LALLEMAND
BAKING UPDATE
VOLUME 1 / NUMBER 5
Preservatives

Practical technology from Lallemand Inc., parent of American Yeast Sales, producers and distributors of Eagle® yeast, fresh and instant.

AMERICAN YEAST SALES · Eagle · fermipan

A Guide to Baking Preservatives

REDUCED-CALORIE products and natural labels require close attention to preservatives. Understanding the active ingredients and how they work is key to choosing the right preservative for the product and label.

HOW PRESERVATIVES WORK

Preservatives extend the shelf life of baked goods by inhibiting the growth of rope bacteria and molds. Rope bacteria *(Bacillus mesentericus)* can be carried through the baking process and cause an unpleasant texture and odor inside yeast-raised products like bread. Molds can contaminate products after baking and then grow on the outside surface. Careful sanitation is key to avoiding both, but it is also important to take warmth, moisture, and acidity into account.

Warmth and moisture increase the chance of spoilage. Sugar and salt reduce the effect of moisture by reducing the amount of available water (water activity). Because fiber absorbs water but does not reduce its activity, reduced calorie products with high water absorption are more prone to spoilage. Traditional rope infections are rare today, but a similar problem with smell, not texture, continues to occur in lean and high-fiber breads.

Acidity decreases the chance of spoilage. Increasing yeast fermentation and adding sour ingredients help by lowering pH. Most preservatives have acids as an active ingredient, which helps to explain their effectiveness. Preservatives can be classified according to the kind of acid they contain: mineral acid, organic acid, or fatty acid.

Mineral acids (like sulfuric, hydrochloric, and phosphoric) are the strongest acids and so have the greatest effect on pH. But they work only by lowering pH and do not contain any other inhibitors. Calcium acid phosphate is an example of a mineral acid preservative because it contains phosphoric acid as an active ingredient.

Organic acids (like lactic, benzoic, and tartaric) have less effect on pH than do mineral acids but are better preservatives because they have an additional inhibitory activity. Raisin juice is an example of an organic acid preservative because it contains tartaric acid as an active ingredient.

Fatty acids (like acetic, sorbic, and propionic) are a specific kind of organic acid with an even stronger inhibitory activity. Calcium propionate is an example of a fatty acid preservative because it contains propionic acid as an active ingredient.

USING PRESERVATIVES

Most preservatives that inhibit bacteria and molds also inhibit yeast. The inhibitory effect of calcium propionate in yeast-raised products can be dealt with by adding the preservative to the dough instead of the preferment (sponge or brew), by using a relatively resistant yeast, and by increasing the amount of yeast. The even stronger inhibitory effect of sorbic acid can only be avoided by applying it topically after baking.

Natural and artificial preservatives contain the same organic and fatty acids as active ingredients but come from different sources and have different use requirements. Natural preservatives have a labeling benefit and may be multifunctional. But generally they are used in higher amounts, are more likely to affect finished product characteristics, and are more costly.

Regulatory requirements for preservatives differ greatly by country. The U.S. FDA considers most baking preservatives GRAS (Generally Recognized As Safe) for their intended use, subject to GMP (Good Manufacturing Practice). The general GMP requirements include that the quantity not exceed that required to accomplish its purpose and that the substance is of an appropriate food grade. Specific requirements apply to finished products that have an established standard of identity and to preservatives that have limitations on quantity or purity.

COMMON PRESERVATIVES

PRODUCT	ACTIVE INGREDIENT	APPLICATIONS	TYPICAL USE LEVEL (% FLOUR OR FILLING)	COMMENTS
Calcium propionate	Propionic acid	Yeast-raised, tortillas	0.2	Better at low pH
Natural mold inhibitor	Propionic acid	Yeast-raised	0.6 – 1.6	Natural
Sodium propionate	Propionic acid	Chemically leavened, pie fillings, tortillas	0.2	Compatible with baking powder
Potassium sorbate	Sorbic acid	Yeast-raised, pie fillings, tortillas	0.02 – 0.1	Topical for yeast-raised
Sodium diacetate	Acetic acid	Yeast-raised	0.2	
Vinegar	Acetic acid	Yeast-raised	1.0	Natural
Raisin juice	Tartaric acid	Yeast-raised	2.0	Natural
Sodium benzoate	Benzoic acid	Pie fillings	0.1	Below pH 4.5
Lactic acid	Lactic acid	Yeast-raised	0.5	
Calcium acid phosphate	Phosphoric acid	Yeast-raised	0.75	Lowers pH

International Perspective:

BAKING PRESERVATIVES IN OTHER COUNTRIES

Calcium propionate is the most common bread preservative in other countries for the same reasons that it's most common in the U.S. and Canada. It is highly effective against bread mold, poses no human health hazard, and contributes little or no flavor at normal use rates.

As in the U.S. and Canada, use rates for calcium propionate elsewhere depend on sanitation practices, shelf life conditions, and regulatory requirements. In Europe, European Economic Community (EEC) regulations limit calcium propionate usage to 0.5% of flour for products in which it is permitted. In Southeast Asia, usage rates can be much higher because the conditions are more favorable to the growth of spoilage organisms.

The regulatory situation is more complex in the EEC than it is in the U.S. or Canada. Generally, preservatives are not used or permitted in products from artisanal bakers, such as crusty breads, that are intended for immediate consumption. Growth in supermarket shopping has led to a parallel increase in the number of packaged, non-crusty products that require a shelf life of one to two weeks.

To accommodate the diversity of products, EEC food additive regulations are categorized into two types. Vertical regulations describe the standards of identity of a specific product, such as French baguette. Horizontal regulations cover general situations, such as whether a specific additive like calcium propionate is permitted. Use of a specific preservative in a specific product is determined by the vertical regulations, while the maximum usage rate is governed by the horizontal regulations.

Calcium Propionate/Yeast Interactions

CALCIUM PROPIONATE is produced by neutralizing propionic acid with calcium hydroxide. When calcium propionate is dissolved in water, it dissociates in the same way as other chemical salts to form calcium ions and propionate ions (reaction 1). Once the propionate ions are in solution, a reaction with water occurs to reform propionic acid (reaction 2):

REACTION 1

$$\text{Ca(Propionate)}_2 \leftrightharpoons \text{Ca}^{++} + 2\ \text{propionate}^-$$

REACTION 2

$$2\ \text{propionate}^- + 2\ H_2O \rightleftharpoons 2\ \text{propionic acid} + 2\ OH^-$$

Because this reaction produces a hydroxide ion, the ratio of propionate to propionic acid is dependent on pH. At lower pH the ratio of propionic acid is higher, and at higher pH it's lower. At pH 4.9 there are equal amounts of propionate and propionic acid.

Calcium propionate is an effective mold inhibitor but also reduces the fermentation rate of most bakers yeast strains. The inhibitory agent is propionic acid, while the ionized or propionate form is not inhibitory. This is how inhibition is thought to occur:

$$\text{propionate} + H_2O \rightleftharpoons \text{propionic acid}$$

(outside the cell)

$$H^+ + \text{propionate} \leftrightharpoons \text{propionic acid}$$

(inside the cell)

$$\text{decreased pH} \rightarrow \text{enzyme inhibition}$$

According to this model, the dissociation of propionic acid inside the cell causes a decrease in pH, which inhibits enzymes that are less active at the lower pH. The ionized form, propionate, is unable to pass through the cell membrane. However, according to the model, propionate would not reduce the pH inside the cell anyway.

The amount of inhibitory propionic acid that forms when non-inhibitory propionate ions react with water depends on the pH of the dough. For example, a change in pH of 0.3 units leads to a twofold change in the concentration of inhibitory propionic acid. This is because pH is a logarithmic function, and the logarithm of 2 is about 0.3. Therefore, effective control of inhibition, either of mold or of yeast fermentation, requires that close attention be paid to control of dough pH.

Lallemand Products for the Baker

Lallemand Inc. is a leading producer of yeast and dough conditioners, and supplies a full range of products to the baking industry through its subsidiaries Lallemand Distribution and American Yeast Sales.

Preservatives
- Powdered, granular, and dust-free calcium propionate
- Sodium propionate
- Natural mold inhibitors
- Potassium sorbate and sorbic acid
- Vinegar and raisin juice

Chemical Leaveners
- Single-acting and double-acting baking powder
- Bakers cream

Yeast Foods and Oxidizers
- Single-strength and double-strength yeast food
- Bromate-free yeast food
- Bromate, L-cysteine, ADA, and ascorbic acid

Emulsifiers
- Sodium stearoyl-2-lactylate (SSL)
- Calcium stearoyl-2-lactylate (CSL)
- Monoglycerides
- Mono- and diglycerides
- Ethoxylated mono- and diglycerides

LALLEMAND
BAKING UPDATE

Lallemand Baking Update is produced by Lallemand Inc. to provide bakers with a source of practical technology for solving problems. If you would like to be on our mailing list to receive future copies, or if you have questions or comments, please contact us at:

LALLEMAND Inc.
1620 Préfontaine
Montréal, QC H1W 2N8 CANADA
tel: (800) 840-4047   (514) 522-2133
fax: (514) 255-6861

LALLEMAND products are distributed by its subsidiaries, AMERICAN YEAST SALES and LALLEMAND DISTRIBUTION.

AMERICAN YEAST SALES

LALLEMAND