

BAKING UPDATE

High-Fiber Bread

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



fermipan


Fiber Chemistry

Like starch, fiber is made up of carbohydrate polymers with sugars as their basic building blocks, but the structure of fiber is more varied and complex. Cellulose is an insoluble fiber that resembles amylose starch with its linear structure of D-glucose units, but is formed by *beta*- instead of *alpha*-1,4 linkages.

Hemicellulose is a general term for the noncellulose fiber fraction of plant cell walls. The basic structure of hemicellulose is a main chain with side chains attached, both of which can be made from a variety of five and six carbon sugars. Pentosans are the part of the hemicellulose fraction where the main chain is made up of five carbon sugars, usually D-xylose. Pentosan fractions can be soluble or insoluble, depending among other factors on their degree of polymerization. The hemicellulose fraction is usually described as insoluble.

The most common wheat pentosan is arabinoxylan, made from a main chain of D-xylose with *beta*-1,4 linkages connected at the carbon 2 or 3 positions to side chains of L-arabinose. Wheat flour pentosans are frequently conjugated to proteins. It appears that ferulic acid ester groups attached to the arabinoxylan chain are involved in oxidative gelation reactions resulting in crosslinks between arabinoxylan chains and (gluten) proteins.

Hemicellulase and pentosanase are general terms for enzymes that hydrolyze these substrates. The most desirable enzymes for baking applications have an endopentosanase activity that breaks down large insoluble pentosans into smaller soluble fragments. The resulting gum has a beneficial effect because it facilitates water uptake, reduces stiffness, and forms a desirable gel.

Pentosanases could also improve gas retention by removing pentosans that are crosslinked to gluten proteins. These pentosans would normally hinder the formation of the gluten network that retains the carbon dioxide gas in the dough. 

High-Fiber Bread Production

VARIETY BREAD consumption is increasing in the U.S. and Canada at the same time that white pan bread consumption is decreasing. Much of the growth is from whole-wheat, multi-grain, low-calorie, and other breads that contain increased amounts of dietary fiber. Formulations for these products differ from regular bread because their fiber ingredients tend to increase water absorption, weaken the dough, and reduce processing tolerance.

FIBER TYPES AND SOURCES

Dietary fiber is plant cell material that is resistant to digestion and so passes through the gastrointestinal tract more or less intact. Dietary fiber can be water soluble, water insoluble, or a combination of the two. Soluble fiber is made up of pentosans, *beta*-glucans, and other gums. They may lower blood cholesterol levels and contribute to a decreased risk of coronary heart disease. Insoluble fibers are mainly composed of cellulose, lignin, hemicellulose, and pectins. They have a positive effect on the passage of food through the intestine and may help

decrease the risk of some types of cancer.

Wheat contains a mixture of soluble and insoluble pentosans in the endosperm and insoluble hemicellulose in the bran, making whole wheat and wheat bran good sources of dietary fiber. Some other common fiber sources for bread production are corn bran, rice bran, oat fiber, soy fiber, and powdered cellulose. The most important criteria for choosing among them are fiber content, cost, color, flavor, water absorption capacity, and water retention capacity after baking. Fiber levels vary from 1 to 4 percent for high-fiber bread, up to 20 percent for low-calorie bread.

INGREDIENT ADJUSTMENTS

Flour used in high-fiber bread needs to be stronger (higher protein) than in white bread. Whole-wheat bread is made with 100% whole-wheat flour and no regular flour. High-fiber and multigrain breads are usually made with regular flour and varying quantities of fibers, other cereal flours, grits, and meals. Low-calorie bread contains high levels of both fiber and wheat gluten.

Continued

HIGH-FIBER BREAD FORMULAS

INGREDIENT	HIGH-FIBER LOW-CALORIE BREAD	HIGH-FIBER BREAD	WHOLE-WHEAT BREAD
Flour			
Regular	88 – 92%	100%	—
Whole wheat	—	—	100%
FIBER	10 – 20%	4% (var)	—
Wheat gluten	8 – 12%	2 – 4% (var)	1 – 2%
Water	108 – 120%	60 – 65%	55 – 60%
Yeast	4 – 6%	3 – 4.5%	3 – 4.5%
Salt	2%	2%	2%
Sugar	8 – 12%	8 – 12%	8 – 12%
Shortening	1% (var)	3%	3%
Emulsifiers	0.5 – 1.5%	0.5 – 1.0%	0.5 – 1.0%
Oxidants/enzymes	var	var	var
Calcium propionate	0.2 – 0.5%	0.2 – 0.5%	0.2 – 0.5%

High-Fiber Bread Production (Continued)

Vital wheat gluten is added at levels up to 12 percent to compensate for the dilution and weakening effects of fiber. In sponge and dough systems, half of the gluten can be added to the sponge and the other half to the dough.

Water levels are greatly increased by the high absorption of gluten and fiber. A rule of thumb is to increase water by 1 to 2 percent for every 1 percent of gluten. Adjusting for fiber absorption is usually done by trial and error because it depends not only on the fiber's water uptake capacity, but also on its hydration rate and water retention after baking.

Yeast dosages are usually increased by 1 to 3 percent to achieve an optimum proof time and adequate loaf volume.

Sugar levels may vary. In high-fiber breads the sugar levels are usually higher than in regular white breads.

Shortening is reduced or eliminated in low-calorie breads. Even a small reduction has a significant effect because fats are such a concentrated source of calories.

Emulsifier levels are increased to make up for the lower amounts of shortening and to counteract the weakening effects of fiber. Dough-stabilizing emulsifiers such as ethoxylated monoglycerides (EMG) and

sodium stearyl lactylates (SSL) are added to stabilize the dough. Starch complexing emulsifiers such as distilled monoglycerides are added to improve crumb softness. Monoglycerides contribute fat calories, but the net effect of substituting them for shortening is favorable because they can be used at lower levels.

Oxidant levels are usually higher for high-fiber breads, which require additional strengthening of the gluten protein. Ascorbic acid levels up to 100 ppm, ADA up to 45 ppm, and bromate up to 75 ppm are quite common. Calcium peroxide is used as a dough dryer that counteracts the dough stickiness of high-fiber breads directly after mixing.

Preservative levels are usually higher for high-fiber breads because of the finished product's higher moisture content. While 0.2 percent calcium propionate is usually adequate in white pan bread, 0.5 percent is often recommended for high-fiber formulations.

PROCESSING CONSIDERATIONS

Presoaking fiber ingredients helps water absorption during mixing because many types of insoluble fibers absorb water slowly. Without presoaking, the dough will be

slack and sticky directly after mixing but will become too stiff during subsequent fermentation, resulting in bread with lower volume and inferior grain.


Fermentation time should be reduced when a sponge or brew process is used. Fiber decreases fermentation tolerance and can produce doughs that collapse at the end of the final proof.

Mix time is more difficult to judge for high-fiber doughs because of the slow water absorption by the fiber during mixing. Fiber decreases mixing tolerance, so it is better to slightly under-mix than to over-mix.

Proof time and temperature should be reduced by increasing the yeast level. When a sponge or brew process is used, part of the yeast can be "spiked" on the dough side.

Scaling weight and finished product volume require extra attention. Oven loss varies greatly depending on the type of fiber used, and calorie claims require careful control of slice weight.

Baking conditions (time and temperature) for high-fiber breads have to be optimized to control browning and to avoid excessive moisture loss. Longer bake times at lower temperatures can help avoid excessive browning.

Slicing can be a problem because of moisture content and crumb texture. Slicer maintenance and blade changes require extra attention. 

Lallemand Dough Conditioners


LALLEMAND supplies various enzyme-based dough conditioners that facilitate the processing of high-fiber breads and can help improve quality and uniformity. These dough conditioners are based on enzyme preparations with hemicellulase or pentosanase activity. These enzymes facilitate the uptake of water by the fiber and improve the quality of high-fiber breads.

Fermaid® WM is a label-friendly natural product that contains deactivated bakers yeast, hemicellulase, and other enzymes. The hemicellulase enzymes in Fermaid® WM break down part of the hemicellulose fraction into the soluble form. The soluble pentosans form gels with a desirable effect on dough structure and water retention.

Fermaid® WM provides the following benefits in high-fiber bread production:

- Eliminates the need for a presoak step, allowing the use of a common sponge or brew for different types of bread.
- Improves machinability, avoiding sticky doughs directly after mixing or during moulding and stiff doughs during final proof.

- Improves fermentation, mixing, and proofing tolerance to reduce waste and provide a more-consistent finished product.
- Increases water retention, reducing moisture loss during baking and increasing moisture content in low-calorie products.
- Provides a label-friendly ingredient statement, especially when used in combination with ascorbic acid as the oxidant.
- Improves loaf volume, crumb softness, crumb resilience, and crumb structure and reduces crumbliness of high-fiber breads.

In addition to Fermaid® WM, Lallemand/American Yeast also offers a full line of Essential®, Eagle®, and Fermaid® dough conditioners. Formulations are available for sponge and dough, flour brew, straight dough, frozen dough, continuous mix, pizza crust, and flour tortilla applications. All of these products are backed by technical support from experienced bakery technicians. 

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.

© 1997 Lallemand Inc.

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

