ARTICLE

Dough and Bread Conditioners

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Food Product DESIGN

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It is the aim of every Master Baker to produce a high-quality bread that is well aerated, tasty, and has an appealing appearance. The decisive factors in the production of such a bread are flour quality, dough mixing, dough temperature, fermentation, manipulation, molding, proofing and baking. A minimal recipe for bread should include flour, water, salt and yeast or sourdough starter. However, it would be difficult to produce a consistent bread day after day using only these ingredients. Variations in flour quality, yeast activity, mixing intensity, proofing and baking combine to affect the finished product. Bakers have long added small amounts of other ingredients to improve bread quality - fats, milk, sugar, malted flour, and other ingredients. These add desirable characteristics such as flavor, color, tenderness and volume. Advances in the understanding of the science behind bread-making processes have led to increasingly sophisticated additives.

Widely accepted by European and North American bakers, dough conditioners are less frequently used in the United States. Properly used, however, dough conditioners help compensate for ingredient and process variability. They provide more consistent quality in the finished bread, and are completely safe and free of preservatives.

A look back

Early bread making was characterized by a long resting period between initial mixing and the final shaping prior to proofing. This was necessary because of the relatively slow production of gas by yeasts to yield a loaf of sufficient volume. Too much ascorbic acid reduced product volume. Once compressed, yeasts became available in the mid-1800s, and this aspect of bread making could proceed much more rapidly. It became apparent that in addition to the production of carbon dioxide, the long resting period produced changes in the dough structure, which enhanced retention of the gas. It may be for this reason that the name given to ingredients added to dough in minor amounts to improve bread quality was first "yeast food," then "flour improvers," and finally "dough conditioners."

The earliest chemical dough conditioners - bleaching agents - were introduced around 1900. Bakers noticed that the best products could not be made with freshly milled flour. Flour required several weeks of aging during which air (oxygen) bleached out the yellowish color and added strength to the gluten. It was found that oxidizers could artificially and quickly "age" the flour. The first true dough conditioner was developed for Ward Baking Company in the United States by three chemists working for Fleischmann.

While the primary function of dough conditioners and bread improvers is still to strengthen the dough, they may also be formulated to soften the dough for improved and faster mixing, provide nutrients for the yeast to increase loaf volume, or reduce staling of the finished bread. Typical dough conditioners in use today contain a variety of ingredients to fulfill these needs and provide high-quality breads rapidly and at a relatively low cost.

Gluten development

The major proteins of bread, gliadin and glutenin, can be viewed as coiled or folded chains, with the structure stabilized by bonds between sulfur atoms (disulfide bonds) on adjacent areas of the molecules (intramolecular bonds). Mixing stretches the molecules and breaks the relatively weak bonds. During resting, the disulfide bonds can re-form either within (as before) or between molecules (intermolecular). When bonds form between molecules, the resulting structure (gluten) is much stronger than the individual proteins. (Used with permission from *Breadmaking Technology*, by Wulf Doerry, 1995, American Institute of Baking, Manhattan, KS.)

It is gluten that has the strength to physically entrap gas bubbles within the loaf, giving bread its desirable texture. Too little protein in the flour, or too little mixing, results in a weak and sticky dough that is easily stretched, but does not retain much gas. Likewise, dough can be overworked, resulting in few intramolecular bonds, and a dough that is strong, but inelastic. Mixing time and energy is thus both a critical and time-consuming part of the bread-making process. Speeding up the dough processing time offers economic advantages - with less dough in process, the baker needs less and smaller equipment, less floor space and less labor. "No time" dough processes, which require little or no resting, are a common goal. Some processes use high-speed, high-energy mixing to speed up the gluten development. Dough conditioners can offer similar results with more traditional equipment. Often dough conditioners and high-speed mixing are combined.

Conditioner function and use

Primarily, dough conditioners include the following types of ingredients:

- Oxidizing agents, which strengthen the dough. This can lead to economies with shortened makeup times or by compensating for low protein in the flour.
- Reducing agents, which serve to encourage the development of gluten, thus shortening the mixing time and decreasing the amount of mixing energy that is needed.
- Emulsifiers, which strengthen the dough, give improved mixing and handling tolerance, increase loaf volume, improve mechanical slicing characteristics, and can retard staling.
- Enzymes, which enhance gas production by yeasts and can help control the strength of the dough.

Other additives may also be used, which can provide yeast nutrients, adjust the acid/alkaline balance of the dough to control fermentation, and provide calcium ions to improve dough strength.

Oxidizers were originally thought to inhibit the action of proteolytic enzymes that could weaken gluten. The mechanism of dough strengthening by oxidizers has been found, however, to be quite different. In addition to disulfide bonding, which strengthens gluten, sulfur atoms on the protein molecules can bind with hydrogen atoms. Sulfur bound to hydrogen cannot form a disulfide linkage. Oxidizers "strip" hydrogen atoms from the sulfur-hydrogen (sulfhydryl) linkages, and make more sulfur available for the gluten-strengthening disulfide bond.

Early oxidizers such as potassium bromate and iodate are effective, but less in favor today, as a small amount can remain in the bread. The bromate and iodate residues are considered potential carcinogens. More commonly used oxidizers today are azodicarbonamide (ADA), which can be used at up to 45 ppm in the United States, and L-ascorbic acid (LAA), or vitamin C, for which there is no usage limit in the United States. ADA works very quickly, and can easily be overused, producing dry dough that is hard to work, low volume and cracked bread surfaces. LAA works slowly; moderate overuse has no deleterious effect on quality and it is commonly used at about 75 ppm. LAA is currently the only oxidizing agent permitted in the European baking industry.

Reducing agents have exactly the opposite effect of oxidizers. They disrupt the disulfide bonds between and within protein molecules, weakening the protein structures. Since the intramolecular disulfide bonds are rapidly "disconnected," the proteins unfold quickly with less mixing. This can also soften the gluten where desired, as in biscuit dough, or can be used in conjunction with a slow-acting oxidizer to reduce mixing time. The oxidizer rebuilds the disulfide bonds between the now-unfolded proteins; otherwise the dough would become too soft and sticky. The most commonly used reducing agent, L-cysteine, works very quickly. Other reducers include sulfites, which can cause allergic reactions, and reduced glutathione in the form of deactivated yeast.

Emulsifiers are complex molecules that have both water- and fat-soluble regions. With one "end" of the molecule effectively dissolved in water and the other dissolved in fat, they are able to help form emulsions, which are stable mixtures of fats and water or water-containing fluids. Although several theories exist to explain how emulsifiers function in bread dough, their effects are well-known. Emulsifiers such as diacetyltartaric acid esters of monoglycerides (DATEM) and stearoyl lactylates (SSL) effectively strengthen the dough and make it more extensible. This results in trapping more gas in smaller bubbles, reducing proofing time, giving a softer, more even-textured bread. The added "stretch" also makes the dough more tolerant to over- or under-mixing.

Other emulsifiers, such as saturated monoglycerides, combine with starch in the flour in ways that prevent over-firming and staling; the bread remains softer for a longer period of time. Lecithin, an emulsifier derived from soy, enhances gas retention, but is less effective than DATEM or SSL. However, it has the unique effect of producing a crust that retains its crispness qualities longer, although it may be thicker and denser. For this reason, it is often used as a component of conditioners for baguettes and other crusty breads.

Enzymes are complex proteins that have the ability to speed up biochemical reactions. They are very specific in terms of the reactions they affect. In general, three types of enzymes are used in bread making: amylase, which converts starch to sugar; protease, which breaks down protein; and lipoxygenase, which bleaches the flour and strengthens the dough.

Natural amylase was formerly provided by malted wheat or barley flour. Soaking the grain started the germination process, in which diastase (a natural amylase) was produced. Malted grain was then dried and ground into malted flour. Today, amylase is commonly produced by a fungal or bacterial fermentation. It is added to the dough, where it converts a portion of the starch in the flour to sugar for the yeast, which increases gas production. Amylase will also delay the gelatinization of the starch during baking, giving more "oven spring." Both of these effects result in increased loaf volume.

Proteases can be added in very carefully controlled amounts. They irreversibly weaken the gluten strands, and thus can be used to counteract very strong, or "bucky," flours. These are not commonly used in Europe, but do find some use in North America, where flours often have a higher protein content. Lipoxygenase releases oxidizers that bleach the natural flour pigments, making a whiter loaf. The oxidizers also increase the gluten strength in the same manner as ascorbic acid or ADA.

Enzyme technology, especially aided by biotechnology, is a rapidly developing field. Scientists can now tailor enzymes with greatly improved functionality; for example, amylases that stop working at a specific point in bread baking, or proteases that can precisely control the strength of a dough.

Dough conditioner considerations

Many artisan bakers avoid the use of dough conditioners. In part, this can be attributed to image; either a wish to avoid the use of "chemicals," or concern about the use of potassium bromate, which is being phased out in the United States. North American bakers also have the luxury of flours with relatively high protein content, so conditioners may be less useful.

Bread made without "chemical additives" can be perceived as more healthful by consumers, but, in fact, all the ingredients in modern dough conditioners have been thoroughly proven safe in scientific studies accepted by the FDA. During baking, the added ingredients perform their function, then break down into harmless, tasteless compounds. Bakers concerned with a "natural" image can still benefit from a limited range of natural conditioners - deactivated yeast, for example, which contributes natural L-cysteine, or deodorized garlic. Both of these are natural reducers and will reduce mixing time and dough strength.

Dough conditioners are adjuncts that have been developed over the course of the past century as a way to speed up and reduce the variability in bread making. They result in more efficient and cost-effective bread-making processes, and produce breads with improved and consistent quality. New advances in science continue to increase the effectiveness of dough conditioners available to bakers.

Klaus Tenbergen started his baking career in European fashion in 1977. He owned a fine dining restaurant, and was the proud owner of a bakery/confectionery/coffee shop for nearly nine years before coming to the United States in 1994. Currently he is the baking instructor at Kendall College, "The School of Culinary Arts," in Evanston, IL. He is a certified Chef Instructor, Bäckermeister (Germany), Master Baker (South Africa) and Certified Master Baker (USA), and well as a member of the Research Chefs Association, Bread Bakers Guild of America, Retailers Bakers Association and the South African Chefs Association. He can be reached via e-mail at Klausbea@mtco.com.