SHELF LIFE EXTENSION

Presented by Aaron Clanton, Baking Curriculum Manager

All Things Baking **October 2011**

- **What determines the shelf-life of a product?**

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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*".

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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”**

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What factors into Shelf life?

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Control of Mold

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

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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.**

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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.**

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Factors Affecting Mold Growth

Condition for mold growth (optimum)	Method of controlling condition
Temperature ≈ 80 °F (27°C)	Air conditioning Heat sterilization
Relative Humidity ≈ 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***

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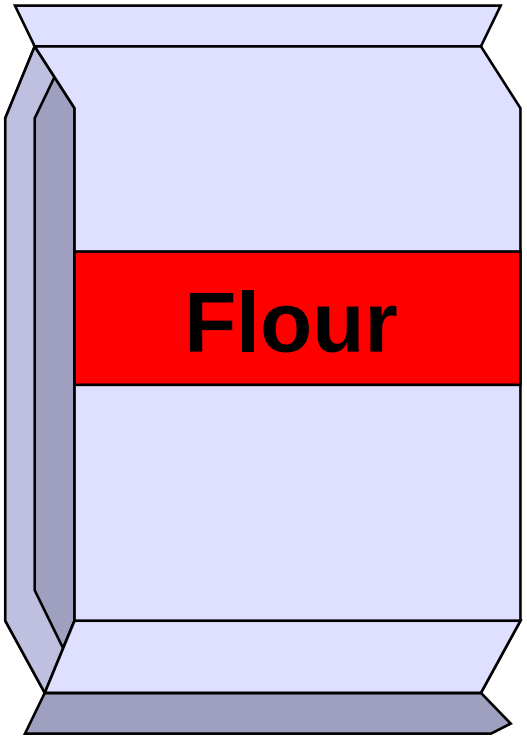
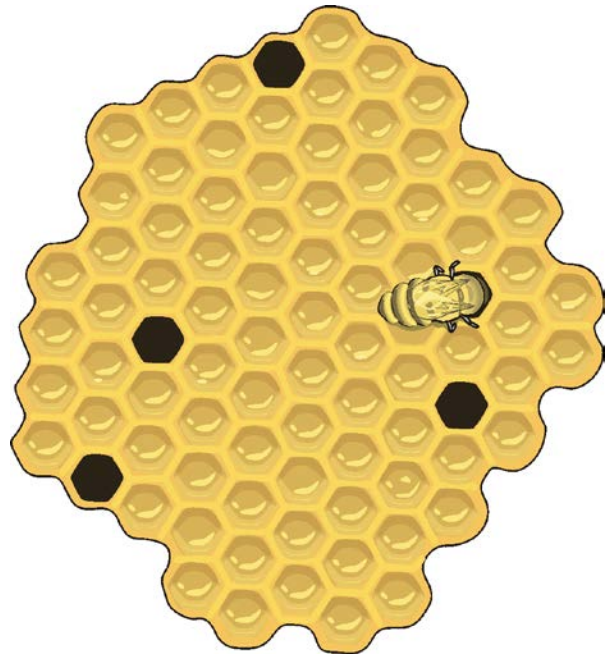
Factors that Enhance Mold Growth

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?

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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

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Minimum Water Activity for Microbial Growth

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

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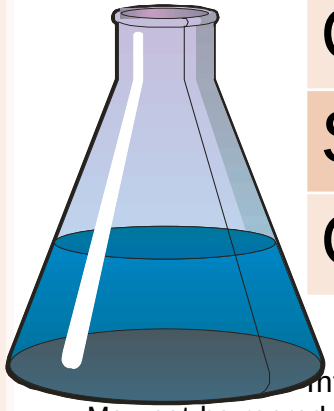
Water Activity of Bakery Products

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



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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**

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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.

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Preservatives

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

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Preservatives types

Chemical

- Propionates
- Benzoates
- Sorbates
- Acetates
- Parabens

Natural

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

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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**

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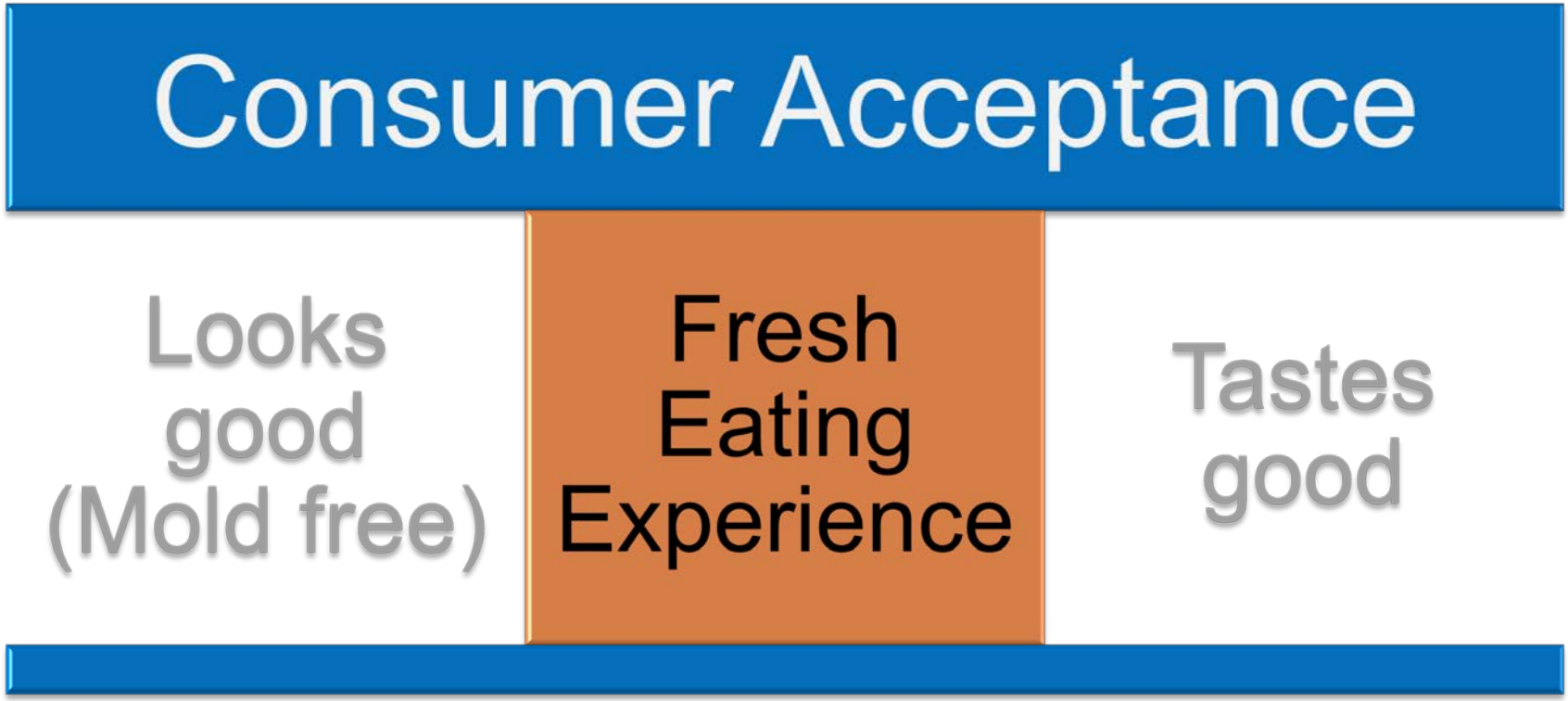
What factors into Shelf life?



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What changes occur over time?

Crust

- Toughens
- Loses friability (crispness)
- Changes from glassy to rubbery state
- Mainly migration of water from crumb
  - Water activity differences

Crumb

- 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?

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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…..

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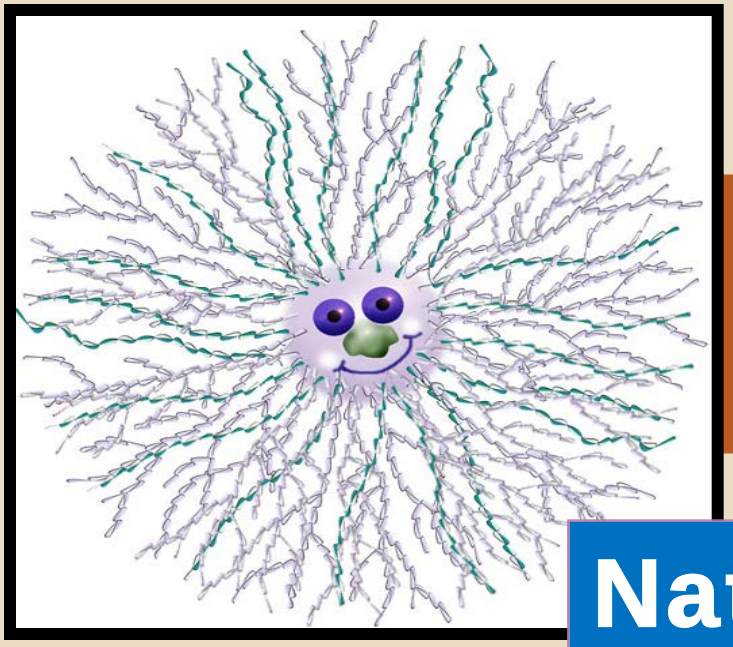
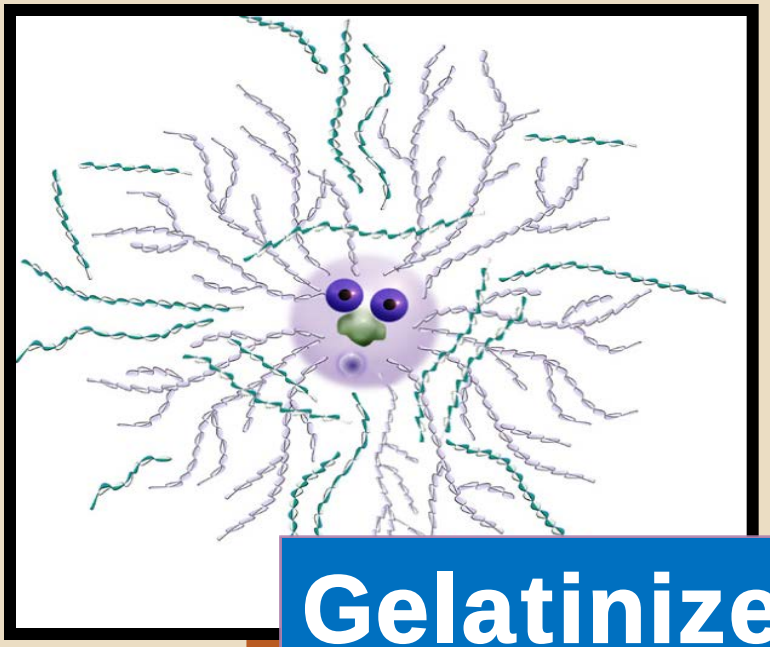


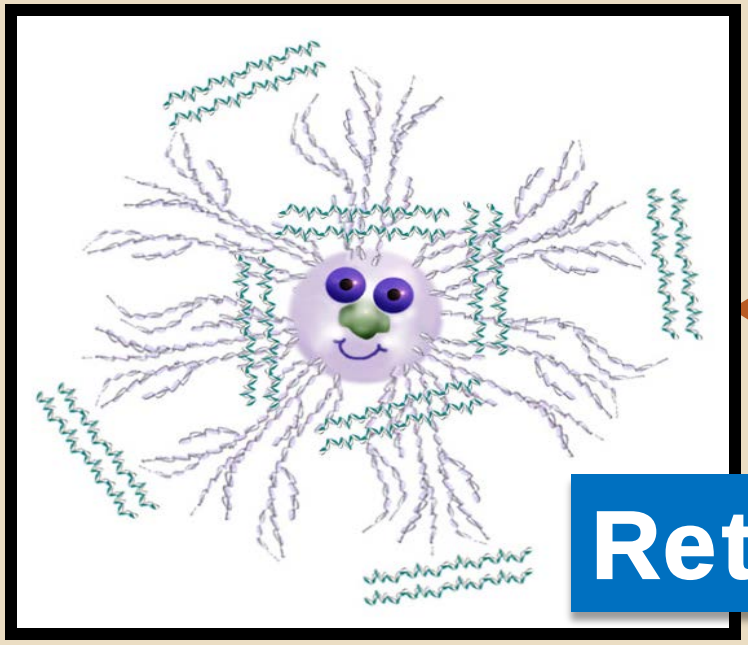
Native

+ H_2O
& heat



Gelatinized

Cools

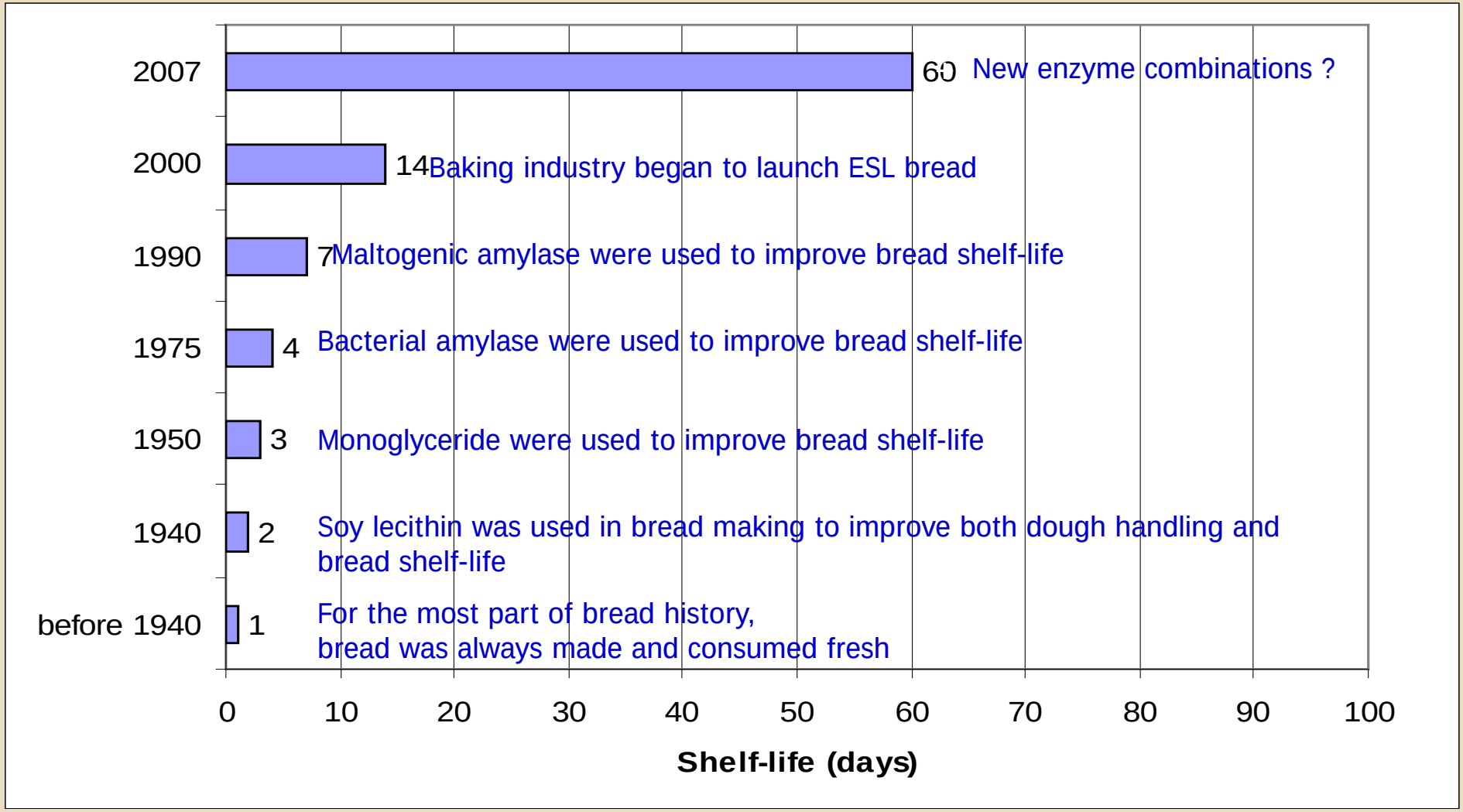


Retrograded

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



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**

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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**

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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 stabilizes icings & toppings

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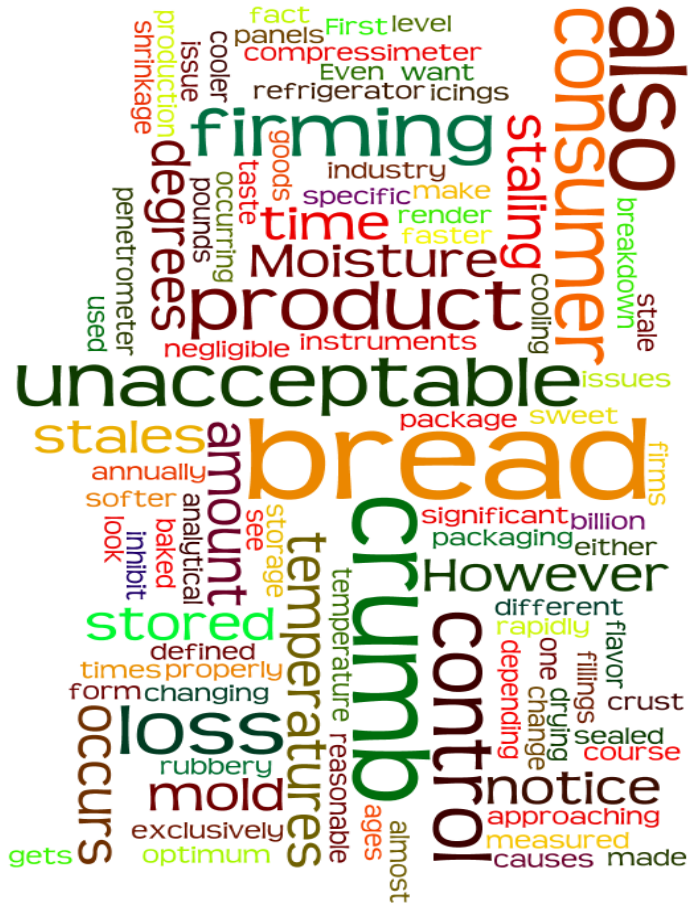
Maximize Shelf-life with Formulation

Continued

- **Slow firming**
  - Use fats
  - And/or emulsifiers
  - And/or crumb softeners
  - And/or enzymes



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Maximize Shelf-life with Formulation

Continued

- **Fats**
  - Slow rate of firming (softens)
  - Increased usage levels
    - **Flavor retention is increased**
    - **Mouth feel / lubricity**
  - Oil usage = ↑softness

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Maximize Shelf-life with Formulation

Continued

- **Emulsifiers**
  - Softens by slowing crumb firming
  - Increased gas retention
  - Increase tenderness
    - **Enhanced air, fat and water incorporation**
      - Stabilized environment
  - Synergy

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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)

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Temperature Profiles of Amylases

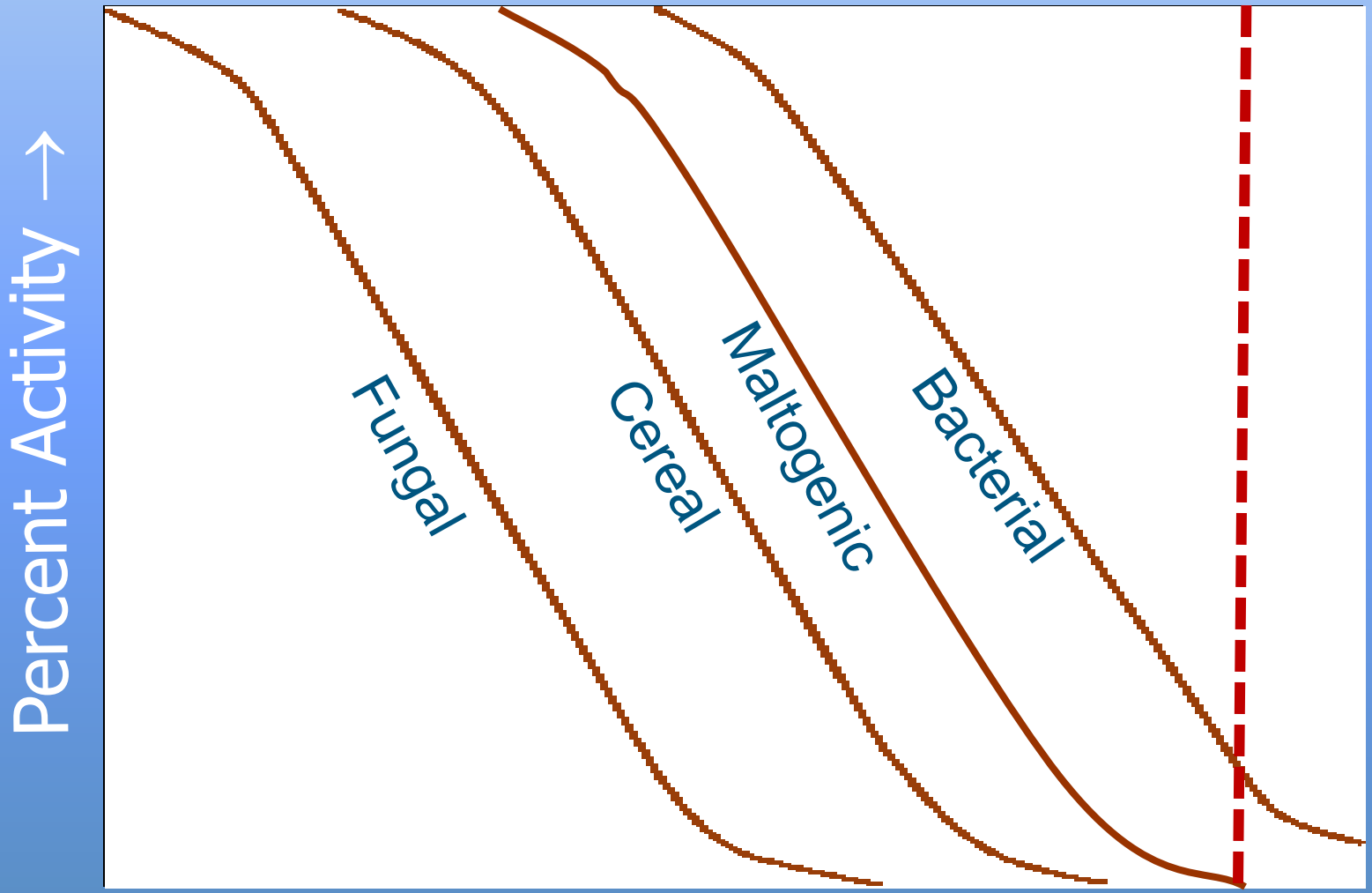

Figure by AIB International

Maximize Shelf-life with Production

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

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Maximize Shelf Life with Packaging

- **MAP packaging**
- **Oxygen scavengers**
- **Barrier films**
- **Surface washes - acids, alcohol**
- **Radiation - Heat, UV, white light**

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Why Extend Shelf Life?

- **Longer market exposure (less stales)**
- **Better logistics (fewer deliveries)**
- **Possible warehousing**
- **Less changeovers**
- **Improved work schedule**
- **Consumer acceptance?**

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