BAKING OVERVIEW

A Brief Primer on Modern Baking

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Baking has seen more changes in the past 60 years than in the previous 2,000 years. The advent of modern breeding and growing practices for wheat, soybeans, and corn; new processing techniques for fats and oils; sugar alternatives; and gum technologies have opened up a virtually infinite number of formulation possibilities. The fun of being a product developer is that you get to test these various ingredients. What can be done with them is limited only by your imagination.

Advances in ingredient technology have made possible many of the innovative products seen on the market today. Just 20 years ago, few people would have thought about the large-scale marketing of baked goods that are fat-free, sugar-free, low-carb, high-fiber, high-protein, organic, or gluten-free. Today, consumers can find most, if not all, of these products in their local grocery stores. Table 1 shows the four major ingredient groups, their typical function, factors that brought about change within their category, and product applications for these new ingredients.

With the advent of new ingredients, the old standards for categorizing ingredients into structure builders and tenderizers have blurred. Many new ingredients enhance the functionality of the standard ingredients. In this column, I will give an overview of some of the ingredients we have to work with today. In future articles, I will explore these ingredients and provide examples of their applications and some of their uses.

The Staff of Life—Wheat

Wheat flour has been with us since before the pharaohs and is still the most common ingredient in baking. The United States is blessed with a wide variety of flours that can be used in almost any kind of product. Each wheat provides its own application in baking. Wheat is grown in almost every corner of the United States, but the bulk of it comes from the Midwest and western states.

The eastern part of the country raises soft red and some white wheat. The Michigan, Indiana, and Ohio area produces the best soft wheats in the country, although people in the Washington, Idaho, and Oregon area may debate this statement about quality. This is the other area where white and some red soft wheats are grown. White wheat works well for pie dough; red wheat with chlorine bleach is good for cookies with consistent spreads and for cakes; a blend of the two wheat types is right for cake doughnuts. Soft wheat also works well in loaf cakes, muffins, and pancakes. Much of the western wheat is exported to the Far East for noodle production.

Soft wheats are used in products that require a tender, short bite or light texture. Using the centermost parts of the wheat germ with the best-quality protein makes the best-quality cake flour when the proper amount of chlorine bleach is applied. Chlorine bleach is added to the flour to lower the gelatinization point of the starches in the flour. pH is used as a measure of the bleaching of the flour. This, along with the advent of emulsified shortenings, has allowed for the development of high-ratio cakes. These two advances permit a higher level of sugar relative to flour to be used in cake formulas, which makes cakes richer and longer lasting.

The north-central part of the United States is where much of the high-protein hard red spring wheat is grown. This wheat is used for breads that require strong flours (i.e., high protein) to provide volume or that use other ingredients that dilute the bread's gluten protein content. This area is also where much of the durum wheat for semolina, used in pasta production, is grown. Hard white spring wheat is becoming more common for whole-wheat breads. The white wheat has a sweeter flavor when compared to the sometimes-bitter note that hard red whole wheat can impart.

The south-central region of the United States is where much of the hard red winter wheats are grown. These typically produce flours with more moderate protein levels and are used to make pan or sandwich breads. Hard red winter wheat flour is also useful in applications where additional structure is needed, such as in muffins and even cakes made from blends of soft and hard wheat flours.

It is difficult to replace gluten-containing flours when making gluten-free products. Wheat and rye contain gluten, as do spelt and kamut. Oats typically fall into this category as well; oat kernels are the same shape as wheat kernels, and it is therefore dif-

Table 1. Ingredient changes: function, products, processing, and product application

Ingredient Group	Typical Use/Quality	Effected by Changes in	New Uses/Qualities
Flours	Structure builder	Breeding, rediscovery of grains, new processing	Phytochemical source, fiber source, gluten free products
Carbohydrates	Tenderizer	Starches, gums, varied chain lengths, fermentation	Texture modifier, sweetener, fiber source, sugar-free products, shelf life extender, fat replacer
Proteins	Structure builder	Breeding, new processing	Nutritional enhancement, sugar-free and/or low-carb products
Fats and oils	Tenderizer	Hydrogenation, interesterification, fractionation, breeding, processing	Emulsifier, flavor enhancer, low- or no-fat products, texture modifier

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ficult to guarantee that no cross-contamination with wheat has occurred during harvesting, transportation, storage, or milling. For gluten-free products, one must achieve structure using other protein sources, such as milk, soy, or egg albumin, and rely on starch gelatinization to give some volume to the product.

Pieces That Bind and Build—Proteins

The cell structure responsible for the light texture in cakes and the domed top of deli-sandwich bread is provided by proteins. Egg, milk and, more recently, soy and whey protein concentrates and isolates are the most common protein sources to supplement the gluten from wheat in baking. The type of product best determines which one to use. The more-soluble proteins, like egg and milk, are applicable over a wider range of products. This is due, in part, to the fact that they do not absorb as much water from the dough system. Using soy or wheat protein requires an increase in the amount of water needed to hydrate doughs or batters. Adding water typically wreaks havoc on batter systems for cakes, muffins, and cookies, causing them to lose volume.

Sugar and All Its Parts—Carbohydrates

The next most common ingredient used in baking is sugar, which is a tenderizer. “Sugar” is the common name for a simple carbohydrate. A single carbohydrate unit can be referred to as a “saccharide unit” or “glucose unit.” Figure 1 shows an alpha-glucose molecule. The corners represent the carbon atoms. The positions of the H and OH groups and the carboxyl groups determine the type of carbohydrate it is. Glucose, fructose, and galactose are some common monosaccharides (composed of one molecule). Table sugar, or sucrose, is a disaccharide made of glucose and fructose molecules connected by a bond between specific carbon atoms in their structure. If those bonding sites are changed, the sugar can change from something the body can digest into something it cannot—a fiber.

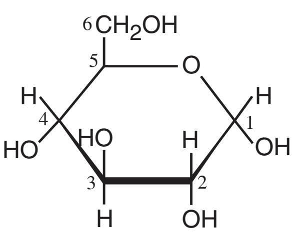

Fig. 1. An α-glucose molecule.

In the past, bakers had few choices of sweeteners: sucrose from sugar cane, corn syrup, molasses (a by-product of sugar refining), and honey. In recent years, processes were developed to make invert sugar, beet sugar, high-fructose corn syrup, and crystalline fructose. Now, technology has advanced to where chain lengths and bond positions can be separated to make many different ingredients for use in many different products. These ingredients (fructooligosaccharides, inulin, maltodextrins, dextrins, and polyols to name a few) allow bakers to produce products with a wide variety of characteristics, including sugar-free, low-carb, reduced-calorie, or high-fiber products and soft-textured products that remain soft for extended periods.

Other parts of the carbohydrate family are starches and gums. These consist of hundreds and thousands of glucose units linked together. They all offer different uses in different product applications. This is an area where application opportunities abound.

Fats and Oils and Their Parts

Fats and oils have been a cornerstone in the advancement of bakery formulations. The refinement of hydrogenation technology and the manipulation of fatty acids and interesterification have allowed product developers to design different shortenings with different functional qualities. Hydrogenation has allowed for the creation of shortenings that are more resistant to rancidity, providing longer shelf life, which makes them popular with bakers. However, hydrogenation can lead to the creation of trans fats.

Trans fats have been a hot-button issue since the FDA began requiring that trans fats be included on the nutrition facts panel of consumer products. Trans fats are monounsaturated fatty acids in which (due to processing techniques, like hydrogenation) the chemical bond at the unsaturated point moves from a cis form to a trans form. However, hydrogenation is not necessarily synonymous with trans fats. Trans fats can be created by the subsequent “cleaning up” of the oil, termed “deodorization,” i.e., the removal of peroxides and free fatty acids before packaging.

Oil can be fully hydrogenated to contain no monounsaturates; this eliminates the risk of trans fats altogether. These products are often referred to as “hard fats.” Such products also have a high melting point and, depending on the chain length of the fatty acids, could be very waxy or even inedible. However, these hard fats can be blended with softer, lower-melting-point oils to create edible, functional, and trans-fat-free shortenings.

The removal of trans fats has pushed manufacturers of fats and oils to learn to be more selective with their hydrogenation techniques as another way of reducing trans fats in shortenings. By controlling process variables, they can minimize trans fat creation, but cannot necessarily create the “trans-fat free” shortenings that many manufacturers want or demand. However, this approach does produce edible shortenings that are typically more stable and functional. The level of saturates is also in a range typical for a traditional hydrogenated shortening, 22–32%.

Interesterification of different oil blends offers another process whereby to make low-trans shortenings. Interesterification of fats involves removing the fatty acids from the glycerol backbone of the triglyceride molecule, using a catalyst or enzyme, and then redistributing them on the glycerol back bone in different combinations.

The ability to manipulate fatty acids and to rearrange them on the glycerol molecule has also permitted the creation of many enhanced emulsifiers. Emulsifiers add softness and tenderness and extend the shelf life of bakery products. They allow the formulator to impart the characteristics of fat without having to use as much fat. This helps to create low-fat or no-fat products. However, some emulsifiers are counted as fat, so the developer doesn’t completely have *carte blanche* to use them in fat-free products.

The Most Plentiful Ingredient

The last basic ingredient is water, which brings all the ingredients together. Water allows proteins to hydrate and form gluten, permits sugars to go into solution, and generates steam to leaven the dough. One of the important things to control is water acidity; the pH can vary even within the same water supply. Acidity can affect the way leavening acids react in chemically leavened products. In yeast-raised products, the mineral content can affect the absorption and, to a lesser extent, how the yeast works. One does not want conditioned water or water that is too soft.

Future articles will cover ingredients and how they function in different products. Given the wide range of possible combinations, we will only be able to scratch the surface of the various possibilities. I hope this series of articles will spark your imagination so that you can usefully and practically apply the information provided to your specific application needs.

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