



Shelf-Life Extension

SHELF LIFE EXTENSION

Presented by Aaron Clanton, Baking Curriculum Manager

All Things Baking

October 2011

- What determines the shelf-life of a product?

SHELF LIFE

“The *length of time* during which the product remains acceptable to the consumer without a significant loss in quality, or how long the consumer perceives a product to be *fresh*”.



Shelf-Life Extension

Staling Most Identified by Consumers

- Visible mold growth = “spoilage”
- Firmness or crumbliness of crumb
 - Dryness
- Flavor loss and/or change
- Loss of shine or migration of color
- Shrinkage or breakdown of filling
- Icings drying or cracking
- “Sugar bloom” or “Fat Bloom”



What factors into Shelf life?

Consumer Acceptance		
Looks good (Mold free)	Fresh Eating Experience	Tastes good

What factors into Shelf life?

Consumer Acceptance		
Looks good (Mold free)	Fresh Eating Experience	Tastes good



Shelf-Life Extension

Control of Mold



- Minimize contamination of product with mold
- Control factors that enhance mold growth
- Establish clear expected shelf life
- Usage of mold inhibitors

Minimizing Mold Contamination

- **Cleaning and Sanitation**
 - Food contact surfaces must be properly cleaned and sanitized.
 - Organic debris should not be allowed to accumulate.
 - Old product, stales, crumbs, waste dough, etc.
 - Cleaning in and around the plant.
 - Any mold growth will produce spores.

Minimizing Mold Contamination

continued

- **Cleaning and Sanitation**

continued

- Air should be filtered to reduce spores in the air.
 - Most spores become airborne.
 - Filtering of any air coming inside.
 - Be sure to filter compressed air as well.
 - Maintain positive pressure to prevent outside air from coming in.





Shelf-Life Extension

Factors Affecting Mold Growth

Condition for mold growth (optimum)	Method of controlling condition
Temperature \approx 80 °F (27°C)	Air conditioning Heat sterilization
Relative Humidity \approx 80 %	Air conditioning
Presence of oxygen, carbon, hydrogen and nitrogen	Modified Atmospheric Packaging, UV Lights, Oxygen Scavengers
Water activity = 0.8 to 1.0	Formulation – if possible
pH = 6 to 7 (slightly acidic)	Use of mold inhibitors***

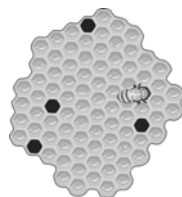
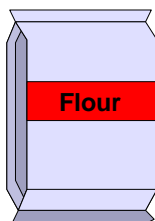
Factors that Enhance Mold Growth

continued

- **Moisture / Water Activity (Aw)**
 - For mold growth water activity is the important measure.
 - Water activity is a measurement of the amount of “free” water in a system.
 - **It measures the amount of water available for chemical reactions (microbial growth).**
 - Water activity is NOT water content.



Moisture vs Water Activity



17% Moisture – which will mold first?



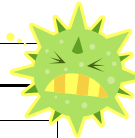
Shelf-Life Extension

a_w and the Baker

- a_w is a useful tool in understanding baked food systems
 - Mold growth, sensory, icing breakdown, color bleeding...
- a_w is a useful tool in protecting the consumer
 - Food safety is a growing concern with new technology

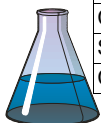
Minimum Water Activity for Microbial Growth

Microorganism	Minimum A_w
Bacteria	0.91
Wild yeasts	0.87
<i>Penicillium</i> molds	0.82
<i>Aspergillus</i> molds	0.78
Halophilic bacteria	0.75
Osmophilic yeast	0.60



Water Activity of Bakery Products

Product	A_w
Bread, rolls	0.96-0.98
Fruit pie fillings	0.95-0.98
Tortillas, muffins	0.91-0.95
Cheeses	0.91-0.95
Cakes, cake donuts	0.85-0.87
Crème-filled cakes	0.78-0.81
Soft cookies	0.50-0.78
Cookies, crackers	0.20-0.30





Shelf-Life Extension

a_w and Moisture Migration

- **Moisture migrates from high a_w to low a_w**
 - Interior to crust
 - Component to component
 - Product to atmosphere; atmosphere to product
- **Impacts packaging choices**



Usage of Mold Inhibitors

- **Preservatives inhibit the growth of microorganisms.**
 - Artificial (chemical)
 - Natural
- **Effect of preservative is related to the level of contamination**
 - High number of spores, inhibitor less effective.
 - Low number of spores, inhibitor more effective.

Preservatives



- **Do not stop microorganism growth ONLY inhibit.**
- **Do NOT replace good manufacturing practices (sanitation and cleaning).**



Shelf-Life Extension

Preservatives types

Chemical

- Propionates
- Benzoates
- Sorbates
- Acetates
- Parabens

Natural

- Vinegar
- Spices
- Raisin juice conc.
- Ethyl alcohol
- Fermented flour or whey

Preservatives and pH ranges



- Benzoates best below pH of 4.5
- Propionates best below pH of 5.5
- Sorbates best below pH of 6.5
- Parabens affective up to a pH of 8.0

What factors into Shelf life?





Shelf-Life Extension

What changes occur over time?

Crust	Crumb
<ul style="list-style-type: none"> • Toughens • Loses friability (crispness) • Changes from glassy to rubbery state • Mainly migration of water from crumb <ul style="list-style-type: none"> • Water activity differences 	<ul style="list-style-type: none"> • Becomes crumbly, harsh, and dry • Loses flavor • Loses moisture • Blamed on starch

What causes the changes?

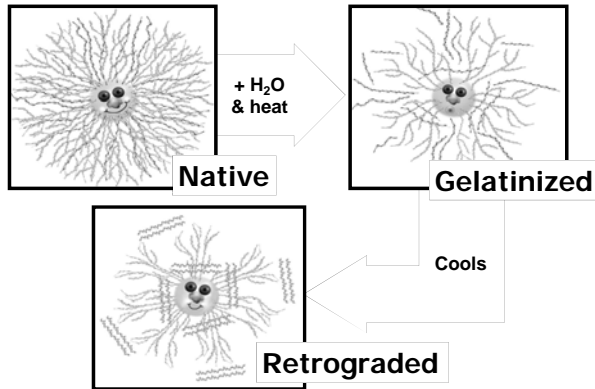
- **Moisture migration**
 - Disproved 150 years ago
 - Boussingault (1858) - staling occurs w/o moisture loss and can be reversed by heat
- **So what is it?**
 - Starch?
 - Protein?
 - Something else?

Staling research

- **Initial focus was on Starch**
 - 1928-1934: J.R. Katz x-ray diffraction studies
 - Freshly gelatinized starch = fresh bread
 - Bread starch retrogrades concurrent with staling
 - Schoch (1947) also studied starch
- **Conclusion was Starch retrogradation causes bread firming.**
 - But.....



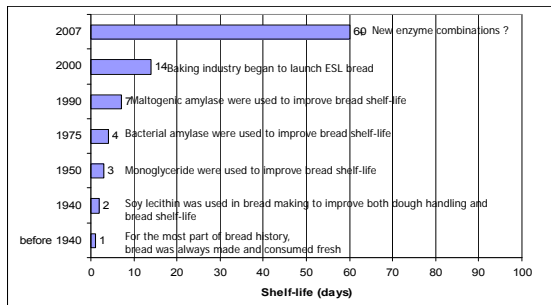
Shelf-Life Extension



Role of Proteins

- **Where is the protein in the picture?**
 - Doughs do not have cross-linked starch and protein
 - Bread appears to have starch-protein crosslinks
 - All flours do not produce bread that firms at the same rate
- **Still many unanswered questions**

Major Historic Events that Affect the Shelf-life of Bread



CARAMEL INGREDIENTS Used with permission.

CSM Bakery Supplies North America



Shelf-Life Extension

Maximize Shelf-life with Formulation



- **Moisture retention**
 - Keep within legal limits!
 - **Breads have a 38% maximum in US**
 - Rich dough
 - Increase hygroscopic ingredients
 - **Sugars**
 - **Gums**
 - **Fibers**

Maximize Shelf-life with Formulation

Continued

- **Sugars**
 - Flavor
 - Crust color
 - Delays starch gelatinization
 - Moisture retention / humectancy
 - Decreases a_w
 - **Monosaccharides generally more effective than disaccharides**



Maximize Shelf-life with Formulation

Continued

- **Gums (hydrocolloids)**
 - Usage levels very low
 - **Less and 0.5% total weight**
 - Moisture retention
 - **Increased finished moisture with proper absorption**
 - **Decreases bake loss**
 - Used to stabilize icings & toppings



Shelf-Life Extension

Effects of Enzymes

● Inactivation temperatures

- Cereal
 - α -amylase: 180-185°F (82-85°C)
 - β -amylase: 160-165°F (71-74°C)
- Fungal: 131-140°F (55-60°C)
- Bacterial: more than 212°F (100°C)

Temperature Profiles of Amylases

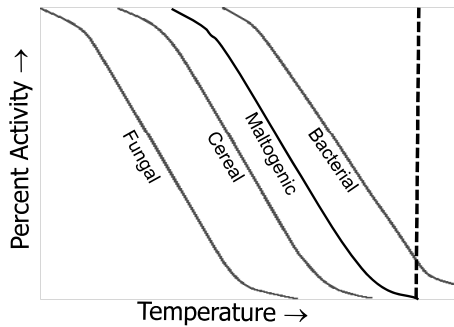


Figure by AIB International

Maximize Shelf-life with Production

- Control volume and density
- Control relative amounts of components
- Use proper packaging
- Constant temperature storage
 - Freeze



