Pushing the Boundaries of Freshness through Hurdle Technology

Many factors have an influence on a product's shelf life. This can range from the ingredients used in a formulation, to the conditions and processes of the facility where it is produced, to the methods of distribution. Finding the perfect balance for each brand poses challenges for even the largest and most experienced bakery manufacturers. This presentation will focus on a range of ingredient solutions that effectively tackle three key issues facing baked goods - staling, molding, and oxidation - and how combing a series of “hurdles” can help you best meet consumers’ needs for safe, affordable, nutritious, and stable foods. It will also outline the newest emerging technologies available when you're asked to push the shelf life extension boundaries.

**Learning Objectives**

- Understand a hurdle technology approach to shelf life extension
- Appreciate ingredients’ role in maintaining product quality and freshness throughout shelf life
- Recognize how hyper-extended shelf life might be applied within your brand portfolio

**Presenter**
David Guilfoyle, DuPont Nutrition & Health

**Presentation Time**
Monday, February 25, 2019
1:30 pm - 2:05 pm

**Session**
Breakout 2
Pushing the Boundaries of Freshness Through Hurdle Technology

David “Guilley” Guilfoyle
Group Manager, Bakery/Fats & Oils
DuPont Nutrition & Health

What is shelf life extension?

*Shelf life extension is the survivability of a product that delivers acceptable quality over an extended period of time, while remaining safe.*
What is shelf life extension?

• Short-term shelf life: 0 days to 3 days
• Traditional shelf life: 4 days to 14 days
• Extended shelf life (ESL): 15 days to 30 days
• Hyper-Extended Shelf Life (HESL): 30+ days

WHY shelf life extension?

• Quality improvement?
• Change in delivery strategy?
• Food protection?
• Reduction in food waste?
Shelf life extension

Three parts of shelf life extension:

- **Antistaling**
- Antimicrobials
- Antioxidants

Antistaling

*Softness and moistness (anti-staling) are key attributes to keeping the survivability of the product quality, deemed acceptable by consumers, over an extended period of time.*
Antistaling

What are the options for maintaining softness and moistness?
- Enzymes
- Emulsifiers
- Hydrocolloids

What are the factors to consider?
- Intended shelf life time
- Formulary costs
- Label restrictions

Antistaling & Enzymes

Enzyme softening blends can have many different enzymes in them:
- Amylases (bacterial, fungal, maltogenic, maltotetrogenic (G4/G+), Glucoamylase, etc.)
- Xylanases
- Lipases
Antistaling & Enzymes

“Why is it necessary to understand what enzymes are in my softening blend?”

- Expense for the length of shelf life intended
- Type of formulation: lean, high fat, high sugar
- Type of processing
- Application type

Antistaling & Enzymes

Carefully select which enzyme blend you are using for each product. You may solve for one issue and create a more undesirable issue in that product.
Antistaling & Hydrocolloids

What if the bakery manufacturer wants to go out to beyond 35 days of shelf life?

An extra piece of the softening quality is the moisture control. So, what would we need to add to maintain moisture control?

Hydrocolloids

What are hydrocolloids?

*Hydrocolloids are* water soluble polymers, *which function by controlling the structure and mobility of water.*
Antistaling & Hydrocolloids

Factors to consider in selection of hydrocolloid:

- Product type
- Desired texture
- Processing conditions, shear, temperature
- Mixing requirements and equipment
- pH of the system
- Hydration Time/Particle Size
- Desired stability
- Interactions / competition with other ingredients
- Cost / functionality desired
- Legal requirements
- Customer requirements for label declaration or ingredient restrictions
## Antistaling & Hydrocolloids

### Alginates:
- Gel forming
- Thickening/viscosity
- Mouthfeel
- Foam stabilization
- Film-forming: glazes
- Heat stability

### Pectin:
- Improved dough characteristics in frozen dough (volume, handling)
- Texture, moisture management, gelation in bake fillings
- Multiple benefits in bake glazes

## Antistaling & Hydrocolloids

### MCC & HPMC:
- Reversible thermal gelation
- Water soluble
- Thickening
- Emulsification/encapsulation
- Film formation
- Binding (hot and cold)
- Air entrainment
- Foam stability
- Freeze-thaw stability
- Provide soluble fiber

### CMC:
- High water absorption/good water retention
- Improved dough stability & machinability
- Improved specific volumes
- Delayed retrogradation of amylose
- Prolonged freshness
- Improved texture and gloss
- Increased plasticity and elasticity
- Gluten free
- Freeze-thaw stability
- Barrier (fillings)
Shelf life extension

Remember the original definition of shelf life extension?

“It is the survivability of a product that delivers acceptable quality over an extended period of time, while remaining safe.”

Three parts of shelf life extension:

• Antistaling
• Antimicrobials
• Antioxidants

Antimicrobials

What are food antimicrobials?

Any treatment, or substance of natural, semisynthetic, or synthetic origin that kills or inhibits the growth of microorganisms, but causes no damage to the consumer.
Antimicrobials

The use of *antimicrobials* is just an **insurance policy** and **not** a “fix it” solution. The **higher** the **microbial load** on a bakery product, the **more stress** the load puts on the **antimicrobial**.

Antimicrobials

**Antimicrobial Considerations**

- Appropriate tool for the job
- Order of addition: In formula, or exterior
- Allergen concerns
- Label: Traditional or Clean
- Ease of application
- Flavor/sensory impact
- Cost-in-use
- Effect of food environment on activity
Antimicrobials
Chemical Preservatives

The basic synthetic antimicrobials that we have been using for many years are calcium propionates, sodium propionates, sorbates, and benzoates.

Antimicrobials
Natural Preservatives

Clean label preservation is a trending topic in bakery goods. Natural options include:

- Fermentates
- Natamycin
In microbial cells, the internal pH of the cell stays near a pH of 7 - regardless of the pH of the environment. So, the amount of hydrogen ion H+ entering and leaving the cell is balanced. Propionic acid in the undissociated acid form can penetrate the cell and release H+ - which then increases the amount of H+ in the cell, causing the pH of the cell to lower. In order to maintain the cell pH the H+ must be pumped out of the cell which takes a lot of energy and reduces cell growth.

Antimicrobials
Synthetic and Organic Acids

Application Details: Mode of Action of Synthetic and Organic Acids, as Inhibitors

**Natamycin**

Mode of Action: Natamycin, a natural antimicrobial peptide

- **Cell Wall Binding**
- **Cellular Membrane Destabilization**
- **Molecular Leakage**
- **Cellular Lysis = fungicidal FUNCTIONALITY**
- **No Growth = fungistatic FUNCTIONALITY**
Antioxidation

The last key to **protect** the **freshness** of the finished bakery product is **antioxidation**. It becomes important as the **shelf life** is extended beyond **30 days**.

Antioxidation

**Lipid Oxidation**

- Major cause of quality deterioration in foods
- Change in flavor, odor, color and texture
- Loss of nutritional value
- Production of toxins
- Limited product shelf-life
Antioxidation

What is rancidity?

It is the natural degradation of fats and oils by oxidation and/or hydrolysis.

Antioxidation

What causes rancidity?

Key Factors that Jumpstart Rancidity:
- Temperature (heat)
- Light
- Oxygen present around the product
- Time
Antioxidation

Antioxidants are substances that, when present in foods at low concentrations compared with that of an oxidizable substrate, markedly \textit{delay or prevent the oxidation of the substrate}.

**Benefits:**
- Minimize oxidation
- Reduce rancidity
- Maintain nutritional value
- Extend shelf-life

Antioxidation

\textbf{Classes of Antioxidants by Mode of Action}

\textbf{Primary or chain-breaking antioxidants}
- Scavenge free radicals, and break chain reactions
- Examples: phenolics, tocopherols, carotenoids, ascorbate, ascorbyl palmitate, BHA, BHT, TBHQ, propyl gallate

\textbf{Secondary antioxidants}
- Metal chelators: citric acid, phosphoric acid, EDTA
- Reducing agent: ascorbic acid, phenolics
- Singlet oxygen quenchers: ascorbic acid, beta-carotene
- Synergistic antioxidants: regenerate primary antioxidants
Antioxidation

Antioxidant Considerations

- Type and level of oil
- Formulation and processing factors
- Type of antioxidant/natural extract
- Regulatory aspects
- Sensory impact
- Desired shelf life
- Method of application

Hyper-Extended Shelf Life

Hyper Extended Shelf Life (HESL) in bakery products

When pushing the boundaries for HESL, there are different factors to consider: moistness, softness, resilience, stackability, flavor, freshness, mold-free, safe to consume, etc.
Putting it all together

<table>
<thead>
<tr>
<th>Shelf life</th>
<th>Recommended ingredients</th>
<th>Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 3 days</td>
<td>Emulsifiers, Enzymes (Fungal Amylase, MAA)</td>
<td>Short term softening.</td>
</tr>
<tr>
<td>4 to 14 days</td>
<td>Emulsifiers, Enzymes (MAA, G+/G4), Antimicrobials (synthetic, fermentates)</td>
<td>Intermediate softening and minimal food protection.</td>
</tr>
<tr>
<td>15 to 30 days</td>
<td>Emulsifiers, Enzymes (MAA, G+/G4), Hydrocolloids, Antimicrobials (synthetic, fermentates, Natamycin)</td>
<td>Longer term softening, moisture control, and food protection</td>
</tr>
<tr>
<td>35+ days</td>
<td>Emulsifiers, Enzymes (MAA, G+/G4, bacterial amylase), Hydrocolloids (CMC), Antimicrobials (synthetic, fermentates, Natamycin), Antioxidants</td>
<td>Hyper extended shelf life maximum softening, moisture control, maximum food protection, and freshness control</td>
</tr>
</tbody>
</table>

Thank you!