

# 1

Understanding the ingredients and equipment used in confectionery is vital for achieving the proper flavors, textures, and preservation of confections, and to remedy challenges as they arise.



**CONFECTIONERY INGREDIENTS AND EQUIPMENT**

Confectionery is arguably the most demanding of the culinary arts, requiring a degree of precision and accuracy unequaled in other areas of the kitchen. A batch of confectionery centers is not as forgiving as a batch of bread or cake. Because confections themselves are smaller than pastries or baked goods, a typical batch of confections uses smaller increments of each ingredient. When scaling and handling small quantities, slight errors translate as sizable percentages of the total. In addition to this basic requirement of precision in the amounts of ingredients, confectionery art demands precise handling techniques. Cocoa butter will crystallize in a desirable form only under specific conditions; if the temperature is a few degrees off, or the amount of agitation is not adequate, the chocolate will bloom, resulting in a ruined product. Sugar too requires exact control over percentage, temperature, and handling in order to achieve the desired result, whether that is the prevention or formation of crystals. These are just some of the factors that the artisan confectioner must deal with every day. By understanding the ingredients commonly used in confectionery, knowing the proper use of confectionery tools, and mastering the basic processes, the artisan confectioner can bring to fruition any creative inspiration.

## CONFECTIONERY INGREDIENTS

Compared with cooking or even baking, confectionery involves relatively few ingredients. It is how those ingredients are handled and the relative quantities of each that makes each confection unique. Understanding the basic properties of each ingredient and how ingredients interact enables the confectioner to succeed in creating precisely the results desired. The importance of this cannot be overstated: when a professional truly understands ingredients, there is nothing that they cannot accomplish in formulation.

### Sweeteners

Sweeteners are the heart of confectionery. One of just five tastes that the human tongue can detect, sweetness is a defining quality of confections. So, naturally, sugars are essential ingredients in confectionery. In addition to providing flavor, sweeteners play a number of roles in confectionery, including acting as a preservative, doctoring and bulking agent, humectant, and source of crystallization. The sweeteners most commonly used in confectionery are sucrose and glucose syrups, but many other sweeteners are also employed for their unique flavors and functionality.

#### SUCROSE

While the word *sugar* may rightfully be applied to a variety of nutritive carbohydrate sweeteners, when the term is used without any modifiers, it refers to sucrose. Sucrose is a disaccharide made up of one molecule of fructose, also known as levulose, bonded with one molecule of dextrose, also known as glucose. (To avoid confusion between *glucose* and *glucose syrup*—a starch-derived product—the term *dextrose* is used in this book to refer to that monosaccharide.) The sucrose commonly used in confectionery is one of the purest food substances available—at least 99.8 percent pure sucrose.

Commercially, sugar is obtained from sugarcane or sugar beets. Although the refining methods are different, there is no difference between the sucrose derived from either source, thanks to excellent processing technology. While artisan confectioners typically purchase sugar in dry crystalline form, mass-production manufacturers are more likely to buy liquid sugar, a syrup consisting of approximately 67 percent sucrose dissolved in water, because it is easier to handle in large quantities.

A defining feature of sucrose is its tendency to crystallize at high concentrations. Understanding this tendency and knowing how to control it are two of the most fundamental concepts in confectionery. (See Saturation and Supersaturation, page 222.) Crystalline sucrose and noncrystalline (amorphous) sucrose behave very differently in terms of their hygroscopicity, stability, water-activity reduction, and flavor release. (See Sucrose Qualities, table below.) At common room temperatures, sucrose is soluble to approximately 67 percent solids—that is, 67 percent sugar and 33 percent water. In order to be shelf stable, sugar confectionery must have a dissolved-solids content of approximately 75 percent or higher. If the product is to remain noncrystalline, as is essential in hard candies and brittles, sucrose alone is not usually acceptable as a sweetener, and doctoring agents must also be added in order to promote stability and prevent crystallization. Glucose syrups are the adjunct sweetener most commonly used to prevent crystallization and increase the solids content.

Sucrose is available in a wide range of crystal sizes and in powdered form with various particle sizes. Powdered sugar, referred to in this book as confectioners' sugar, is categorized by its degree of fineness, specified by a number, with the highest number indicating the smallest particle size. The confectioners' sugars categorized as 6X and 10X are the ones most commonly used, but others are also available. American-made confectioners' sugar is an exception when it comes to the purity of sucrose; it contains approximately 3 percent cornstarch to prevent caking.

### SUCROSE QUALITIES

AMORPHOUS SUCROSE	CRYSTALLINE SUCROSE
Exhibits a high level of hygroscopicity	Exhibits a relatively low level of hygroscopicity
Reduces $A_w$	Has little effect on $A_w$
Holds fat in emulsion	Expels fat
Dissolves quickly in the mouth	Dissolves more slowly in the mouth
Is chemically reactive	Is not chemically reactive
Releases flavor relatively rapidly	Releases flavor more slowly

$A_w$  = water activity; see pages 40–42.

### MOLASSES

A thick brown syrup that is a by-product of the sugar-refining process, molasses is used in confectionery primarily for its distinctive flavor and its doctoring properties. Because it contains a significant amount of invert sugar, minerals, and amino acids extracted during the refining process, it has a tendency to brown during cooking as a result of the Maillard reaction (see page 237) and to increase the hygroscopicity of products that contain it.

Molasses is available in varying degrees of darkness and flavor intensity. When it is obtained early in the sugar-refining process, it is relatively light in color and flavor; molasses from the later stages of refining has a darker color and a more intense flavor. The darkest molasses, known as blackstrap molasses, is used primarily in the distilling industry, in yeast manufacturing, and for animal feed, although a small percentage of it is sold for use in human food. All molasses used for human consumption comes from sugarcane, not sugar beets.

### BROWN SUGAR

The most common form of brown sugar is made by fully refining sucrose and then restoring a measured amount of cane-sugar molasses to the refined sugar. The result is sugar crystals

that have a thin molasses coating and a soft, moist texture. The added molasses provides flavor and increases the sugar's hygroscopicity and its propensity for browning when heated. Producing brown sugar by this method affords the manufacturer control over the product, permitting greater consistency from batch to batch. Brown sugar is available in several grades, depending on the type of molasses and other ingredients added to it. Commercially, brown sugar is given a number to indicate how dark it is, with the highest number indicating the darkest sugar. The grades of brown sugar most commonly found are 6, 8, 10, and 13.

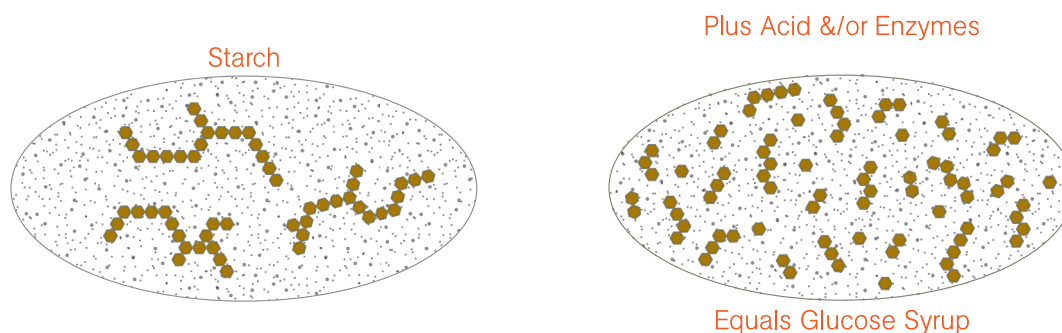
Turbinado sugar is a type of brown sugar produced by leaving some of the molasses in during the refining process rather than fully refining the sugar and then adding molasses back to it. Because the molasses in turbinado sugar is inside the crystal rather than on its surface, this sugar is not soft and moist like the commonly produced brown sugar but consists of hard crystals with a golden hue. Whether it deserves it or not, turbinado sugar has developed a reputation as a more natural alternative to fully refined white sugar. It is available in various crystal sizes.

### INVERT SUGAR

Invert sugar is made by splitting disaccharide sucrose into its two component monosaccharides, fructose (also known as levulose) and dextrose (also known as glucose). (See Inversion, page 220.) Commercially, inversion may be accomplished by exposing disaccharide sucrose to an acid, usually hydrochloric acid, or treating it with the enzyme invertase. Invert sugar is valued by confectioners for its doctoring capacity, which is its most common function in confectionery formulation. It is sweeter than sucrose, more hygroscopic and, unlike sucrose, it readily contributes to Maillard browning. (See Maillard Reaction, page 237.) Because sucrose alone is soluble only to approximately 67 percent at room temperature, and invert sugar is soluble to approximately 80 percent, invert sugar is frequently added to sugar confectionery to increase the dissolved-solids content, lower water activity, and extend shelf life. Invert sugar is most commonly found as a creamy liquid paste containing approximately 80 percent solids.

### GLUCOSE SYRUP

*Glucose syrup* is the legal name for nutritive sweeteners made by the hydrolysis of edible starch. The name of the source starch may replace the word *glucose* in the name of the syrup; for example, *corn syrup* is a permissible name for glucose syrup derived from cornstarch. Glucose syrups are made by hydrolyzing the long dextrose chains (polysaccharides)



LEFT: Starch is a polysaccharide. Each molecule is made up of thousands of dextrose molecules bonded together. RIGHT: When treated with acid or enzymes, the starch molecule is broken down or converted into shorter sugar chains. Glucose syrup is a blend of short and long chains in a small amount—about 20 percent—of water.

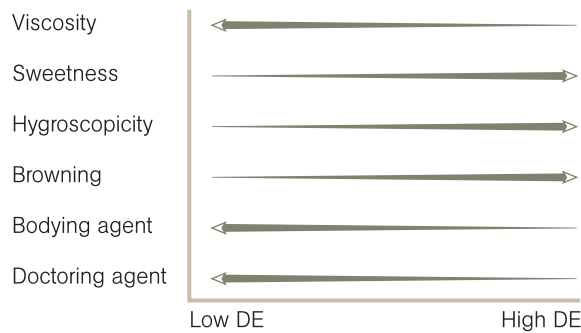
contained in starch and converting them into shorter chains (polymers) of dextrose molecules. The process of breaking the bonds between dextrose molecules during syrup manufacture is called conversion, and it is accomplished with the use of acids or enzymes, or both. (See conversion diagrams on page 4.) Most American glucose syrups are made from corn starch because of its wide availability and low cost, and these are commonly known as corn syrup. In Europe most glucose syrups are made from wheat or potato starch, but there is effectively no difference among syrups made from the starches of corn, wheat, or potatoes.

One of the most important factors to consider when selecting a glucose syrup is the syrup's DE, or dextrose equivalence. DE is the specification used to describe how much the starch molecule has been broken down into simpler sugars. Starches are examples of compounds called polysaccharides—that is, thousands of dextrose molecules chemically bonded together. While it is not exactly chemically accurate, the DE of glucose syrup may be considered roughly the percentage of the starch that has been converted to sugar. For instance, unhydrolyzed starch has a DE of 0; that is, none of the bonds has been broken; all of the thousands of dextrose molecules are still bonded into one large unit. Pure dextrose has a DE of 100, meaning that 100 percent of the bonds from the original starch molecule have been broken, resulting in 100 percent single dextrose molecules.

The DE of glucose syrup profoundly influences the syrup's characteristics. High-DE syrups are sweeter, more hygroscopic, less viscous, and more prone to Maillard browning than low-DE syrups are. (See comparison table on page 5.) By definition, glucose syrups are required to have a DE of at least 20. The glucose syrup most commonly used in confectionery has a DE of approximately 42. When a formula calls for glucose syrup or corn syrup without specifying the DE, this is the syrup that should be used. Other commonly available syrups include those of approximately 27 DE and 63 DE, each with its own degrees of viscosity, reactivity, sweetness, and so on.

Understanding the concept and ramifications of DE is only the beginning of selecting a glucose syrup. Some specialty glucose syrups that are widely available include high-fructose syrup and high-maltose syrup, which are produced by the action of enzymes that create a particular carbohydrate profile. Each syrup has its own unique qualities. Of most interest to artisan confectioners, though, is high-maltose syrup. It resists browning at high temperature and so is useful in hard-candy applications. Compared to the glucose syrup most commonly used in confectionery, high-maltose syrup has lower viscosity when hot, making it easier to work with, and its lower hygroscopicity protects finished candy from damage due to humidity. Many of the European-made glucose syrups are high maltose, and American manufacturers also make a range of high-maltose syrups.

### Characteristics of Glucose Syrups



*The DE of a glucose syrup greatly influences many of its characteristics. The figure illustrates some of the differences between lower- and higher-DE syrups. The arrows indicate an increase in the given quality as the DE number changes. For instance, viscosity increases as DE decreases and sweetness increases as DE increases. While these are good general guidelines, specialty glucose syrups such as high-maltose syrup and high-fructose syrup may exhibit slightly different qualities.*

Glucose-syrup manufacturers produce a variety of syrups of varying DEs and carbohydrate profiles, as well as other specifications, for a wide range of applications. When special syrups are desired, it is advisable to ask the manufacturer to recommend a product for a specific application and to supply a sample for trial use. Specification sheets that list the DE, conversion process, and carbohydrate profiles for syrups are available from manufacturers and on their web sites.

## HONEY

Honey is the substance that bees produce naturally from gathered plant nectar. Chemically, honey bears considerable resemblance to invert sugar; the sugars in it are mainly fructose and dextrose in nearly equal proportion, with a moisture content of approximately 17 percent. In addition to these main components, honey contains smaller quantities of other sugars as well as proteins and acids that provide its characteristic flavor and color. The flavor and color of honey is greatly influenced by the types of flowers from which the bees gather the nectar. Therefore, honeys can range from the dark, richly flavored buckwheat honey to the lighter orange blossom honey. Many other honeys are available, each with a unique flavor profile. Although it possesses the same doctoring and humectant properties as invert sugar, honey browns more readily during cooking and is used in confectionery mainly to impart its flavor.

## MAPLE

Maple syrup and maple sugar are both made by concentrating the sap from the sugar maple tree. Sap from maple trees typically contains approximately 2 percent sugar, nearly all of which is sucrose. To concentrate the sugar, the sap is boiled in open evaporators in order to remove the desired quantity of water. Maple syrup is boiled to a dissolved-solids content of just over 66 percent. At this concentration the syrup is saturated but will not crystallize easily. Maple sugar is made by removing more water and inducing crystallization of the sugars. In addition to removing water, boiling causes Maillard browning and some inversion. Maillard browning, in particular, is crucial to the development of maple syrup's and maple sugar's characteristic flavor, so the time and temperature must be carefully controlled for optimal results. (See Maillard Reaction, page 237.) The flavor of maple syrup and sugar is influenced by environmental factors such as climate, soil type, and mostly, the point in the season when the sap is harvested. Maple syrup is graded by the color of the syrup: Golden Color, Amber Color, Dark Color, Very Dark Color. The darker colored syrups have correspondingly stronger, more robust flavor. The confectioner should select the syrup according to the desired flavor profile of the product in which it is used.

## ALTERNATIVE SWEETENERS

A wide range of alternative sweeteners is available, with still others in development all the time. These range from the polyols, or sugar alcohols, such as sorbitol and maltitol, to aspartame and sucralose. These sweeteners unquestionably have applications in the marketplace. For example, they are suitable for consumption by those with diabetes or those wishing to avoid simple carbohydrates. Working with alternative sweeteners is a discipline in and of itself; such sweeteners behave very differently from traditional carbohydrate sweeteners, and each has its own unique properties. This book focuses on the creation of artisan confectionery using traditional ingredients and methods, so alternative sweeteners are not used in the formulations or addressed in the discussions of theory.

## Fats

Fat plays a vital role in many types of confectionery, from chocolate to caramels and nougat, improving viscosity, texture, flavor, and mouthfeel. Many different fats are available to the confectioner, including hydrogenated and/or fractionated fats manufactured for specific confectionery applications. Although these fats have something to offer, they are generally designed to act as low-cost replacements for the fats used in traditional formulations, such as butter, cocoa butter, and coconut fat. The formulations in this book use traditional fats and do not include the hydrogenated alternatives.

### COCOA BUTTER

Cocoa butter is the most important fat in confectionery; it is also among the most expensive and most difficult to control. One unique quality of cocoa butter is its narrow melting range, which is just below normal human body temperature; cocoa butter remains solid up to a temperature very close to its melting point and then melts rapidly. This is why even at a warm room temperature, chocolate remains crisp, yet melts rapidly in the mouth. Cocoa butter is capable of setting in several different crystal forms, making it relatively difficult to work with. (See Polymorphism of Cocoa Butter, page 55.) It is also costly because it must be pressed from cocoa beans, themselves an expensive commodity. Aside from its use in chocolate, cocoa butter may be added to some confection centers to improve shortness and firmness.

### BUTTER

Butter is the second most frequently used fat in artisan confectionery. It may be added to confections either directly or through the use of dairy products containing butterfat. Butter used for confectionery should always be unsalted sweet cream butter.

Butter is obtained by churning cream, agglomerating the fat, and then separating the butter from the remaining buttermilk. Butter is not a pure fat, but an emulsion of water in fat; it also contains milk solids and lactose. (See Emulsions, page 98.) Because of the presence of protein from the milk solids and the reducing sugar lactose, butter contributes to Maillard browning when it is cooked in confectionery formulas. Butterfat may be isolated from the water and other components in butter by boiling the butter to separate the emulsion. This results in pure butter oil that contains no moisture. This anhydrous form of butter is sometimes used in manufacturing chocolate.

One of the primary functions of butter in confectionery is to combine with cocoa butter to create a softer fat that melts at a lower temperature than pure cocoa butter does. This is desirable both for centers such as ganache and sometimes for chocolate manufactured with the addition of butterfat. (See Eutectics, page 333.)

### LAURIC FATS

Lauric fats are occasionally used by the artisan confectioner, primarily for the powerful eutectic effect they have when combined with cocoa butter. (See Eutectics, page 333.) Examples of lauric fats are coconut fat and palm kernel oil; of the two, coconut fat is more commonly used by the artisan confectioner. When it is combined with cocoa butter, the resulting eutectic often has a melting point that is lower than either of the original fats, resulting in a meltaway center.

At room temperature, coconut fat is a relatively hard fat, one that may be fractionated and/or hydrogenated to provide specific desired melting points. RBD (refined, bleached, deodorized) coconut fat that is not hydrogenated has a melting point of 25°C (76°F),

is widely available, and is well suited to the formula applications in this book. Deodorized coconut fat should be used to avoid contributing undesired coconut flavor to confections. In certain applications, such as taffy and nougat, coconut fat may be a lower-cost alternative to cocoa butter and can contribute to the shorter, less chewy texture desired in these confections. When deciding whether to use lauric fat, the confectioner must take into account flavor, texture, and reactions with other ingredients like cocoa butter.

## Dairy Products

Dairy products play several important roles in confectionery, including providing moisture, amino acids, and lactose for Maillard browning; contributing to confections' fat content; and acting as an emulsifier. Dairy products are available to the artisan confectioner in many forms, each with its own advantages. One dairy product can often be substituted for another, depending on the fat, water, and milk-solids content of the choices available.

### FRESH DAIRY PRODUCTS

Fresh dairy products include nonfat milk, whole milk, half-and-half, and cream. The single primary difference among them—fat content—is the property by which the U.S. Food and Drug Administration (FDA) defines and classifies each of these fresh dairy products. Fresh dairy products are valued by the artisan confectioner for their flavor, and they are, when practical, the dairy products of choice.

The main drawbacks of fresh dairy products are storage requirements, high water content, and cost. Dairy storage seldom presents a large obstacle to the artisan confectioner, who purchases such products frequently and in small enough quantities that storage does not become an issue. Water content can be a problem, though, when making confections such as caramels, which use a large quantity of dairy product and require long cooking to remove moisture.

Although it is possible to use all fresh dairy products to make such confections, the prolonged cooking times required not only makes them less efficient to produce but could also cause the milk solids to curdle. For these confections, therefore, processed dairy products can be used. They provide all the milk solids necessary and contain far less water to remove during cooking. A combination of fresh and processed dairy products can provide some of the advantages of each. For making ganache, however, fresh dairy products are always the ingredients of choice.

### PROCESSED DAIRY PRODUCTS

The processed dairy products commonly used in confectionery include sweetened condensed milk, evaporated milk, and dry milk. Each has its own characteristics that make it suited to particular applications.

Sweetened condensed milk, which is frequently used in the production of caramels, is made by adding approximately 18 percent sugar to whole milk, then removing the water under vacuum to half the milk's original volume. Sweetened condensed milk must contain 8 percent milk fat, 28 percent total milk solids, and, since it is not heat-treated during canning, sufficient sugar to prevent spoilage. Sweetened condensed milk is more resistant to curdling during cooking than either evaporated milk or fresh dairy products. This stability, combined with the milk's low moisture content, makes it the dairy product of choice in many caramel formulas. Sweetened condensed milk is also available as a fat-free product.

Evaporated milk is whole milk that has had a substantial portion of its water removed. It contains at least 6.5 percent milk fat and at least 16.5 percent nonfat milk solids and may contain emulsifiers and stabilizers. Evaporated milk is heat treated to prevent spoilage and

must be refrigerated after opening. The reduced water content of evaporated milk, as compared with fresh dairy products, makes it well suited to caramel production, although it is more prone to curdling than sweetened condensed milk.

Artisan confectioners seldom use dry milk in cooked mixtures. One of the few applications for dry milk in artisan confectionery is in making nougats, which are designed to crystallize during storage. Dry milk helps to seed the nougat, promoting crystallization, and it adds flavor and fat. Dry milk is available as nonfat dry milk and dry whole milk powders. Whole milk powder is less commonly available, as it is prone to rancidity from the butterfat content.

### CULTURED DAIRY PRODUCTS

Cultured dairy products, such as yogurt, sour cream, and buttermilk, are seldom used in artisan confectionery because of their tendency to curdle when heated. One minor exception is crème fraîche, which can be used to make ganache provided it is not heated to a temperature sufficient to cause curdling.

## Flavoring and Coloring Agents

### FLAVORS

Flavors used in artisan confectionery are most often aromatic food ingredients such as spices, nuts, extracts, and purées. In certain cases—when making hard candies, for example—it is difficult and impractical to use these ingredients, so manufactured flavors must be employed. These may be either “natural flavors” or “artificial flavors.” Apart from the labeling, there is little difference between the two. Each category is created by combining various organic compounds to replicate a naturally occurring item. The only difference between natural and artificial flavors is the source of the chemicals used to make a flavoring.

The FDA has precise guidelines for the way flavorings can be labeled. In order for a flavoring to be called “natural,” its components must be derived from plant materials, meat, dairy, or seafood sources, by any of a number of processes, including extraction, distillation, fermentation, and hydrolysis. “Artificial” flavors are those whose components do not come from these sources. All natural and artificial flavors used in a product must be declared on its label. Natural flavorings typically command a higher price because deriving components from the allowable food and plant sources is more expensive than obtaining them from other sources and because consumers value the term “natural” and often turn away from anything containing the word *artificial*. Artisan confectioners should be extremely judicious in the use of manufactured flavors, adding them to only products that cannot practically be flavored with food ingredients.

Other types of flavoring occasionally used by artisan confectioners are organic acids such as citric acid, naturally occurring in lemons; malic acid, naturally occurring in apples; and tartaric acid, naturally occurring in grapes. When used as flavoring agents, these acids balance sweetness and more realistically mimic fruit flavors. Each type of acid has its own flavor-release profile and affects a confection’s flavor differently. These same acids may be used as components in confectionery reactions such as sugar inversion, starch hydrolysis, and pectin gelling. Because of acids’ reactivity, exercise caution with regard to the amounts used and the stages at which they are added. These ingredients can also be harmful to skin and eyes and therefore must always be handled with care.

### COLORS

In certain areas of confectionery, the addition of color is normal and expected. It is difficult to imagine hard candies without added color, and truly striking effects can be obtained by

coloring chocolate and using color-lined molds to make confections. It is part of the philosophy of artisan confectionery, however, that when possible, no unnatural color or flavor should be added.

Colors for confectioners are divided into two categories: fat-soluble and water-soluble. Fat-soluble colors are used for coloring chocolate or cocoa butter. They are designed to dissolve in fats and so are ideally suited for use in chocolate. Fat-soluble colors are commonly found either in a liquid form that is predissolved in oil or cocoa butter, or in a powder form that must be dissolved. The predissolved form is slightly more convenient to use, but similar results can be obtained from either variety. When dry colors are used, they must first be dissolved in a small quantity of cocoa butter, which is then mixed into chocolate or more cocoa butter for application. Dry colors are often difficult to dissolve fully and can require agitation and grinding. For this reason it is advisable to prepare a quantity of colored cocoa butter in advance that can simply be melted and used when needed.

Another colorant that has become widely used in artisan confectionery is colored cocoa butter. Many of these colors are opaque rather than transparent, and, as a result, when they are brushed or spread into a mold before the chocolate lining, the mold takes on the color of the cocoa butter rather than the color of chocolate. These opaque colors have been a decided trend in chocolates in recent years; they are the colorant used to create the very brightly colored shell-molded chocolates that have become popular in the upscale chocolate market.

Another type of colorant approved by the FDA for food use is interference colors. These mica-based powders can be brushed dry onto set chocolate to provide a unique surface quality. Unlike many of the dry-powder colors, interference colors are approved for food use up to 1.25 percent of the weight of the finished product. They are typically slightly metallic, and their hues vary with the angle from which they are viewed, giving them a striking appearance. Interference colors are not effective when mixed with chocolate; they should always be brushed on after the chocolate has set or brushed into a mold prior to lining with chocolate.

Water-soluble colors are used to color hard candies and other aqueous systems. These colors are available in liquid, paste, gel, and dry forms. Dry colors should be hydrated before being added to a mixture. Whatever form of color is used, it should be as concentrated as possible so as not to add excess water to the confection, thus softening it. This is particularly important for hard candies if they are colored after cooking. To minimize water content, it is advisable to use paste and dry colors, which are more suitable than liquids and gels for most sugar confectionery.

## Nuts and Seeds

Nuts and seeds are commonly used in confectionery for their flavor, texture, and fat content. Various nuts may be used by the artisan confectioner; these include hazelnuts, almonds, pecans, and macadamias. While they all differ botanically, their general qualities and handling requirements are virtually the same. Their common trait is a high fat content, and the fat they contain is prone to rancidity. For that reason, nuts and seeds should always be stored in a cool place, away from anything that can contribute to the onset of rancidity: light, oxygen, and reactive metals such as cast iron or copper. The flavor of most nuts is improved from toasting prior to their use. Different nuts reach their peak flavor with different degrees of toasting, and it is up to the confectioner to determine the level of toasting that best complements each variety of nut. The oil content of nuts is a double-edged sword; oil is responsible for much of nuts' appeal, but it does not store well and can be responsible for fat migration, resulting in softened chocolate and fat bloom. The more finely ground the nuts in a confection are, the more fat is released, and the more pronounced these effects can become. Seeds

such as sesame seeds, pumpkin seeds (pepitas), peanuts, and cocoa nibs are all similar to nuts in their storage and use requirements.

## Water

Water is probably the most overlooked ingredient in confectionery, and yet it is among the most important. Almost every confection contains water, and it serves vital functions in confectionery, including controlling texture and influencing shelf life. It also acts as a solvent to dissolve sugar and as a medium in which reactions such as Maillard browning can occur.

Controlling the amount of water in products is one of the most fundamental steps in confectionery. Water content directly affects the consistency of all finished products, from ganache to marzipan to hard candy. Along with affecting a confection's firmness, excessive free water can also lead to spoilage. The total water content of confectionery is controlled by cooking to remove the desired quantity of water; the amount of free water is controlled by the dissolved-solids content, which binds water, preventing spoilage. (See Water Activity, page 40.)

In confectionery it is often necessary to dissolve sugar, regardless of whether the end results are to be crystallized, as with fudge and fondant, or amorphous, as with toffee, caramels, and hard candies. Water acts as a solvent for sugar. It is also the medium that permits the myriad reactions that regularly occur in confectionery. Maillard browning, inversion, and emulsification are a few of the common reactions and processes that benefit from or require water.

Water in confectionery may come from dairy products, fruit purées, or fruit juices, or, more commonly, it may be added to formulas directly. Potable tap water is perfectly adequate for confectionery use, but there are occasions when differences between various sources of water may become apparent. The most common differences are in pH and mineral content.

Most tap water is somewhat acidic; the more acidic the water, the more inversion occurs when that water is used to cook confections. Although a small difference, it may be noticeable with sugar confectionery such as hard candies, where excessive inversion can make the candies soft and sticky, and with fondant or fudge, where excessive inversion can inhibit crystallization and result in a softer product. Water with a high mineral content can also contribute to sugar inversion. Because of the generally excellent quality and purity of American drinking water, the confectioner's water source is seldom a problem; however, due to variations in pH and mineral content in water from different sources, a disparity in results can occur from one location to another.

## CONFECTIONERY EQUIPMENT

Confectionery is a highly specialized discipline that requires the use of appropriate equipment, some of which is not commonly found in pastry kitchens. Precisely what equipment a confectioner requires depends on the size of the operation and the types of confections being produced: a hard-candy operation, for example, requires entirely different facilities and equipment from those needed for making and enrobing ganache centers. The confections made in a hotel's pastry shop require much different equipment from that used to produce wholesale shell-molded chocolates.

General tool requirements are listed in the paragraphs that follow. They are given in tiers, from the most basic requirements in tier one, to automated production equipment in tier three.

## Tier One

The tools and equipment in tier one are intended for the production of relatively small batches of the wide range of confections represented in this book, such as might be produced in a restaurant, hotel, or catering operation.

**CHOCOLATE MELTERS:** Having a supply of melted chocolate on hand saves valuable time. A variety of melters are available. The most important factors in choosing one are temperature control and size. The right melter is one that accurately controls the temperature for proper melting and maintains the crucial temperatures of different types of chocolates. Its size should be appropriate for the production requirements.

**CLIMATE CONTROL SYSTEM:** A climate-controlled environment is quite possibly the most fundamental element of the confectionery process. Temperature must be controllable, and humidity must be kept to a minimum for the successful production of all confectionery, including chocolate and sugarwork.

**CONFECTIONERY FRAMES:** Metal bars of varying thicknesses or one-piece frames are used for slabbing (i.e., spreading) centers on a stone slab. The formulas in this work are made using metal frames with 12-in bars of three depths:  $\frac{1}{4}$  in,  $\frac{3}{8}$  in, and  $\frac{1}{2}$  in. Other sizes may be used to achieve confections of different thicknesses, but the formula yields may require adjustment. In addition to the frames used for slabbing centers, a larger set of bars surrounding the stone



CLOCKWISE FROM TOP LEFT: Silicone stencil, caramel cutter, dipping tools, refractometer, infrared thermometer, praline cutters, bars for creating confectionery frames.

slab can be helpful for containing large batches of hot mixtures, such as fudge or hard candy, while they cool.

**DIPPING FORKS:** For the small-scale chocolatier, these are absolutely essential tools for dipping centers. Dipping forks are often sold in sets of 10 or 12, but most chocolatiers find that two or three forks receive 90 percent of the use.

**FONDANT FUNNEL:** This tool is essential for depositing fondants, caramels, jellies, and other liquid centers into molds or shells. Automatic funnels permit greater accuracy and control than old-fashioned stick funnels do.

**FOOD PROCESSOR:** A professional-grade food processor is indispensable for the production of small batches of marzipan and gianduja, as well as for the myriad other tasks it performs.

**HAND TOOLS:** A selection of basic hand tools for stirring, cutting, and working with chocolate—scrapers, spoons, brushes, knives, palette knives, and so on—is required for basic confectionery production. Plastic stirrers are generally preferable to wooden implements because they do not harbor moisture or bacteria.

**MIXERS:** Depending on the confections and the batch sizes, 5-qt, 12-qt, or 20-qt and larger planetary mixers are valuable in confectionery, particularly for producing aerated confections such as nougat and marshmallow.

**PLEXIGLAS SHEETS:** Plexiglas sheets are convenient flat surfaces on which to place just-dipped confections to crystallize. They are also useful for slabbing ganache, allowing portability as the ganache crystallizes. The size most convenient for confectionery work is 12 in by 16 in by 3/16 in. Two of these efficiently fit onto standard American size sheet pans.

**POLYCARBONATE CHOCOLATE MOLDS:** These durable plastic molds for producing shell-molded confections are available in many styles.

**SCALE:** Accuracy in scaling is essential to confectionery success. A digital scale that reads in single-gram increments and also displays U.S. units is recommended. A scale with a capacity of 5 kg/11 lb is adequate for production of small batches of confectionery.

**STAINLESS-STEEL BOWLS:** An assortment of bowls for mixing ingredients and working with chocolate is mandatory in the confectionery shop.

**STANDARD COOKWARE:** Small batches of confections do not require special cookware; standard stainless-steel saucepans are adequate for the job. Untreated aluminum is not recommended.

**STANDARD GAS STOVE:** For small-scale production, a professional-output gas stove with two, four, or six burners is adequate for cooking batches of confectionery.

**STONE SLAB:** A marble, granite, or another nonporous stone slab is vital for cooling sugar confectionery and for chocolate work. Stone is ideal for its heat conductivity and thermal mass; it quickly draws heat out of substances without becoming significantly warm itself. To possess the best thermal-mass properties, the stone for confectionery use should be as thick as possible and large enough to easily hold the largest batch size made in the shop.

**THERMOMETERS:** Digital thermocouples are the most useful all-around thermometers, as they can be used both for high-temperature sugar boiling and for chocolate and ganache. Alcohol-filled glass thermometers are reliable instruments that never run low on batteries, but separate thermometers are required for different temperature ranges. Bimetal thermometers are slower to react and are not as accurate as thermocouple technology. Surface-reading infrared thermometers are excellent for monitoring the temperature of chocolate. The same thermometer should be used each time; small differences between individual thermometers can cause inconsistent results.

## Tier Two

Used together with the tier-one tools, these will assist the confectioner in producing any of the confections in this book more expeditiously and will allow for more efficient work and the production of larger batches.

**CANDY KETTLES:** Copper kettles with rounded bottoms, designed to fit into candy stoves, greatly increase the efficiency of cooking. The copper conducts heat extremely well, the rounded bottom provides the maximum surface area for heat transfer, and the large surface area ensures the most rapid evaporation of water. Care must be taken not to cook anything in these untreated kettles that could react with the copper and form toxins.

**CANDY STOVE:** For larger-scale sugar confectionery, a candy stove is indispensable. Candy stoves have tremendous heat output and are designed for rapid and efficient heat transfer when used with candy kettles. Fast cooking not only makes a confectionery operation more profitable, but also prevents excessive inversion and Maillard browning.

**CARAMEL CUTTER:** The multiple wheels of this device allow caramel and other sugar confectionery to be cut into squares.

**GUITAR:** Also known as a confectionery cutter, a guitar cuts ganache, jellies, marzipan, and other softer centers quickly and accurately.

**HEAT GUN:** A heat gun such as those used for removing paint is valuable for such tasks as maintaining the temperature of tempered chocolate and warming molds.

**IMMERSION BLENDER:** An immersion blender can be used to restore separated ganache, agitate chocolate for tempering, and remove lumps from mixtures.

**PANNING MACHINE:** This rotating drum machine is essential for producing any of the panned items such as chocolate-coated nuts and dried fruits discussed in this book.

**PRALINE CUTTERS:** These specialized tools are used to cut shapes from a precoated slab of center, such as marzipan. They are sold in sets of six, with various shapes included.

**REFRACTOMETER:** This tool measures the sugar content of syrups. It is valuable for use in candying fruit and producing jellies, as it can determine the solids content to ensure consistency from batch to batch. A refractometer is superior to a saccharometer or hydrometer for this purpose.

**SHELL-MOLDING MACHINE:** Several hand-operated machines are available to fill chocolate molds and thus increase efficiency.

### technique

## TRANSFER MOLDS

Transfer molds are used exactly as any other polycarbonate mold would be, but with the additional steps of inserting a transfer sheet into the mold before use and removing the base prior to unmolding. The temperature and degree of temper of the chocolate is doubly important when

transfer molds are used, as chocolate that is too cool or is overseeded when deposited will not pick up the design from the transfer sheet. Once the filled and sealed molds have set, they should be refrigerated briefly, just as other molds are, to liberate the latent heat of

crystallization, to contract the chocolate, and to ensure the maximum shine from the transfer sheet. Removing the base plate of the mold makes unmolding extremely simple. (For more information on working with molds, see page 77.).

**SPRAY GUN:** A spray gun can be used to spray chocolate for decorative purposes or to bottom large numbers of individual centers at a time. Some spray guns rely on a separate compressor; others generate their own pressure.

**STORAGE FREEZER:** When proper procedures are followed, a freezer permits longer storage of confections in anticipation of the busiest seasons.

**TEMPERING MACHINE:** A wide range of tempering machines is available, from small tabletop units that temper only 1kg of chocolate, to units that continuously temper hundreds of kilograms. For larger-scale confectionery shops, a larger tempering machine greatly streamlines production.

**UPGRADED FOOD PROCESSOR:** Larger, more powerful processors, called “Stephan machines,” some with vacuum pumps, are helpful when making large quantities of high-quality marzipan and gianduja and emulsifying ganache.

**VACUUM-PACKAGING EQUIPMENT:** This equipment prepares confections for prolonged storage in a freezer.

## Tier Three

Machinery is available to handle virtually every aspect of candy production. The following equipment allows a relatively high-yield artisan confectioner to produce larger quantities with greater accuracy and speed, for increased volume and profitability. Any one of the following pieces of equipment for large-scale production of confectionery represents a substantial investment and is intended for very specific production needs.

**BATCH WARMERS, PULLERS, SIZERS, CUTTERS:** Every artisan hard-candy operation requires this equipment in order to be economically viable.

**DEPOSITOR:** This item portions large batches of centers to be enrobed.

**ENROBER WITH COOLING TUNNEL:** Nothing increases production capacity like an enrober. (See page 16.) This machine eliminates the need for hand-dipping and greatly enhances production. Properly set up cooling tunnels help to ensure perfect crystallization of the chocolate surrounding the centers.

**FIRE MIXER:** A mixer with a burner under the bowl is ideal for the production of caramels and other confections that require long cooking with constant stirring.

**FONDANT MAKER:** This item beats cooked sugar into fondant and is designed for confectioners who require large quantities of fondant for use in centers.

**PACKAGING EQUIPMENT:** This is particularly important for presenting and preserving individual pieces such as unenrobed caramels, hard candy, and taffy.

**REFINER (MÉLANGEUR):** Two-roller refiners can be used to make excellent-quality marzipan and gianduja in large quantities.

**SHELL-MOLDING EQUIPMENT:** Various parts of shell-molding production can be partially or fully automated for efficiency.

**VACUUM COOKER:** A vacuum cooker removes water at lower temperatures than open cooking does and ensures rapid production and less caramelization in hard candies.

**WATER-ACTIVITY METER:** This unit is especially important if the products being made are ganache, marzipan, or other high-moisture centers. A water-activity meter allows the confectioner to adjust formulas for maximum shelf life and for compatibility when two or more types of centers are combined in one confection.

## SPECIAL EQUIPMENT

Confectionery operations with a focus on specific types of centers or processes must be equipped accordingly. The following are three different types of operations, or parts within an operation, and the equipment that would be needed for a moderate level of production in each. While bigger, faster, and more expensive machinery is always available for a price, the hypothetical operations shown here demonstrate a more moderate approach. In none of the scenarios is automation taken to an extreme, thus preserving the artisan aspect of the business and limiting the investment. Additionally, the equipment requirements listed are for production only. Each of these scenarios assumes proper storage, including refrigeration, as well as warehousing and packaging facilities.

### ENROBERS

An enrobing line is the heart of most artisan confectioners' production facilities; without this vital piece of equipment, it would simply not be possible to produce enough enrobed chocolates for the confectioner's output to be economically viable. An enrobing line represents a substantial investment, and there are several brands and models with various features from which the artisan confectioner may choose. Among the factors influencing the choice of enrobers, potential throughput is of prime consideration. An enrober that is too small for current and future needs will create a bottleneck in production. Buying an enrober that is too large is a waste of both money and space. The potential output of an enrober is based on two factors: the width of the belt and the length of the cooling tunnel.

The width of the belt determines how many centers can be loaded per linear foot of belt. Most artisan confectioners are likely to use an enrober with a belt from 18 to 25 cm/7 to 10 in wide. To determine the pieces per linear foot, multiply the number of centers per row across the belt by the number of rows that can be loaded lengthwise on a foot of the belt. For instance, on an 18-cm/7-in belt, enrobing a typical-size center, 4 centers will fit across the width of the belt and 7 centers will fit in a foot length. Therefore, in a linear foot of belt, there are 7 rows of 4 or 28 centers. The wider the belt is, the more centers can be loaded on a linear foot and the greater the potential output of the enrober.

The speed of the belt is determined by the required

cooling time and the length of the cooling tunnel. For most chocolate applications (not compound coating) the requisite cooling time is approximately 8 minutes; this is the desired cooling time that will be used in the following example. Regardless of the length of the tunnel, the belt must move at a speed that will travel the length of the cooling tunnel in those 8 minutes. To determine the speed of the belt in feet per minute, divide the length of the tunnel in feet by the desired cooling time in minutes. For example, if the desired cooling time is 8 minutes, and the tunnel is 3.7 m/12 ft long, 12 ft divided by 8 minutes = 46 cm/1.5 ft per minute. The longer the tunnel, the faster the belt can move and the greater the potential output.

## Panning Operation

Assorted chocolate panned nuts and dried fruits are the items produced in this operation. Because these centers have different weights, the potential output varies according to which centers are being produced. An average nut weight is used for the calculation below. In this scenario, two machines are operated simultaneously on a daily basis to engross centers and also to polish and glaze the centers that were engrossed the day prior. Each day of this operation sees 113.4 kg/250 lb of centers engrossed in each of the pans, and the same quantity of centers is polished and glazed in each.

### technique

To determine the number of enrobed centers produced per minute of enrober operation, multiply the number of centers per linear foot by the feet per minute (fpm) of the belt. In the example given above, there are 28 centers per linear foot. Multiplying that number by 1.5 fpm = 42 centers per minute potential output from the enrober. Multiplying this number by 60 will yield the number of centers per hour, in this case 2520.

The complete formula for enrober yield may be expressed as follows:

$$\begin{aligned} & (\text{centers in a row across belt} \times \\ & \text{rows of centers per foot of belt}) \\ & \times \\ & (\text{length of tunnel} \div \\ & \text{desired cooling time}) \\ & \times \\ & 60 = \\ & \text{number of finished enrobed} \\ & \text{confection per hour} \end{aligned}$$

This information can easily be converted to weight as well as used to determine the amount of tempered chocolate required.

The weight of the finished product is determined by multiplying the number of products by the weight of an individual finished piece. Fourteen grams, or  $\frac{1}{2}$  oz, is a typical weight for a finished confection of this sort. Using the example above, 2520 finished enrobed confections per hour multiplied by 14 g/ $\frac{1}{2}$  oz give an hourly output in weight of approximately 35.28 kg, or 77 lb 12 oz.

The amount of chocolate required depends on the size and shape of the pieces produced as well as the viscosity of the chocolate, but if 40 percent of the finished weight is enrobing chocolate, then, in this example, approximately 14 kg,

or 31 lb, of tempered chocolate is required per hour of enrober operation.

Of course, potential throughput is not the only factor to consider when choosing an enrober. Different machines have various features such as bottomers and cold plates, blowers, detailers, and packing tables; longer cooling tunnels may feature two- or three-zone cooling. Availability of service and price point are always legitimate concerns when investing in equipment as well.

For an illustrated guide to the setup of a moderate-size enrobing operation, see Appendix B, page 540.

#### ITEMS PRODUCED

Chocolate-coated nuts, dried fruit, coffee beans, cereals, and blends

#### APPROXIMATE OUTPUT

226.8 kg/500 lb per day, depending on the centers

#### EQUIPMENT REQUIREMENTS

- ◆ Two revolving pans, each approximately 107 cm/42 in wide
- ◆ Fans and ducting for blowing air on pans
- ◆ One chocolate melter, with capacity of 136 kg/300 lb; tempering not required
- ◆ Six rolling racks with sheet pans
- ◆ Stainless-steel work tables
- ◆ Small goods: scales, ladles, scrapers, measures, thermometers, humidity meter

#### ENVIRONMENTAL REQUIREMENT

Climate control that maintains 20°C/68°F and less than 60% relative humidity in panning area.

For an illustrated guide to the setup of a moderate-size panning operation, see Appendix B, page 541.

## Shell-Molding Operation

In this operation, shell-molded chocolates with ganache and caramel-based fillings are produced. The scenario assumes that an operator is able to complete 40 molds per hour for 6 hours each day. An average mold yields 340 g/12 oz of finished product, so the output from this operation is approximately 81.7 kg/180 lb per day.

#### ITEMS PRODUCED

Shell-molded filled chocolates; ganache and caramel fillings

#### APPROXIMATE OUTPUT

82 kg/180 lb per day

#### EQUIPMENT REQUIREMENTS

- ◆ Chocolate melter-temperer, with capacity of at least 45 kg/100 lb
- ◆ Polycarbonate chocolate molds; a minimum of 15 of each variety used in the operation (a total of at least 80 molds)
- ◆ Vibrating table
- ◆ Hand-depositing machine for fillings
- ◆ Stove for cooking ganache and caramel
- ◆ Warming cabinet
- ◆ Refrigerator capable of maintaining 10°C/50°F
- ◆ Stainless-steel work tables
- ◆ Rolling racks and sheet pans
- ◆ Wire screens
- ◆ Cookware for ganache
- ◆ Small goods: scales, ladles, scrapers, measures, thermometers, humidity meter

#### ENVIRONMENTAL REQUIREMENT

Climate control that maintains 20°C/68°F and less than 60% relative humidity in workroom.  
For an illustrated guide to the setup of a moderate-size shell-molding operation, see Appendix B, page 539.

## Enrobing Operation

This operation produces assorted enrobed centers. Assuming adequate cooking, cooling, and cutting facilities, the limiting factor on production is the size and speed of the enrober. (See Enrobers, page 16.) This example uses a small enrober fitted with an 18-cm/7-in belt and a 3.7-m/12-ft cooling tunnel that a small-scale artisan confectioner might employ.

#### ITEMS PRODUCED

Enrobed centers of ganache, gianduja, nougat, marzipan, butter ganache, and jellies

#### APPROXIMATE OUTPUT

159 kg/350 lb per day

#### EQUIPMENT REQUIREMENTS

- ◆ Convection oven for toasting nuts
- ◆ Stove
- ◆ Refrigerator capable of maintaining 10°C/50°F
- ◆ Candy stove
- ◆ Large stone cooling table
- ◆ Confectionery frames
- ◆ Guitar
- ◆ Twenty-qt planetary mixer
- ◆ Stephan machine
- ◆ Food processor
- ◆ Chocolate melter, appropriate size for operation
- ◆ Enrober with 18-cm/7-in cooling belt and 3.7-m/12-ft cooling tunnel
- ◆ Warming cabinet
- ◆ Rolling racks and sheet pans
- ◆ Candy kettles
- ◆ Cookware
- ◆ Small goods: scales, ladles, scrapers, measures, thermometers, humidity meter, palette knives

#### ENVIRONMENTAL REQUIREMENTS

Cooking area separate from cutting and enrobing area.

Climate control that maintains 20°C/68°F and less than 60% relative humidity in area for cutting and enrobing.

For an illustrated guide to the setup of a moderate-size enrobing operation, see Appendix B, page 540.