LALLEMAND
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Enzymes

Practical technology from Lallemand Inc.

A Guide to Baking Enzymes

ENZYMES ARE USED as flour additives and dough conditioners to replace chemical ingredients and to perform other functions in a label-friendly way. Understanding their characteristics can help millers, ingredient suppliers, and bakers to use enzymes more effectively.

TYPES OF ENZYMES

Amylases break down the starch in flour into dextrins and sugars. *Alpha*-amylase and *beta*-amylase occur naturally in wheat, but the natural level of *alpha*-amylase is usually too low and variable for optimal breadmaking.

Malt is used to standardize the *alpha*-amylase activity of most bread flour. Malted wheat or barley flour is added at the mill, or diastatic malt syrup can be added at the bakery.

Fungal amylase is also used to standardize the *alpha*-amylase activity of bread flour. Fungal amylase is commonly used in dough conditioners to improve oven spring.

Other amylases are more temperature stable so that they work at later stages of baking. These intermediate stability, maltogenic, bacterial, and thermostable amylases are used primarily in antistaling products because they convert more of the starch into forms that resist firming.

Glucoamylase breaks down the dextrins generated by amylases into glucose sugar. Glucose is easier for yeast to ferment than maltose and can be used to partially replace other sugars in the recipe.

Hemicellulase, along with cellulase, pentosanase, and xylanase, breaks down the insoluble fiber in wheat flour, rye flour, and fiber supplements. The types used in breadmaking leave the water-soluble fiber intact and release bound water into the dough to improve machinability and loaf volume. Others, used in cracker production, break down soluble fiber and reduce the amount of water needed for mixing.

Protease breaks down the gluten protein in wheat flour. For breadmaking this can improve gas retention, but with a trade-off for less tolerance. For cracker production this improves machinability, with gas retention not as important.

Lipoxygenase from soy flour oxidizes the fats in flour to form peroxides. The peroxides bleach the flour pigments, which results in a whiter crumb color.

Glucose oxidase oxidizes ascorbic acid to dehydro-ascorbic acid. The dehydro-ascorbic acid modifies the gluten protein by forming linkages that increase its strength.

Lipase and especially phospholipase, break down the fat-containing parts of flour to produce emulsifiers that strengthen the dough and soften the crumb.

Transglutaminase creates links between gluten molecules and strengthens the dough.

GENERAL CHARACTERISTICS

Enzymes are large proteins that act as catalysts to speed up reactions without themselves being changed. They are produced by plants, animals, and microorganisms but are not living organisms themselves. Enzymes are highly active, so only small quantities are required, and highly specific, so a single enzyme usually catalyzes only a single reaction. Each enzyme has its own pH and temperature range, and the progress of its reaction depends on those conditions along with time and concentration.

Enzymes are named for the compounds they work on (carbohydrases, proteases, lipases) and the kinds of reactions they catalyze (hydrolases, oxidases). Most commercial enzymes are produced from microorganisms, so their genus and species is

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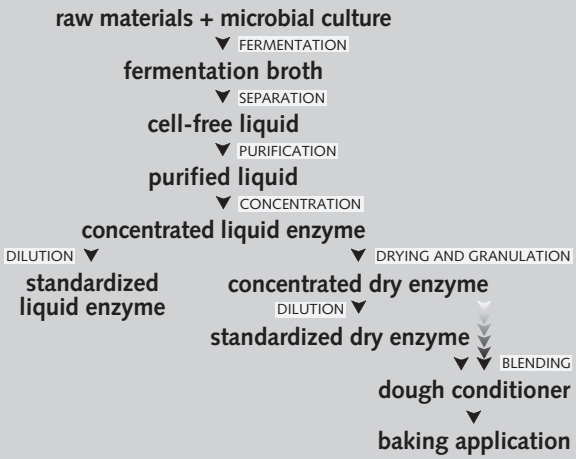
BAKING ENZYMES

NAME	FUNCTION	APPLICATIONS
Malt flour	Breaks down starch, produces maltose sugar	Flour standardization
Fungal amylase	Breaks down starch, produces maltose sugar	Flour standardization, dough conditioners, sweetening
Bacterial amylase	Breaks down starch	Dough conditioners, antistaling
Thermostable amylase	Breaks down starch	Antistaling
Intermediate stability amylase	Breaks down starch	Antistaling
Maltogenic amylase	Breaks down starch, produces maltose sugar	Antistaling
Glucoamylase	Produces glucose sugar	Sweetening
Hemicellulase/Cellulase Pentosanase Xylanase	Breaks down fiber, releases bound water	Dough conditioners
Fungal protease	Breaks down gluten	Flour standardization, dough conditioners, cracker production
Bacterial protease	Breaks down gluten	Cracker production
Bromelain	Breaks down gluten	Flour standardization
Lipoxygenase	Oxidizes fats, bleaches flour pigments	Crumb whitening
Glucose oxidase Hexose oxidase	Oxidizes gluten	Dough conditioners
Lipase Phospholipase	Breaks down fats, oils, phospholipids	Emulsifier replacement
Transglutaminase	Modifies gluten	Dough conditioners

ENZYME PRODUCTION

Most commercial enzymes, including baking enzymes, are produced by submerged culture fermentation. A selected microorganism is grown on a mix of nutrients in a fermenter with carefully controlled agitation, aeration, temperature, and pH. Most enzymes are extracellular, so they remain in the fermentation broth when the broth is separated from the microbial cells by centrifugation or filtration. After separation, the cell-free liquid may be purified to remove non-enzyme material. The purified liquid then undergoes membrane filtration or evaporation to produce a concentrated liquid enzyme.

Most baking enzymes are formulated into dry products. The concentrated liquid enzyme is dried, granulated, and diluted to produce dust-free particles with a standardized activity. The standardized enzyme can be used or blended into a dough conditioner, bread improver, or baking mix. Unstandardized enzymes are too concentrated and variable to be dosed in a bakery but can be used for blending. Liquid enzymes are used for other applications, like brewing and distilling, but are not commonly used for baking.



Lallemand Baking Enzymes

LALLEMAND was an early innovator in the use of enzymes in baking and has several key patents on their application. Today, Lallemand Baking Solutions specializes in the development and application of enzymes and enzyme-based dough conditioners.

RESEARCH

Lallemand's regional baking laboratories develop new products and optimize them to work with local ingredients:

- Montreal, Canada
- Mexico City, Mexico
- Johannesburg, South Africa
- Breda, Netherlands
- Lisbon, Portugal

FORMULATION

Enzymes, enzyme blends, dough conditioners, and custom formulations are available under the Essential®, Fermaid®, and other trade names, for a wide variety of baked goods:

- Breads, buns, rolls
- Flat breads, tortillas
- Pizza, bagels
- Pretzels, crackers
- Pies, pastry

SUPPORT

Lallemand Baking Solutions provides technical service by professional bakers who can assist customers with all types of formulation challenges:

- Flour standardization
- Formula optimization
- Cost reduction
- Mix time reduction
- Bake time reduction
- Process tolerance
- Emulsifier replacement
- Bromate and ADA replacement
- Cysteine replacement
- Clean label
- Volume and texture improvement
- Shelf life extension

A Guide to Baking Enzymes

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also an important way of identifying them.

Enzyme preparations are complex mixtures that normally contain more than one activity but are usually standardized and sold on the basis of a single activity measurement. Depending on the application, other "side activities" may also be relevant.

Enzyme activity is measured using assay procedures that are usually different from application conditions and that generally vary among enzyme suppliers. Addition levels and product comparisons should be based on baking trials, not activity specifications.

The shelf life and storage conditions for enzymes depend on their physical forms. Liquids usually have the shortest shelf life and should be stored under refrigeration. Powders and tablets are usually stable for a year or more when stored at room temperature.

Because enzymes are proteins, skin contact and inhalation of dust or aerosols can cause allergic reactions in some sensitive individuals. Prolonged contact with concentrated proteases can also cause skin and eye irritation. Proper handling procedures should be provided on a Safety Data Sheet (SDS). Additional information is provided in the Enzyme Technical Association's *Working Safely With Enzymes*, which is available from Lallemand or at www.enzymeassociation.org.

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Lallemand Baking Update is produced by Lallemand Inc. to provide bakers with a source of practical technology for solving problems. You can find the latest issues online at www.lallemandbaking.com.

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