31

BAKESHOP PRODUCTION: BASIC PRINCIPLES AND INGREDIENTS

At one time, it was common for food-service establishments to produce their own breads, desserts, and other baked goods. Today, many operations find it more economical to buy these products from commercial bakeries. However, many other owners and chefs have discovered that offering fresh, "home-baked" breads, cakes, and pastries attracts customers and increases profits. With little more than an oven and a mixer, many cooks turn out attractive baked items that set their operations apart from competitors.

For this reason, it is important for you to learn the fundamentals of baking, even if you intend to become a cook rather than a baker. These chapters will not make a professional baker out of you. A baker requires far more technical and specialized information than can be presented in this short space. But you will learn the basic methods for producing a wide variety of breads, desserts, and pastries with only the simplest of resources.

In this chapter, we introduce bakeshop production with a discussion of the basic processes and ingredients common to nearly all baked goods. This will give you the understanding necessary to proceed to actual production in the succeeding chapters.

AFTER READING THIS CHAPTER, YOU SHOULD BE ABLE TO

1. Perform basic bakeshop math.
2. Explain the changes that take place in a dough or batter during mixing, baking, and storing.
3. Describe the major ingredients of baked goods and their functions and characteristics.

FORMULAS AND MEASUREMENT

If you consider that most bakery products are made of the same few ingredients—flour, shortening, sugar, eggs, water or milk, and leavening—you should have no difficulty understanding the importance of accuracy in the bakeshop, where slight differences in proportions or procedures can mean great differences in the final product.

If you have begun your food-service studies in a kitchen production laboratory, you surely have been told many times of the importance of measurement, not only for portion control and cost control but also for consistency in the quality of the final product. However, you have, no doubt, also learned there is a great deal of margin for error and that it is possible (if not desirable) to cook many foods without measuring anything. Coming into the bakeshop, where measurement is absolutely essential, may be a bit of a shock to you after your kitchen experiences, but it should reinforce the habits of accuracy you may have let slip.

If, on the other hand, you are beginning your practical studies in the bakeshop, then you will do well to pay particular attention to the principles of measurement presented here. They will be valuable to you throughout your career.

Bakers generally talk about ***formulas*** rather than ***recipes***. If this sounds more like the chemistry lab than the kitchen, it is with good reason. The bakeshop is much like a chemistry laboratory both in the scientific accuracy of all the procedures and in the complex reactions that take place during mixing and baking.

MEASUREMENT

All ingredients must be weighed. Accuracy of measurement, as we have already said many times, is critical in the bakeshop. Measurement is by weight rather than by volume because weight is much more accurate. Unlike in recipes for the home baker, you will not see a professional baker's formula calling for 6 cups flour.

To demonstrate to yourself the importance of weighing rather than measuring by volume, measure 1 cup flour in two ways. (1) Sift some flour and lightly spoon it into a dry measure. Level the top and weigh the flour. (2) Scoop some unsifted flour into the same measure and pack it lightly. Level the top and weigh the flour. Note the difference. No wonder home recipes can be so inconsistent!

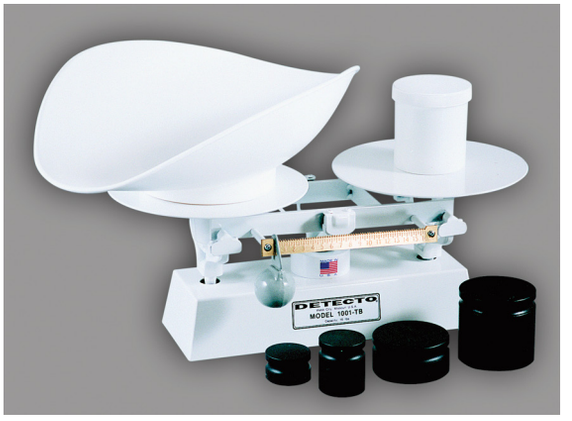
Digital professional scale

Courtesy of Cardinal Detecto

PROCEDURE for Using a Baker's Balance Scale

The principle of using a baker's scale is simple: The scale must balance before setting the weights, and it must balance again after scaling. The example cited illustrates using a scale with U.S. units. The same procedure is used for metric scales.

1. Set the scale scoop or other container on the left side of the scale.
2. Balance the scale by placing counterweights on the right side and/or adjusting the ounce weight on the horizontal bar.
3. Set the scale for the desired weight by placing weights on the right side and/or by moving the ounce weight. For example, to set the scale for 1 pound 8 ounces, place a 1-pound weight on the right side and move the ounce weight to the right 8 ounces. If the ounce weight is already over 8 ounces, so that you cannot move it another 8, add 2 pounds to the right side of the scale and subtract 8 ounces by moving the ounce weight 8 places to the left. The result is still 1 pound 8 ounces.
4. Add the ingredient being scaled to the left side until the scale balances.



Balance scale

Courtesy of Cardinal Detecto

The baker's term for weighing out ingredients is ***scaling***.

The following ingredients may be measured by ***volume*** because they weigh ***1 pound per pint or 1 kilogram per liter***:

Water Milk Eggs

Thus, if a formula calls for 2 pounds eggs, you may measure 2 pints (1 quart). (Liquid flavoring ingredients, such as vanilla extract, normally measured in very small quantities, may also be measured by volume; 1 tablespoon equals ½ ounce.) In the metric system, 1 milliliter water weighs 1 gram; 1 liter weighs 1 kilogram. All other liquid ingredients (such as corn syrup and molasses) and all dry ingredients are normally weighed.

BAKER'S PERCENTAGES

Bakers use a simple but versatile system of percentages for expressing their formulas. Bakers' percentages express the amount of each ingredient used as a percentage of the amount of flour used.

To put it differently, the percentage of each ingredient is its total weight divided by the weight of the flour and multiplied by 100 percent, or

$$\frac{\text{Weight of ingredient}}{\text{Weight of flour}} \times 100\% = \%\ \text{of ingredient}$$

Thus, flour is always 100 percent. (If two kinds of flour are used, their total is 100 percent.) Any ingredient that weighs the same as the flour is also given as 100 percent. The following ingredients from a cake formula illustrate how these percentages are used. Both U.S. and metric examples are given. (Note that numbers may be rounded off for practical measuring.) Check the figures with the above equation to make sure you understand them.

Ingredient	Weight	Percentage
Cake flour	5 lb	100 %
Sugar	5 lb	100 %
Baking powder	4 oz	5 %
Salt	2 oz	2.5 %
Emulsified shortening	2 lb 8 oz	50 %
Skim milk	3 lb	60 %
Egg whites	3 lb	60 %
Total	18 lb 14 oz	377.5 %

Ingredient	Weight	Percentage
Cake flour	2500 g	100 %
Sugar	2500 g	100 %
Baking powder	125 g	5 %
Salt	60 g	2.5 %
Emulsified shortening	1250 g	50 %
Skim milk	1500 g	60 %
Egg whites	1500 g	60 %
Total	9435 g	377.5 %

The advantage of using baker's percentages is that the formula is easily adapted for any yield, and single ingredients may be varied without changing the whole formulation. Please remember that these numbers do not refer to the percentage of the total yield. They are simply a way of expressing ***ingredient proportions***. The total of these percentage numbers will always be greater than 100 percent.

PROCEDURE for Calculating the Weight of an Ingredient if the Weight of Flour is Known

1. Change the ingredient percentage to decimal form by moving the decimal point two places to the left.
2. Multiply the weight of the flour by this decimal to get the weight of the ingredient.

Example (U.S.): A formula calls for 20 percent sugar and you are using 10 pounds flour. How much sugar do you need?

$$20\% = 0.20$$
$$10 \text{ lb} \times 0.20 = 2 \text{ lb sugar}$$

***Note*:** In the U.S. system, weights must normally be expressed all in one unit, either ounces or pounds, in order for the calculation to work, as explained in Chapter 4.

Example (Metric): A formula calls for 20 percent sugar and you are using 5000 grams (5 kg) flour. How much sugar do you need?

$$20\% = 0.20$$
$$5000 \text{ g} \times 0.20 = 1000 \text{ g sugar}$$

PROCEDURE for Converting a Formula to a New Yield

1. Change the total percentage to decimal form by moving the decimal point two places to the left.
2. Divide the desired yield by this decimal figure to get the weight of flour.
3. If necessary, round off this number to the next highest figure. This will allow for losses in mixing, makeup, and panning, and it will make calculations easier.
4. Use the weight of flour and remaining ingredient percentages to calculate the weights of the other ingredients, as in the previous procedure.

Example: In the previous sample cake formula, how much flour is needed if you require 6 pounds (3000 g) cake batter?

$$6 \text{ lb} = 96 \text{ oz}$$
$$377.5\% = 3.775$$
$$96 \text{ oz} \div 3.775 = 25.43 \text{ oz}$$

or, rounded off, 26 oz (1 lb 10 oz)

$$3000 \text{ g} \div 3.775 = 794.7 \text{ g}$$

or, rounded off, 800 g

Clearly, the percentage system we have been discussing is used only when flour is a major ingredient, as in breads, cakes, and cookies. For these formulas, we use a written format different from our regular recipe format in this book.

In these formulas, the indicated yield is the total weight of the ingredients. This figure indicates the weight of the batter or dough. It is the figure we need to know for the purpose of scaling the dough or batter into loaves or pans. The finished weight of the baked goods will be less because moisture is lost during baking.

Also, please note that all yields, including percentage totals, are rounded off to the next lower whole number. This eliminates unimportant fractions and makes reading and calculating easier.

SELECTION OF INGREDIENTS

In addition to measuring, there is another basic rule of accuracy in the bakeshop: ***Use the exact ingredients specified***.

As you will learn in this chapter, different flours, shortenings, and other ingredients do not function alike. Bakers' formulas are balanced for specific ingredients. Do not substitute bread flour for pastry flour or regular shortening for emulsified shortening, for example. They won't work the same way.

Occasionally, a substitution may be made, such as instant yeast for compressed yeast (p. 916), but not without adjusting the quantities or rebalancing the formula.

KEY POINTS TO REVIEW

- What is the proper way to measure bakeshop ingredients? Why?
- What is the procedure for weighing ingredients using a baker's balance scale?
- How do you use baker's percentages to calculate the weight of ingredients in a baking formula?

MIXING, BAKING, AND STORING PROCESSES

WHAT IS GLUTEN?

Gluten is a substance made up of proteins present in wheat flour; it gives structure and strength to baked goods.

In order for gluten to be developed, the proteins must first absorb water. Then, as the dough or batter is mixed or kneaded, the gluten forms long, elastic strands. As the dough or batter is leavened, these strands capture the gases in tiny pockets or cells, and we say the product rises. When the product is baked, the gluten, like all proteins (p. 114), coagulates or solidifies and gives structure to the product.

HOW DOES THE BAKER CONTROL GLUTEN?

Flour is mostly starch, but its protein or gluten content, not its starch, concerns the baker most. Without gluten proteins to give structure, baked goods would not hold together.

The baker must be able to control the gluten, however. For example, we want French bread to be firm and chewy, which requires much gluten. On the other hand, we want cakes to be tender, which means we want very little gluten development.

Ingredient proportions and mixing methods are determined, in part, by how they affect the development of gluten. The baker has several methods for adjusting gluten development.

1. **Selection of flours.**
   Wheat flours are classified as ***strong*** or ***weak***, depending on their protein content.

   Strong flours come from ***hard wheat*** and have a high protein content.

   Weak flours come from ***soft wheat*** and have a low protein content.

   Thus, we use strong flours for breads and weak flours for cakes.

   Only wheat flour develops gluten. To make bread from rye and other grains, the formula must be balanced with some high-gluten wheat flour, or the bread will be heavy.

2. **Shortening.**
   Any fat used in baking is called a **shortening** because it shortens gluten strands. It does this by surrounding the particles and lubricating them so they do not stick together. Thus, ***fats are tenderizers***. A cookie or pastry that is very crumbly due to high fat content is said to be short.

   You can see why French bread has little or no fat, while cakes contain a great deal.

3. **Liquid.**
   Because gluten proteins must absorb water before they can be developed, the amount of water in a formula can affect toughness or tenderness. To keep them tender, pie crusts and crisp cookies are made with very little liquid.

4. **Mixing methods.**
   In general, the more a dough or batter is mixed, the more the gluten develops. Thus, bread doughs are mixed or kneaded for a long time to develop the gluten. Cakes, pie crusts, muffins, and other products that must be tender are mixed for a short time.

   It is possible to overmix bread dough, however. Gluten strands stretch only so far. They break if the dough is overmixed.

THE BAKING PROCESS

The changes undergone by a dough or batter as it bakes are basically the same for all baked products, from breads to cookies and cakes. You should know what these changes are so you can learn how to control them.

The stages in the baking process take place as follows. Be aware that many of these steps occur at the same time, not one after the other. For example, escape of water vapor and other gases begins almost at once, but it is more rapid later in the baking process.

1. **Melting of fats.**
   Different fats melt—and release trapped gases—at different temperatures, so the proper shortening should be selected for each product. Most fats used in baking melt between 90° and 130°F (32° and 55°C).

   As the fats melt, they surround the air cells and make the product more tender.

2. **Formation and expansion of gases.**
   Some gases are already present in the dough, as in proofed bread dough and in sponge cake batters. As they are heated, the gases expand and leaven the product.

   Some gases are not formed until heat is applied. Yeast and baking powder form gases rapidly when first placed in the oven. Steam is also formed as the moisture of the dough is heated.

   As the product rises, the cell walls become thinner as they are stretched by the expanding gases. This tenderizes the product.

   Leavening and leavening agents are discussed in more detail beginning on page 915.

3. **Killing of yeast and other microorganisms.**
   In addition to yeast, doughs may contain other microorganisms, including bacteria and molds. Most of these, including yeast, die when the item reaches about 140°F (60°C). When yeast dies, fermentation stops and no more gas is released.

4. **Coagulation of proteins.**
   Like all proteins, gluten and egg proteins coagulate or solidify when they reach high enough temperatures. This is the process that gives structure to baked goods.

   Correct baking temperature is important. If the temperature is too high, coagulation will start too soon, before the expansion of gases has reached its peak. The product will have poor volume or a split crust. If the temperature is too low, the proteins will not coagulate soon enough, and the product may collapse.

5. **Gelatinization of starches.**
   The starches absorb moisture, expand, and become firmer.

6. **Escape of water and other gases.**
   This takes place throughout the baking process, but it is fastest during the later stages of baking. Water evaporation decreases the weight of the product and also enables crust formation.

7. **Crust formation and browning.**
   Browning occurs when sugars caramelize and starches and proteins undergo Maillard browning (p. 114). This contributes to flavor. Milk, sugar, and egg increase browning.

   A crust is formed as water evaporates from the surface and leaves it dry.

STALING

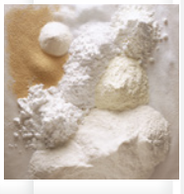
Staling is the change in texture and aroma of baked goods due to the change in structure and the loss of moisture by the starch granules. Stale baked goods have lost their fresh-baked aroma and are firmer, drier, and more crumbly than fresh products.

Prevention of staling is a major concern of the baker because most baked goods lose quality rapidly.

Staling can be slowed by three techniques:

1. **Protecting the product from air.**
   Wrapping bread in plastic and covering cakes with icing are two examples.
   Unfortunately, hard-crusted breads, which stale rapidly, should not be wrapped, or the crusts will become soft. These bread products should always be served fresh.
2. **Adding moisture retainers to the formula.**
   Fats and sugars are good moisture retainers, and products high in these ingredients keep best.
   Some of the best French bread has no fat at all, and if it is not served within hours of baking, it will begin to stale. For longer keeping, bakers often add a very small amount of fat and/or sugar to the formula.
3. **Freezing.**
   Baked goods frozen ***before*** they become stale maintain quality for longer periods. They should be served very soon after thawing. Frozen breads may be reheated with excellent results if they are served immediately.
   Refrigerating actually speeds staling rather than slowing it. Only baked goods that could develop health hazards, such as those with cream fillings, are refrigerated.

Loss of crispness is caused by absorption of moisture, so it is, in a sense, the opposite of staling. This is a problem with low-moisture products such as cookies and pie crusts. The problem is usually solved by proper storage in airtight wraps or containers to protect the products from moisture in the air. Prebaked pie shells should be filled as close to service time as possible.



KEY POINTS TO REVIEW

- What is gluten? What are four ways to control gluten development in doughs and batters?
- What are seven changes that take place in doughs and batters as they are baked?
- How can you slow the rate at which baked goods become stale?

INGREDIENTS

The following introduction to baking ingredients is necessarily simplified. If you decide to pursue a career as a baker, you will need to learn a great deal of technical information. However, the basic information presented here is enough to enable you to produce a full range of baked items in a small bakeshop or restaurant kitchen.

FLOURS, MEALS, AND STARCHES

White Wheat Flour

White wheat flour is milled from wheat kernels after the outer covering, called ***bran***, and the germ are removed. Wheat flour normally contains 63 to 73 percent starch and 6 to 15 percent protein. The rest is moisture, fat, sugar, and minerals.


Bread flour


Cake flour


Pastry flour


Hand test for flour strength (from left to right): bread flour, pastry flour, cake flour

Wheat flour is the source of the protein called ***gluten***, which you remember is one of the essential elements in baking. Bakers select flour on the basis of its gluten content. Flours high in protein are called ***strong***, and those low in protein are called ***weak***. (*Note*: Rye, barley, oats, and some other grains also contain gluten proteins, but these proteins do not develop into a gluten structure as do the proteins in wheat flour. Thus, for the baker, these other grains in effect do not contain gluten, but people with gluten intolerance may still have to avoid them in their diets.)

For our purposes, in the small bakeshop, we need to know about three kinds of wheat flour:

1. **Bread flour** is a strong flour used for making breads, hard rolls, and any product that requires high gluten. The best bread flours are ***patent flours,*** which come from the interior portions of the kernel. ***Straight*** flours are also strong flours.
2. **Cake flour** is a weak or low-gluten flour made from soft wheat. It has a soft, smooth texture and a pure white color. Cake flour is used for cakes and other delicate baked goods that require low gluten content.
3. **Pastry flour** is lower in gluten than bread flour but higher than cake flour. It has the same creamy white color as bread flour, not the pure white of cake flour. Pastry flour is used for cookies, pie pastry, some sweet yeast doughs, biscuits, and muffins.

Being able to identify these three flours by sight and touch is an important skill because, sooner or later, someone will dump a bag of flour into the wrong bin, and you will need to recognize the problem.

Bread flour feels slightly coarse when rubbed between the fingers. If squeezed into a lump, it falls apart as soon as the hand is opened. Its color is creamy white.

Cake flour feels smooth and fine. It stays in a lump when squeezed in the palm of the hand. Its color is pure white.

Pastry flour feels like cake flour but has the creamy color of bread flour.

All-purpose flour, seen in retail markets, is not often found in bakeshops. This flour is formulated to be slightly weaker than bread flour so it can be used for pastries as well. A professional baker, however, prefers to use flours formulated for specific purposes because these give the best results.

Whole Wheat Flour

Whole wheat flour is made by grinding the entire wheat kernel, including the bran and germ. The germ, which is the embryo of a new wheat plant, is high in fat, which can become rancid. This is why whole wheat flour does not keep as well as white flour.

Because it is made from wheat, whole wheat flour contains gluten, so it can be used alone in bread making. However, a bread made with 100 percent whole wheat will be heavy because the gluten strands are cut by the sharp edges of the bran flakes. Also, the fat from the wheat germ contributes slightly to the shortening action. This is why most whole wheat breads are strengthened with white bread flour.

Bran flour is flour to which bran flakes have been added. The bran may be coarse or fine, depending on specifications.

Rye Flour

Next to white and whole wheat, rye is the most popular flour in bread making. Because rye flour does not develop much gluten, breads made with it are heavy unless some hard wheat flour is added.

Rye flour is available in three shades, ***light***, ***medium***, and ***dark***. ***Rye meal***, or **pumpernickel**, is a coarse meal made from the whole rye grain.

Rye blend is a mixture of rye flour and hard wheat flour.

Other Flours

Products milled from other grains are occasionally used to add variety to baked goods. These include cornmeal, buckwheat flour, soy flour, potato flour, oat flour, and barley flour. The term ***meal*** is used for products that are not as finely ground as flour.

All these products must normally be used in combination with wheat flour because they do not form gluten.

Starches

In addition to flours, other starch products are also used in the bakeshop. Unlike flour, they are used primarily to thicken puddings, pie fillings, and similar products. The principles of thickening with starches are covered in Chapter 9.

The most important starches in dessert production are as follows:

1. ***Cornstarch*** has a special property that makes it valuable for certain purposes. Products thickened with cornstarch set up almost like gelatin when cooled. For this reason, it is used to thicken cream pies and other products that must hold their shape.
2. ***Waxy maize*** and other ***modified starches*** also have valuable properties. They do not break down when frozen, so are used for products that are to be frozen. Also, they are clear when cooked, and give a brilliant, clear appearance to fruit pie fillings.

   Waxy maize does not set up firm like cornstarch but, rather, makes a soft paste, which has the same consistency hot and cold. Thus, it is not suitable for cream pie fillings.
3. ***Instant starches*** are precooked or pregelatinized, so they thicken cold liquids without further cooking. They are useful when heat will damage the flavor of the product, as in fresh fruit glazes (such as strawberry).

FATS

We have said that one of the main functions of fats in baking is to shorten gluten strands and tenderize the product. We can summarize the reasons for using fats in baked items as follows:

- To tenderize the product and soften the texture.
- To add moistness and richness.
- To increase keeping quality.
- To add flavor.
- To assist in leavening when used as creaming agents or when used to give flakiness to puff pastry, pie dough, and similar products.

Shortenings

Any fat acts as a shortening in baking because it shortens gluten strands and tenderizes the product. However, we usually use the word ***shortening*** to mean any of a group of solid fats, usually white and tasteless, that are specially formulated for baking.

Because shortenings are used for many purposes, manufacturers have formulated different kinds of fats with different properties. Following are the three main types of shortening.

Regular Shortenings

These shortenings have a tough, waxy texture, and small particles of the fat tend to hold their shape in a dough or batter. This type of shortening does not melt until a high temperature is reached.

Regular shortening has good creaming ability. This means that a large quantity of air can be mixed into it to give a batter lightness and leavening power. Therefore, it is used in products mixed by the creaming method, such as certain cookies.

Because of its texture, this type of shortening is used for flaky products such as pie crusts and biscuits. It is also used in breads and many pastries. Unless another shortening is specified, regular shortening is generally used.

Emulsified Shortenings

These are soft shortenings that spread easily throughout a batter and quickly coat the particles of sugar and flour. Because of their easy spreading, they give a smoother and finer texture to cakes and make them moister.

Emulsified shortening is often used whenever the weight of sugar in a cake batter is greater than the weight of flour. Because this shortening spreads so well, a simpler mixing method can be used, as explained in Chapter 34. Such cakes are referred to as ***high-ratio*** cakes, so emulsified shortening is sometimes called ***high-ratio shortening***.

In addition, emulsified shortening is used in certain icings because it can hold more sugar and liquid without curdling.

Puff Pastry Shortenings

Puff pastry shortenings are firm like regular shortening. They are especially formulated for puff pastry and other doughs that form layers, such as Danish pastry.

Butter and Margarine

Shortenings are manufactured to have certain textures and hardness. Butter, on the other hand, is a natural product that doesn't have these advantages. It is hard and brittle when cold and soft at room temperature, and it melts easily. Consequently, doughs made with butter are hard to handle. Margarine is a little easier to handle, but it has many of the same disadvantages.

On the other hand, butter and margarine have two major advantages:

1. **Flavor.**
   Shortenings are intentionally flavorless, but butter has a highly desirable flavor.
2. **Melting qualities.**
   Butter melts in the mouth. Shortenings do not. After eating pastries or icings made with shortening, one can be left with an unpleasant film of shortening coating the mouth.

For these reasons, many bakers and pastry chefs feel the advantages of butter outweigh its disadvantages for some purposes.

Oils

Oils are liquid fats. They are not often used as shortening in baking because they spread through a batter or dough too thoroughly and shorten too much. Their usefulness in the bakeshop is limited primarily to greasing pans and proofing bowls, to deep-frying doughnuts, and to serving as a wash for some kinds of rolls. A few quick breads and cakes use oil as a shortening.

SUGARS

Sugars or sweetening agents are used for the following purposes in baking:

- To add sweetness and flavor.
- To create tenderness and fineness of texture by weakening the gluten structure.
- To give crust color.
- To increase keeping qualities by retaining moisture.
- To act as creaming agents with fats.

We customarily use the term ***sugar*** for regular refined sugars derived from sugar cane or beets. The chemical name for these sugars is **sucrose**. However, other sugars of different chemical structure are also used in the bakeshop. The following are the more important sugars.

Regular Refined Sugars, or Sucrose

Refined sugars are classified by the size of grains:

1. **Granulated sugar.**

   Regular granulated, also called ***fine granulated*** or ***table sugar***, is the most familiar and the most commonly used.

   Very fine and ***ultrafine*** sugars are finer than regular granulated. They are prized for making cakes and cookies because they make a more uniform batter and can support higher quantities of fat.

   Sanding sugars are coarser and are used for coating doughnuts, cakes, and other products.

2. **Confectioners' or powdered sugars.**

   Confectioners' sugars are ground to a fine powder and mixed with a small amount of starch to prevent caking. They are classified by coarseness or fineness.

   10X is the finest sugar. It gives the smoothest texture in icings.

   6X is the standard confectioners' sugar. It is used in icings, toppings, and cream fillings.

   Coarser types (***4X*** and ***XX***) are used for dusting or for any purposes for which 6X and 10X are too fine.

Molasses and Brown Sugar

Molasses is concentrated sugar cane juice. ***Sulfured molasses*** is a byproduct of sugar refining. It is the product that remains after most of the sugar has been extracted from cane juice. ***Unsulfured molasses*** is not a byproduct but a specially manufactured sugar product. Its taste is less bitter than that of sulfured molasses.

Molasses contains large amounts of sucrose, plus other sugars, acids, and impurities.

Brown sugar is mostly sucrose, but it also contains varying amounts of molasses and other impurities. The darker grades contain more molasses.

Because molasses and brown sugar contain ***acids***, they can be used with baking soda to provide leavening (p. 916).

Molasses retains moisture in baked goods and so prolongs freshness. However, crisp cookies made with molasses quickly become soft for the same reason.

Glucose Corn Syrup

Corn syrup is a liquid sweetener manufactured by breaking down the starch molecules of cornstarch into simple sugar molecules called ***glucose***. Not all the starch is broken down during the process. Low-conversion syrups are only slightly sweet and are quite thick because of the high starch content. Regular, all-purpose corn syrups are medium-conversion syrups in which half the starch is converted to glucose.

Corn syrup aids in retaining moisture and is used in some icings and in candy making.

Honey

Honey is a natural sugar syrup consisting largely of glucose and fructose, plus other compounds that give it flavor. Honeys vary considerably in flavor and color, depending on their source. Flavor is the major reason for using honey, especially because it can be expensive.

Honey contains invert sugar, which means it stays smooth and resists crystallizing. Like molasses, it contains ***acid***, which enables it to be used with baking soda as a leavening.

Malt Syrup

Malt syrup is used primarily in yeast breads. It serves as food for the yeast and adds flavor and crust color to the breads.

KEY POINTS TO REVIEW

- What three main types of white wheat flour are used in the bakeshop? Describe them.
- What five functions do fats have in baked goods?
- What is the difference between regular and emulsified shortening? When compared with shortening, what are two advantages and one disadvantage of using butter in baked goods?
- What five functions do sugars have in baked goods? What is the difference between regular granulated sugar and confectioners' sugar?

LIQUIDS

Gluten cannot be developed without moisture, so liquids are essential to the baking process.

Pie crusts provide a good illustration of how liquids function in baking. If too much water is incorporated in a pie dough, a lot of gluten develops and the crust is tough. If no water at all is used, no gluten develops and the crust does not hold together.

Some of the moisture in doughs and batters changes to steam during baking. This contributes to leavening.

Water

Water is the basic liquid in baking, especially in breads.

Tap water is normally suitable for most baking purposes. However, in some localities, the water may be ***hard***, meaning it contains many dissolved minerals. These minerals may strengthen gluten too much, causing the dough to be too elastic and hard to work. In these areas, the water may have to be treated for use in baking.

Milk and Cream

Milk products, as described in Chapter 26, are important in baking. These products include liquid whole and skim milk, buttermilk, and dry milk solids.

Milk contributes to the texture, flavor, nutritional value, keeping quality, and crust color of baked goods:

1. ***Whole milk*** contains fat, which must be calculated as part of the shortening in a dough. For this reason, whole and skim milk are not interchangeable in a formula unless adjustments are made for the fat.
2. ***Buttermilk,*** which is slightly acid, is often used in conjunction with baking soda as a leavening agent in quick breads.
3. ***Cream*** is not often used as a liquid in doughs and batters, except in a few specialty products. In these instances, it is used as a shortening as well as a liquid because of its fat content. Cream is more important in the production of fillings and toppings.
4. ***Dry milk*** is often used because of its convenience and low cost. In some formulas, it is not necessary to reconstitute it. The milk powder is included with the dry ingredients, and water is used as the liquid.

Other Sources of Liquid

Eggs, honey, molasses, and even butter (about 15 percent water) contribute moisture to a dough or batter. In many cookies, for example, eggs are the only liquid in the formula.

EGGS

Forms

As we discussed in Chapter 25, eggs are purchased in the following forms:

1. Whole shell eggs.
2. Frozen: whites, yolks, whole, and whole with extra yolks.
3. Dried: whole, whites, yolks.

Functions

Eggs perform the following functions in baking:

1. **Structure.**
   Like gluten protein, egg protein coagulates to give structure to baked products. This is especially important in high-ratio cakes, where the high sugar and fat content weakens the gluten.
   If used in large quantities, eggs make baked products tough or chewy unless balanced by high fat and sugar, which are tenderizers.
2. **Emulsification of fats.**
   Egg yolks contain natural emulsifiers, which help produce smooth batters. This contributes to both volume and texture.
3. **Leavening.**
   Beaten eggs incorporate air in tiny cells or bubbles. In a batter, this trapped air expands when heated and aids in leavening.
4. **Shortening action.**
   The fat in egg yolks acts as a shortening. This is an important function in products that are low in other fats.
5. **Moisture.**
   Whole eggs are about 70 percent water, egg whites about 86 percent water, and egg yolks about 49 percent water. This moisture must be calculated as part of the total liquid in a formula.
6. **Flavor.**
7. **Nutritional value.**
8. **Color.**
   Yolks impart a yellow color to doughs and batters. Also, eggs brown easily and contribute to crust color.

LEAVENING AGENTS

Leavening is the production or incorporation of gases in a baked product to increase volume and to produce shape and texture. These gases must be retained in the product until the structure is set enough (by the coagulation of gluten and egg protein) to hold its shape.

Exact measurement of leavening agents is important because small changes can produce major defects in baked products.

Yeast

Fermentation is the process by which yeast acts on carbohydrates and changes them into carbon dioxide gas and alcohol. This release of gas produces the leavening action in yeast products. The alcohol evaporates completely during and immediately after baking.

Yeast is a microscopic plant. As a living organism, it is sensitive to temperature.

34°F (1°C)	Inactive; storage temperature.
60°–70°F (15°–20°C)	Action is slow.
70°–90°F (20°–32°C)	Best growth; proofing temperature for bread doughs.
Above 100°F (38°C)	Reaction slows.
140°F (60°C)	Yeast is killed.

Yeast is available in three forms:

Fresh yeast

1. **Fresh yeast**, also called ***compressed yeast***, is moist and perishable and is preferred by professional bakers. It is usually purchased in 1-lb (450-g) cakes.
2. **Active dry yeast** is a dry, granular form of yeast. Active dry yeast must be rehydrated in four times its weight of warm water—about 110°F (43°C)—before use. When using active dry yeast in a bread formula, use part of the water in the formula to dissolve the yeast. Do not add more water.
3. **Instant dry yeast** is also a dry granular form of yeast, but it does not have to be dissolved in water before use. It can be mixed directly with the flour. It also produces more gas than regular dry yeast, so less of it is needed. Instant dry yeast is sometimes called ***rapid-rise*** or ***quick-rise*** yeast.

   Instant yeast is the form of yeast used in all the formulas in Chapter 32.
4. In doughs with a high sugar content, a special type of instant yeast called **osmotolerant yeast** is often indicated in the formula, as this yeast performs better in sweet doughs. If osmotolerant yeast is called for in the formula and you have only regular instant yeast, increase the quantity of yeast by 30 percent.

Active dry yeast; instant dry yeast

Until the development of instant yeast, professional bakers preferred fresh yeast. Today, however, instant yeast is widely used in bakeshops. In this book, when yeast is required in a formula, instant yeast is specified. To substitute fresh yeast or active dry yeast, use the following guidelines.

To convert instant dry yeast to fresh yeast, multiply the quantity by 3. For example, if the formula calls for 0.5 ounces instant yeast, multiply by 3 to get 1.5 ounces fresh yeast.

To convert instant dry yeast to active dry yeast, multiply the quantity by 1.4. For example, if the formula calls for 30 grams of instant yeast, multiply by 1.4 to get 42 grams active dry yeast.

Yeast contributes flavor in addition to leavening action.

Chemical Leaveners

Chemical leaveners are those that release gases produced by chemical reactions.

Baking Soda

Baking soda is the chemical sodium bicarbonate. If ***moisture*** and an ***acid*** are present, soda releases carbon dioxide gas, which leavens the product.

Heat is not necessary for the reaction (although the gas is released faster at higher temperatures). For this reason, products leavened with soda must be baked at once, or the gases will escape and leavening power will be lost.

Acids that react with soda in a batter include honey, molasses, buttermilk, fruits, cocoa, and chocolate. Sometimes cream of tartar is used for the acid. The amount of soda used in a formula is generally the amount needed to balance the acid. If more leavening power is needed, baking powder, not more soda, is used.

Baking Powder

Baking powders are mixtures of baking soda plus an acid to react with it.

Because baking powders do not depend on acid ingredients for their leavening power in a formula, they are more versatile.

Single-acting baking powders require only moisture to be able to release gas. Like baking soda, they can be used only if the product is to be baked immediately after mixing.

Double-acting baking powders release some gas when cold, but they require heat for complete reaction. Thus, cake batters made with these can incorporate the leavening agent early in the mixing period and can stand for some time before being baked.

Do not include more baking powder than necessary in a formula because undesirable flavors may be created.

Baking Ammonia

Baking ammonia is the chemical ammonium carbonate. It decomposes during baking to form carbon dioxide gas and ammonia gas. Only heat and moisture are necessary for it to work. No acids are needed.

Because it decomposes completely, it leaves no residue that can affect flavor. However, it can be used only in small products, like cookies, which allow the ammonia gas to be completely driven off.

Baking ammonia releases gases quickly, so it is sometimes used in products like cream puffs where rapid leavening is desired.

Air

Air is incorporated into a batter primarily by two methods, creaming and foaming. This air expands during baking and leavens the product.

1. **Creaming** is the process of beating fat and sugar together to incorporate air. It is an important technique in cake and cookie making. Some pound cakes and cookies are leavened almost entirely by this method.
2. **Foaming** is the process of beating eggs, with or without sugar, to incorporate air. Foams made with whole eggs are used to leaven sponge cakes, while angel food cakes, meringues, and soufflés are leavened with egg white foams.

Steam

When water turns to steam, it expands to 1,600 times its original volume. Because all baked products contain some moisture, steam is an important leavening agent.

Puff pastry, cream puffs, popovers, and pie crusts use steam as their major or only leavening agent.

If the starting baking temperature for these products is high, steam is produced rapidly and leavening is greatest.

SALT, FLAVORINGS, AND SPICES

Salt

Salt plays an important role in baking. It is more than just a seasoning or flavor enhancer. It also has these functions:

1. Salt strengthens gluten structure and makes it more stretchable. Thus, it improves the texture of breads.
2. Salt inhibits yeast growth. It is, therefore, important for controlling fermentation in bread doughs and in preventing the growth of undesirable wild yeasts.

For these reasons, the quantity of salt in a formula must be carefully controlled.

Chocolate and Cocoa

Chocolate and cocoa are derived from cocoa or cacao beans. When the beans are roasted and ground, the resulting product is called ***chocolate liquor***, which contains a white or yellowish fat called ***cocoa butter***.

Cocoa is the dry powder that remains after part of the cocoa butter is removed from chocolate liquor.

Dutch process cocoa is processed with an alkali. It is slightly darker, smoother in flavor, and more easily dissolved in liquids than regular cocoa.

Bitter or ***unsweetened chocolate*** is straight chocolate liquor. In some less expensive brands, some of the cocoa butter may be replaced by another fat.

Sweetened dark chocolate is bitter chocolate with the addition of sugar in varying amounts. If the percentage of sugar is low, it is sometimes called ***semisweet*** or ***bittersweet***.

Milk chocolate is sweet chocolate with the addition of milk solids. It is used primarily in candy making. (None of the recipes in this book call for milk chocolate.)

Cocoa and chocolate are high in starch. When cocoa is added to a cake formula, it is sometimes considered part of the flour proportion for this reason.

Spices

Spices are discussed in detail in Chapter 6. The most important spices in the bakeshop are cinnamon, nutmeg, mace, cloves, ginger, caraway, cardamom, allspice, anise, and poppy seed.

Because spices are used in small quantities, it is not much more expensive to use the best quality, and the results are superior.

Spices should be measured by weight unless the quantity is so small that measuring spoons are necessary.

Extracts and Emulsions

Extracts are flavorful oils and other substances dissolved in alcohol. These include vanilla, lemon, and bitter almond.

Emulsions are flavorful oils mixed with water with the aid of emulsifiers such as vegetable gums. Lemon and orange are the most frequently used emulsions.

The flavorings of extracts and emulsions may be natural or artificial. Natural flavorings give the best results, but they are often expensive. Artificial flavorings must be used in moderation to avoid creating strong or undesirable flavors in baked items.

KEY POINTS TO REVIEW

- What are the two main liquids used to make doughs and batters? How do liquids affect gluten development?
- What eight functions do eggs have in baked goods?
- What three types of yeast are used in the bakeshop? How does yeast make bread rise?
- What is the difference between baking soda and baking powder?

TERMS FOR REVIEW

gluten
strong flours
weak flours
shortening
staling
bread flour
cake flour
pastry flour
whole wheat flour
pumpernickel
rye blend
regular shortening
emulsified shortening
sucrose
confectioners' sugar
leavening
fermentation
fresh yeast
active dry yeast
instant dry yeast
osmotolerant yeast
chemical leaveners
single- and double-acting baking powders
creaming
foaming
extracts
emulsions

QUESTIONS FOR DISCUSSION

1. Below are ingredients for a white cake. The weight of the flour is given, and the proportions of other ingredients are indicated by percentages. Calculate the weights required for each.

Cake flour	3 lb or 1500 g (100%)
Baking powder	4%
Shortening	50%
Sugar	100%
Salt	1%
Milk	75%
Egg whites	33%
Vanilla	2%

2. Discuss four factors that affect the development of gluten in doughs and batters.
3. Why do some cakes fall if they are removed from the oven too soon?
4. Which kind of cake would you expect to have better keeping qualities—a sponge cake, which is low in fat, or a high-ratio cake?
5. Why is white wheat flour used in rye breads? in whole wheat breads? Some bakeries in Europe produce a kind of pumpernickel bread with 100 percent rye flour. What would you expect its texture to be like?
6. Describe how to distinguish among bread, pastry, and cake flours by touch and sight.
7. What is the difference between regular and emulsified shortenings?
8. Shortbread is a type of cookie made with flour, butter, and sugar, but no liquid. What would you expect its texture to be like? Why?