LALLEMAND
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Enzymes in Flour

Practical technology from Lallemand Inc.

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. This

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Standardizing Enzyme Levels in Flour

BEFORE 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 (60°C), 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 fermentation in

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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 (Iodine)	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 beta-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	SKB Units/1,000 kg
<225	<200	0	0
225 – 250	200 – 300	0 – 8,000	0 – 175,000
250 – 300	300 – 500	8,000 – 16,000	175,000 – 350,000
300 – 340	500 – 800	16,000 – 24,000	350,000 – 525,000
340 – 380	800 – 1500	24,000 – 32,000	525,000 – 700,000
>380	>1500	32,000	700,000

Measuring Enzyme Activity *(Continued)*

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 mode rate 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.

Lallemand Dough Conditioners

FUNGAL *alpha*-amylase has advantages over malt and other enzymes for standardizing flour and is a key ingredient in most Lallemand dough conditioners.

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. In many situations, the best approach is for the baker to purchase unstandardized flour and add an optimum amount of fungal amylase or a dough conditioner containing fungal amylase. This avoids variations caused by malt quality or by analytical or mixing errors at the flour mill. It also allows the baker to tailor the amount of *alpha*-amylase to each recipe.

The fungal *alpha*-amylase levels in Lallemand dough conditioners provide an additional improvement, even when using properly standardized flour. The added improvement comes from the enzyme's action on the starch in the dough to delay crumb set in the oven. This allows more "oven spring" and increases volume, helping the initial softness of the bread. The same action also helps to improve crust color and crumb texture in a controlled way. The fungal *alpha*-amylase used in Lallemand dough conditioners is free of protease so avoids the problems of overdosing or dough weakening that can occur with malt and other enzymes.

Lallemand Baking Solutions offers a full range of Essential® high performance enzyme-based dough conditioners for all types of dough systems and for a variety of baked goods applications. Lallemand products are backed by a skilled technical support staff that will be happy to assist you in determining which product best suits your process and application.

Standardizing Enzyme Levels in Flour

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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.

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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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