements

- Flavor
- Shape
- Size
- Texture
- Grade
ALMOND QUALITY: FOREIGN MATERIAL

• Preventative programs in place
  - Glass and hard/brittle plastic program
• FM prevention, detection and control steps
  - E.g. x-ray, metal detectors, magnets, filters, screens
  - Documentation of root cause and corrective actions
• Zero tolerance for High Risk Foreign Material
  - E.g. glass, plastic, ferrous & non-ferrous metal, other nut meats
ALMOND QUALITY: FLAVOR & STABILITY

• Initial flavor is as important as final shelf-life flavor
• Case Study – Kisses with Almonds
ALMOND QUALITY: FLAVOR & STABILITY

• Sensory liking over-shelf life is correlated to oxidative stability.
ALMOND QUALITY: FLAVOR & STABILITY

- Controlling temperature during roasting can mitigate oxidative degradation through shelf life.

![Peroxide Value vs Roasting Temperature](image1)

![Storage Stability when Optimally Roasted](image2)
Managing Quality for Almond Processing
Anthony Melo
Director of Quality
Blue Diamond Growers
Overview

• Almond Processing Design
• Variability
• Quality Checks/Inspections
• Know Your Customer (Specifications)
• Cost of Quality
• People and Culture
• Summary
Almond Processing Design

• Design For Success
  – Foreign Material and Sizing
  – Appearance (chip/scratch)
  – Insect Damage

• Make sure you have the right equipment

• Develop training simultaneously

• Effective first, Efficient second
Variability

• Reducing variability increases the ability to meet customer requirements

• Lot’s of tools in statistics to understand variability in a process

• Keep it simple
Quality Checks/Inspections

• Validate the process

• Verify the process (hourly checks)

• Processes will drift, be prepared to change

• Processes are perfectly designed to give us the results we receive. If we don’t like the results, change the process.
Know Your Customer (Specifications)

• Meet with your customer
  – Just because there is a spec doesn’t mean it’s right

• Customer Requirements is the key focus
  – SIPOC (Suppliers, Inputs, Process, Outputs, and Customers)

• Calculate your specifications before committing (Cpk)
  – “In process improvement efforts, the process capability index or process capability ratio is a statistical measure of process capability: the ability of a process to produce output within specification limits.”
Cost of Quality

• There is a cost to quality
  – Cost of inspection
  – Cost of rework
  – Cost of meeting specifications

• Sometimes good enough, is good enough
People and Culture

• Hiring

• Set everyone up for 100% success

• Expectations

• Accountability

• Empower

• Full Use of Time and Abilities

• Professional Job Design
Summary

• Design for Success

• Know your customers

• Understand that there is variability

• Understand cost of quality

• Don’t forget your people

• Don’t over complicate; be extraordinary at the basics
Thank you!