

# BAKING UPDATE

## Enzymes in Flour

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



fermipan

### Measuring Enzyme Activity

Measuring amylase activity in flour is a challenge because the enzyme and the starch substrate are both present and interact. There is a wide variety of methods, but they can be grouped according to some common characteristics.

**Autolytic methods** are used on flour samples to measure the amount of enzyme activity occurring as the flour acts on itself. They cannot be used directly on enzyme preparations.

**Defined substrate methods** are used on enzyme preparations to measure their activities as they act on purified starch. They cannot be used directly on flour samples. An exception is the Grain Amylase Analyzer, which extracts the enzyme activity from flour samples before reacting it with a defined substrate.

**Alpha-amylase methods** are used mostly on flour and enzyme preparations.

*Continued*

### Standardizing Enzyme Levels in Flour

**B**EFORE MILLING, wheat starch is made up of microscopically small granules that are completely insoluble in cold water and resistant to enzymes. During milling, 5 to 10 percent of the granules are damaged so that they become soluble and available to enzymes as soon as water is added. During baking, undamaged starch granules swell and become soluble (gelatinize) at about 140°F, so the remainder of the starch then becomes available to enzymes.

Wheat also contains *alpha*-amylase and *beta*-amylase enzymes that act on starch. *Beta*-amylase is normally produced in wheat at relatively high, consistent amounts. *Alpha*-amylase is produced at lower and more variable amounts depending on the wheat variety and weather during growth, harvest, and storage.

*Alpha*- and *beta*-amylase begin to act on

the damaged starch in a dough as soon as mixing starts. *Alpha*-amylase converts the damaged starch into dextrins, while *beta*-amylase converts the dextrins into maltose sugar. There is usually plenty of *beta*-amylase present, so the amount of sugar formed depends on the amount of damaged starch and the rate of formation depends on the amount of *alpha*-amylase.

Maltose formation is important because it affects the amount of yeast fermentation, which in turn affects dough development, flavor, and leavening. The importance of *alpha*-amylase to yeast fermentation is greatest in a straight lean dough process where maltose is the main fermentable sugar. It is also important in a sponge or brew preferment where maltose production may be limited by the level of either *alpha*-amylase activity or damaged starch. *Alpha*-amylase has little influence on fermenta-

*Continued*

### AMYLASE ACTIVITY TEST METHODS

Method	Where Used	Principle	Procedure	Typical Values
Amylograph (Brabender)	Flour Flour with malt	Viscosity	BU = peak viscosity on scale of 1000 for flour heated 1.5°C/min. to 95°C	800–900 BU (untreated flour) 450–550 BU (treated flour)
Modified Amylograph (Brabender)	Flour with fungal amylase	Viscosity	BU = minimum viscosity on scale of 1000 for flour/pregelatinized starch heated to 63°C	150–200 BU (treated flour)
Hagberg (Falling Number)	Flour Flour with malt	Viscosity	FN = seconds for stirrer to fall through flour suspension after 1 min. at 100°C	>400 sec. (untreated flour) 225–275 sec. (treated flour)
Modified Hagberg (Falling Number)	Flour with fungal amylase	Viscosity	FN = seconds for stirrer to fall through flour/pregelatinized starch mixture at 30°C	
Wohlgemuth (SKB)	Malt Fungal amylase	Iodine Reaction	SKB unit = 1g starch converted by 1g malt in 1 hour at 30°C	5,000 SKB/enzyme tablet
Fungal Amylase (Gist-brocades)	Fungal amylase	Iodine Reaction	FAU = 1g starch converted in 1 hour based on 11–25 min. at pH 5.0, 30°C	1 FAU unit = 15.4 SKB units
Fungal Amylase (alternate)	Fungal amylase	Iodine Reaction	FAU = 5.26g starch converted in 1 hour based on 7–20 min. at pH 4.7, 37°C	1 FAU unit = 27.8 SKB units
Fungal Amylase (Phadebas®)	Fungal amylase	Dye Release	FAU = 1g starch converted in 1 hour based on 11–25 min. at pH 5.0, 30°C	1 FAU unit = 15.4 SKB units
Grain Amylase Analyzer (GAA)	Flour with malt or fungal amylase	Turbidity	GAA unit = nephelos units from <i>beta</i> -limit-dextrin conversion in 1 min. at 37°C	360–560 GAA (treated flour)
Diastatic Activity* (AACC)	Flour	Reducing Sugar	DA unit = 1mg maltose from 10g flour in 1 hour at pH 4.7, 30°C	<500 units (untreated flour) >500 units (treated flour)
Lintner*	Malt	Reducing Sugar	°Lintner = maltose equivalents from starch x 0.25	100°Lintner (malt flour) 20°Lintner (malt extract)

\* Tests for *beta*-amylase (all others are for *alpha*-amylase)

## FLOUR STANDARDIZATION WITH FUNGAL AMYLASE

STARTING VALUE OF FLOUR		FUNGAL AMYLASE TO ADD	
Falling Number (FN)	Brabender Units (BU)	SKB Units/cwt	Enzyme Oz./cwt*
<225	<200	0	0
225 – 250	200 – 300	0 – 8,000	0 – 0.04
250 – 300	300 – 500	8,000 – 16,000	0.04 – 0.08
300 – 340	500 – 800	16,000 – 24,000	0.08 – 0.12
340 – 380	800 – 1500	24,000 – 32,000	0.12 – 0.16
>380	>1500	32,000	0.16

\* Bakezyme® P20 (454 FAU/g)

### Measuring Enzyme Activity (Continued)

This is the activity that varies in untreated flour and is the most important to standardize for baking performance.

**Beta-amylase methods** are traditionally used on malt, even though this activity is not as important for flour standardization.

**Viscosity methods** like the Amylograph and Falling Number rely on the principle that starch gets thicker when it gelatinizes and thinner when it is broken down by *alpha*-amylases. Most are only suitable for malt-treated flour because they use temperatures that inactivate fungal amylase. Some modified viscosity methods use pregelatinized starch and lower temperatures so they can be used to determine fungal amylase activity in flour.

**Iodine reaction methods** like the Wohlgemuth (SKB) are based on the blue color that forms when long starch chains coil around iodine molecules. When *alpha*-amylases convert starch to dextrins, the blue color diminishes in proportion to the

activity. Iodine reaction methods use moderate reaction conditions and so work on both fungal and malt enzyme samples.

**Dye release** is used by the Phadebas® method and is based on the color produced when *alpha*-amylase converts a dyed insolubilized starch into soluble dextrins. It uses moderate reaction conditions and is usually used on fungal enzyme samples.

**Turbidity** is used by the Grain Amylase Analyzer and is based on the clearing that takes place as a *beta*-limit-dextrin is hydrolyzed by *alpha*-amylase. It uses moderate reaction conditions and will work on flour with either malt or fungal amylase.

**Reducing sugar methods** like Lintner measure the maltose produced by *beta*-amylases in malt or flour. *Alpha*-amylase also increases maltose production from starch in the presence of excess *beta*-amylase, but methods based on this principle are not used for measuring fungal amylase activity. 

## Flour Treatment Alternatives With Bakezyme® P

**B**AKEZYME® P is a fungal *alpha*-amylase enzyme with advantages over malt and other fungal enzymes.

Malted wheat or barley flour are not ideal for flour standardization because their *alpha*-amylase activities vary, overdosing can cause sticky crumb texture, and protease can reduce loaf volume. Some fungal amylases also have significant protease levels and can also reduce loaf volume. Bakezyme® P is free of protease and can be used for flour standardization to avoid the problems with malt or other fungal amylases.

Bakezyme® P can also be added to dough conditioners and mixes or at the bakery to provide an additional improvement, even when using properly standardized flour. The additional improvement comes from the action of *alpha*-amylase in the oven where it delays crumb setting and increases loaf volume. The same action also helps to im-

prove crust color and crumb texture in a controlled way without the problems of overdosing or weakening from protease.

In many situations, the best approach is for the baker to purchase unstandardized flour and add an optimum amount of Bakezyme® P or a dough conditioner containing Bakezyme® P. This avoids variations caused by malt or other fungal enzymes and allows the baker to tailor the amount of *alpha*-amylase to each recipe.

Bakezyme® P is available in a variety of standardized activities, including concentrated levels for use at the mill and less concentrated for convenient scaling in the bakery. Bakezyme® PS and PFP are also available with standardized levels of fungal protease activity for applications where a controlled amount of gluten modification is desirable. 

Bakezyme® is a trademark of Royal Gist-brocades NV, Delft, Holland.

## Standardizing Enzyme Levels in Flour

(Continued)

tion in doughs where excess sugar is present.

During baking, *alpha*-amylase breaks down a portion of the starch granules as they begin to gelatinize and before the enzyme itself is inactivated. This increases loaf volume by delaying crumb setting and allowing more expansion of the dough. The level of *alpha*-amylase affects the breakdown of starch during baking and so has an effect on loaf volume even when it does not affect yeast fermentation.

The *alpha*-amylase level in most flour for breadmaking is standardized at the mill by adding about 0.25 percent of malted barley or wheat flour. The amount of malt *alpha*-amylase is important because if too much is present during baking it will overconvert the gelatinizing starch into dextrins, which cause stickiness. The protease content of the malt is also important because this enzyme breaks down gluten and can cause weakness and small volume.

The *alpha*-amylase level in flour can also be standardized at the mill or adjusted at the bakery using fungal enzymes. The amount of fungal *alpha*-amylase is not as critical as with malt because it is inactivated earlier in the oven and will not cause stickiness. 

### 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

*To the best of our knowledge, the information in Lallemand Baking Update is true and accurate. However, any recommendations or suggestions are made without warranty or guarantee.*

© 1996 Lallemand Inc.

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

