Lactic Acid: A Safe, label friendly way to reduce pH in Baked Goods

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Key Areas for Review

- What is Lactic Acid – history and functionality
- Why use Lactic Acid solutions in baking
- Versatility and use across food applications

What is Lactic Acid

History and Functionality

Lactic Acid in Bread

Lactic acid bacteria and yeast are abundantly present in flour. When provided water and favorable environmental conditions, fermentation will begin and lactic acid bacteria will form, pH will drop and flavor becomes more sour

History of Lactic Acid

- 1760: Lactic acid fermentation noted in the Netherlands
- 1880: First production of lactic acid based on fermentation by French chemist Henry
- 2007: Production begins in Thailand
- 1999: Production begins in USA
- 1986: Purchase of Ayuso (Spanish factory)
- 1993: Joint venture HVA/CSM
Lactic Acid is naturally present in the human body and in multiple foods

People have consumed lactic acid for centuries, as it is an inherent part of fermented foods. It is naturally produced in the human body and is an important part of gut health.

### Why Lactic Acid

**A natural antimicrobial**, lactic acid has been extensively studied for its effects against pathogenic and spoilage bacteria under both lab and commercial-use conditions. Not only that but lactic acid is also:

- Naturally present and naturally fermented
- Safe, non-toxic, easy-to-use
- Effective for pathogen reduction
- Effective pH reduction
- Biobased and sustainable
- Easily biodegradable in wastewater treatment plants

### Lactic acid at low acidity can kill bacteria

Weak acids like lactic can pass through the cell wall in their whole or "un-dissociated form" and ultimately cause cell death by acidifying the cytoplasm.

### Antimicrobial effect of organic acids

- pH is the key
- While strong acids can lower pH, they readily dissociate and less easily pass into the cytoplasm

### Lactic acid reduces pathogens

H⁺ + lactate ⇌ lactic acid

PO₂²⁺ H⁺ H⁺ H⁺ Lactate

\[ \text{Cytoplasm completely acidifies} \]

**Healthy**

**Leak cells**
Acidification can be an effective preservation control for some pathogens, but yeast and molds are highly tolerant and able to continue growth among the widest ranges of pH. Acidification can be an effective pH hurdle for some microorganisms. Here is a pH hurdle diagram showing the pH ranges for various pathogenic microorganisms.

<table>
<thead>
<tr>
<th>pH</th>
<th>Microorganisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yeast, Candida</td>
</tr>
<tr>
<td>2</td>
<td>Listeria, Enterobacteria</td>
</tr>
<tr>
<td>3</td>
<td>Campylobacter</td>
</tr>
<tr>
<td>4</td>
<td>Salmonella</td>
</tr>
<tr>
<td>5</td>
<td>Escherichia</td>
</tr>
</tbody>
</table>

Calcium Propionate (propionic acid) is not completely effective against all common bread molds. For preservation systems to be effective, the system must be in a pH range that allows for activity. Calcium Propionate (propionic acid) is not completely effective against all common bread molds. Mold Inhibition predictive modeling. For preservation systems to be effective, the system must be in a pH range that allows for activity.

Acid Usage in Baking

- Fumaric – breaks sulfur-to-sulfur bonds in protein network, most common in tortillas.
- Citric – very water soluble with a sharp sourness. Not commonly used in the US.
- Vinegar – common for bakery applications
- Sorbic, malic, lactic, propionic, phosphoric...

Value of Using Lactic Acid In Baked Goods

We are experts in understanding the effects of hurdle technology as it relates to baked goods. We are experts in understanding the effects of hurdle technology as it relates to baked goods. Series of steps, processes & ingredients that help maintain the stability, quality, and safety of food.

Our lactic acid & fermented solutions allow us to increase the hurdles for microorganisms to develop, making it difficult for mold to cultivate.

Selecting an acidification system – pH control

Selecting an acidification system – pH control.
Using Organic Acids to Manage Bread pH

Dough Development and Stability

Dough Development and Stability

Strength and Stability of Dough

Alveograph:
- Measure flexibility of dough as it relates to flour
- Resulting values measure:
  - Strength
  - Stability

Alveograph Parameters for Bread Dough
(consistent pH ~ 5.2 for the treatments)

Yeast Activity with Vinegar
Risograph Evaluation

Yeast Activity with Lactic Acid
Risograph Evaluation
Impact of Acidulant on Proof Time

Flavoring with organic acids

Lactic acid boosting sweet fruity and dairy flavors:
- Red fruits (strawberry, cherry, forest fruits)
- Tropical fruits (peach, mango, passion fruit)
- Dairy (yogurt, milky flavors)
- Has good fit with cola, vanilla, caramel, coffee

Mild, delayed impact & Masking lingering effects of HIS
- Reduce bitterness in energy drinks

Consumers focus on Flavor

“This solution is fantastic! Breads and tortillas produced with lactic acid have a much cleaner aroma and flavor while maintaining a low pH. This works especially well in problem products that require high levels of preservation.”

Our sensory analysis concluded that tortillas made with Lactic Acid are preferred over the control

“I love the new Tortillas with the Lactic Acid – they taste better and smell better”

Micro organisms are everywhere!

Versatility and Use Across Food Applications

- Soil
- Water
- Air
- Surfaces
- Manure
- Hide

Infographic courtesy of the Centers for Disease Control and Prevention
Lactic acid spray used for carcass surface treatment

- Used already for a long time as an antimicrobial intervention
- CFU reduction of E. coli, Salmonella, Enterobacteriaceae and others
- Biobased, sustainable product
- Safe chemical for humans
- Safe chemical for the environment
- Easily biodegradable in wastewater treatment plant

Pathogen Control Study (I)
Results for whole cantaloupes (Alvarado-Casillas et al)

*Compared to control

S. typhimurium on control = log 4.4
E. coli O157:H7 on control = log 4.7

Lactic acid in tempering water

- Aerobic Bacteria
- Enterobacteriaceae
- Yeasts
- Molds

Preservation requires a deep understanding of microbiology and the use of different technologies

Microbiology Screening
- Full screening and isolation of the major microorganisms of food systems

Preservation
- Use of current knowledge and development of new preservation solutions to limit microorganism growth
- Special treatments
- Other organic compounds

Screening
- Selection of more effective and cost-effective pH control solutions that can work in synergy with inhibitors

pH Control
- We optimize our solutions by selecting the combinations that produce the best results while maintaining flavor and quality
- Natural flavors

Consumer Experience

Final Takeaway

- Proven performance
- Why use Lactic Acid solutions in baking — flavor, pH stability, compatibility to development
- Versatility and use across food applications — industry growth with multi-functional benefits