

Understanding Ingredients for the Canadian Baker

Understanding Ingredients for the Canadian Baker

The BC Cook Articulation Committee

BCCAMPUS
VICTORIA, B.C.



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1. "Open Educational Resources," *Hewlett Foundation*, <https://hewlett.org/strategy/open-educational-resources/> (accessed September 27, 2018).

Preface

This book is intended to give students a basic understanding of the various types and uses of ingredients used in the baking industry, and how certain ingredients, in particular grains and flours, are produced, graded, and processed in Canada.

Understanding Ingredients for the Canadian Baker is one of a series of Culinary Arts books developed to support the training of students and apprentices in British Columbia's food service and hospitality industry. Although created with the Professional Cook and Baker programs in mind, these have been designed as a modular series, and therefore can be used to support a wide variety of programs that offer training in food service skills.

Other books in the series include:

- Food Safety, Sanitation, and Personal Hygiene
- Working in the Food Service Industry
- Workplace Safety in the Food Service Industry
- Meat Cutting and Processing for Food Service
- Human Resources in the Food Service and Hospitality Industry
- Nutrition and Labelling for the Canadian Baker
- Basic Kitchen and Food Service Management

The series has been developed collaboratively with participation from public and private post-secondary institutions.

Introduction

Ingredients play an important role in baking. Not only do they provide the structure and flavour of all of the products produced in the bakery or pastry shop, their composition and how they react and behave in relation to each other are critical factors in understanding the science of baking. This is perhaps most evident when it comes to adapting formulas and recipes to accommodate additional or replacement ingredients while still seeking a similar outcome to the original recipe.

In this book, we look at each of the main categories of baking ingredients, listed below, and then explore their composition and role in the baking process. In addition to these categories, we will discuss the role that salt and water play in the baking process.

The main categories of baking ingredients are:

- Grains and flours
- Sweeteners
- Fats oils
- Leavening agents
- Eggs
- Dairy products
- Chocolate and other cocoa products
- Nuts and seeds
- Thickening agents
- Spices and other flavourings
- Fruit

Note: For most measurements used in the open textbook series, both S.I. (metric) and U.S./imperial values are given. The exception is nutritional information, which is always portrayed using metric values in both Canada and the United States.

I

Grains and Flours

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1.

The History of Wheat Flour

Archaeologists who did excavations in the region of the lake dwellers of Switzerland found grains of wheat, millet, and rye 10,000 years old. The Romans perfected the rotary mill for turning wheat into flour. By the time of Christ, Rome had more than 300 bakeries, and Roman legions introduced wheat throughout their empire. Improved milling processes were needed because even when wheat was milled twice and bolted (sifted) through silk gauze, the result was still a yellowish flour of uneven texture and flecked with germ and bran.

In the second half of the 19th century, there were great changes in the flour milling process. An American inventor, Edmund LaCroix, improved the process with a purifier to separate the **middlings** (bran, germ, and other coarse particles) from the particles that form smooth-textured white flour. In recent years, the demand for whole grain milling has increased because whole grain food products have proved to be more nutritious than products made from white flour. (More information on whole grain and artisan milling is provided later in this section.)

In Canada, large-scale wheat growing didn't occur until after the Prairies were settled in the 1800s. Hard wheat, such as Red Fife, Marquis, and Selkirk, earned Canada a position as the granary for Britain and many other European countries. Today, most of the wheat grown in Western Canada is the hard Red Spring variety. Soft wheats, such as soft red and soft white, are primarily grown in Quebec and Ontario. Many of the original wheat growers have passed on their farms to the next generations, while others branched out to organic farming and milling. One of these farms, Nunweiler's, has a heritage that goes back to the early 1900s when the original wheat in Canada, Red Fife and Marquis, was grown on this farm.

Today, the major wheat growing areas of North America are in the central part of the continent, in the Great Plains of the United States and the Canadian Prairies. From Nebraska south, winter wheat can be grown, while to the north through Saskatchewan spring wheat dominates. Many American states and some Canadian provinces grow both kinds. In fact, there are very few states that don't grow some wheat. Kansas, the site of the American Institute of Baking, could be said to be at the heart of the U.S. wheat growing area, while Saskatchewan is the Canadian counterpart.

2.

Agencies Responsible for Wheat and Grain

In Canada, various governing bodies responsible for aspects of wheat and grain emerged over the years. G3 Canada and the Canadian Grain Commission are responsible for grain handling. Agriculture and Agri-Food Canada is the federal department that oversees both organizations. The National Farmers Union (NFU) is a direct-member organization consisting of farmers and non-farmers. NFU acts in the interest of all types of farming, promotes nutritious foods, and works toward developing economic and social policies. A few of these issues include food security and sustainability. The organization is involved in shaping policies and securing legislation to farmers' benefits.

The Canadian Wheat Board

The Canadian Wheat Board (CWB) was established in the early 1930s by the Parliament of Canada. It is the official marketing board, responsible for buying and selling wheat and barley in Alberta, Saskatchewan, Manitoba, and British Columbia. The CWB will be dissolved by 2016 as a result of Agricultural Growth Act but will continue to operate on a voluntary basis until the organization becomes privatized. The duties of the CWB will be passed on to G3 Canada.

The Canadian Grain Commission

The Canadian Grain Commission (CGC) acts in the interests of grain producers and is guided by the Canada Grain Act. The CGC establishes and maintains standards of quality for Canadian grain, regulates grain handling in Canada, and ensures that grain is a dependable commodity for domestic and export markets (Canadian Grain Commission, 2008). Several regulations and policies fall under the Canada Grain Act that are monitored and reinforced by CGC. Some of these regulations include grain grades and inspection, licences for grain elevators and dealers, and enforcement procedures. The CGC also ensures Canadian grain marketability on a domestic and global level. Other services include grain inspections and analytical testing.

3.

Classification of Wheat

Wheat can be classified in three ways:

- Colour (e.g., red, yellow, white)
- Planting season: spring wheat, planted in the spring and harvested in early fall; winter wheat, planted in the fall, harvested the following summer
- Characteristics of the grain: durum, hard bread wheat, and soft wheat

In Canada, hard spring wheat suitable for yeast products is grown on the Prairies. In southern Alberta, where winters are not as severe, some hard winter wheat is grown. Irrigated land in Alberta also produces some white soft winter wheat. The main soft white winter wheat growing area is southern Ontario.

The CGC categorizes wheat by regions as well as different varieties of wheat by classes. As the CGC states, “the varieties within each class are grouped by their functional characteristics. For example, varieties in the Canada Prairie Spring Red class have medium hard kernels and medium dough strength. Canadian wheat classes are categorized by Canada Western and Canada Eastern, the regions in which the varieties are grown” (CGC, 2015, p1).

Wheat Classes

A list of the different classes of Eastern and Western wheat is as follows:

Eastern Wheat Classes

- Canada Eastern Amber Durum (CEAD)
- Canada Eastern Hard Red Winter (CEHRW)
- Canada Eastern Hard White Spring (CEHWS)
- Canada Eastern Red Spring (CERS)
- Canada Eastern Soft Red Winter (CESRW)
- Canada Eastern Soft White Spring (CESWS)
- Canada Eastern White Winter (CEWW)

Western Wheat Classes

- Canada Prairie Spring Red (CPSR)
- Canada Prairie Spring White (CPSW)
- Canada Western Amber Durum (CWAD)
- Canada Western Extra Strong (CWES)
- Canada Western Hard White Spring (CWHWS)
- Canada Western Red Spring (CWRS)
- Canada Western Red Winter (CWRW)
- Canada Western Soft White Spring (CWSWS)

The characteristics and end uses of Eastern and Western wheat can be found online.

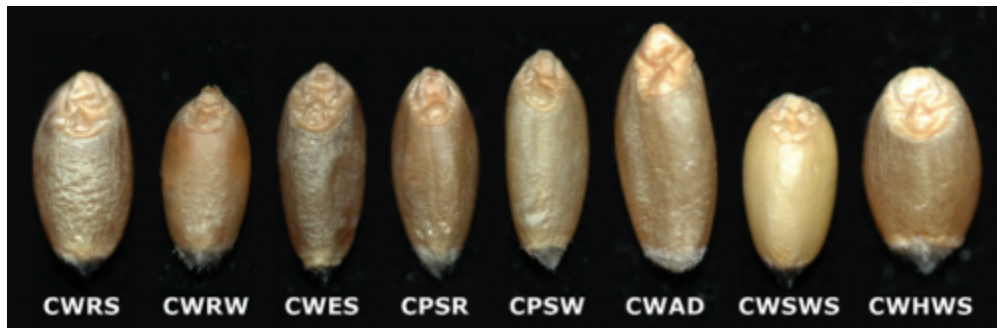


Figure 1. Classes of wheat.

In Canada, grains are divided into “official grains of Canada” and “unofficial grains of Canada.” The former is regulated by the Canada Grain Act, whereas the unofficial grains are not subject to grading purposes. An example of an unofficial grain is the Canadian Western General all-purpose wheat, which produces great yield and has high starch but low **protein** content, thus affecting the end uses. This type of wheat is used for animal feed and, therefore, does not have to meet strict milling requirements.

Additional information on the qualities and protein content as well as classifications of Western Canadian wheat can be found in the CGC document [Quality of Western Canadian Wheat \[PDF\]](#).

The United States recognizes seven market classes of wheat. The first five, listed below, are the most important:

- Hard red winter (planted in the fall, harvested the following summer)
- Soft red winter
- Hard red spring (planted and harvested the same year)
- Durum
- Red durum

Characteristics of the Major Wheat Groups

The major wheat groups each have differing characteristics. This also determines their use in food production and baking. The following identifies the major characteristics of each of the three major wheat groups.

- **Durum wheats:** Durum wheats are generally high in gluten-producing proteins. They are, in effect, the “hardest” wheats. They are used for making semolina, which is made into macaroni and other pastas.
- **Hard wheats:** Hard wheats include hard winter wheats and hard spring wheats. Canadian Western Red Spring (CWRS) is the major hard wheat in Canada. Hard Red Winter (HRW) and Hard Red Spring (HRS) are the U.S. equivalents. They contain more gluten-producing proteins than soft wheat, and are used for making bread flours and all-purpose flours.
- **Soft wheats:** Soft wheats are low in gluten-producing protein. Soft Red Winter (SRW) is the chief of these in the United States. They are milled into cake and pastry flours.

Media Attributions

- Classes of Wheat © Canadian Grain Commission

4.

Milling of Wheat

Milling of wheat is the process that turns whole grains into flours. The overall aims of the miller are to produce:

- A consistent product
- A range of flours suitable for a variety of functions
- Flours with predictable performance

The very first mill operation is analyzing the grain, which determines criteria such as the **gluten** content and amylase activity. It is at this point that decisions about blending are made.

Following analysis, milling may be divided into three stages:

1. Cleaning and conditioning – ridding the grain of all impurities and readying it for milling
2. Crushing or breaking – breaking down the grain in successive stages to release its component parts
3. Reduction – progressive rollings and siftings to refine the flour and separate it into various categories, called *streams*

Cleaning

Wheat received at the mill contains weeds, seeds, chaff, and other foreign material. Strong drafts of air from the aspirator remove lighter impurities. The **disc separator** removes barley, oats, and other foreign materials. From there, the wheat goes to the scourers in which it is driven vigorously against perforated steel casings by metal beaters. In this way, much of the dirt lodged in the crease of the wheat berry is removed and carried away by a strong blast of air. Then the magnetic separator removes any iron or steel.

At this point, the wheat is moistened. Machines known as *whizzers* take off the surface moisture. The wheat is then **tempered**, or allowed to lie in bins for a short time while still damp, to toughen the bran coat, thus making possible a complete separation of the bran from the flour-producing portion of the wheat berry. After tempering, the wheat is warmed to a uniform temperature before the crushing process starts.

Crushing or Breaking

The objectives at this stage are twofold:

1. Separate as much bran and germ as possible from the endosperm
2. Maximize the flour from the resulting endosperm

Household grain mills create flour in one step — grain in one end, flour out the other — but the commercial mill breaks the grain down in a succession of very gradual steps, ensuring that little bran and germ are mixed with any endosperm.

Although the process is referred to as *crushing*, flour mills crack rather than crush the wheat with large steel rollers. The rollers at the beginning of the milling system are corrugated and break the wheat into coarse particles. The grain passes through screens of increasing fineness. Air currents draw off impurities from the **middlings**. *Middlings* is the name given to coarse fragments of endosperm, somewhere between the size of semolina and flour. Middlings occur after the “break” of the grain.

Bran and germ are sifted out, and the coarse particles are rolled, sifted, and purified again. This separation of germ and bran from the endosperm is an important goal of the miller. It is done to improve dough-making characteristics and colour. As well, the germ contains oil and can affect keeping qualities of the flour.

Reduction

In the reduction stage, the coarser particles go through a series of fine rollers and sieves. After the first crushing, the wheat is separated into five or six streams. This is accomplished by means of machines called **plansifters** that contain sieves, stacked vertically, with meshes of various sizes. The finest mesh is as fine as the finished flour, and some flour is created at an early stage of reduction.

Next, each of the divisions or streams passes through cleaning machines, known as *purifiers*, a series of sieves arranged horizontally and slightly angled. An upcurrent draught of air assists in eliminating dust. The product is crushed a little more, and each of the resulting streams is again divided into numerous portions by means of sifting. The final crushings are made by perfectly smooth steel rollers that reduce the middlings into flour. The flour is then bleached and put into bulk storage. From bulk storage, the flour is **enriched** (thiamine, niacin, riboflavin, and iron are added), and either bagged for home and bakery use or made ready for bulk delivery.

Extraction Rates

The extraction rate is a figure representing the percentage of flour produced from a given quantity of grain. For example, if 82 kg of flour is produced from 100 kg of grain, the extraction rate is 82% ($82 \div 100 \times 100$). Extraction rates vary depending on the type of flour produced. A whole grain flour, which contains all of the germ, bran, and endosperm, can have an extraction rate of close to 100%, while

12 Grains and Flours

white all-purpose flours generally have extraction rates of around 70%. Since many of the nutrients are found in the germ and bran, flours with a higher extraction rate have a higher nutritional value.

5.

Flour Streams and Types of Wheat Flour

Modern milling procedures produce many different **flour streams** (approximately 25) that vary in quality and chemical analysis. These are combined into four basic streams of edible flour, with four other streams going to feed.

- Top patent flour: This stream is composed of only the purest and most highly refined streams from the mill. It is low in ash and is approximately 50% of the flour extracted. The term *ash* indicates the mineral content (e.g., phosphorus) of the flour. When flour is burned, all that is left is the burned mineral elements that constitute ash.
- Second patent flour: This flour is composed of streams with an intermediate degree of refinement. It has an average ash content of approximately 0.45% and represents about 35% of the total flour.
- First clear flour: This stream contains the balance of the flour that possesses baking properties, and is high in ash and protein content. It is usually about 15% of the total flour.
- Second clear flour: This grade contains the poorest flour streams. It is very high in ash (approximately 0.75%), and has little or no baking quality. It is about 2% of the total flour.
- Feed streams: The balance of the streams from the mill are classed as feed. Feeds are marketed as bran, **wheat shorts**, flour middlings, and wheat germ.

Within the streams of edible flours, there are a number of different types of flour used in food preparation. Each has different characteristics, and with those come different uses, as described below.

All-Purpose Flour

General purpose or home use flours are usually a blend of hard spring wheats that are lower in protein (gluten) content than bread flours. They are top patent flours and contain sufficient protein to make good yeast breads, yet not too much for good quick breads, cakes, and cookies.

Note: A word about gluten quality as opposed to gluten quantity: The fact that a particular flour contains a high quantity of protein, say 13% to 15%, does not necessarily mean that it is of high quality. It may contain too much ash or too much damaged starch to warrant this classification. High quality is more important in many bread applications than high quantity. All-purpose flour is an example of a high-quality flour, with a protein content of about 12%.

Graham Flour

A U.S. patented flour, graham flour is a combination of whole wheat flour (slightly coarser), with added bran and other constituents of the wheat kernel.

Bread Flour

Bread flour is milled from blends of hard spring and hard winter wheats. They average about 13% protein and are slightly granular to the touch. This type of flour is sold chiefly to bakers because it makes excellent bread with bakery equipment, but has too much protein for home use. It is also called strong flour or hard flour and is second patent flour.

For example, the specification sheet on bread flour produced by a Canadian miller might include the following information:

Ingredients: Wheat flour, amylase, ascorbic acid, niacin, iron, thiamine mononitrate, riboflavin, azodicarbonamide, folic acid.

Moisture: 14.2%

Ash: 0.54%

Protein (5.7 x N) 13.00%

Along with this information there is microbiological data and an allergen declaration. (Note that the formula in parentheses beside “Protein” is simply the laboratory’s way of deriving the protein figure from the nitrogen content.)

Cake Flour

Cake flour is milled from soft winter wheats. The protein content is about 7% and the granulation is so uniform and fine that the flour feels satiny. An exception is a high-protein cake flour formulated especially for fruited pound cakes (to prevent the fruit from sinking).

Clear Flour

Clear flour comes from the part of the wheat berry just under the outer covering. Comparing it to first patent flour is like comparing cream to skim milk. It is dark in colour and has a very high gluten content. It is used in rye and other breads requiring extra strength.

Gluten Flour

Gluten flour is made from wheat flour by removing a large part of the starch. It contains no more than 10% moisture and no more than 44% starch.

Pastry Flour

Pastry flour is made from either hard or soft wheat, but more often from soft. It is fairly low in protein and is finely milled, but not so fine as cake flour. It is unsuitable for yeast breads but ideal for cakes, pastries, cookies, and quick breads.

Self-Rising Flour

Self-rising flour has leavening and salt added to it in controlled amounts at the mill.

Wheat Germ Flour

Wheat germ flour consists entirely of the little germ or embryo part of the wheat separated from the rest of the kernel and flattened into flakes. This flour should be refrigerated.

Whole Wheat Flour

Whole wheat flour contains all the natural parts of the wheat kernel up to 95% of the total weight of the wheat. It contains more protein than all-purpose flour and produces heavier products because of the bran particles.

Whole Wheat Pastry Flour

Whole wheat pastry flour is milled from the entire kernel of soft wheat, is low in gluten, and is suitable for pastry, cakes, and cookies.

Hovis Flour

Most of the germ goes away with the shorts and only a small fraction of the total quantity can be recovered in a fairly pure form. At the mill, a special process developed in England to improve its keeping qualities and flavour cooks this fraction. It is then combined with white flour to make Hovis flour, which produces a loaf that, though small for its weight, has a rich, distinctive flavour.

Triticale Flour

The world's first new grain, triticale is a hybrid of wheat and rye. It combines the best qualities of both grains. It is now grown commercially in Manitoba.

Semolina

Semolina is the granular product consisting of small fragments of the endosperm of the durum wheat kernel. (The equivalent particles from other hard wheat are called *farina*.) The commonest form of semolina available commercially is the breakfast cereal Cream of Wheat.

No-Time Flour

The primary goal of all bakers has been to reduce production time and keep costs to a minimum without losing quality, flavour, or structure. After extensive research, millers have succeeded in eliminating bulk fermentation for both sponge and straight dough methods. No-time flour is flour with additives such as ascorbic acid, bromate, and cysteine. It saves the baker time and labour, and reduces floor space requirements. The baker can use his or her own formulas with only minor adjustments.

Blending Flours

Blending of flours is done at the mill, and such is the sophistication of the analysis and testing of flours (test baking, etc.) that when problems occur it is generally the fault of the baker and not the product. Today the millers and their chemists ensure that bakers receive the high grade of flour that they need to produce marketable products for a quality-conscious consumer. Due to the vagaries of the weather and its effect on growing conditions, the quality of the grain that comes into the mill is hardly ever constant. For example, if damp weather occurs at harvest time, the grain may start to sprout and will cause what is known as *damaged starch*. Through analysis and adjustments in grain handling and blending, the miller is able to furnish a fairly constant product.

Bakers do blend flours, however. A portion of soft flour may be blended with the bread flour to reduce the toughness of a Danish pastry or sweet dough, for example. Gluten flour is commonly used in multigrain bread to boost the aeration.

6.

Flour Terms and Treatments

In addition to types of flour, you may come across various other terms when purchasing flour. These include some terms that refer to the processing and treatment of the flour, and others outlining some of the additives that may be added during the milling and refining process.

Bleached

Bleaching and maturing agents are added to whiten and improve the baking quality quickly, making it possible to market the freshest flour. Even fine wheat flours vary in colour from yellow to cream when freshly milled. At this stage, the flour produces doughs that are usually sticky and do not handle well. Flour improves with age under proper storage conditions up to one year, both in colour and quality.

Because storing flour is expensive, toward the close of the 19th century, millers began to treat freshly milled flour with oxidizing agents to bleach it and give it the handling characteristics of naturally aged flour. Under the category of maturing agents are included materials such as chlorine dioxide, chlorine gas plus a small amount of nitrosyl chloride, ammonium persulfate, and ascorbic acid. No change occurs in the nutritional value of the flour when these agents are present.

The Health Products and Food Branch of Health Canada approves and controls the use of flour treatments and additives. There are two classes of material used to bleach flour. A common one, an organic peroxide, reacts with the yellow pigment only, and has no effect on gluten quality. Chlorine dioxide, the most widely used agent in North America, neutralizes the yellow pigment and improves the gluten quality. It does, however, destroy the tocopherols (vitamin E complex).

Enriched

Iron and three of the most necessary B vitamins (thiamin, riboflavin, and niacin), which are partially removed during milling, are returned to white flour by a process known as enrichment. No change occurs in taste, colour, texture, baking quality, or caloric value of the flour.

Pre-sifted

During the milling process, flour is sifted many times through micro-fine silk. This procedure is known as pre-sifting. The mesh size used for sifting varies from flour to flour. There are more holes per square inch for cake flour than, for example, bread flour, so that a cup of cake flour has significantly more minute particles than does a cup of bread flour, is liable to be denser, and weigh slightly more. Sifted

18 Grains and Flours

flour yields more volume in baked bread than does unsifted flour, simply because of the increased volume of air.

7.

Flour Additives

A number of additives may be found in commercial flours, from agents used as dough conditioners, to others that aid in the fermentation process. Why use so many additives? Many of these products are complementary – that is, they work more effectively together and the end product is as close to “ideal” as possible. Nevertheless, in some countries the number of additives allowed in flour are limited. For instance, in Germany, ascorbic acid remains the only permitted additive.

Some of the additives that are commonly added to flour include those described below.

Bromate

Until the early 1990s, bromate was added to flour because it greatly sped up the oxidation or aging of flour. Millers in Canada stopped using it after health concerns raised by the U.S. Food and Drug Administration (FDA). In the United States, bromate is allowed in some states but banned in others (e.g., California).

Azodicarbonamide (ADA)

Approved in the United States since 1962, but banned in Europe, ADA falls under the food additives permitted in Canada. ADA is a fast-acting flour treatment resulting in a cohesive, dry dough that tolerates high water absorption. It is not a bleach, but because it helps produce bread with a finer texture it gives an apparently whiter crumb. It does not destroy any vitamins in the dough.

Bakers who want to know if their flours contain ADA or other chemical additives can request this information from their flour suppliers.

L-Cysteine

An amino acid, L-cysteine speeds up reactions within the dough, thus reducing or almost eliminating bulk fermentation time. In effect, it gives the baker a “no-time” dough. It improves dough elasticity and gas retention.

Ascorbic Acid

Ascorbic acid was first used as a bread improver in 1932, after it was noticed that old lemon juice added

to dough gave better results because it improved gas retention and loaf volume. Essentially vitamin C (ascorbic acid) has the advantage of being safe even if too much is added to the dough, as the heat of baking destroys the vitamin component. The addition of ascorbic acid consistent with artisan bread requirements is now routine for certain flours milled in North America.

Calcium Peroxide

Calcium peroxide (not to be confused with the peroxide used for bleaching flour) is another dough-maturing agent.

Glycerides

Glycerides are multi-purpose additives used in both cake mixes and yeast doughs. They are also known as surfactants, which is a contraction for “surface-acting agents.” In bread doughs, the main function of glycerides is as a crumb-softening agent, thus retarding bread staling. Glycerides also have some dough-strengthening properties.

Sodium Stearoyl Lactylate

Approved for use in the United States since 1961, this additive improves gas retention, shortens proofing time, increases loaf volume, and works as an anti-staling agent.

8.

Whole Grain and Artisan Milling

Whole grain and artisan milling is the type of milling that was practised before the consumer market demanded smooth white flours that are refined and have chemical additives to expedite aging of flours. Artisan milling produces flours that are less refined and better suited to traditional breads, but also contain little to no additives and have higher nutritional content. For that reason, demand for these types of flour is on the rise.

Artisan millers (also known as micro millers) process many non-stream grains, including spelt, kamut, buckwheat, and other non-gluten grains and pulses. This offers bakers opportunities to work with different grains and expand their businesses. Artisan flours are readily available directly from millers or through a distributor. Knowing the origin of the grains and the quality of the ingredients in baking is important for artisan bakers.

Whole grain flours are on the increase as consumers become more aware of their benefits. Whole grain flour, as the name suggests, is made from whole grains. Whole wheat flours in Canada, however, can have up to 5% of the grain removed (germ) and still be classified as whole wheat. More [information about whole grains](#) can be found on the Government of Canada's website.

Many artisan millers purchase their grains directly from growers and not through the Canadian Wheat Board. As well, several millers demand that their grains be Canadian in origin. This method of purchasing establishes trustworthy working relationships with the grain growers and promotes transparency in grain growing and food safety practices. Grain growers that sell their grains to artisan millers apply conventional or organic growing practices. Grain growers and millers have to go through vigorous processes to obtain the **certified organic** certification for their grains or products, which guarantees that no chemical additives have been used.

How organic grain is processed varies. Stone milling and impact hammer milling methods are typical when minimal refined whole grain flour is preferred. Information on several Canadian artisan millers that produce various whole grain flours can be found at [Anita's Organic Mill](#); [Daybreak Mill](#); [True Grain](#); [Urban Grains](#); and [Fieldstone Organics](#). Organic flours have gained popularity in the baking industry. As consumers become more aware of them, we see the demand swinging back toward whole grain and artisan milling as a preference.

9.

Flour in Baking

Flour forms the foundation for bread, cakes, and pastries. It may be described as the skeleton, which supports the other ingredients in a baked product. This applies to both yeast and chemically leavened products.

The strength of flour is represented in protein (gluten) quality and quantity. This varies greatly from flour to flour. The quality of the protein indicates the strength and stability of the flour, and the result in bread making depends on the method used to develop the gluten by proper handling during the fermentation. Gluten is a rubber-like substance that is formed by mixing flour with water. Before it is mixed it contains two proteins. In wheat, these two proteins are **gliadin** and **glutenin**. Although we use the terms *protein* and *gluten* interchangeably, gluten only develops once the flour is moistened and mixed. The protein in the flour becomes gluten.

Hard spring wheat flours are considered the best for bread making as they have a larger percentage of good quality gluten than soft wheat flours. It is not an uncommon practice for mills to blend hard spring wheat with hard winter wheat for the purpose of producing flour that combines the qualities of both. Good bread flour should have about 13% gluten.

Storing Flour

Flour should be kept in a dry, well-ventilated storeroom at a fairly uniform temperature. A temperature of about 21°C (70°F) with a relative humidity of 60% is considered ideal. Flour should never be stored in a damp place. Moist storerooms with temperatures greater than 23°C (74°F) are conducive to mould growth, bacterial development, and rapid deterioration of the flour. A well-ventilated storage room is necessary because flour absorbs and retains odours. For this reason, flour should not be stored in the same place as onions, garlic, coffee, or cheese, all of which give off strong odours.

Flour Tests

Wheat that is milled and blended with modern milling methods produce flours that have a fairly uniform quality all year round and, if purchased from a reliable mill, they should not require any testing for quality. The teacher, student, and professional baker, however, should be familiar with qualitative differences in flours and should know the most common testing methods.

Flours are mainly tested for:

- Colour

- Absorption
- Gluten strength
- Baking quality

Other tests, done in a laboratory, are done for:

- Albumen
- Starch
- Sugar
- Dextrin
- Mineral and fat content

Colour

The colour of the flour has a direct bearing on baked bread, providing that fermentation has been carried out properly. The addition of other ingredients to the dough, such as **brown sugar**, malt, molasses, salt, and coloured margarine, also affects the colour of bread.

To test the colour of the flour, place a small quantity on a smooth glass, and with a spatula, work until a firm smooth mass about 5 cm (2 in.) square is formed. The thickness should be about 2 cm (4/5 in.) at the back of the plate to a thin film at the front. The test should be made in comparison with a flour of known grade and quality, both flours being worked side by side on the same glass. A creamy white colour indicates a hard flour of good gluten quality. A dark or greyish colour indicates a poor grade of flour or the presence of dirt. Bran specks indicate a low grade of flour.

After making a colour comparison of the dry samples, dip the glass on an angle into clean water and allow to partially dry. Variations in colour and the presence of bran specks are more easily identified in the damp samples.

Absorption

Flours are tested for absorption because different flours absorb different amounts of water and therefore make doughs of different consistencies. The absorption ability of a flour is usually between 55% and 65%. To determine the absorption factor, place a small quantity of flour (100 g/4 oz.) in a bowl. Add water gradually from a beaker containing a known amount of water. As the water is added, mix with a spoon until the dough reaches the desired consistency. You can knead the dough by hand for final mixing and determination of consistency. Weigh the unused water. Divide the weight of the water used by the weight of the flour used. The result is the absorption ability in percentage. For example:

Weight of flour used 100 g (4 oz.)

Weight of water used 60 g (2.7 oz.)

Therefore absorption = $6/10$ or 60%

Prolonged storage in a dry place results in a natural moisture loss in flour and has a noticeable effect on the dough. For example, a sack of flour that originally weighed 40 kg (88 lb.) with a moisture content of 14% may be reduced to 39 kg (86 lb.) during storage. This means that 1 kg (2 lb.) of water is lost and must be made up when mixing. The moisture content of the wheat used to make the flour is also important from an economic standpoint.

Hard wheat flour absorbs more liquid than soft flour. Good hard wheat flour should feel somewhat granular when rubbed between the thumb and fingers. A soft, smooth feeling indicates a soft wheat flour or a blend of soft and hard wheat flour. Another indicator is that hard wheat flour retains its form when pressed in the hollow of the hand and falls apart readily when touched. Soft wheat flour tends to remain lumped together after pressure.

Gluten Strength

The gluten test is done to find the variation of gluten quality and quantity in different kinds of flour. Hard flour has more gluten of better quality than soft flour. The gluten strength and quality of two different kinds of hard flour may also vary with the weather conditions and the place where the wheat is grown. The difference may be measured exactly by laboratory tests, or roughly assessed by the variation of gluten balls made from different kinds of hard flours.

For example, to test the gluten in hard flour and all-purpose flour, mix 250 g (9 oz.) of each in separate mixing bowls with enough water to make each dough stiff. Mix and develop each dough until smooth. Let the dough rest for about 10 minutes. Wash each dough separately while kneading it under a stream of cold water until the water runs clean and all the starch is washed out. (Keep a flour sieve in the sink to prevent dough pieces from being washed down the drain.) What remains will be crude gluten. Shape the crude gluten into round balls, then place them on a paper-lined baking pan and bake at 215°C (420°F) for about one hour. The gluten ball made from the hard flour will be larger than the one made from all-purpose flour. This illustrates the ability of hard flour to produce a greater volume because of its higher gluten content.

Ash Content

Ash or mineral content of flour is used as another measurement of quality. Earlier in the chapter, we talked about extraction rates as an indicator of how much of the grain has been refined. Ash content refers to the amount of ash that would be left over if you were to burn 100 g of flour. A higher ash content indicates that the flour contains more of the germ, bran, and outer endosperm. Lower ash content means that the flour is more highly refined (i.e., a lower extraction rate).

Baking Quality

The final and conclusive test of any flour is the kind of bread that can be made from it. The baking test enables the baker to check on the completed loaf that can be expected from any given flour. Good

volume is related to good quality gluten; poor volume to young or green flour. Flour that lacks stability or power to hold during the entire fermentation may result in small, flat bread. Flour of this type may sometimes respond to an increase in the amount of yeast. More yeast shortens the fermentation time and keeps the dough in better condition during the pan fermentation period.

10.

Rye Flour

Rye is a hardy cereal grass cultivated for its grain. Its use by humans can be traced back over 2,000 years. Once a staple food in Scandinavia and Eastern Europe, rye declined in popularity as wheat became more available through world trade. A crop well suited to northern climates, rye is grown on the Canadian Prairies and in the northern states such as the Dakotas and Wisconsin.

Rye flour is the only flour other than wheat that can be used without blending (with wheat flour) to make yeast-raised breads. Nutritionally, it is a grain comparable in value to wheat. In some cases, for example, its lysine content (an amino acid), is even biologically superior.

The brown grain is cleaned, tempered, and milled much like wheat grain. One difference is that the rye endosperm is soft and breaks down into flour much quicker than wheat. As a result, it does not yield semolina, so purifiers are seldom used. The bran is separated from the flour by the break roller, and the flour is further rolled and sifted while being graded into chop, meal, light flour, medium flour, and dark flour.

- Chop: This is the miller's name for the coarse stock after grinding in a break roller mill.
- Meal: Like chop, meal is made of 100% extraction obtained by grinding the entire rye kernel.
- Light rye flour: This is obtained from the centre of the rye kernel and is low in protein and high in starch content. It can be compared to white bread flour and is used to make light rye breads.
- Medium rye flour: This is straight flour and consists of all the kernels after the bran and shorts have been removed. It is light grey in colour, has an ash content of 1%, and is used for a variety of sourdough breads.
- Dark rye flour: This is comparable to first clear wheat flour. It has an ash content of 2% and a protein content of 16%. It is used primarily for heavier types of rye bread.

The lighter rye flours are generally bleached, usually with a chlorine treatment. The purpose of bleaching is to lighten the colour, since there is no improvement on the gluten capability of the flour.

Extraction of Rye Flour

The grade of extraction of rye flour is of great importance to the yield of the dough and the creation of a particular flavour in the baked bread. Table 1 shows the percentage of the dry substances of rye flour by grade of extraction.

Table 1 Dry Substances of Rye Flour by Grade of Extraction

Substance	70% Extraction Rate	85% Extraction Rate
Ash	0.8%	1.4%
Fat	1.2%	1.7%
Protein	8.1%	9.6%
Sugar	6.5%	7.5%
Starch	72.5%	65.1%
Crude fibre	0.5%	1.3%
Pentosans	5.2%	7.6%
Undefinable	5.2%	5.8%

Note that ash, fibre, and **pentosans** are higher in the 85% extraction rate flour, and starch is lower. Pentosans are gummy carbohydrates that tend to swell when moistened and, in baking, help to give the rye loaf its cohesiveness and structure. The pentosan level in rye flour is greater than that of wheat flour and is of more significance for successful rye bread baking.

Rye flours differ from wheat flours in the type of gluten that they contain. Although some dark rye flours can have a gluten content as high as 16%, this is only gliadin. The glutenin, which forms the elasticity in dough is absent, and therefore doughs made only with rye flour will not hold the gas produced by the yeast during fermentation. This results in a small and compact loaf of bread.

Starch and pentosans are far more important to the quality of the dough yield than gluten. Starch is the chief component of the flour responsible for the structure of the loaf. Its bread-making ability hinges on the age of the flour and the acidity. While rye flour does not have to be aged as much as wheat flour, it has both a “best after” and a “best before” date. Three weeks after milling is considered to be good.

When the rye flour is freshly milled, the starch gelatinizes (sets) quickly at a temperature at which amylases are still very active. As a result, bread made from fresh flour may be sticky and very moist. At the other extreme, as the starch gets older, it gelatinizes less readily, the enzymes cannot do their work, and the loaf may split and crack. A certain amount of starch breakdown must occur for the dough to be able to swell.

The moisture content of rye flour should be between 13% and 14%. The less water in the flour, the better its storage ability. Rye should be stored under similar conditions to wheat flour.

Differences between Rye and Wheat

Here is a short list of the differences between rye and wheat:

- Rye is more easily pulverized.
- Rye does not yield semolina.

- Gluten content in rye is not a significant dough-making factor.
- Starch is more important for bread making in rye flour than in wheat flour.
- The pentosan level in rye flour is higher and more important for bread making.
- Rye flour has greater water binding capability than wheat flour, due to its starch and pentosan content.

In summary, both wheat and rye have a long history in providing the “staff of life.” They are both highly nutritious. North American mills have state-of-the-art technology that compensates for crop differences, thus ensuring that the baker has a reliable and predictable raw material. Flour comes in a great variety of types, specially formulated so that the baker can choose according to product and customer taste.

11.

Other Grains and Flours

Several other types of grains are commonly used in baking. In particular, corn and oats feature predominantly in certain types of baking (quick breads and cookies respectively, for instance) but increasingly rice flour is being used in baked goods, particularly for people with gluten sensitivities or intolerances. The trend to whole grains and the influence of different ethnic cultures has also meant the increase in the use of other grains and pulses for flours used in breads and baking in general.

Corn

Corn is one of the most widely used grains in the world, and not only for baking. Corn is used in breads and cereals, but also to produce sugars (such as dextrose and corn syrup), starch, plastics, adhesives, fuel (ethanol), and alcohol (bourbon and other whisky). It is produced from the **maize** plant (the preferred scientific and formal name of the plant that we call *corn* in North America). There are different varieties of corn, some of which are soft and sweet (corn you use for eating fresh or for cooking) and some of which are starchy and are generally dried to use for baking, animal feed, and popcorn.

Corn is one of the grains defined in [Canada Grain Regulations – Section 5](#). This means that the Canadian Grain Commission establishes and maintains quality standards for corn. The Canadian Grain Commission defines Canadian grain standards and assesses the grade of grains against these standards. The [Grain Grading Guide](#) contains all the standards for Canadian grain. [Chapter 17 of the Grain Grading Guide](#) presents the standards for corn.

Varieties Used in Baking

- Cornmeal has a sandy texture and is ground to fine, medium, and coarse consistencies. It has most of the husk and germ removed, and is used in recipes from the American South (e.g., cornbread) and can be used to add texture to other types of breads and pastry.
- Stone-ground cornmeal has a texture not unlike whole wheat flour, as it contains some of the husk and germ. Stone ground cornmeal has more **nutrients**, but it is also more perishable. In baking, it acts more like cake flour due to the lack of gluten.
- Corn flour in North America is very finely ground cornmeal that has had the husk and germ removed. It has a very soft powdery texture. In the U.K. and Australia, corn flour refers to cornstarch.
- Cornstarch is the starch extracted from the maize kernel. It is primarily used as a thickener in baking and other cooking. Cornstarch has a very fine powdery consistency, and can be dissolved easily in water. As a thickening agent, it requires heat to set, and will produce

products with a shiny, clear consistency.

- Blue cornmeal has a light blue or violet colour and is produced from whole kernels of blue corn. It is most similar to stone-ground cornmeal and has a slightly sweet flavour.

Rice

Rice is another of the world's most widely used cereal crops and forms the staple for much of the world's diet. Because rice is not grown in Canada, it is not regulated by the Canadian Grain Commission.

Varieties Used in Baking

- Rice flour is prepared from finely ground rice that has had the husks removed. It has a fine, slightly sandy texture, and provides crispness while remaining tender due to its lack of gluten. For this reason, many gluten-free breads are based on rice flours or blends that contain rice flour.
- Short grain or pearl rice is also used in the pastry shop to produce rice pudding and other desserts.

Oats

Oats are widely used for animal feed and food production, as well as for making breads, cookies, and dessert toppings. Oats add texture to baked goods and desserts.

Oats is also one of the grains defined in Canada Grain Regulations – Section 5, which means that the Canadian Grain Commission establishes and maintains quality standards for oats. Chapter 7 of the Grain Grading Guide contains the standards for oats.

Varieties Used in Baking

- Bakers will most often encounter rolled oats, which are produced by pressing the de-husked whole kernels through rollers.
- Oat bran and oat flour are produced by grinding the oat kernels and separating out the bran and endosperm.
- Whole grain oat flour is produced by grinding the whole kernel but leaving the ground flour intact.
- Steel-cut oats are more commonly used in cooking and making breakfast cereals, and are the chopped oat kernels.

Other Grains and Pulses

A wide range of additional flours and grains that are used in ethnic cooking and baking are becoming more and more widely available in Canada. These may be produced from grains (such as kamut, spelt, and quinoa), pulses (such as lentils and chickpeas), and other crops (such as buckwheat) that have a grain-like consistency when dried. Increasingly, with allergies and intolerances on the rise, these flours are being used in bakeshops as alternatives to wheat-based products for customers with special dietary needs. (For more on this topic, see the chapter Special Diets, Allergies, Intolerances, Emergent Issues, and Trends in the open textbook *Nutrition and Labelling for the Canadian Baker.*)

12.

Key Takeaways

Key Takeaways

- Wheat is by far the most common grain and flour used in the baking industry.
- Grains produced in Canada fall under the control of the Canada Grain Act and Regulations.
- Flours can be produced from cereals, grains, legumes, and other plants for a wide range of uses in baking.
- The function and use of grains and flours in baking varies greatly, depending on the type of flour and its protein and gluten content.

Sweeteners in Baking

Learning Objectives

- Identify and describe sugar and other sweeteners used in the food service industry
- Describe the production of sugar and other sweeteners
- Describe the function of sweeteners in baking

We often think of baked goods as being sweet, and sweeteners play an important role in the world of food and baking in particular. Sweetness is one of the key elements of taste (which is explored in more detail in the open textbook *Nutrition and Labelling for the Canadian Baker*) but sugars play many other important roles in baking, including contributing to texture, colour, and the chemical processes needed for fermentation. Sweetness is only one of the considerations, and this group of ingredients and how they affect different aspects of the baking process is a key to understanding baking science.

13.

Sugar Chemistry

Chemically, sugar consists of carbon (C), oxygen (O), and hydrogen (H) atoms, and is classified as a **carbohydrate**. There are three main groups of sugars, classified according to the way the atoms are arranged together in the molecular structure. These groups are the following:

- **Monosaccharides** or simple sugars. **Dextrose (glucose)** is the major monosaccharide. Others are **levulose** or **fructose** (found in **honey** and many fruits), and galactose, which is a milk sugar. Such sugars do not readily crystallize. (*Mono* means *one*, indicating that the sugar consists of only one molecule.)
- **Disaccharides** or complex sugars. Sucrose (common sugar) is the primary example of a disaccharide. Maltose, found in cereals, and **lactose**, found in milk, are others.
- **Polysaccharides**. Examples are starches, dextrins, and cellulose.

Bakers are not concerned with polysaccharides but rather with the monosaccharides and disaccharides. The latter two both sweeten, but they cannot be used interchangeably because they have different effects on the end product. These differences are touched on later in the book.

Sugar Names

It is helpful to understand some of the conventions of the names of different sugars. Note that sugar names often end in “ose”: sucrose, dextrose, maltose, lactose, etc. **Sucrose** is the chemical name for sugar that comes from the cane and beet sugar plants.

Note that glucose is the chemical name for a particular type of sugar. What is sometimes confusing is that glucose occurs naturally, as a sugar molecule in substances such as honey, but it is also produced industrially from the maize plant (corn).

The Canadian Food and Drug Regulations (FDR) govern the following definitions:

- **Sugars**: All monosaccharides and disaccharides. Used for nutrition labelling purposes.
- **Sweetening agent**: Any food for which a standard is provided in Division 18 of the Food and Drug Regulation, or any combination of these. Includes sugar (sucrose), sugar syrups, and molasses derived from sugar cane or sugar beet, dextrose, glucose and syrups, honey and lactose. Excludes sweeteners considered to be food additives.
- **Sweetening ingredient**: Any sugar, **invert sugar**, honey, dextrose, glucose, or glucose solids, or any combination of these in dry or liquid form. Designed for sweetening fruits, vegetables, and their products and substitutes.

- **Maple syrup:** The syrup obtained by the concentration of maple sap or by the dilution or solution of a maple product, other than maple sap, in potable water.
- **Sweetener:** Any food additive listed as a sweetener. Includes both sugar alcohols and high intensity-sweeteners such as acesulfame-potassium, aspartame, and sucralose.
- **Sugar alcohols:** Food additives that may be used as sweeteners. Includes isomalt, lactitol, maltitol, maltitol syrup, mannitol, sorbitol, sorbitol syrup, xylitol, and erythritol.

14.

Sugar (Sucrose)

For the remainder of this section, we will be referring to sugar generally to mean sucrose and its derivatives.

Sugar is a natural food. **Chlorophyll**, the green colouring matter in plants, is the key to the natural production of sugar. The process used by green plants is called **photosynthesis**. Plants build all other food substances, such as protein and oil, directly or indirectly from this sugar.

The two plants that yield the most sugar and are commercially grown are sugar cane and sugar beet. **Raw sugar** is made in large refineries by crushing cane sugar (*Saccharum officinarum*) or beet root (*Beta vulgaris*) to obtain juice. Boiling the juice removes water, and with further processing, unrefined raw sugar is obtained (sometimes also known as *panela*). Generally, cane sugar is produced by tropical countries and the beet sugar by cooler, temperate areas.

Sugar cane is actually a giant grass that stores sugar in its stalk. Planting the cane is something like planting potatoes. It is grown in warm, moist countries, and cane accounts for approximately 80% of the world's sugar; the remaining 20% is produced from sugar beet. Brazil and India are the largest cane producers, with Brazil alone accounting for over 25% of the world's sugar. Other producing regions significant to North America's sugar supply are Thailand, China, Hawaii, the Caribbean, Philippines, and Australia.

Sugar beet was developed in the early 1800s. Since that time, sugar beet farming has spread to all parts of the temperate climatic zone. A root crop, it is more tolerant of northern climates and is grown as far north as Minnesota and Michigan in the United States. In Canada it was once grown in Alberta, Manitoba, southern Ontario, and Quebec, but today, all beet sugar produced in Canada is grown in southern Alberta.

In countries like Canada, sugar beet plays a very minor role, and the bulk of Canadian refined sugar comes from imported raw sugar from cane sources in South and Central America, Australia, and the Caribbean. Whatever its provenance, sugar is a uniform product of great purity.

Today, the Canadian industry consists of cane sugar refineries located in Montreal, Toronto, and Vancouver, as well as the one remaining sugar beet plant in Taber, Alberta, which processes about 150,000 tonnes of beets each year. These factories are all operated by the same company, Lantic Inc., which resulted from a merger of Canada's two leading sugar producers, Lantic Sugar Limited and Rogers Sugar Ltd. in 2008. The two companies had worked together as one for a number of years before the amalgamation, and the sugar produced is still marketed under the two brands: Lantic in Eastern Canada and Rogers in Western Canada.

Cane refiners import primary-processed sugar cane called "raws." By law, this product requires further

purification and refining to be sold in Canada, as raw sugar does not meet the Canadian standards for health and hygiene.

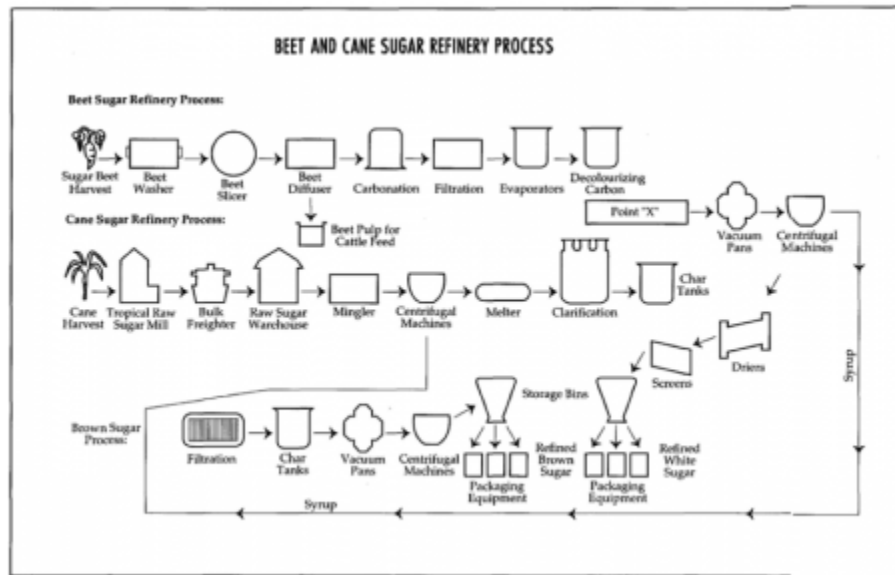


Figure 2. Sugar refining process.

Media Attributions

- Sugar refining process © Baking Association of Canada

15.

Sugar Refining

While some refining usually occurs at source, most occurs in the recipient country. The raw sugar that arrives at the ports is not legally edible, being full of impurities.

At the refinery, the raw brown sugar goes through many stages:

- Washing and boiling
- Filtering to remove impurities
- Evaporation to the desired crystal size under vacuum to avoid caramelization
- Centrifuging, in which the fluid is spun off leaving the crystals
- Drying in a rotating drum with hot air
- Packaging in various sizes, depending on the intended market

Sugar beet undergoes identical steps after the initial processing, which involves:

- Slicing the beets and extracting the sugar with hot water
- Removing impurities
- Filtration
- Concentration in evaporators

From here, the process is identical to the final steps in cane processing. See Figure 2 which illustrates the process.

Some of the sugar passes through a machine that presses the moist sugar into cubes and wraps and packages them; still other sugar is made into icing sugar. The sugar refining process is completely mechanical, and machine operators' hands never touch the sugar.

Brown and yellow sugars are produced only in cane sugar refineries. When sugar syrup flows from the centrifuge machine, it passes through further filtration and purification stages and is re-boiled in vacuum pans such as the two illustrated in Figure 2. The sugar crystals are then centrifuged but not washed, so the sugar crystals still retain some of the syrup that gives the product its special flavour and colour.

During the whole refining process almost 100 scientific checks for quality control are made, while workers in research laboratories at the refineries constantly carry out experiments to improve the refining process and the final product. Sugar is carefully checked at the mills and is guaranteed to have a high purity. Government standards both in the United States and Canada require a purity of at least 99.5% sucrose.

Are animal ingredients included in white sugar?

Bone char — often referred to as natural carbon — is widely used by the sugar industry as a decolourizing filter, which allows the sugar cane to achieve its desirable white colour. Other types of filters involve granular carbon or an ion-exchange system rather than bone char.

Bone char is made from the bones of cattle, and it is heavily regulated by the European Union and the USDA. Only countries that are deemed BSE-free can sell the bones of their cattle for this process.

Bone char is also used in other types of sugar. Brown sugar is created by adding molasses to refined sugar, so companies that use bone char in the production of their regular sugar also use it in the production of their brown sugar. Confectioner's sugar — refined sugar mixed with cornstarch — made by these companies also involves the use of bone char. Fructose may, but does not typically, involve a bone-char filter.

Bone char is not used at the sugar beet factory in Taber, Alberta, or in Montreal's cane refinery. Bone char is used only at the Vancouver cane refinery. All products under the Lantic trademark are free of bone char. For the products under the Rogers trademark, all Taber sugar beet products are also free of bone char. In order to differentiate the Rogers Taber beet products from the Vancouver cane products, you can verify the inked-jet code printed on the product. Products with the code starting with the number "22" are from Taber, Alberta, while products with the code starting with the number "10" are from Vancouver.

If you want to avoid all refined sugars, there are alternatives such as sucanat and turbinado sugar, which are not filtered with bone char. Additionally, beet sugar — though normally refined — never involves the use of bone char.

16.

Forms of Sugar Used in the Bakeshop

Sugar in its various forms is the third most used ingredient in the bakeshop, exceeded only by flour and water. The following sections describe the forms of sugar available to bakers, and Table 2 shows the differences in composition of the leading types.

Cube Sugar

Cube sugar, or lump sugar, is made from the first refined syrup, which is the highest grade. It is formed in moulds while the sugar is still moist, then dried in ovens and packed. Cube sugar is excellent for sugar boiling in caramel work.

Granulated Sugar

Refined granulated sugar is the most common form of sugar used. It is produced in various crystal sizes (fine, super fine, and berry are a few). Custom sizes are also available from some manufacturers, since any size crystal is possible at the factory depending on when the process is halted. The Canadian Food and Drug Regulations require a minimum purity of 99.8% sucrose, but all refined white sugar produced in Canada exceeds 99.9%.

Bulk Granulated

Many food manufacturers purchase granulated sugar in bulk form to save handling and storage costs in their plants. It is delivered in specially designed trucks (20 tonnes) or railway cars (85 tonnes).

Liquid Sugar

Some food manufacturers prefer this mixture of water and sugar. Liquid sugar is metered into the manufacturing process. There are many grades and blends of liquid sugar tailored to suit food manufacturers' requirements.

Invert Sugar

When water and sugar are heated in the presence of a weak acid solution and/or enzymes, the sucrose

breaks up into sweeteners of simpler chemical structure, creating **invert sugar**. A similar process occurs in the stomach. Like commercial glucose, invert sugar is a thick, colourless syrup and consists of 38% dextrose, 38% levulose, and 24% water. It is slightly sweeter than sucrose and is popular with some industrial users like soft drink bottlers and confectioners. Invert sugar is a good example of a monosaccharide — that is, despite the presence of a high concentration of sugar, it stays as a thick syrup.

Icing Sugar

Also known as confectionary or **powdered sugar**, icing sugar is produced by grinding high-grade crystals. This sugar passes through a series of sieves, yielding a selection of icing sugars. Icing sugar contains from 3% to a maximum of 5% starch (either cornstarch or wheat starch) to retard lumping or crystallization. Tricalcium phosphate may be added in the United States at a level of 1% for the same purpose.

Note: Icing sugar that contains wheat starch is not a gluten-free ingredient!

Fondant Sugar

Fondant sugar is an especially fine icing sugar designed for frostings, doughnut glazes, and cold fondants. One of these super-fine icing sugars comes without any cornstarch, but with a small percent of invert sugar. It is designed for instant fondant centres for chocolate manufacture.

Brown Sugar and Golden (Yellow) Sugar

Brown sugar, light brown sugar, and yellow sugar are refined products containing a molasses-flavoured syrup giving the products a distinctive taste and colour. They are available in a variety of grades and colours and are soft sugars.

Keep this sugar moist. If stored in dry conditions, the sugar becomes lumpy and hard. If the ambient humidity is high, the sugar can be left exposed. If the air is dry, it must be kept well covered.

Demerara Sugar

This is a dark brown sugar containing coarse crystals.

Golden Syrup

Golden syrup is a by-product of sugar refining. When the syrups, after repeated boiling, no longer yield crystals, the syrup is filtered and concentrated.

Molasses

Molasses is a by-product of the cane and beet refining processes. Cane sugar molasses is edible and comes in many grades from fancy to black strap molasses. Sugar beet molasses is non-edible but has other industrial uses. Molasses is also available in dry form. In Canada, blackstrap molasses is another name for cooking molasses.

Raw Cane Sugar

This product is imported into Canada in special bulk cargo ships. Conditions under which it is manufactured and shipped vary.

Table 2 Composition of Various Sugars

Component	Granulated Sugar	Icing Sugar	Invert Sugar	Yellow Sugar
Moisture	0.03%	0.4%	23%	3%
Sucrose	99.95%	97%	4%	94%
Invert Sugar			73%	
Starch		3%		
pH			3.8-4.2	

Note: These figures are rounded and may vary depending on place of production.

Sweetness in Sugar

Sweetness is influenced by many factors including temperature, pH, and the presence of other substances that need not themselves be sweeteners. The relative sweetness of sugar and other carbohydrate sweeteners is shown in Table 3. Note that sucrose is the reference standard to which all the other types of sugar are compared. This reference is called the **sweetness equivalent**.

Table 3 Relative Sweetness of Sugars

Type of Sugar	Sweetness Equivalent
Fructose/levulose	1.73
Invert sugar	1.30
Sucrose	1.00 (reference)
Glucose/dextrose	0.74 – 0.80
Sorbitol	0.60
Mannitol	0.50
Maltose	0.33-0.45
Galactose	0.32
Lactose	0.16

What this table tells us is that mannitol, for example, is only half as sweet as sucrose. Therefore, two level teaspoons of mannitol would be needed in a cup of coffee to obtain the same sweetness level as one teaspoon of sucrose.

17.

The Application of Sugar

As mentioned, sugar is the third most used ingredient in the bakeshop. Sugar has several functions in baking. The most recognized purpose is, of course, to sweeten food, but there are many other reasons sugar is used in cooking and baking:

- It can be used for browning effect, both **caramelization** and the **Maillard reaction**, on everything from breads to cookies to cakes. Browning gives a pleasant colour and flavour to the finished product. Caramelization results from the action of heat on sugars. At high temperatures, the chemical changes associated with melting sugars result in a deep brown colour and new flavours. The Maillard reaction results from chemical interactions between sugars and proteins at high heat. An amino group from a protein combines with a reducing sugar to produce a brown colour in a variety of foods (e.g., brewed coffee, fried foods, and breads).
- It acts as the most important tenderizing agent in all baked goods, and one of the factors responsible for the spread in cookies. It helps delay the formation of gluten, which is essential for maintaining a soft or tender product.
- It makes an important contribution to the way we perceive the texture of food. For example, adding sugar to ice cream provides body and texture, which is perceived as smoothness. This addition helps prevent lactose crystallization and thus reduces sugar crystal formation that otherwise causes a grainy texture sometimes associated with frozen dairy products.
- It preserves food when used in sufficient quantity.
- In baking, it increases the effectiveness of yeast by providing an immediate and more usable source of nourishment for the yeast's growth. This hastens the leavening process by producing more carbon dioxide, which allows the dough to rise at a quicker and more consistent rate.

Just as there are many functions of sugar in the bakeshop, there are different uses for the various types of sugar as well:

- Fine granulated sugar is most used by bakers. It generally dissolves easily in mixes and is pure enough for sugar crafters to boil for “pulled” sugar decorations.
- Coarse granulated sugar may be used for a topping on sugar cookies, puff pastry, and Danish pastries as it doesn't liquefy or caramelize so readily. In some European countries, an extra coarse sugar (called *hail* — a literal translation) is used for this purpose.
- Icing or powdered sugar is used in icings and fillings and in sifted form as a top decoration on many baked goods.

- Brown or yellow sugars are used where their unique flavour is important, or in bakeries where an old-fashioned or rustic image is projected. Brown sugar can usually be substituted for white sugar without technical problems in sugar/batter mixes such as cakes and muffins, and in bread dough.

18.

Agave

Agave has gained popularity in the food industry due to some of its nutritional properties. The agave nectar is obtained from the sap of the heart of the agave plant, a desert succulent, which is also used to produce tequila. The syrup/sugar production process of agave is similar to that of sugar. See more about the nutritional properties and application of agave in the chapter Special Diets, Allergies, Intolerances, Emerging Issues, and Trends in the open textbook *Nutrition and Labelling for the Canadian Baker*.

19.

Glucose/Dextrose

The sugar known as glucose has two origins:

- In a natural form in most fruits
- In a processed form from corn (corn syrup)

In baking, we usually refer to industrially made glucose. It is made from corn and the resulting product, a thick syrup, is then adjusted to a uniform viscosity or consistency. The particular form of the syrup is defined by what is known as the *dextrose equivalent*, or DE for short. Corn syrup is the most familiar form of glucose.

In plant baking, high-fructose corn syrup (HFCS) is the major sweetening agent in bread and buns. It consists of roughly half fructose and half dextrose. Dextrose (chemically identical to glucose) is available in crystalline form and has certain advantages over sucrose:

- It is easily fermentable.
- It contributes to browning in bread and bun making.
- In crystalline form, it is often used in doughnut sugars as it is more inclined to stay dry and non-greasy.
- It is **hygroscopic** and valued as a moisture-retaining ingredient.
- It retards crystallization in syrups, candies, and fondant.

Corn syrup is made from the starch of maize (corn) and contains varying amounts of glucose and maltose, depending on the processing methods. Corn syrup is used in foods to soften texture, add volume, prevent crystallization of sugar, and enhance flavour.

Table 3 showed that glucose/dextrose has a sweetening level of approximately three-quarters that of sugar. Table 4 shows the amount of corn syrup or HFCS needed to replace sugar in a formula.

Table 4 Replacement Factor for Corn Syrup and High-Fructose Corn Syrup

Type of Sugar	Solids	Replacement Factor
Granulated sugar	100%	1.0
Regular corn syrup	80%	1.25
High-fructose corn syrup	71%	1.41

Glucose, HFCS, and corn syrup are not appropriate substitutions for sucrose in all bakery products. Certain types of cakes, such as white layer cakes, will brown too much if glucose or HFCS is used in place of sugar.

20.

Honey

Honey is a natural food, essentially an invert sugar. Bees gather nectar and, through the enzyme invertase, change it into honey. Honey varies in composition and flavour depending on the source of the nectar. The average composition of honey is about 40% levulose, 35% dextrose, and 15% water, with the remainder being ash, waxes, and gum.

Blended honey is a mixture of pure honey and manufactured invert sugar, or a blend of different types of honey mixed together to produce a good consistency, colour, and aroma. Dehydrated honey is available in a granular form.

Store honey in a tightly covered container in a dry place and at room temperature because it is hygroscopic, meaning it absorbs and retains moisture. Refrigeration or freezing won't harm the colour or flavour but it may hasten granulation. Liquid honey crystallizes during storage and is re-liquefied by warming in a double boiler not exceeding a temperature of 58°C (136°F).

Honey is used in baking:

- As a sweetener
- To add unique flavour
- In gingerbread and special cookies where a certain moistness is characteristic of the product
- To improve keeping qualities

There are several types of honey available:

- Comb honey is “packed by the bees” directly from the hive.
- Liquid honey is extracted from the comb and strained. It is the type used by most bakers.
- Creamed honey has a certain amount of crystallized honey added to liquid honey to give body to the final product.
- Chunk honey consists of pieces of comb honey as well as liquid.
- Granulated honey has been crystallized.

In the United States, honey categories are based on colour, from white to dark amber. Honey from orange blossom is an example of white honey. Clover honey is an amber honey, and sage and buckwheat honeys are dark amber honeys.

21.

Malt

Malt is the name given to a sweetening agent made primarily from barley. The enzymes from the germ of the seeds become active, changing much of the starch into maltose, a complex sugar. Maltose has a distinct flavour and is used for making yeast products such as bread and rolls. Malt is considered to be relatively nutritious compared to other sweeteners.

Malt is available as:

- Flour
- Malt syrup
- Malt extract
- Dried malt

The flour is not recommended since it can lead to problems if not scaled precisely. Malt syrup is inconvenient to work with, as it is sticky, heavy, and bulky. Dried malt is the most practical, though it must be kept protected from humidity.

There are two distinct types of malt:

- Diastatic malt flour is dried at low temperature, thus retaining the activity of the diastatic enzymes.
- Non-diastatic malt flour is darker in colour. It is treated at high temperature, which kills the enzymes, and the result is non-diastatic malt.

Crushing malted grain in water produces malt syrup. This dissolves the maltose and soluble enzymes. The liquid is concentrated, producing the syrup. If the process is continued, a dry crystallized product called dried malt syrup is obtained.

Malt syrup has a peculiar flavour, which many people find desirable. It is used in candy, malted milk, and many other products. The alcoholic beverage industry is the largest consumer of malt by far, but considerable quantities are used in syrup and dried malt syrup, both of which are divided into diastatic and non-diastatic malt.

Both diastatic and non-diastatic malts add sweetness, colour, and flavour to baked products. Both are valuable since they contain malt sugar, which is fermented by the yeast in the later stages of fermentation. Other sugars such as glucose and levulose are used up rapidly by fermenting yeast in the early stages of fermentation.

Diastatic malt is made with various levels of active enzymes. Malt with medium diastatic activity is

recommended. Normally, bread bakers will find sufficient enzymes in well-balanced flour from a good mill, so it is unnecessary to use diastatic malt.

When using dry diastatic malt, about the same weight should be used as liquid regular diastatic malt. Adjustment is made at the factory insofar as the enzyme level is increased in the dry product to compensate. Since the dry type contains about 20% less moisture than the liquid type, add water to make up the difference if dry diastatic malt is substituted for malt syrup.

The main uses of malt in the bakery are to:

- Add nutritive value, as it is rich in vitamins and essential amino acids
- Lengthen shelf life through its ability to attract moisture
- Help fermentation by strengthening the gluten and feeding the yeast
- Make products more appealing through browning of the crust
- Add unique flavour to products when used in sufficient quantity

Table 5 shows the suggested use levels for malt.

Table 5 Recommended Level of Malt for Various Baked Goods

Product	Percentage of Flour Weight
White pan bread	0.5-1.5
Sweet goods	1.5-3.0
French/Italian bread	0.5-2.0
Whole wheat bread	5.0-9.0
Pretzels	1.5-6.0
Hard rolls	3.0-5.5

22.

Maple Syrup

Canada is responsible for 84% of the world's maple syrup production, with the United States being responsible for the remaining 16%. Maple syrup is made by boiling and evaporating the sap of the sugar maple tree. Because sap is only 2% or 3% sugar, it takes almost 40 litres of sap to make 1 litre of syrup. This makes maple syrup a very expensive sweetener. It is prized for its unique flavour and sweet aroma. Don't confuse maple-flavoured pancake or table syrup with real maple syrup. Table syrup is made from inexpensive glucose or corn syrup, with added caramel colouring and maple flavouring.

Maple syrup in Canada has two categories:

1. Canada Grade A, which has four colour/flavour classes
 - (i) golden, delicate taste
 - (ii) amber, rich taste
 - (iii) dark, robust taste
 - (iv) very dark, strong taste
2. Canada Processing Grade, which has no colour descriptors (any maple syrup that possesses minimal food quality defects but still meets all government regulatory standards for food quality and safety for human consumption)

This definition and grading system gives consumers more consistent and relevant information about the varieties, and helps them make informed choices when choosing maple syrup.

Darker maple syrups are better for baking as they have a more robust flavour. Using maple sugar is also a good way to impart flavour. Maple sugar is what remains after the sap of the sugar maple is boiled for longer than is needed to create maple syrup. Once almost all the water has been boiled off, all that is left is a solid sugar. It can be used to flavour some maple products and as an alternative to cane sugar.

For a video on maple syrup production, see [The Faces of Business: Mapleside Sugar Bush](#).

23.

Sugar Substitutes

In Canada, food additives such as sugar substitutes, which cover both artificial sweeteners and intense sweeteners obtained from natural sources, are subject to rigorous controls under the *Food and Drugs Act* and *Food and Drug Regulations*. New food additives (or new uses of permitted food additives) are permitted only once a safety assessment has been conducted and regulatory amendments have been enacted.

Several sugar substitutes have been approved for use in Canada. These include acesulfame-potassium, aspartame, polydextrose, saccharin, stevia, sucralose, thaumatin, and sugar alcohols (polyols) like sorbitol, isomalt, lactitol, maltitol, mannitol, and xylitol. Please see the [Health Canada webpage Sugar Substitutes](#) for more information on sugar substitutes.

Bakers must be careful when replacing sugar (sucrose) with these sugar substitutes in recipes. Even though the sweetness comparison levels may be similar (or less), it is generally not possible to do straight 1-for-1 substitution. Sugar (sucrose) plays many roles in a recipe:

- It is a bulking agent.
- It absorbs moisture.
- It is a tenderizer.
- It adds moisture and extends shelf life.
- It adds colour (caramelization).

Sugar substitutes may not work in a recipe in the same way.

More [information on sugar substitutes and their relative sweetness](#) can be found online.

24.

Key Takeaways

Key Takeaways

- Sugar comes from a variety of sources. Our primary sugar, sucrose, comes from two sources: sugar cane and sugar beet, but both these sugars are chemically identical.
- As a food item, sugars are classed as carbohydrates, being formed from carbon, oxygen, and hydrogen atoms.
- There are three types of sugar, two of which are most important in their applications for the baker: monosaccharides (simple sugars) and disaccharides (complex sugars).
- Simple sugars comprise glucose (also known as dextrose), levulose, and galactose.
- Complex sugars comprise sucrose (our regular sugar), maltose, and lactose.
- Glucose is the same as dextrose, and fructose is the same as levulose.
- Relative sweetness varies among the different sugar types, from low as in lactose, to high as in levulose.
- Sugar has a wide range of applications in baking.

Fats and Oils

Learning Objectives

- Identify and describe fats and oils used in the food service industry
- Describe the refining and production of fats and oils
- Describe the function of fats and oils in baking

Fats and oils are important in the baking process and to our diet. This section reviews the common terms used with fats and oils and provides basic information on their relevance in baking and food production.

Fats and oils are fundamentally and chemically similar, but oil is liquid, while fat is solid, at room temperature. However, any oil, when sufficiently chilled, will solidify. Conversely, any edible fat will liquefy when sufficiently heated.

The various needs of food manufacturers and dietary changes by consumers have determined the evolution of fat manufacturing. To a large extent, vegetable oils have displaced animal fats in food production.

Note that the fats and oils discussed here are different from essential oils. The oils we discuss in this section are fixed oils. Stain a piece of paper towel with a fixed oil, such as canola or melted lard, and the stain will remain. Stain a piece of paper with an essential oil, such as the oil from a lemon, and it will disappear.

25.

Understanding Fats and Oils

Fats and oils are organic compounds that, like carbohydrates, are composed of the elements carbon (C), hydrogen (H), and oxygen (O), arranged to form molecules. There are many types of fats and oils and a number of terms and concepts associated with them, which are detailed further here.

Lipids

In baking, **lipids** is generally a synonym for fats. Baking books may talk about the “lipid content of eggs,” for example.

Triglycerides

Triglycerides is another chemical name for the most common type of fats found in the body, indicating that they are usually made up of three (tri) fatty acids and one molecule of glycerol (glycerine is another name) as shown in Figure 3. (The mono and diglycerides that are used as emulsifiers have one and two fatty acids respectively.)

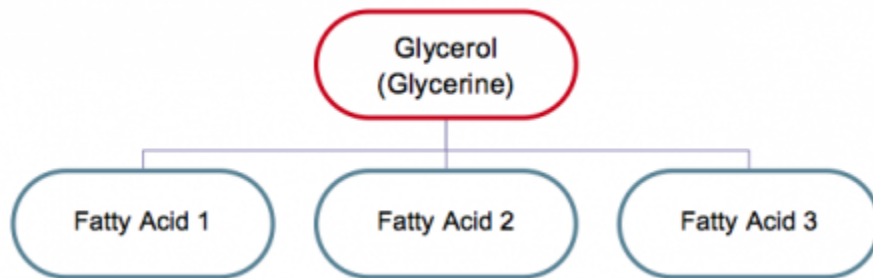


Figure 3. Composition of fats (triglycerides)

Fatty Acids

Each kind of fat or oil has a different combination of fatty acids. The nature of the fatty acid will determine the consistency of the fat or oil. For example, stearic acid is the major fatty acid in beef fat, and linoleic acid is dominant in seed oils. Fatty acids are defined as short, medium, or long chain, depending on the number of atoms in the molecule.

The reason that some fat melts gradually is that as the temperature rises, each fatty acid will, in turn, soften, as its melting point is reached. Fats that melt all of a sudden mean that the fatty acids are of the

same or similar type and have melting points within a narrow range. An example of such a fat is coconut fat: one second it is solid, the next, liquid.

Table 6 shows the characteristics of three fatty acids.

Table 6: Characteristics of Fatty Acids

Type of Fatty Acid	Melting Point	Physical State (at room temperature)
Stearic	69°C (157°F)	Solid
Oleic	16°C (61°F)	Liquid
Linoleic	-12°C (9°F)	Liquid

Rancid

Rancid is a term used to indicate that fat has spoiled. The fat takes on an unpleasant flavour when exposed to air and heat. Unsalted butter, for example, will go rancid quickly if left outside the refrigerator, especially in warm climates.

Oxidation/Antioxidants

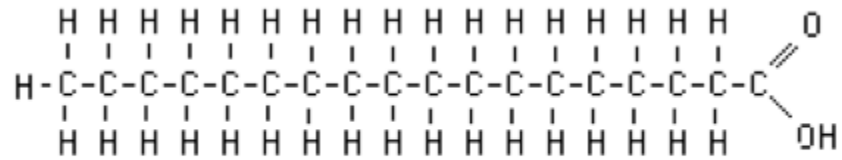
Oxidation (exposure to air) causes rancidity in fats over time. This is made worse by combination with certain metals, such as copper. This is why doughnuts are never fried in copper pans!

Some oils contain natural antioxidants, such as tocopherols (vitamin E is one kind), but these are often destroyed during the processing. As a result, manufacturers add synthetic antioxidants to retard rancidity. BHA and BHT are synthetic antioxidants commonly used by fat manufacturers.

Saturated/Unsaturated

Saturated and *unsaturated* refer to the extent to which the carbon atoms in the molecule of fatty acid are linked or bonded (saturated) to hydrogen atoms. One system of fatty acid classification is based on the number of double bonds.

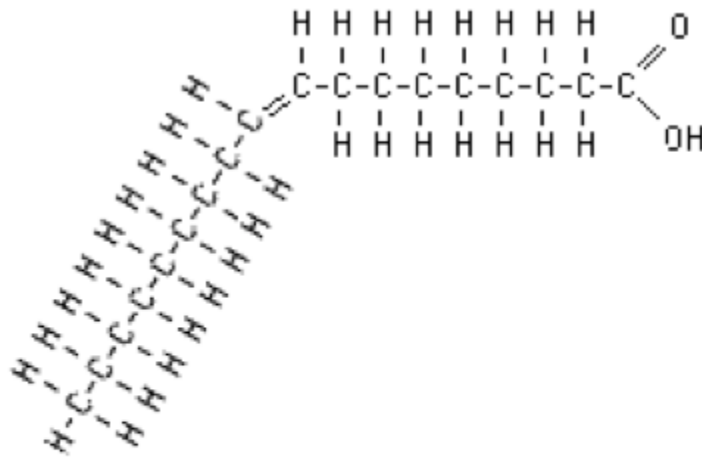
- 0 double bonds: saturated fatty acids. Stearic acid is a typical long-chain saturated fatty acid (Figure 4).



Stearic acid, a saturated fatty acid

Figure 4. Stearic acid. [\[Image Description\]](#)

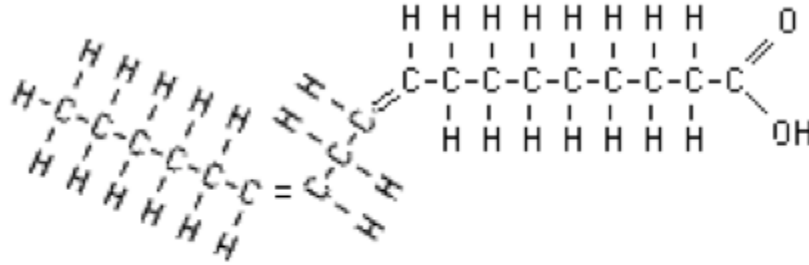
- 1 double bond: monounsaturated fatty acids. Oleic acid is a typical monounsaturated fatty acid (Figure 5).



Oleic acid, a monounsaturated fatty acid.
Note that the double bond is *cis*; this is the common natural configuration.

Figure 5. Oleic acid. [\[Image Description\]](#)

- 2 or more double bonds: polyunsaturated fatty acids. Linoleic acid is a typical polyunsaturated fatty acid (Figure 6).



Linoleic acid, a polyunsaturated fatty acid.
Both double bonds are *cis*.

Figure 6. Linoleic acid. [Image Description]

Saturated fat is a type of fat found in food. For many years, there has been a concern that saturated fats may lead to an increased risk of heart disease; however, there have been studies to the contrary and the literature is far from conclusive. The general assumption is that the less saturated fat the better as far as health is concerned. For the fat manufacturer, however, low saturated fat levels make it difficult to produce oils that will stand up to the high temperatures necessary for processes such as deep-frying. Hydrogenation has been technology's solution. Hydrogenation will be discussed later in the chapter.

Saturated fat is found in many foods:

- Animal foods (like beef, chicken, lamb, pork, and veal)
- Coconut, palm, and palm kernel oils
- Dairy products (like butter, cheese, and whole milk)
- Lard
- Shortening

Unsaturated fat is also in the foods you eat. Replacing saturated and **trans fats** (see below) with unsaturated fats has been shown to help lower **cholesterol** levels and may reduce the risk of heart disease. Unsaturated fat is also a source of omega-3 and omega-6 fatty acids, which are generally referred to as “healthy” fats. Choose foods with unsaturated fat as part of a balanced diet using [Canada's Food Guide](#).

Even though unsaturated fat is a “good fat,” having too much in your diet may lead to having too many **calories**, which can increase your risk of developing obesity, type 2 diabetes, heart disease, and certain types of cancer.

There are two main types of unsaturated fats:

- Monounsaturated fat, which can be found in:
 - Avocados

- Nuts and seeds (like cashews, pecans, almonds, and peanuts)
- Vegetable oils (like canola, olive, peanut, safflower, sesame, and sunflower)
- Polyunsaturated fat, which can be found in:
 - Fatty fish (like herring, mackerel, salmon, trout and smelt)
 - Fish oils
 - Nuts and seeds (like cashews, pecans, almonds and peanuts)
 - Vegetable oils (like canola, corn, flaxseed, soybean and sunflower)

Hydrogenation

Simply put, hydrogenation is a process of adding hydrogen gas to alter the melting point of the oil or fat. The injected hydrogen bonds with the available carbon, which changes liquid oil into solid fat. This is practical, in that it makes fats versatile. Think of the different temperature conditions within a bakery during which fat must be workable; think of the different climatic conditions encountered in bakeries.

Trans Fat

Trans fat is made from a chemical process known as “partial hydrogenation.” This is when liquid oil is made into a solid fat. Like saturated fat, trans fat has been shown to raise LDL or “bad” cholesterol levels, which may in turn increase your risk for heart disease. Unlike saturated fat, trans fat also lowers HDL or “good” cholesterol. A low level of HDL-cholesterol is also a risk factor for heart disease.

Until recently, most of the trans fat found in a typical Canadian diet came from:

- Margarine (especially hard margarine)
- Commercially fried foods
- Bakery products made with shortening, margarine, or oils containing partially hydrogenated oils and fats (including cakes, cookies, crackers, croissants, doughnuts, fried and breaded foods, muffins, pastries, and other snack foods)

The Food and Drug Regulations (FDR) specifically prescribe what information must be displayed on a label. The *trans fat* content of food is one piece of core nutrition information that is required to be declared in a nutrition facts table. More information on a nutrition facts table and labelling details can be found in the open textbook *Nutrition and Labelling for the Canadian Baker*.

Emulsification (Emulsified Shortenings)

Emulsification is the process by which normally unmixable ingredients (such as oil and water) can be combined into a stable substance. Emulsifiers are substances that can aid in this process. There are natural emulsifiers such as lecithin, found in egg yolks. Emulsifiers are generally made up of

monoglycerides and diglycerides and have been added to many hydrogenated fats, improving the fat's ability to:

- Develop a uniformly fine structure
- Absorb a high percentage of sugar
- Hold in suspension a high percentage of liquid

Emulsified shortenings are ideal for cakes and icings, but they are not suitable for deep-frying.

Stability

Stability refers to the ability of a shortening to have an extended shelf life. It refers especially to deep-frying fats, where a smoke point (see below) of 220°C to 230°C (428°F to 446°F) indicates a fat of high stability.

Smoke Point

The smoke point is the temperature reached when fat first starts to smoke. The smoke point will decline over time as the fat breaks down (see below).

Fat Breakdown

The technical term for fat breakdown is hydrolysis, which is the chemical reaction of a substance with water. In this process, fatty acids are separated from their glycerol molecules and accumulate over time in the fat. When their concentration reaches a certain point, the fat takes on an unpleasant taste, and continued use of the fat will yield a nasty flavour. The moisture, which is at the root of this problem, comes from the product being fried. This is why it is a good reason to turn off the fryer or turn it to “standby” between batches of frying foods such as doughnuts. Another cause of fat breakdown is excessive flour on the product or particles breaking off the product.

Image Descriptions

Figure 4 image description: Diagram of the chemical makeup of stearic acid, labelled “Stearic acid, a saturated fatty acid.” A row of 18 carbon atoms are bonded together, with each (except for the rightmost) bonded to one hydrogen atom above and below, and the leftmost carbon atom bonded to a third hydrogen atom, for a total of 35 hydrogen atoms. The rightmost carbon atom is bonded to 1 hydrogen monoxide molecule and double bonded to 1 oxygen molecule. [[Return to Figure 4](#)]

Figure 5 image description: Diagram of the chemical makeup of oleic acid, labelled “Oleic acid, a monounsaturated fatty acid. Note that the double bond is *cis*; this is the common natural configuration.” A row of 9 carbon atoms is double bonded to a row of 9 other carbon atoms. The row on the right is straight, and the double bond tilts down and to the left so that the left-hand group is at an angle. The

first 8 carbon atoms in the left-hand group each have a hydrogen atom bonded to it from the top and the bottom. The first carbon atom has a third hydrogen atom bonded to its left, and the ninth carbon atom has only 1 hydrogen atom bonded to its top. In the right-hand group, the first carbon atom has only 1 hydrogen atom bonded to its top, and the next 7 each have a hydrogen atom bonded to its top and bottom. The ninth carbon atom is bonded to 1 hydrogen monoxide molecule and double bonded to 1 oxygen molecule. [[Return to Figure 5](#)]

Figure 6 image description: Diagram of the chemical makeup of linoleic acid, labelled “Linoleic acid, a polyunsaturated fatty acid. Both double bonds are *cis*.” From left to right, a row of 6 carbon atoms is double bonded to 3 carbon atoms, which in turn are double bonded to a row of 9 carbon atoms. The left-hand row tilts downward to the right; the middle row tilts upward to the right; and the right-hand row is straight. In the left-hand group, the first 5 carbon atoms each have one hydrogen atom bonded to its top and one bonded to its bottom. The first carbon atom is bonded to a third hydrogen atom on its left side. The sixth carbon atom is bonded to only 1 hydrogen atom on its bottom. In the second group, the first carbon atom is bonded to 1 hydrogen atom on the bottom, the second carbon atom has one hydrogen atom on top and on the bottom, and the third carbon atom is bonded to one hydrogen atom on top. In the final group, the first carbon atom is bonded to one hydrogen atom on top. The next 7 carbon atoms each have a hydrogen atom on top and on the bottom. The ninth carbon atom is bonded to 1 hydrogen monoxide molecule and double bonded to 1 oxygen molecule. [[Return to Figure 6](#)]

Media Attributions

- [Stearic Acid](#) © James Baggott
- [Oleic acid](#) © James Baggott
- [Linoleic Acid](#) © James Baggott

26.

Sources of Bakery Fats and Oils

Edible fats and oils are obtained from both animal and vegetable sources. Animal sources include:

- Beef
- Pork
- Sheep
- Fish

In North America, the first two are the prime sources.

Vegetable sources include canola, coconut, corn, cotton, olive, palm fruit and palm kernel, peanut, soya bean, safflower, and sunflower.

Refining of Fats and Oils

The major steps in refining fats and oils are as follows:

- Free fatty acids are neutralized and treated with an alkali.
- Colour is removed.
- The fat is hydrogenated.
- The fat is deodorized.
- The fat is chilled and beaten to make it softer and whiter. This is done by a votator (a machine that cools and kneads liquid margarine).
- Fat is stored to facilitate the correct crystallization (tempering).

27.

Major Fats and Oils Used in Bakeries

Table 7 lists the composition of major fats and oils used in bakeries.

Table 7 Composition of Typical Fats¹

Fat type	Saturated (g/100 g)	Monounsaturated (g/100 g)	Polyunsaturated (g/100 g)	Cholesterol (mg/100 g)	Vitamin E (mg/100 g)
Lard	40.8	43.8	9.6	93	0.60
Duck fat	33.2	49.3	12.9	100	2.70
Butter	54.0	19.8	2.6	230	2.00
Coconut oil	85.2	6.6	1.7	0	.66
Palm kernel oil	81.5	11.4	1.6	0	3.80
Palm oil	45.3	41.6	8.3	0	33.12
Cottonseed oil	25.5	21.3	48.1	0	42.77
Wheat germ oil	18.8	15.9	60.7	0	136.65
Soybean oil	14.5	23.2	56.5	0	16.29
Olive oil	14.0	69.7	11.2	0	5.10
Corn oil	12.7	24.7	57.8	0	17.24
Sunflower oil	11.9	20.2	63.0	0	49.00
Safflower oil	10.2	12.6	72.1	0	40.68
Hemp oil	10	15	75	0	12.34
Canola/ Rapeseed oil	5.3	64.3	24.8	0	22.21

1. Table 7. Composition of typical fats by Wikipedia. © Creative Commons Attribution-ShareAlike 3.0 Unported Licence.

Lard

Lard is obtained from the fatty tissues of pigs, with a water content of 12% to 18%. Due to dietary concerns, lard has gradually lost much of its former popularity. It is still extensively used, however, for:

- Yeast dough additions
- Pie pastry
- Pan greasing

Lard has a good plastic range, which enables it to be worked in a pie dough at fairly low temperatures (try the same thing with butter!). It has a fibrous texture and does not cream well. It is therefore not suitable for cake making. Some grades of lard also have a distinctive flavour, which is another reason it is unsuitable for cake making.

Butter

Butter is made from sweet, neutralized, or ripened creams pasteurized and standardized to a fat content of 30% to 40%. When cream is churned or overwhipped, the fat particles separate from the watery liquid known as buttermilk. The separated fat is washed and kneaded in a water wheel to give it plasticity and consistency. Colour is added during this process to make it look richer, and salt is added to improve its keeping quality.

In Canada, the following regulations apply to butter:

- Minimum 80% milk fat by weight
- Permitted ingredients: milk solids, salt, air or inert gas, permitted food colour, permitted bacterial culture
- The grade and grade name for butter and butter products is Canada 1.

Sweet (or unsalted) butter is made from a cream that has a very low acid content and no salt is added to it. It is used in some baking products like French butter cream, where butter should be the only fat used in the recipe. Keep sweet butter in the refrigerator.

From the standpoint of flavour, butter is the most desirable fat used in baking. Its main drawback is its relatively high cost. It has moderate but satisfactory shortening and creaming qualities. When used in cake mixing, additional time, up to five minutes more, should be allowed in the creaming stage to give maximum volume. Adding an emulsifier (about 2% based on flour weight) will also help in cake success, as butter has a poor plastic range of 18°C to 20°C (64°F to 68°F).

Butter and butter products may also be designated as “whipped” where they have had air or inert gas uniformly incorporated into them as a result of whipping. Whipped butter may contain up to 1% added edible casein or edible caseinates.

Butter and butter products may also be designated as “cultured” where they have been produced from cream to which a permitted bacterial culture has been added.

Margarine

Margarines are made primarily from vegetable oils (to some extent hydrogenated) with a small fraction of milk powder and bacterial culture to give a butter-like flavour. Margarines are very versatile and include:

- General purpose margarine with a low melting point, suitable for blending in dough and general baking
- Cake margarine with excellent creaming qualities
- Roll-in margarine, which is plastic and suitable for Danish pastries
- Puff pastry roll-in, which is the most waxy and has the highest melting point

Margarine may be obtained white, but is generally coloured. Margarine has a fat content ranging from 80% to 85%, with the balance pretty much the same as butter.

In Canada, the following regulations apply to margarine:

- Margarine must contain at least 80% fat and added vitamins A and D. The edible fat/oil may be of vegetable, animal, or marine origin except milk fat, and may have been hydrogenated, fractionated, or modified.
- Margarine must be intended for substantially the same uses as butter. (This specification is intended to be used by food services in procurement of food. It does not apply to special margarines, such as calorie-reduced, baker’s, or whipped margarine.)

Oil content claims on margarine

The claim that margarine contains a certain percentage of a specific oil in advertisements should always be based on the percentage of oil by weight of the total product. All the oils used in making the margarine should be named. For example, if a margarine is made from a mixture of corn oil, cottonseed oil, and soybean oil, it would be considered misleading to refer only to the corn oil content in an advertisement for the margarine. On the other hand, the mixture of oils could be correctly referred to as vegetable oils.

It used to be that you could only buy margarines in solid form full of saturated and trans fat. The majority of today’s margarines come in tubs, are soft and spreadable, and are non-hydrogenated, which means they have low levels of saturated and trans fat. Great care must be taken when attempting to substitute spreadable margarine for solid margarine in recipes.

Shortenings

Since the invention of hydrogenated vegetable oil in the early 20th century, *shortening* has come almost

exclusively to mean hydrogenated vegetable oil. Vegetable shortening shares many properties with lard: both are semi-solid fats with a higher smoke point than butter and margarine. They contain less water and are thus less prone to splattering, making them safer for frying. Lard and shortening have a higher fat content (close to 100%) compared to about 80% for butter and margarine. Cake margarines and shortenings tend to contain a bit higher percentage of monoglycerides than margarines. Such “high-ratio shortenings” blend better with hydrophilic (attracts water) ingredients such as starches and sugar.

Health concerns and reformulation

Early in this century, vegetable shortening became the subject of some health concerns due to its traditional formulation from partially hydrogenated vegetable oils that contain trans fats. The apparent link between trans fats and adverse health effects has raised alarm bells. Consequently, a low trans-fat variant of Crisco brand shortening was introduced in 2004. In January 2007, all Crisco products were reformulated to contain less than one gram of trans fat per serving, and the separately marketed trans-fat free version introduced in 2004 was consequently discontinued. Since 2006, many other brands of shortening have also been reformulated to remove trans fats. Non-hydrogenated vegetable shortening can be made from palm oil.

Hydrogenated vegetable shortenings

Hydrogenated shortenings are the biggest group of fats used in the commercial baking industry. They feature the following characteristics:

- They are made from much the same oils as margarine.
- They are versatile fats with good creaming ability.
- Their hydrogenation differs according to the specific use for which the fat is designed.
- They are 100% fat – no water.
- They keep well for six to nine months.

Variations on these shortenings are: emulsified vegetable shortenings, roll-in pastry shortenings, and deep-frying fats.

Emulsified vegetable shortenings

Emulsified vegetable shortenings are also termed *high-ratio fats*. The added emulsifiers (mono- and diglycerides) increase fat dispersion and give added fineness to the baked product. They are ideal for high-ratio cakes, where relatively large amounts of sugar and liquid are incorporated. The result is a cake:

- Fine in texture
- Light in weight and of excellent volume
- Superior in moisture retention (good shelf life)
- Tender to eat

This is also the fat of choice for many white cake icings.

Roll-in pastry shortenings

This type of shortening is also called special pastry shortening (SPS). These fats have a semi-waxy consistency and offer:

- Large plastic range
- Excellent extensibility
- Excellent lifting ability

They are primarily used in puff pastry and Danish pastry products where lamination is required. They come in various specialized forms, with varying qualities and melting points. It is all a matter of compromise between cost, palatability, and leavening power. A roll-in that does not have “palate cling” may have a melting point too low to guarantee maximum lift in a puff pastry product.

Deep-Frying Fats

Deep-frying fats are special hydrogenated fats that have the following features:

- High smoke point of up to 250°C (480°F)
- High heat stability and resistance to fat breakdown
- No undesirable flavour on finished products
- No greasiness when cold

These fats contain an anti-foaming agent.

Vegetable Oils

Vegetable oil is an acceptable common name for an oil that contains more than one type of vegetable oil. Generally, when such a vegetable oil blend is used as an ingredient in another food, it may be listed in the ingredients as “vegetable oil.”

There are two exceptions: if the vegetable oils are ingredients of a cooking oil, salad oil, or table oil, the oils must be specifically named in the ingredient list (e.g., canola oil, corn oil, safflower oil), and using the general term *vegetable oil* is not acceptable. As well, if any of the oils are coconut oil, palm oil, palm kernel oil, peanut oil, or cocoa butter, the oils must be specifically named in the ingredient list.

When two or more vegetable oils are present and one or more of them has been modified or hydrogenated, the common name on the principal display panel and in the list of ingredients must include the word “modified” or “hydrogenated,” as appropriate (e.g., modified vegetable oil, hydrogenated vegetable oil, modified palm kernel oil).

Vegetable oils are used in:

- Chemically leavened batters (e.g., muffin mixes)
- Dough additives (to replace the fat)
- Short sponges (to replace the butter or fat)

Coconut Fat

Coconut fat is often used to stabilize butter creams as it has a very small plastic range. It has a quite low melting point and its hardness is due to other factors. It can be modified to melt at different temperatures, generally between 32°C and 36°C (90°F and 96°F).

The Importance of Melting Points

As mentioned above, all fats become oils and vice versa, depending on temperature. Physically, fats consist of minute solid fat particles enclosing a microscopic liquid oil fraction. The consistency of fat is very important to the baker. It is very difficult to work with butter (relatively low melting point) in hot weather, for example. At the other extreme, fats with a very high melting point are not very palatable, since they tend to stick to the palate. Fat manufacturers have therefore attempted to customize fats to accommodate the various needs of the baker.

Fats with a melting range between 40°C and 44°C (104°F and 112°F) are considered to be a good compromise between convenience in handling and palatability. New techniques allow fats with quite high melting points without unpleasant palate-cling.

Table 8 shows the melting points of some fats.

Table 8 Melting Points of Typical Fats

Type of Fat	Melting Point
Coconut fat	32.5°C–34.5°C (90.5°F–4.1°F)
Regular margarine	34°C (93°F)
Butter	38°C (100°F)
Regular shortenings	44°C–47°C (111°F–116°F)
Roll-in shortenings	40°C–50°C (104°F–122°F)
Roll-in margarine	44°C–54°C (111°F–130°F)

Blending

It is probably safe to say that most fats are combinations or blends of different oils and/or fats.

They may be all vegetable sources. They may be combined vegetable and animal sources. A typical ratio is 90% vegetable source to 10% animal (this is **not** a hard and fast rule). Formerly, blends of vegetable and animal oils and fats were termed *compound fats*. Nowadays, this term, if used at all, may refer also to combinations of purely vegetable origin.

28.

Functions of Fat in Baking

The following summarize the various functions of fat in baking.

Tenderizing Agents

Used in sufficient quantity, fats tend to “shorten” the gluten strands in flour; hence their name: shortenings. Traditionally, the best example of such fat was lard.

Creaming Ability

This refers to the extent to which fat, when beaten with a paddle, will build up a structure of air pockets. This aeration, or creaming ability, is especially important for cake baking; the better the creaming ability, the lighter the cake.

Plastic Range

Plastic range relates to the temperature at which the fatty acid component melts and over which shortening will stay workable and will “stretch” without either cracking (too cold) or softening (too warm). A fat that stays “plastic” over a temperature range of 4°C to 32°C (39°F to 90°F) would be rated as excellent. A dough made with such a fat could be taken from the walk-in cooler to the bench in a hot bakeshop and handled interchangeably. Butter, on the other hand, does not have a good plastic range; it is almost too hard to work at 10°C (50°F) and too soft at 27°C (80°F).

Lubrication

In dough making, the fat portion makes it easier for the gluten network to expand. The dough is also easier to mix and to handle. This characteristic is known as *lubrication*.

Moistening Ability

Whether in dough or in a cake batter, fat retards drying out. For this purpose, a 100% fat shortening will be superior to either butter or margarine.

Nutrition

As one of the three major food categories, fats provide a very concentrated source of energy. They contain many of the fatty acids essential for health.

29.

Key Takeaways

Key Takeaways

- Fats and oils are manufactured and selected by the baker on the basis of certain functions or special characteristics.
- Fats and oils used in baking are made from animal and vegetable sources, with the trend toward vegetable sources.
- Fats and oils form one of the three major food groups and are concentrated energy sources.
- The major categories of fat used by the baker are:
 - Butter
 - Margarine
 - Regular shortenings
 - Hydrogenated shortenings
- The functions of fat in baking are:
 - Shortening
 - Lubrication
 - Lamination
 - Creaming
 - Moistening
 - Deep-frying

IV

Leavening Agents

Learning Objectives

- Identify and describe leavening agents used in the food service industry
- Describe the production of leavening agents
- Describe the function of leavening agents in baking

The word *leavening* in the baking trade is used to describe the source of gas that makes a dough or batter expand in the presence of moisture and heat. Leavening agents are available in different forms, from yeast (the organic leavener) to chemical, mechanical, and physical leaveners. Bakers choose the appropriate type of leavening based on the product they are making.

30.

Yeast

Yeast is a microscopic unicellular fungus that multiplies by budding, and under suitable conditions, causes fermentation. Cultivated yeast is widely used in the baking and distilling industries. History tells us that the early Chaldeans, Egyptians, Greeks, and Romans made leavened bread from fermented doughs. This kind of fermentation, however, was not always reliable and easy to control. It was Louis Pasteur, a French scientist who lived in the 19th century, who laid the foundation for the modern commercial production of yeast as we know it today through his research and discoveries regarding the cause and prevention of disease.

Types of Yeast

There are several types of yeast.

Wild Yeast

Wild yeast spores are found floating on dust particles in the air, in flour, on the outside of fruits, etc. Wild yeasts form spores faster than cultivated yeasts, but they are inconsistent and are not satisfactory for controlled fermentation purposes.

Compressed Yeast

Compressed yeast is made by cultivating a select variety, which is known by experiment to produce a yeast that is hardy, consistent, and produces a fermentation with strong enzymatic action. These plants are carefully isolated in a sterile environment free of any other type of yeast and cultivated on a plate containing nutrient agar or gelatin. Wort, a combination of sterilized and purified molasses or malt, nitrogenous matter, and mineral salts is used to supply the food that the growing yeast plants need to make up the bulk of compressed yeast.

After growing to maturity in the fermentation tank, the yeast is separated from the used food or wort by means of centrifugal machines. The yeast is then cooled, filtered, pressed, cut, wrapped, and refrigerated. It is marketed in 454 g (1 lb.) blocks, or in large 20 kg (45 lb.) bags for wholesale bakeries.

Figure 7 illustrates the process of cultivating compressed yeast, and Table 9 summarizes its composition.

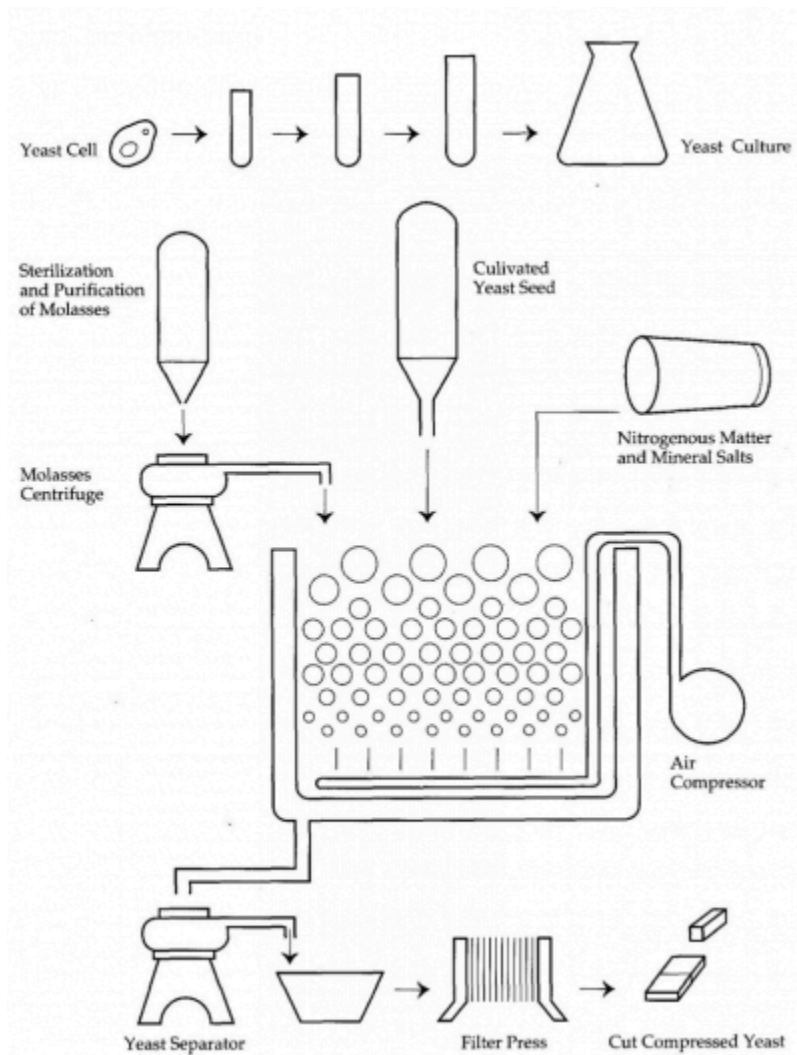


Figure 7. Production of compressed yeast. *[Image Description]*

Table 9 Average Composition of Fresh (Compressed) Yeast

Component	Percentage
Water	68% to 73%
Protein	12% to 14%
Fat	0.6% to 0.8%
Carbohydrate	9% to 11%
Mineral Matter	1.7% to 2%

Active Dry Yeast

Active dry yeast is made from a different strain than compressed yeast. The manufacturing process is the same except that the cultivated yeast is mixed with starch or other absorbents and dehydrated. Its

production began after World War II, and it was used mainly by the armed forces, homemakers, and in areas where fresh yeast was not readily available.

Even though it is a dry product, it is alive and should be refrigerated below 7°C (45°F) in a closed container for best results. It has a moisture content of about 7%. Storage without refrigeration is satisfactory only for a limited period of time. If no refrigeration is available, the yeast should be kept unopened in a cool, dry place. It should be allowed to warm up to room temperature slowly before being used.

Dry yeast must be hydrated for about 15 minutes in water at least four times its weight at a temperature between 42°C and 44°C (108°F and 112°F). The temperature should never be lower than 30°C (86°F), and dry yeast should never be used before it is completely dissolved.

It takes about 550 g (20 oz.) of dry yeast to replace 1 kg (2.2 lb.) of compressed yeast, and for each kilogram of dry yeast used, an additional kilogram of water should be added to the mix. This product is hardly, if ever, used by bakers, having been superseded by instant yeast (see below).

Instant Dry Yeast

Unlike instant active dry yeast that must be dissolved in warm water for proper rehydration and activation, instant dry yeast can be added to the dough directly, either by:

- Mixing it with the flour before the water is added
- Adding it after all the ingredients have been mixed for one minute

This yeast can be reconstituted. Some manufacturers call for adding it to five times its weight of water at a temperature of 32°C to 38°C (90°F to 100°F). Most formulas suggest a 1:3 ratio when replacing compressed yeast with instant dry. Others vary slightly, with some having a 1:4 ratio. In rich Danish dough, it takes about 400 g (14 oz.), and in bread dough about 250 g to 300 g (9 oz. to 11 oz.) of instant dry yeast to replace 1 kg (2.2 lb.) of compressed yeast. As well, a little extra water is needed to make up for the moisture in compressed yeast. Precise instructions are included with the package; basically, it amounts to the difference between the weight of compressed yeast that would have been used and the amount of dry yeast used.

Instant dry yeast has a moisture content of about 5% and is packed in vacuum pouches. It has a shelf life of about one year at room temperature without any noticeable change in its gassing activity. After the seal is broken, the content turns into a granular powder, which should be refrigerated and used by its best-before date, as noted on the packaging.

Instant dry yeast is especially useful in areas where compressed yeast is not available. However, in any situation, it is practical to use and has the advantages of taking up less space and having a longer shelf life than compressed yeast.

Cream Yeast

Creamy yeast is a soft slurry-type yeast that is used only in large commercial bakeries and is pumped into the dough.

Yeast Food

Yeast food is used in bread production to condition the dough and speed up the fermentation process. It consists of a blend of mineral salts such as calcium salt or ammonium salt and potassium iodate. It has a tightening effect on the gluten and is especially beneficial in dough where soft water is used. The addition of yeast food improves the general appearance and tasting quality of bread. The retail baker does not use it much.

Image Descriptions

Figure 7 long description: Diagram of the production of compressed yeast. To cultivate compressed yeast, you first start with a yeast cell. That cell grows and is transferred from test tube to test tube until it becomes a yeast culture, which is depicted in an Erlenmeyer flask. Then, the cultivated yeast seed goes into an air compressor, along with nitrogenous matter and mineral salts, as well as molasses, which has first been sterilized, purified, and put through a centrifuge. The air compressor looks like a boxy machine with different-sized circles representing air bubbles and what looks like a long tube ending in a circle leading out of the main vat. The mixture passes through the air compressor, then goes into a yeast separator, which is a machine that stands on two legs and has a round vat with a spout coming out of it. What comes out of the spout and into a bowl goes through a filter press, which has two angled shapes at each end and thin lines in the middle, almost like an accordion. The filter press produces cut compressed yeast, which is depicted as rectangular prisms that look like chocolate bars. [\[Return to Figure 7\]](#)

Media Attributions

- Production of Compressed Yeast © Baking Association of Canada

31.

Yeast in Baking

The Functions of Yeast

Yeast has two primary functions in fermentation:

- To convert sugar into carbon dioxide gas, which lifts and aerates the dough
- To mellow and condition the gluten of the dough so that it will absorb the increasing gases evenly and hold them at the same time

In baked products, yeast increases the volume and improves the flavour, texture, grain, colour, and eating quality. When yeast, water, and flour are mixed together under the right conditions, all the food required for fermentation is present as there is enough soluble protein to build new cells and enough sugar to feed them.

Activity within the yeast cells starts when enzymes in the yeast change complex sugar into invert sugar. The invert sugar is, in turn, absorbed within the yeast cell and converted into carbon dioxide gas and alcohol. Other enzymes in the yeast and flour convert soluble starch into malt sugar, which is converted again by other enzymes into fermentable sugar so that aeration goes on from this continuous production of carbon dioxide.

Proper Handling of Yeast

Compressed yeast ages and weakens gradually even when stored in the refrigerator. Fresh yeast feels moist and firm, and breaks evenly without crumbling. It has a fruity, fresh smell, which changes to a sticky mass with a cheesy odour. It is not always easy to recognize whether or not yeast has lost enough of its strength to affect the fermentation and the eventual outcome of the baked bread, but its working quality definitely depends on the storage conditions, temperature, humidity, and age.

The optimum storage temperature for yeast is -1°C (30°F). At this temperature it is still completely effective for up to two months. Yeast does not freeze at this temperature.

Other guidelines for storing yeast include:

- Rotating it properly and using the older stock first
- Avoiding overheating by spacing it on the shelves in the refrigerator

Yeast needs to breathe, since it is a living fungus. The process is continuous, proceeding slowly in the

refrigerator and rapidly at the higher temperature in the shop. When respiration occurs without food, the yeast cells starve, weaken, and gradually die.

Yeast that has been frozen and thawed does not keep and should be used immediately. Freezing temperatures weaken yeast, and thawed yeast cannot be refrozen successfully.

32.

Using Yeast

Many bakers add compressed yeast directly to their dough. A more traditional way to use yeast is to dissolve it in lukewarm water before adding it to the dough. The water should never be higher than 50°C (122°F) because heat destroys yeast cells. In general, salt should not come into direct contact with yeast, as salt dehydrates the yeast. (Table 10 indicates the reaction of yeast at various temperatures.)

It is best to add the dissolved yeast to the flour when the dough is ready for mixing. In this way, the flour is used as a buffer. (Buffers are ingredients that separate or insulate ingredients, which if in too close contact, might start to react prematurely.) In sponges where little or no salt is used, yeast buds quickly and fermentation of the sponge is rapid.

Table 10 How Yeast Reacts at Different Temperatures

Temperature	Reaction
15°C–20°C (60°F–68°F)	slow reaction
26°C–29°C (80°F–85°F)	normal reaction
32°C–38°C (90°F–100°F)	fast reaction
59°C (138°F)	terminal death point

Never leave compressed yeast out for more than a few minutes. Remove only the amount needed from the refrigerator. Yeast lying around on workbenches at room temperature quickly deteriorates and gives poor results. One solution used by some bakeries to eliminate trips to the fridge is to have a small portable cooler in which to keep the yeast on the bench until it is needed. Yeast must be kept wrapped at all times because if it is exposed to air the edges and the corners will turn brown. This condition is known as air-burn.

33.

Enzymes

Enzymes are not ingredients as such, but they are present in other ingredients, chief among them are flour and yeast. Understanding how enzymes work is very helpful in understanding fermentation.

Enzymes are as unique as fingerprints. They can be defined as minute substances produced by living organisms that bring about or speed up certain chemical changes. For example, enzymes act in the human digestive tract to break down food.

The action of enzymes is specific, and each class of enzymes has only one particular chemical **conversion** that it will bring about. For example, one kind of enzyme converts sugar into carbon dioxide and alcohol, and this is the only direct function it can perform.

A clue to recognizing enzymes is by the ending of their names, which usually is *ase* as in *maltase*. The sugar that maltase works on ends in *ose* as in *maltose*. There are a few exceptions; for example, papain, present in papaya and used as a tenderizer, is also an enzyme.

Sometimes the terms are confusing. For example, the two enzymes amylase and diastase work in such a similar way that they can be thought of as the same for the purposes of baking. Both these enzymes work on starch. Sometimes books refer to *amylolytic activity*, to refer to the work done by amylase, and sometimes they refer to *diastatic activity* to refer to the work done by the diastase. For convenience, in this book we use the term *diastatic* as much as possible.

Enzymes Present in Flour

Enzymes present in flour are diastase/amylase and protease.

Diastase/Amylase

Under the right conditions, diastase will break up some starch, liquefy it, and convert it into malt sugar. This provides food for the yeast and sugars that help to brown the loaf later on in baking. It is a very important function in lean dough where little or no sugar has been added. Diastase or amylase is destroyed at 77°C (170°F) during baking, at which point the dough stops expanding.

At the flour mill, one of the laboratory tasks is to determine if the grain has the correct balance of enzymes. Either too few or too many can affect the handling and fermentation of dough. One problem when too many enzymes are present is evident in rye flour, where the integrity of the starch is especially important.

The amount of diastase in grain varies from year to year, depending on harvest conditions. In a damp harvest season, the grain may start to sprout, which is a signal for enzymes to become active. The starch from such grain is said to be damaged, which is not a completely bad thing, as a certain amount of damaged starch is desirable to provide yeast food. The miller adjusts this level, if necessary, by adding amylase, and blending flours.

Protease

Protease is found in flour, but also in malt and yeast. Protease converts a portion of protein that cannot be dissolved in water into another form, which will dissolve in water. In this condition, the protein can be used by yeast as food. The protein makes the gluten more extensible by softening it, and produces amino acids (see Figure 8).

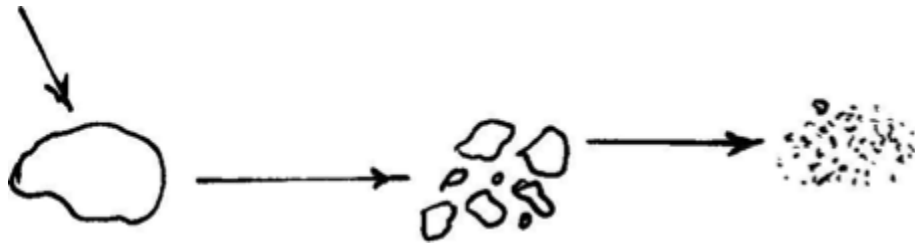


Figure 8. Proteolytic breakdown.

Protease starts to work immediately after the dough is mixed. It is instrumental in imparting good flavour and digestibility to the baked bread.

Enzymes Present in Yeast

The two principal enzymes present in yeast are maltase and invertase. In addition, there are several other minor enzymes in yeast, each of which contributes in some way to the total changes brought about by yeast activity in the dough. Some of these changes assist in imparting flavour and digestibility to the finished bread.

Maltase

Maltase changes malt sugar (also known as maltose) into simple sugar.

Invertase

Invertase converts cane sugar into simple sugar. This enzyme only has work to do if granulated cane sugar has been added to the dough. It does not break down maltose, for example.

Zymase

Zymase works on simple sugar that has been produced by the action of invertase and maltase. Zymase

changes the simple sugar into alcohol and carbon dioxide gas, which causes dough to rise and expand (see Figure 9).

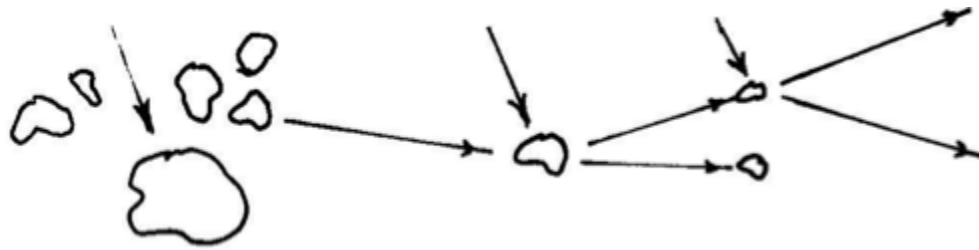


Figure 9. Diastatic activity.

In summary, enzymes work in fermented dough to effect starch reduction and sugar production. This enables the yeast to thrive and produce carbon dioxide, which leavens the bread. Each enzyme has a particular job to do. The enzyme level is checked at the mill laboratory, and flour delivered to the baker is generally perfectly balanced with the correct level for reliable fermentation.

Media Attributions

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- Diastatic Activity © Baking Association of Canada. Image used with permission.

34.

Baking Powder

Baking powder is a dependable, high-quality chemical leavener. To be effective, all baking powders rely on the reaction between one or more acids on sodium bicarbonate to produce carbon dioxide gas. Just as with yeast leavening, the presence of carbon dioxide gas creates air bubbles that cause the product to rise.

There are two main types of baking powders available on the market:

- Continuous or single-action baking powder
- Double- or multiple-action baking powder

The difference between continuous- and double-action baking powders is simply the rate of reaction:

- Continuous-action baking powder uses one acid, which continuously reacts with the soda to release gas steadily throughout the baking process until all the gassing power is spent.
- Double-action baking powder contains two different acids, which react with soda at different stages of the baking process. One acid reacts to give off a small amount of gas at low temperature, and the other major acid reacts at baking temperatures to give off the bulk of the gas.

The Leavening Mechanism of Baking Powder

Before baking, approximately 15% of the CO₂ gas is released in the cold stage. Eighty-five percent of the CO₂ gas is released in the oven starting at approximately 40°C (105°F). Some leavening power is apparently lost in the cold stage, but there is usually still adequate gassing power in the remaining portion.

When the baking powder is activated through moisture and heat, the gas works its way into the many cells created by the mixing or creaming of the batter and starts to expand them. This process comes to a halt when the starch gelatinizes and the cells become rigid. This starts at about 60°C (140°F) and is more or less complete at around 75°C (167°F). After this point, some gas may still be created, but it simply escapes through the porous structure of the product.

Using Baking Powder

For even distribution throughout the batter, baking powder should be sifted with the flour or other dry ingredients. For most cakes, about 5% baking powder to the weight of the flour produces an optimum

result. Accurate scaling is important, since a little too much may cause the product to collapse. (Note this is unlike yeast, where an “overdose” will usually simply cause a more rapid rise.)

35.

Sodium Bicarbonate

When sodium bicarbonate (baking soda) is moistened and heated, it releases carbon dioxide gas. If it is moistened and heated in the presence of sufficient acid, it will release twice as much gas as if it is moistened and heated without the presence of an acid.

Slightly acidic ingredients provide the mix with some of the necessary acids for the release of carbon dioxide gas. Examples are:

- Honey
- Molasses
- Ginger
- Cocoa
- Bran

For this reason, some of the mixes contain baking powder only while others contain a combination of baking powder and baking soda. If an excessive amount of baking soda is used in a cake batter without the presence of sufficient acid, the normally white cake crumb will have a yellowish-brown colour and a strong undesirable smell of soda.

The gas evolves very fast at the beginning of baking when the **pH** level is still on the acidic side (pH of around 5 to 6). Once the soda neutralizes the acid, the dough or batter quickly becomes **alkaline** and the release of gas is reduced. Mixes and doughs leavened with baking soda must be handled without delay, or the release of the gas may be almost exhausted before the product reaches the oven.

The darker colour of the crumb found on the bottom half of a cake or muffins is caused by the partial dehydration of the batter that is heated first during baking. In spiced honey cookies and gingerbread, baking soda is used alone to give them quick colour during baking and yet keep the products soft.

In chocolate cakes, baking soda is used in conjunction with baking powder to keep the pH at a desirable level. However, it is important to know whether the cocoa powder you are using is natural or treated by the Dutch process. In the Dutch process, some of the acid in the cocoa is already neutralized, and there is less left for the release of gas in the mix. This means more baking powder and less baking soda is used.

Baking soda in a chocolate mix not only counteracts the acid content in the baked cake but also improves the grain and colour of the cake. A darker and richer chocolate colour is produced if the acid level is sufficient to release all the carbon dioxide gas. On the other hand, the reddish, coarse, open-grained crumb in devil's food cake is the result of using baking soda as the principal leavening agent.

The level of baking soda depends on the nature of the product and on the other ingredients in the formula. Cookies, for example, with high levels of fat and sugar, do not require much, if any, leavening.

Table 11 provides the recommended amounts of baking soda for different products. Note that the percentages appear small compared to the 5% level of baking powder suggested because baking powder contains both an acid agent and a leavening agent.

Table 11 Recommended Amounts of Baking Soda

Product	Amount of Baking Soda (% of flour weight)
Cookies	0.4–0.6
Cakes	0.5–1.0
Cake doughnuts	0.7–1.0
Pancakes	1.4–2.0

36.

Cream of Tartar

Cream of tartar is a white crystalline compound that exists in grapes, tamarinds, and other fruits. It is prepared from the sediments in wine barrels and is called *argol*. The argol is dissolved in hot water, and the colouring matter is removed by means of clay or egg albumin. After being purified by crystallization, it is ready for the market.

Cream of tartar has no leavening capacity by itself, but can be used in combination with sodium bicarbonate to provide the acid necessary for leavening. It was formerly used for making baking powder but that practice has been largely discontinued because of cost and its too quick reaction time. In some recipes, it is used alone. Cream of tartar is also an excellent stabilizer for egg whites.

Further refining of cream of tartar will isolate the principal active ingredient, tartaric acid, which is clear and odourless. It is soluble in water and has a rapid reaction in a batter when mixed with baking soda. It is also used to make soft cheeses such as mascarpone.

37.

Ammonium Bicarbonate

Ammonium bicarbonate is a white crystalline powder used in flat, spiced cookies, such as gingerbreads, and in eclair paste. It must be dissolved in the cold liquid portion of the batter. At room temperature, decomposition of CO_2 in the batter is minimal. When heated to approximately 60°C (140°F) decomposition is more noticeable, and at oven temperature, decomposition takes place in a very short time. Ammonium bicarbonate should only be used in low moisture-containing products that are not dense. Providing that these conditions are met, there will be no taste and odour remaining from the ammonium.

38.

Handling Chemically Leavened Products

Mixes containing chemical leaveners can either be refrigerated or frozen as long as the temperature is below 5°C (41°F). Although some carbon dioxide is released during the first stages of refrigeration, moderately good results are obtained from mixes that have been refrigerated for a long period of time. Frozen mixes should be allowed to thaw slowly in the refrigerator before being used. To avoid moisture loss, the mix must be covered during refrigeration.

39.

Key Takeaways

Key Takeaways

- Yeast is a living organism indispensable to bakers. It is the agent responsible for leavening most breads. It is made under carefully controlled factory conditions, using just one of many strains of yeast. It is available in two basic forms:
 - Compressed or “fresh” yeast, with a moisture content of about 70% and a shelf life of a few weeks
 - Instant active dry yeast, vacuum packed with a moisture content of about 4% and a shelf life of up to a year if unopened. Once opened, it is good for several weeks if properly handled.
- The conversion ratios for the many brands of dry yeast are shown on the packages. They are about 1:3, dry to compressed.
- The functions of yeast are twofold:
 - To create carbon dioxide to make the bread rise
 - To mellow or improve the gluten
- When handling yeast, avoid warm temperatures. Don’t combine yeast with salt. Keep yeast in a cool place, near the freezing temperature. Keep it well wrapped, but allow space for breathing.
- Chemical leaveners include baking powder, baking soda, cream of tartar, and ammonium bicarbonate

V

Eggs

Learning Objectives

- Identify and describe eggs and egg products used in the food service industry
- Describe the grading of eggs and egg products
- Describe the function of eggs and egg products in baking

Eggs are among the most important and most expensive ingredients used by the baker. They can account for up to 50% of the total cost of ingredients used in some recipes. Proper purchase, storage, handling, and use of eggs are factors that must be thoroughly understood to ensure high-quality products.

40.

Grading

Fresh hen eggs are sold by grade in all provinces. All shell eggs that are imported, exported, or shipped from one province to another for commercial sale must be graded. In Canada, it is mandatory to have all eggs graded by the standards set by Agriculture and Agri-Foods Canada (AAFC). The grade name appears on cartons. The grades Canada A and Canada B bear the maple leaf symbol with the grade name inside, and Canada C and Nest Run eggs will have the grade name printed in block text. The grades indicate the quality of the egg and should not be confused with size. Only Canada A are available in different sizes. The average large size egg weighs about 56 g (2 oz.) as indicated in Table 12.

Table 12 Canada Grade A egg sizes

Size	Weight (including shell)
Peewee	Less than 42 g (1.5 oz.)
Small	At least 42 g (1.5 oz.)
Medium	At least 49 g (1.75 oz.)
Large	At least 56 g (2 oz.)
Extra Large	At least 63 g (2.25 oz.)
Jumbo	70 g (2.5 oz.) or more

The Canada grade symbol does not guarantee that the eggs are of Canadian origin, but it does guarantee that the products meet Canadian government standards. Agriculture Canada inspects all egg-processing plants to ensure that the products are wholesome and processed according to sanitary standards. The pasteurization of “packaged” egg product is also monitored.

The criteria for grading eggs are:

- Weight
- Cleanliness
- Soundness and shape of shell
- Shape and relative position of yolk within the egg
- Size of air cell free of abnormalities
- Freedom from dissolved yolk and blood spots

Canada A

Canada A eggs are clean, normal in shape with sound shells, and have the finest interior quality. They are ideal for all uses. The yolks are round and compact and surrounded by very thick, firm albumen. Canada A eggs are a premium quality and in limited supply on the retail market. If eggs are not sold within a limited time, unsold stocks are returned to the supplier. Eggs graded as A must meet the minimum weight for the declared size (see Table 12.) The size designation for Canada A eggs must appear on the label.

Canada B

Canada B eggs have very slight abnormalities. This grade is fine for baking, where appearance is not important. These eggs must weigh at least 49 g (1.75 oz.). There are no size designations on the label for Canada B eggs.

Canada C

Canada C is considered a processing grade and provides a safe outlet for the disposition of cracked eggs. Canada C eggs must be shipped to a federally registered processed egg station and pasteurized as a means of controlling the higher risk of salmonella or other microbial contamination that may be found in cracked eggs.

These eggs are suitable for processing into commercially frozen, liquid, and dried egg products. Sizes are not specified.

Canada Nest Run

Since Canada Nest Run eggs are generally sent for further processing, they are usually not washed, candled (a process discussed later in this chapter), or sized. However, nest run eggs must meet the minimum quality requirements prescribed by the Egg Regulations. This grade, as with other Canada grades, can only be applied to eggs in a federally registered egg station.

41.

Composition and Nutrition

The three main components of eggs are the shell, the white, and the yolk. The average whole large egg, weighing 56 g (2 oz.) is composed of 12% shell, 58% white, and 30% yolk by weight. Protein is found in both the white and the yolk, but almost all of the fat is found in the yolk (see Figure 10 and Tables 13 and 14).

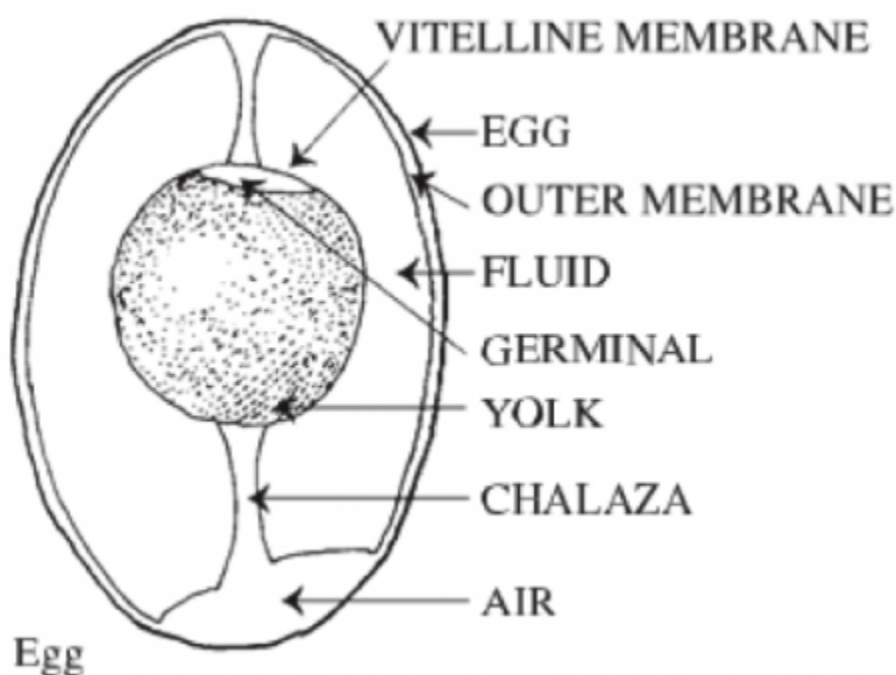


Figure 10. Composition of an egg. *[Image Description]*

Table 13 Composition of Eggs by Percent of Weight

Component	Whole Egg	Yolk	White
Moisture	73.0	49.0	86.0
Protein	13.3	16.7	11.6
Lipid	11.5	31.6	0.2

Note that traces of sugar and ash are also present in an egg.

Table 14 Nutritional Content of a Large Egg

Element	Whole Egg	Yolk	White
Weight	50 g	17 g	33 g
Protein	6 g	3 g	3 g
Fat	5 g	5 g	Trace
Cholesterol	216 mg	216 mg	0
Calcium	25 mg	2 mg	27 mg
Iron	1.0 mg	0.6 mg	Trace
Sodium	63 mg	7 mg	54 mg
Potassium	60 mg	16 mg	47 mg
Vitamin A	96 RE	99 RE	0 RE

Note: B-complex vitamins, not itemized, are well represented in eggs, as are amino acids. “RE” stands for retinol equivalent, a term used in nutritional measurement.

Worth noting is the concentration of certain food elements in different parts of the egg. Note for example that all the cholesterol is in the yolk. The yolk is relatively rich in iron and the white is high in calcium.

In practice, when separating large eggs, one estimates the weight of the white as 30 g (1 oz) and the yolk as 20 g (0.7 oz). The colour of the shell, which is either a creamy white or brown, is relevant to the breed of the hen, and there is no other basic difference in the content of the egg or the shell.

The colour of the yolk depends on the diet of the hens. Bakers have a preference for eggs with dark yolks. Certainly the appearance of cakes made with such eggs is richer. Tests have found that, although eggs with darker yolks tend to produce moister sponge cakes, the cakes are somewhat coarser and less tender.

Image Descriptions

Figure 10 image description: Diagram demonstrates the components of an egg. First there is the outer shell (labelled “egg”), followed by the outer membrane, then fluid. The round yolk is at the centre of the egg. Beneath it is a strip called the chalaza, which leads to an air sac near the shell. At the top of the yolk is the germinal, and around the whole yolk is the vitelline membrane. [\[Return to Figure 10\]](#)

42.

Egg Products

A number of egg products besides whole shell eggs are used in the baking and food service industry. By law, all egg products other than shell eggs are pasteurized to protect them against salmonella, and the low temperature at which they are kept inhibits bacterial activity, although under certain conditions they may spoil very rapidly.

The chief categories of egg products available are:

- Liquid eggs (whole eggs and whole eggs with additional yolks)
- Frozen eggs (whole eggs, egg whites, and egg yolks)
- Dried and powdered eggs (whole eggs, egg whites, and meringue powder)

Liquid and Frozen Eggs

Liquid and frozen whole eggs are preferred in large bakeries where cracking and emptying of shells is not economical. They are also one of the most economical ways of purchasing eggs. Liquid and frozen whole eggs are sometimes “fortified” by the addition of egg yolks. Some bakers feel that liquid or frozen eggs don’t yield the same volume in sponge cakes as fresh eggs, and there is a certain bias in favour of shell eggs.

If stored in the freezer at -18°C (0°F) or lower, liquid and frozen eggs will keep for long periods with minimum loss of quality. Thawing should take place in the refrigerator or under cold water without submerging the container. Leaving frozen eggs at room temperature to thaw is a bad practice because the outside layers of egg can reach a temperature favourable to bacteria while the centre is still frozen. Heat should never be used to defrost eggs. Unused portions must be refrigerated and used within 24 hours.

Frozen egg yolks consist of 90% egg yolks and 10% sugar to prevent the yolk from gelling and to avoid separation of the fat.

Spray-Dried Whole Eggs and Egg Whites

Dried eggs are used by some bakers as a convenience and cost saver. As with frozen eggs, some bakers doubt their performance in products such as sponge cakes. But dried eggs produce satisfactory results because of the addition of a carbohydrate to the egg before the drying process, usually corn syrup, which results in foaming comparable to fresh eggs.

Dried whole eggs should be stored unopened in a cool place not over 10°C (50°F), preferably in the

refrigerator. They are reconstituted by blending 1 kg (2.2 lb.) of powdered whole egg with 3 kg (6.6 lb) of cold water. The water is added slowly while mixing. Once reconstituted, dried eggs should be used immediately or refrigerated promptly and used within an hour.

In mixes such as muffins and cake doughnuts, dried eggs can be mixed in with the other dry ingredients and do not have to be reconstituted. In layer cake formulas, dried eggs are blended with the other dry ingredients before the fat and some water are added, followed by the balance of liquid in two stages.

Spray-dried egg whites are reconstituted by mixing 1 kg (2.2 lb.) of powdered egg white with 1 kg (2.2 lb.) of cold water, letting it stand for 15 minutes, and then adding 9 kg (20 lb.) of cold water. When used in cake mixes, the powdered egg white is blended with the other dry ingredients, but only 7 L (7 qt.) of cold water is used for every 1 kg (2.2 lb.) of powdered egg white.

Dry Egg Substitutes or Replacements

Egg substitutes are made from sweet cheese, whey, egg whites, dextrose, modified tapioca starch, **sodium** caseinate, and artificial colour and flavour. They are cost-cutters and can be used alone or in combination with fresh or dried eggs in cakes, cookies, and fillings. One kg (2.2 lb.) of powder is mixed with 4 kg (9 lb.) of water to replace powdered eggs.

Meringue Powder

While it is not a pure dehydrated egg white, meringue powder is widely used by bakers to make baked Alaska, royal icing, and toppings. It contains vegetable gums and starches to absorb moisture and make it whip better.

43.

The Function of Eggs

Eggs are a truly multifunctional ingredient and have many roles to play in the bakeshop. Their versatility means that product formulas may be adjusted once the properties of eggs are understood. For example, in French butter cream, egg whites may be substituted in the summer for whole eggs to give a more stable and bacteria-free product (egg white is alkaline, with pH 8.5). A yolk or two may be worked into a sweet short paste dough to improve its extensibility. Sponge cake formulas can be adjusted, for example, with the addition of egg yolks in jelly rolls to improve rolling up.

If a recipe is changed by replacing some or all of the eggs with water, two factors must be remembered:

1. Water replacement is about 75% of the egg content, since egg solids constitute about 25% of the egg.
2. Leavening ability is lessened and must be made up by the addition of chemical leavening.

Other uses of eggs are:

- Leavening: They will support many times their own weight of other ingredients through their ability to form a cell structure either alone or in combination with flour. The egg white in particular is capable of forming a large mass of cells by building a fine protein network.
- Moistening and binding: The fat in eggs provides a moistening effect, and the proteins present coagulate when heated, binding ingredients together.
- Thickening: Eggs are valuable thickeners in the cooking of chiffon pie fillings and custard.
- Emulsifying: Lecithin, present in the yolk, is a natural emulsifier and assists in making smooth batters.
- Customer appeal: Eggs enhance the appearance of products through their colour and flavour, and they improve texture and grain.
- Structure: Eggs bind with other ingredients, primarily flour, creating the supporting structure for other ingredients.
- Shelf life: The shelf life of eggs is extended through the fat content of the yolk.
- Nutrition: Eggs are a valuable food in every respect. Note, however, that 4% of the lipid in egg yolk is cholesterol, which may be a concern to some people. Developments in poultry feed claim to have reduced or eliminated this cholesterol level.
- Tenderizing: The fat in eggs acts like a shortening and improves the tenderness of the baked cake.

Keep these points in mind when using eggs:

- Spots in eggs are due to blood fragments in the ovary. Such eggs are edible and may be used.
- The albumen or egg white is soluble in cold water, congeals at 70°C (158°F), and remains insoluble from then on.
- Cover leftover yolks or whites tightly and refrigerate. Add a little water on top of yolks, or mix in 10% sugar, to prevent crusting. Do not return unused portions to the master container.
- Use clean utensils to dip egg products from their containers.

44.

Storing Eggs

Whole eggs are the perfect medium for the development of bacteria and mould. Eggs with an undesirable odour may be high in bacteria or mould. While some of these odours disappear in baking, some will remain and give an off-taste to the product if the odour is concentrated and strong.

Store fresh eggs in the refrigerator in cartons to prevent moisture loss and absorption of odours. If refrigerator space is at a premium, eggs are stable for up to three weeks if kept at a temperature of 13°C to 15°C (55°F to 60°F). Naturally, this must be in a location with invariable conditions.

Food poisoning can result from using eggs held too long before using. Liquid or cracked eggs should be kept under refrigeration at all times.

Whole eggs can be checked for freshness with the candling or salt water method:

- Candling method: Hold the egg up to a light in a darkened room or positioned so that the content or condition of the egg may be seen. If the yolk is held firmly by the white when the egg is turned, and the egg is clean and not broken, then the egg is of good quality. Smell or odour is not readily revealed unless the shell is broken.
- Salt water method: Add 100 g of salt to 1 L (3.5 oz. to 1 qt.) of water. Allow to dissolve completely. When an egg is placed in this mixture, its level of buoyancy determines the age of the egg. An old egg will float to the surface, while a fresher egg will sink to the bottom.

45.

Key Takeaways

Key Takeaways

- The federal governments of both Canada and the United States have strictly defined standards for egg products. Great care must be taken in their handling because of the hazard of salmonella. Products other than shell eggs are pasteurized for this reason. Shell eggs have a limited shelf life and must be kept cool.
- Eggs are available in three broad categories:
 - Shell eggs
 - Liquid or frozen eggs
 - Dried eggs
- The functions of eggs are many. Chief among these are structure, aeration, and tenderizing.

VI

Dairy Products

Learning Objectives

- Identify and describe milk and dairy products used in the food service industry
- Describe the production of milk and dairy products
- Describe the function of milk and dairy products in baking

Milk and milk products are some of our oldest and best-known natural foods. In baking, milk is used fresh, condensed, powdered, skimmed, or whole. The great bulk, weight, and perishability of fresh milk plus the expense of refrigeration makes it a relatively high-cost ingredient, and for this reason, most modern bakeries use non-fat powdered milk or buttermilk powder.

Over the past 20 years, there has been a trend to lower fat content in dairy products. This reflects the high caloric value of milk fat, and also is compatible with the trend to leaner, healthier nutrition. These “low-fat” products often have the fat replaced with sugars, so care must be taking in substituting these ingredients in a recipe. For bakers, this trend has not meant any great changes in formulas: a 35% milk fat or a 15% cream cheese product usually works equally well in a cheesecake. Some pastry chefs find lowering the richness in pastries and plated desserts can make them more enjoyable, especially after a large meal.

Table 15 provides the nutritional properties of milk products.

Table 15 Nutritional Properties of Milk Products (per 100 g)

Nutrient	Whole Milk (3.5% milk fat)	Skim Milk (0.1% milk fat)	Coffee Cream (18% milk fat)	Heavy or Whipping Cream (36% milk fat)
Protein	3.22 g	3.37 g	3 g	2 g
Fat	3.25 g	0.08 g	19 g	37 g
Cholesterol	10 mg	2 mg	66 mg	137 mg
Potassium	143 mg	156 mg	122 mg	75 mg
Calcium	113 mg	125 mg	96 mg	65 mg
Magnesium	10 mg	11 mg	9 mg	7 mg
Sodium	40 mg	42 mg	40 mg	40 mg
Vitamin A (IU)	102 IU	204 IU	656 IU	1470 IU

Note: Besides the elements shown in Table 15, all dairy products contain vitamin B-complex.

“IU” stands for International Units, a term used in nutritional measurement.

46.

Milk

Homogenized milk is fresh milk in which the fat particles are so finely divided and emulsified mechanically that the milk fat cannot separate on standing. The milk fat is forced into tiny droplets. As soon as the droplets form, milk proteins and emulsifiers form a protective film around each one, preventing the fat from reuniting. The tiny droplets stay suspended indefinitely, and milk fat no longer separates and rises to the top as a cream layer. In other words, homogenized dairy products are stable emulsions of fat droplets suspended in milk. It is also said that homogenized milk is more readily digestible.

Pasteurization of milk was developed in 1859 by the French chemist Louis Pasteur. One method of pasteurization is to heat milk to above 71°C (160°F), maintain it at this temperature for a set time, then cool it immediately to 10°C (50°F) or lower. This kills all harmful bacteria that carry the potential threat of bovine tuberculosis and fever from cows to humans.

The two main types of pasteurization used today are high-temperature, short-time (HTST, also known as “flash”) and higher-heat, shorter time (HHST). Ultra-high-temperature (UHT) processing is also used.

- High-temperature, short-time (HTST) pasteurization is done by heating milk to 72°C (161°F) for 15 seconds. Milk simply labelled “pasteurized” is usually treated with the HTST method.
- Higher-heat, shorter time (HHST) milk and milk products are pasteurized by applying heat continuously, generally above 100°C (212°F) for such time to extend the shelf life of the product under refrigerated conditions. This type of heat process can be used to produce dairy products with extended shelf life (ESL).
- Ultra-high-temperature (UHT) processing holds the milk at a temperature of 140°C (284°F) for four seconds. During UHT processing, milk is sterilized rather than pasteurized. This process allows milk or juice to be stored several months without refrigeration. The process is achieved by spraying the milk or juice through a nozzle into a chamber that is filled with high-temperature steam under pressure. After the temperature reaches 140°C (284°F) the fluid is cooled instantly in a vacuum chamber and packed in a pre-sterilized, airtight container. Milk labelled UHT has been treated in this way.

For more information on pasteurization, visit the [Canadian Food Inspection Agency web page about HHST processing](#).

47.

Milk Products

Cream

The usual minimum standard for cream is 10% fat content, though it ranges between 10% and 18%. Cream in this range may be sold as half and half, coffee cream, or table cream.

Whipping cream is about 32% to 36% in milk fat content. Cream with 36% or higher is called heavy cream. This percentage of fat is not a mandated standard; much less than this and the cream simply will not whip. For best whipping results, the cream should be 48 to 60 hours old and be cold. A stabilizer, some sugar, and flavour may be added during whipping. Before adding stabilizer, check the ingredients on the carton; some whipping creams nowadays have added agents such as carrageenan, in which case an additional stabilizer may not be necessary.

Canadian cream definitions are similar to those used in the United States, except for that of “light cream.” In Canada, what the U.S. calls light cream is referred to most commonly as half and half. In Canada, “light cream” is low-fat cream, usually meaning it is cream with 5% to 6% fat. You can make your own light cream by blending milk with half-and-half.

In Quebec, country cream is sold, which contains 15% milk fat. If you are using recipe that calls for country cream, you may substitute 18% cream.

If you have recipes from the UK, you might see references to *double cream*. This is cream with about 48% milk fat, which is not readily available in Canada, except in some specialty stores. Use whipping cream or heavy cream instead.

Table 16 lists some of the common cream types and their uses.

Table 16 Cream Types and Fat Content

Name	Minimum Milk Fat	Additional Definition	Main Uses
Whipping cream	32%	Heavy cream has at least 36% milk fat	Whips well, can be piped; custards, cream fillings, confectionary products
Table cream	18%	Coffee cream	Added to coffee, poured over puddings, used in sauces
Half-and-half	10%–12%	Cereal cream	Added to coffee; custards and ice cream mixes
Light cream	5%–10%		Added to coffee

Buttermilk

There are two methods to produce buttermilk:

- Inoculating milk with a specific culture to sour it
- Churning milk and separating the liquid left over from the butter

The second method is where buttermilk gets its name, but today, most of what is commonly called buttermilk is the first type. Buttermilk has a higher acid content than regular milk (pH of 4.6 compared with milk's pH of 6.6).

The fermented dairy product known as *cultured buttermilk* is produced from cow's milk and has a characteristically sour taste caused by lactic acid bacteria. This variant is made using one of two species of bacteria — either *Lactococcus lactis* or *Lactobacillus bulgaricus*, which creates more tartness in certain recipes.

The acid in buttermilk reacts with the sodium bicarbonate (baking soda) to produce carbon dioxide, which acts as the leavening agent.

Sour Cream

Sour cream is made from cream soured by adding lactic acids and thickened naturally or by processing. Milk fat content may vary from 5.5% to 14%. The lactic acid causes the proteins in sour cream to coagulate to a gelled consistency; gums and starches may be added to further thicken it. The added gums and starches also keep the liquid whey in sour cream from separating.

Use sour cream in cheesecakes, coffee cakes, and pastry doughs. Low-fat and fat-free sour cream are available. Low-fat sour cream, which is essentially cultured half-and-half or light cream (and usually contains 7% to 10% milk fat), is often satisfactory as a substitute for regular sour cream in baking. These products are higher in moisture and less rich in flavour than regular sour cream.

Crème Fraîche

Crème fraîche (fresh cream) is a soured cream containing 30% to 45% milk fat and having a pH of around 4.5. It is soured with bacterial culture. Traditionally it is made by setting unpasteurized milk into a pan at room temperature, allowing the cream to rise to the top. After about 12 hours, the cream is skimmed off. During that time, natural bacteria in the unpasteurized milk ripens the cream, turning it into a mildly sour, thickened product.

An effective substitute can be made by adding a small amount of cultured buttermilk or sour cream to whipping cream and allowing it to stand in a warm spot for 10 hours or more before refrigerating. As the cream ripens from the growth of the lactic acid bacteria, it thickens and develops a sour flavour. This product is similar to sour cream, but it has a higher milk fat content.

Milk Substitutes

Milk substitutes are becoming increasingly popular as replacements for straight skim milk powders. Innumerable replacement blends are available to the baker. Their protein contents range from 11% to 40%; some are wet, some are dry-blended. Product types vary from all dairy to mostly cereal. All-dairy blends range from mostly dry skim milk to mostly whey. A popular blend is whey mixed with 40% soy flour solids and a small quantity of sodium hydroxide to neutralize the whey acidity.

Dough consistency may be a little softer if the milk in the replacement blend exceeds 3%, and this could dictate the need to increase dough mixing by at least half a minute. However, absorption and formula changes are seldom necessary when switching from dry milk to a blend, or from a blend to a blend.

For nutritional labelling, or when using a blend in a non-standardized product that must carry an itemized ingredient label, all blend components must be listed in their proper order on the label.

The Canadian Food Inspection Agency defines modified milk ingredients as any of the following in liquid, concentrated, dry, frozen, or reconstituted form:

- Calcium-reduced skim milk
- Casein: This a protein in milk and is used as a binding agent. Caseins are also used in wax to shine fruits and vegetables, as an adhesive, and to fortify bread. Caseins contain common amino acids.
- Caseinate: This protein is derived from skim milk. Bodybuilders sometimes take powder enriched with calcium caseinate because it releases proteins at an even, measured pace.
- Cultured milk products: These are milk products that have been altered through controlled fermentation, including yogurt, sour cream, and cultured buttermilk.
- Milk serum proteins
- Ultra-filtered milk: The Canadian Food and Drug Regulations define this type of milk as that which “has been subjected to a process in which it is passed over one or more semi-permeable membranes to partially remove water, lactose, minerals, and water-soluble vitamins without altering the whey protein-to-casein ratio and that results in a liquid product.”
- Whey: This is serum by-product created in the manufacture of cheese.
- Whey butter: Typically oily in composition, whey butter is made from cream separated from whey.
- Whey cream: This is cream skimmed from whey, sometimes used as a substitute for sweet cream and butter.
- Any component of milk that has been altered from the form in which it is found in milk.

Milk Powder

Milk powder is available in several different forms: whole milk, skim milk (non-fat dry milk),

buttermilk, or whey. They are all processed similarly: the product is first pasteurized, then concentrated with an evaporator, and finally dried (spray or roller dried) to produce powder.

- Whole milk powder must contain no less than 95% milk solids and must not exceed 5% moisture. The milk fat content must be no less than 2.6%. Vitamins A and D may be added and the emulsifying agent lecithin may also be added in an amount not exceeding 0.5%.
- Skim milk powder (non-fat dry milk) must contain no less than 95% milk solids and must not exceed 4% moisture or 1.5% fat.
- Buttermilk powder must contain no less than 95% milk solids and must not exceed 3% moisture or 6% fat.
- Whey powder consists primarily of carbohydrate (lactose), protein (several different whey proteins, mainly lactalbumins and globulins), various minerals, and vitamins. Whey powder is a valuable addition to the functional properties of various foods as well as a source of valuable nutrients because it contains approximately 50% of the nutrients in the original milk.

Table 17 compares the composition of milk and two powdered milk products.

Table 17 Comparison of Fresh and Powdered Milk Products (% by weights)

Component	Whole Milk	Skim Milk Powder (Non-fat Dry Milk)	Buttermilk Powder
Milk fat	3.25	0.7	5.0
Protein	3.5	36.0	34.0
Milk sugar (lactose)	4.9	51.0	48.0
Minerals	0.8	8.2	7.9
Water	87.0	3.0	3.0
Calcium	0.12	1.3	1.3

- To make 10 L (22 lb.) of liquid skim milk from skim milk powder, 9.1 L (2.4 gal.) of water and 900 g (2 lb.) of skim milk powder are required.
- To make 10 L (22 lb.) of whole milk from skim milk powder, 8.65 L (2.25 gal) of water, 900 g (2 lb.) of skim milk powder, and 450 g (1 lb.) of butter are needed.

When reconstituting dried milk, add it to the water and whisk in immediately. Delaying this, or adding water to the milk powder, will usually result in clogging. Water temperature should be around 21°C (70°F).

Evaporated Milk

Sometimes called concentrated milk, this includes evaporated whole, evaporated partly skimmed, and

evaporated skim milks, depending on the type of milk used in its production. Canadian standards require 25% milk solids and 7.5% milk fat.

All types of evaporated milk have a darker colour than the original milk because at high temperatures a browning reaction occurs between the milk protein and the lactose. After 60% of the water is removed by evaporation, the milk is homogenized, cooled, restandardized, and canned. It is then sterilized by heating for 10 to 15 minutes at 99°C to 120°C (210°F to 248°F). Controlled amounts of disodium phosphate and/or sodium citrate preserve the “salt balance” and prevent coagulation of the milk that might occur at high temperatures and during storage.

Sweetened Condensed Milk

Sweetened condensed milk is a viscous, sweet-coloured milk made by condensing milk to one-third of its original volume, which then has sugar added. It contains about 40% sugar, a minimum of 8.5% milk fat, and not less than 28% total milk solids.

48.

Milk in Bread Baking

In the dough stage, milk increases water absorption. Consequently, dough made with milk should come softer from the mixer than dough made with water. Other aspects of milk in yeast doughs include:

- Dough may be mixed more intensively.
- Milk yields dough with a higher pH compared to water dough, and the fermentation will be slower.
- Fermentation tolerance (the ability of the dough to work properly in a range of temperatures) will be slightly improved.
- Bench time will be extended as the dough ferments more slowly at this stage. (Final proof times will be about the same, as by this time the yeast has adjusted to the condition of the dough.)

Bread made with milk will colour faster in the oven and allowance should be made for this. If taken out too early after a superficial examination of crust colour, it may collapse slightly and be hard to slice. The loaf should be expected to have a darker crust colour than bread made without milk.

In the finished product, milk will make bread that has:

- Greater volume (improved capacity to retain gas)
- Darker crust (due to the lactose in the milk)
- Longer shelf life (due partly to the milk fat)
- Finer and more “cottony” grain
- Better slicing due to the finer grain

If skim milk or skim milk powder is used, some of the above benefits will not be so evident (e.g., longer shelf life, which is a result of the fat in the milk).

The type of sugar found in milk, lactose, has little sweetening power and does not ferment, so in dough made with skim milk powder, sugar has to be added or the fermentation will be very slow. While lactose is not fermentable, it caramelizes readily in the oven and produces a healthy crust colour. The recommended amount of skim milk powder used in fermented dough is 2% to 8% based on flour, and up 15% in cakes.

Buttermilk and sour milk are used to make variety breads. They have a lower pH and require a shorter fermentation for good results.

49.

Yogurt

Yogurt is a thick or semi-solid food made from pasteurized milk fermented by lactic bacteria. The milk coagulates when a sufficient quantity of lactic acid is produced. Yogurt is a rich, versatile food capable of enhancing the flavour and texture of many recipes. It is prepared sweetened or unsweetened, and is used in baking to make yogurt-flavoured cream cakes, desserts, and frozen products. Yogurt is an unstandardized product in Canada — that is, it does not have to conform to specific calorific requirements.

50.

Lactose

This milk sugar is a complex sugar (see sugar section). It is available commercially spray-dried and in crystalline form. There are many advantages to using it in various baking applications:

- Because of its low sweetening value compared to sucrose, it can lend texture and create browning while keeping the sweetness level at low values, which many consumers prefer. It can be used to replace sucrose up to a 50% level, or replace it entirely in products like pie pastry.
- Lactose improves dough handling properties and the colour of the loaf.
- In pie crusts, it gives good colour to top and bottom crusts, more tender crusts, and retards sogginess.
- In machine-dropped cookies, lactose can help the dough release better from the die.
- In cakes and muffins, it gives body without excessive sweetening and improves volume.
- Lactose binds flavours that are normally volatile and thus intensifies or enhances flavour.

51.

Cheese

Cheese is a concentrated dairy product made from fluid milk and is defined as the fresh or matured product obtained by draining the whey after coagulation of casein.

Cheese making consists of four steps:

1. Curdling of the milk, either by enzyme (rennet) or by lactic curdling (natural process)
2. Draining in which the whey (liquid part) is drained from the curd (firm part)
3. Pressing, which determines the shape
4. Ripening, in which the rind forms and the curd develops flavour

Cheese can be classified, with some exceptions, into five broad categories, as follows. Examples are given of specific cheeses that may be used in baking.

1. Fresh cheese: High moisture content and no ripening characterize these products. Examples: cottage cheese, baker's cheese, cream cheese, quark, and ricotta.
2. Soft cheeses: Usually some rind, but with a soft interior. Example: feta.
3. Semi-soft cheeses: Unripened cheeses of various moisture content. Example: mozzarella.
4. Firm cheeses: Well-ripened cheese with relatively low moisture content and fairly high fat content. Examples: Swiss, cheddar, brick.
5. Hard cheeses: Lengthy aging and very low moisture content. Example: Parmesan.

In baking, cheeses have different functions. Soft cheeses, mixed with other ingredients, are used in fillings for pastries and coffeecakes. They are used for certain European deep-fried goods, such as cannoli. They may also be used, sometimes in combination with a richer cream cheese, for cheesecakes. All the cheeses itemized under fresh cheese (see above) are all more or less interchangeable for these functions. The coarser cheese may be strained first if necessary. The firmer cheeses are used in products like cheese bread, quiches, pizza, and cheese straws.

A brief description of the cheeses most likely to be used by bakers follows.

Dry Curd Cottage Cheese

This is a soft, unripened, acid cheese. Pasteurized skim milk is inoculated with lactic-acid-producing bacteria, and a milk-clotting enzyme (rennet) is added. Following incubation, the milk starts to clot, and

it is then cut into cubes. After gentle cooking, the cubes or curds become quite firm. At this point, the whey is drained off, and the curd is washed and cooled with cold water.

Creamed Cottage Cheese

Creamed or dressed cottage cheese consists of dry curd cottage cheese combined with a cream dressing. The milk fat content of the dressing determines whether the final product is “regular” (4% milk fat) or low fat (1% to 2% milk fat).

Baker’s Cheese

This is a soft, unripened, uncooked cheese. It is made following exactly the same process as for dry curd cottage cheese, up to and including the point when the milk clot is cut into cubes. This cheese is not cooked to remove the whey from the curd. Rather, the curd is drained through cloth bags or it may be pumped through a curd concentrator. The product is then ready to be packaged. The milk fat content is generally about 4%.

Quark

Quark (or quarg) is a fresh unripened cheese prepared in a fashion similar to cottage cheese. The mild flavour and smooth texture of quark make it excellent as a topping or filling for a variety of dishes. Quark is similar to baker’s cheese, except acid is added to it (it is inoculated with lactic-acid-producing bacteria), and then it is blended with straight cream to produce a smooth spread containing approximately 7% milk fat. Today there are low-fat quarks with lower percentage, and high-fat versions with milk fat adjusted to 18%. Quark cheese can often be used in place of sour cream, cottage cheese, or ricotta cheese.

Cream Cheese

Cream cheese is a soft, unripened, acid cheese. A milk-and-cream mixture is homogenized and pasteurized, cooled to about 27°C (80°F), and inoculated with lactic-acid-producing bacteria. The resulting curd is not cut, but it is stirred until it is smooth, and then heated to about 50°C (122°F) for one hour. The curd is drained through cloth bags or run through a curd concentrator. Regular cream cheese is fairly high fat, but much lighter versions exist now.

Ricotta

Ricotta is a fresh cheese prepared from either milk or whey that has been heated with an acidulating agent added. Traditionally lemon juice or vinegar was used for acidulation, but in commercial production, a bacterial culture is used. The curds are then strained and the ricotta is used for both sweet and savory applications.

Mascarpone

Mascarpone is a rich, fresh cheese that is a relative of both cream cheese and ricotta cheese. Mascarpone is prepared in a similar fashion to ricotta, but using cream instead of whole milk. The cream is acidified (often by the direct addition of tartaric acid) and heated to a temperature of 85°C (185°F), which results in precipitation of the curd. The curd is then separated from the whey by filtration or mechanical means. The cheese is lightly salted and usually whipped. Note that starter culture and rennet are not used in the production of this type of cheese. The high-fat content and smooth texture of mascarpone cheese make it suitable as a substitute for cream or butter. Ingredient applications of mascarpone cheese tend to focus on desserts. The most famous application of mascarpone cheese is in the Italian dessert tiramisu.

Table 18 provides the composition of various types of cheeses.

Table 18 Composition of Various Cheeses (% by weight)

Cheese	Moisture	Milk Fat	Salt
Dry curd cottage cheese	80	0.4	n/a
Regular creamed cottage cheese	79	4	1
Low fat (1% and 2%) creamed cottage cheese	79	1–2	1
Baker's cheese	79	4	1
Quark	72	5–7	n/a
Quark (high fat)	59	18	n/a
Cream cheese	54 (varies)	17–37	1
Ricotta	72–75	8–13	n/a
Mascarpone	46	60–75	1

52.

Key Takeaways

Key Takeaways

- Milk and other dairy products are widely used in baking and desserts.
- Milk and milk products have an effect on bread doughs, by increasing water absorption and slowing fermentation time. The resulting doughs are also softer and richer than doughs made only with water.
- The most common types of cheese used by bakers and pastry chefs are soft and unripened cheeses.

VII

Chocolate and Other Cocoa Products

Learning Objectives

- Identify and describe chocolate and cocoa products used in the food service industry
- Describe the production of chocolate and cocoa products
- Describe the function of chocolate and cocoa products in baking

The homeland of chocolate is South and Central America. When the Spanish colonized Mexico, they kept chocolate a secret for some 100 years. The Spanish then took it to West Africa, and this region now produces two-thirds of the world's chocolate. Chocolate has always had the reputation of a narcotic and an aphrodisiac, and today it still conjures up images of temptation and indulgence.

Like most tropical fruit trees, the cocoa tree blooms, buds, and produces fruit all at the same time. The tree can grow to approximately 8 m (26 ft.) high. Its fruit is a melon-like pod with approximately 50 to 60 kernels inside (each the size of a lima bean). The ripe fruit is taken off the tree and kept until completely ripe (approximately four days). The fruit is then split open.



Figure 11. A cacao pod.

To improve the colour and the taste, including lessening the bitter taste, the beans go through a fermentation process. They are then washed and dried in the sun. After this process, they are ready for marketing. Cocoa beans contain between 45% and 55% cocoa fat, which is also called cocoa butter.

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53.

From the Cocoa Bean to the Finished Chocolate

In North America, chocolate manufacturing started in Massachusetts in 1765. Today, in the factory, the beans get cleaned, and magnets take out metallic parts, and then sand, dust, and other impurities are removed. Some starch will be changed into dextrins in the roasting process to improve flavour. Machines break the beans and grind them fine until a flowing liquid is produced, called chocolate liquor. Through hydraulic pressure, cocoa butter is reduced from 55% to approximately 10% to 24% or less, and the residue forms a solid mass called *press cake*.

The press cake is then broken, pulverized, cooled, and sifted to produce commercial cocoa powder. The baking industry uses primarily cocoa powders with a low fat content.

At the factory, chocolate is also subject to an additional refining step called **conching**. Conching has a smoothing effect. The temperature range in this process is between 55°C and 65°C (131°F and 149°F). Sugar interacts with protein to form amino sugars, and the paste loses **acids** and moisture and becomes smoother.

Watch this [video on the chemistry of chocolate](#) to learn about the chemical reactions related to heat, melting point, and formation of crystal structures in chocolate.

54.

Chocolate Produced for the Baking Industry

True chocolate contains cocoa butter. The main types of chocolate, in decreasing order of cocoa liquor content, are:

- Unsweetened (bitter) chocolate
- Dark chocolate
- Milk chocolate
- White chocolate

Unsweetened Chocolate

Unsweetened chocolate, also known as bitter chocolate, baking chocolate, or cooking chocolate, is pure cocoa liquor mixed with some form of fat to produce a solid substance. The pure ground, roasted cocoa beans impart a strong, deep chocolate flavour. With the addition of sugar in recipes, however, it is used as the base for cakes, brownies, confections, and cookies.

Dark (Sweet, Semi-Sweet, Bittersweet) Chocolate

Dark chocolate has an ideal balance of cocoa liquor, cocoa butter, and sugar. Thus it has the attractive, rich colour and flavour so typical of chocolate, and is also sweet enough to be palatable. It does not contain any milk solids. It can be eaten as is or used in baking. Its flavour does not get lost or overwhelmed, as in many cases when milk chocolate is used. It can be used for fillings, for which more flavourful chocolates with high cocoa percentages ranging from 60% to 99% are often used. *Dark* is synonymous with semi-sweet, and *extra dark* with bittersweet, although the ratio of cocoa butter to solids may vary.

- Sweet chocolate has more sugar, sometimes almost equal to cocoa liquor and butter amounts (45% to 55% range).
- Semi-sweet chocolate is frequently used for cooking. It is a dark chocolate with less sugar than sweet chocolate.
- Bittersweet chocolate has less sugar and more liquor than semi-sweet chocolate, but the two are often interchangeable when baking. Bittersweet and semi-sweet chocolates are sometimes referred to as *couverture* (see below). The higher the percentage of cocoa, the less sweet the chocolate is.

Milk Chocolate

Milk chocolate is solid chocolate made with milk, added in the form of milk powder. Milk chocolate contains a higher percentage of fat (the milk contributes to this) and the melting point is slightly lower. It is used mainly as a flavouring and in the production of candies and moulded pieces.

White Chocolate

The main ingredient in white chocolate is sugar, closely followed by cocoa butter and milk powder. It has no cocoa liquor. It is used mainly as a flavouring in desserts, in the production of candies and, in chunk form in cookies.

55.

Compound Chocolate

Compound chocolate is the most commonly used chocolate in the baking industry today. It is also referred to in the trade as coating chocolate, confectionary coating, non-temper coatings, or baker's chocolate. **Note:** It should not be confused with the Baker's brand chocolate, easily obtained in supermarkets, which is generally pure chocolate.

A typical chocolate coating contains approximately 35% to 40% fat, which is a type of hard fat (usually hydrogenated palm kernel oil), 8% to 18% cocoa, approximately 2% milk solids, and a small amount of lecithin and flavour; the remainder is pulverized sugar. Since there is no cocoa butter (generally) present in compound chocolate, it offers a cost savings, and it eliminates the time spent needed in tempering.

Because of the replacement of cocoa butter, compound chocolates are not appropriate to use in moulding applications. With the other oils and fats in compound chocolate, it will not set as firmly as a cocoa butter chocolate, making it difficult if not impossible to remove from a mould. Another factor to consider is that properly tempered cocoa butter chocolate will shrink slightly, and this aids in the removal from moulds.

Compound chocolate melts at approximately 35°C to 37°C (95°F to 99°F) and is best for coating at approximately 40°C (104°F). If any liquefying agent is needed, palm kernel oil can be used. Most compound chocolate is thin enough for coating.

The shelf life of fresh bakery goods enrobed with compound coating does not present any problems with **bloom** because hard fat is used to adjust the melting point and carries enough seed to make tempering unnecessary. While temperature control is not as critical as when using true chocolate, heating coating to 50°C (122°F) and higher could destroy seed crystals and reduce the coating's viscosity.

Coatings that are well adapted to freezing are produced. Here, ability to withstand the freeze/thaw cycle without brittleness and cracking is important. In any case, products going into the freezer should be tightly enclosed in plastic wrap. The wrap should not be removed until the product is defrosted.

56.

Couverture

The usual term for top quality chocolate is **couverture**. Couverture chocolate is a very high-quality chocolate that contains extra cocoa butter. The higher percentage of cocoa butter, combined with proper tempering, gives the chocolate more sheen, firmer “snap” when broken, and a creamy mellow flavour. Dark, milk, and white chocolate can all be made as couvertures.

The total percentage cited on many brands of chocolate is based on some combination of cocoa butter in relation to cocoa liquor. In order to be labelled as couverture by European Union regulations, the product must contain not less than 35% total dry cocoa solids, including not less than 31% cocoa butter and not less than 2.5% of dry non-fat cocoa solids. Couverture is used by professionals for dipping, coating, moulding, and garnishing.

What the percentages don’t tell you is the proportion of cocoa butter to cocoa solids. You can, however, refer to the nutrition label or company information to find the amounts of each. All things being equal, the chocolate with the higher fat content will be the one with more cocoa butter, which contributes to both flavour and mouthfeel. This will also typically be the more expensive chocolate, because cocoa butter is more valuable than cocoa liquor.

But keep in mind that just because two chocolates from different manufacturers have the same percentages, they are not necessarily equal. They could have dramatically differing amounts of cocoa butter and liquor, and dissimilar flavours, and substituting one for the other can have negative effects for your recipe. Determining the amounts of cocoa butter and cocoa liquor will allow you to make informed decisions on chocolate choices.

Canadian Definitions and Regulations

The legislation for cocoa and chocolate products in Canada is found in Division 4 of the *Food and Drug Regulations* (FDR), under the *Food and Drugs Act* (FDA). The Canadian Food Inspection Agency (CFIA) is responsible for administering and enforcing the FDR and FDA. Here are some of the regulations governing cocoa and chocolate:

- Cocoa butter must be the only fat source. Chocolate sold in Canada cannot contain vegetable fats or oils.
- Chocolate must contain chocolate liquor.
- The only sweetening agents permitted in chocolate in Canada are listed in Division 18 of the Food and Drug Regulations.
- Artificial sweeteners such as aspartame, sucralose, acesulfame potassium, and sugar alcohols (sorbitol, maltitol, etc.) are not permitted.
- Milk and/or milk ingredients are permissible.
- Emulsifying agents are permissible, as are flavours such as vanilla.

Cocoa butter and sugar quantities are not defined in the regulations. Some semi-sweet chocolate may be sweeter than so-called sweet chocolate. And remember that bittersweet chocolate is not, as you might expect, sugarless. Only if the label states “unsweetened,” do you know that there is no sugar added.

Products manufactured or imported into Canada that contain non-permitted ingredients (vegetable fats or oils, artificial sweeteners) cannot legally be called chocolate when sold in Canada. A non-standardized name such as “candy” must be used.

Finally, lecithin, which is the most common emulsifying agent added to chocolate, is approved for use in chocolate in North America and Europe, but Canadian regulations state that no more than 1% can be added during the manufacturing process of chocolate. Emulsifiers like lecithin can help thin out melted chocolate so it flows evenly and smoothly. Because it is less expensive than cocoa butter at thinning chocolate, it can be used to help lower the cost. The lecithin used in chocolate is mainly derived from soy. Both GMO (**genetically modified** organism) and non-GMO soy lecithin are available. Check the manufacturer’s packaging and ingredient listing for the source of soy lecithin in your chocolate.

58.

Dutch Process Cocoa

This Dutch process is a treatment of the chocolate product with alkali, usually potassium carbonate. Cocoa beans have a pH of approximately 5.2. The treatment with alkali raises the pH of the finished product to 6.8 and higher. The process affects the flavour and colour of the chocolate product. Alkaline solution is generally applied to the raw beans or nibs but not to the liquor. If alkali is used in the cocoa liquor, it tends to react and leaves a soapy flavour.

Dutch cocoa is generally more expensive than natural cocoa. Whether or not the cocoa powder is Dutch process has some importance for some recipes. The Dutch process:

- Lowers acidity
- Increases solubility
- Enhances colour
- Smooths flavour

Because Dutch cocoa has a neutral pH and is not acidic like natural cocoa, it cannot be used in recipes that use baking soda as the leavening agent, which relies on the acidity of the cocoa to activate it. Rather, Dutch process cocoa can be used in recipes that use baking powder for leavening.



Figure 12. Dutch process and natural cocoa.

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59.

Viscosity

Viscous means “sticky” and the term *viscosity* refers to the way in which the chocolate flows. Chocolate comes in various viscosities, and the confectioner chooses the one that is most appropriate to his or her needs. The amount of cocoa butter in the chocolate is largely responsible for the viscosity level. Emulsifiers like lecithin can help thin out melted chocolate, so it flows evenly and smoothly. Because it is less expensive than cocoa butter at thinning chocolate, it can be used to help lower the cost of chocolate.

Moulded pieces such as Easter eggs require a chocolate of less viscosity. That is, the chocolate should be somewhat runny so it is easier to flow into the moulds. This is also the case for coating cookies and most cakes, where a thin, attractive and protective coating is all that is needed. A somewhat thicker chocolate is advisable for things such as ganache and flavouring of creams and fillings. Where enrobers (machines to dip chocolate centres) are used, the chocolate may also be thinner to ensure that there is an adequate coat of couverture.

Viscosity varies between manufacturers, and a given type of chocolate made by one manufacturer may be available in more than one viscosity. Bakers sometimes alter the viscosity depending on the product. A vegetable oil is sometimes used to thin chocolate for coating certain squares. This makes it easier to cut afterwards.

Chips, Chunks, and Other Baking Products

Content and quality of chocolate chips and chunks vary from one manufacturer to another. This chocolate is developed to be more heat stable for use in cookies and other baking where you want the chips and chunks to stay whole. Ratios of chocolate liquor, sugar, and cocoa butter differ. All these variables affect the flavour.

Chips and chunks may be pure chocolate or have another fat substituted for the cocoa butter. Some high-quality chips have up to 65% chocolate liquor, but in practice, liquor content over 40% tends to smear in baking, so high ratios defeat the purpose.

Many manufacturers package their chips or chunks by count (ct) size. This refers to how many pieces there are in 1 kg of the product. As the count size number increases, the size of the chip gets smaller. With this information, you can choose the best size of chip for the product you are producing.

Other chocolate products available are chocolate sprinkles or “hail,” used as a decoration; chocolate curls, rolls, or decorative shapes for use on cakes and pastries; and chocolate sticks or “batons,” which are often baked inside croissants.

60.

Storing Chocolate

Chocolate will keep for up to a year at a temperature of 18°C to 20°C (64°F to 68°F) with a relative humidity level of 60%. These are the ideal storage conditions. It is not always possible in bakeries to meet the ideal, but in general, room temperature is all right. Chocolate must be kept safe from odours and humidity, and therefore the refrigerator is not the ideal place to store it.

These guidelines apply also to all pure chocolate products, such as chocolate chips, hail, and sticks. All must be protected from humidity and odours and kept cool and dry at room temperature in sealed containers or in the original packaging.

61.

Key Takeaways

Key Takeaways

- Chocolate making, like sugar refining, takes place mainly in the importing countries. The process is quite detailed. Essentially the beans are broken down into cocoa mass (press cake) and cocoa butter and then reconstituted, along with other ingredients such as milk, sugar, lecithin, and flavour into tailor-made products for the commercial market.
- One exception is compound chocolate, which has another oil substituted for the cocoa butter. It therefore needs no tempering, which real chocolate does. This is the most popular chocolate product used by bakers for regular bakery work.
- One product, after most of the cocoa butter is extruded, is cocoa powder. Dutch process cocoa powder is made when the normally acidic cocoa mass is made slightly alkaline. Cocoa powder may come sweetened.
- The “stickiness” of chocolate varies with the intended purpose. This is called its *viscosity*. Chocolate should be stored at about 20°C (68°F) in a clean area free from foreign odours.

VIII

Nuts and Seeds

Learning Objectives

- Identify and describe nuts and seeds used in the food service industry
- Describe the production of nuts, seeds, and nut and seed products
- Describe the function of nuts, seeds, and nut and seed products in baking

The term *nut* in the culinary sense, refers to a wide range of products. Generally, nuts are dry, edible fruits or seeds that have a high fat content. Nuts and seeds are an excellent source of protein, some being equal to meat, fish, and poultry. They are used in baking and cooking, eaten raw, roasted, or pressed for oil.

62.

Nuts and Nut-like Ingredients

Nuts are a very expensive ingredient in the baking industry and must be handled with care. Bakers require knowledge and understanding of how to use them in recipes and the potential hazards due to allergies. Awareness of cross-contamination is important, as food that should not contain the allergen could become dangerous to eat for those who are allergic.



Figure 13. Common-nuts.

Allergies are severe adverse reactions that occur when the body's immune system overreacts to a particular allergen. When someone comes in contact with an allergen, the symptoms of a reaction may develop quickly and rapidly progress from mild to severe.

In Canada, peanuts and tree nuts (almonds, Brazil nuts, cashews, hazelnuts, macadamia nuts, pecans, pine nuts, pistachio nuts, and walnuts) fall into the category of the priority food allergens. Note that peanuts are not true nuts; they are from the legume family. However, in some cases people with a tree nut allergy also react to peanuts.

Coconut and nutmeg are not considered tree nuts for the purpose of food allergen labelling in Canada and are not usually restricted from the diet of someone allergic to tree nuts. Coconut is a seed of a fruit and nutmeg is obtained from the seeds of a tropical tree. However, some people react to coconut and nutmeg. People with tree nut allergies should consult their doctor or allergist before trying coconut or nutmeg products.

Due to the severity of nut allergies, any product containing nuts, or that may have come in contact with nuts, should be identified in the bakery, on the package, and on the menu.

The more common types of nuts that are used in the bake shop are listed below.

Coconut

Coconut is the fruit of the coconut palm, consisting of a thick, fibrous brown oval husk under which there is a thin, hard shell enclosing a layer of edible white meat. Ninety-five percent of all commercial coconut grown comes from the Philippines and Sri Lanka. After harvesting, coconuts are shelled, pared, and the white pure coconut meat is washed and pasteurized. The coconut meat is then fed into the shredder. Because of the many uses for the finished product, the meat is cut in different sizes using appropriate cutting heads. Some of these cuts are coarse, medium, macaroon, and extra fine for granulated cuts, and flake, chip, and thread for fancy cuts. In baking, they are used in cookies, coloured for decorations, and roasted for coating cakes.

Cashews

Cashews are kidney-shaped nuts that come from a tropical evergreen tree. In baking they are used whole or broken in fruitcakes or sliced and roasted on cakes and fancy pastries.



Figure 14. Cashews.

Walnuts

Walnuts come from a tree native to the temperate parts of the northern hemisphere. They are one of the most widely used nuts in baking, mainly because of their cost. They are halved to serve as decorations on fancy cakes, broken in fruit cakes, or flaked and roasted on the sides of butter cream cakes and fancy pastries.



Figure 15. Walnuts.

Hazelnuts or Filberts

Hazelnuts, also called filberts, are the edible nuts of the cultivated European hazel tree, a member of the birch family. They are used for decorations on cakes and pastries, in nougat and praline paste, ground in macaroon-type cookies, or flaked and roasted on the sides of cakes and French pastries. Hazelnuts are the only commercially produced nut in British Columbia.



Figure 16. Hazelnuts.

Almonds

Almonds are nut-like kernels of the small, dry, peach-like fruit of a tree growing in warm regions. Producing countries are Italy, France, Morocco, United States, Portugal, and Australia.

There are two distinct types of almonds: the sweet and the bitter almond. The former are the well-known edible almonds of the world's market. Sweet almonds are eaten as nuts, or used in confectionery. Like hazlenuts, they are used ground as ingredients, flaked and roasted for decoration, and in paste form. The kernel of the bitter almond is as inedible as peach kernels. When freed from prussic acid, the oil of bitter almond is used in the manufacture of flavouring extracts. Almonds contain about 45% to 50% of a fixed oil.



Figure 17. Almonds.

Peanuts

Peanuts grow in brittle pods, ripening underground and containing one to three edible seeds. Ground or flaked, they are used roasted on the sides of cakes and pastries and as peanut butter in cookies.



Figure 18. Peanuts.

Pecans

Pecans come from a North American tree of the walnut family. The edible nut is in a thin, smooth, olive-shaped shell. Fancy halves are used for decorations on cakes and on fruitcakes, or broken in Christmas cake, in pecan rolls made with sweet dough, and in tarts and pies.



Figure 19. Pecans.

Pistachios

Pistachios are the yellow-green seeds from the nut of the pistachio tree, a small tree of the cashew family. This precious nut is mostly used for decorations on fancy cakes and French pastries and for flavouring butter creams and ice creams.



Figure 20. Pistachios.

Brazil Nuts

Brazil nuts are hard-shelled, three-sided, oily, edible seeds of a South American tree. They grow in clusters, like segments of an orange, in large, round, hard-shelled fruits. In baking they are used whole in fruitcakes, or flaked and roasted on cakes and pastries.



Figure 21. Brazil nuts.

Chestnuts

Chestnuts are also called *maroons*. They are not to be confused with the ornamental horse chestnut,

which is a different tree. The best quality chestnuts come from Italy and Spain. They are used mainly in ice cream desserts and cooking. Candied sweet chestnuts are called *marrons glacés*.



Figure 22. Chestnuts.

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63.

Other Nut Products

In the United States, walnut, pistachio, and pecan pastes are marketed. Pastes with a combination of nuts, including coconut and even sesame seeds, along with sugar are also available.

Many companies market macaroon paste under various patented names. Macaroon paste is similar in composition to almond paste, but whereas almond paste is bound with water, macaroon paste contains egg whites.

Many nut crunches can be bought for use as an ingredient, or for masking and decorating cakes and pastries. Again, they can be a combination of almonds, coconut, cashew nuts, peanuts, sugar, and flavours.

64.

Nut Pastes and Butters

Nut pastes and butters are used widely in the baking and pastry industry. Pastes are generally products that are finely ground, and contain sugar and other ingredients. Nut butters are produced using primarily the nuts and nut oils, sometimes with sugar and emulsifiers added.

Almond Paste

Almond paste is a fine-ground mixture of half almond and half sugar, or two parts almonds and one part sugar. One type of almond paste is called marzipan. Marzipan is made by an addition of icing sugar, glucose syrup, or egg whites. It is believed that marzipan dates back to AD 24.

At one time, bakers made their own paste, which is a long, tedious job. Since special machines are required to make almond paste economically, it is produced today mainly in large factories.

The paste-making process consists of these steps:

- The almonds are first blanched and then soaked in cold water.
- The almonds are chopped and mixed with the sugar.
- The mixture is ground through a special cylinder-roller machine.
- The creamy mixture is boiled, with more sugar, to dissolve the sugar crystals. The sugar and almonds bind together to form a solid paste. The cooking also sterilizes the almond paste.

Almond paste is usually sold in an airtight container and should be kept in a cool place and properly over-wrapped. If refrigerated, it needs to be protected from humidity. Almond paste may be used for fancy cakes, to mask cakes, and in fillings and fancy cookies. It is considered the most versatile and decorative medium of all.

Working with almond paste requires extreme cleanliness in all parts of production, especially when hand modelling. When modelling, use icing sugar or cornstarch only. Keep free of flour at all times.

Kernel Paste

Kernel paste can serve as a substitute for almond paste. It is made from apricot kernels and peanuts and very few almonds — and therefore it is less expensive than almond paste.

Nougat Paste

Nougat paste, also called hazelnut paste, is made with the finest ingredients, such as hazelnuts and almonds, sugar and vegetable fats, cocoa powder and skim milk powder. Nougat paste is used in butter icing and cookies.

Peanut Butter

Peanut butter is widely used in cookies and other baking, such as fillings and bars. Natural peanut butter contains only peanuts and peanut oil, and may have a small amount of salt added, while processed peanut butters also contain sugar and emulsifiers. Due to allergy concerns, peanut products must always be labelled and handled with care.

65.

Key Takeaways

Key Takeaways

- Nuts and seeds are nutritious and versatile ingredients. They are used whole, sliced, ground. In combination with sugar and other ingredients they can be used in paste form. Their functions are as ingredients and decorations.

IX

Thickening Agents

Learning Objectives

- Identify and describe thickening agents used in the food service industry
- Describe the production and properties of thickening agents
- Describe the function of thickening agents in baking

Two types of thickening agents are recognized: starches and gums. Most thickening agents are of vegetable origin; the only exception is gelatin. All the starches are products of the land; some of the gums are of marine origin.

Bakers use thickening agents primarily to:

- Make fillings easier to handle and bake
- Firm up products to enable them to be served easily
- Provide a glossy “skin” to improve finish and reduce drying

Types of Thickening Agents

Cornstarch

Cornstarch is the most common thickening agent used in the industry. It is mixed with water or juice and boiled to make fillings and to give a glossy semi-clear finish to products. Commercial cornstarch is made by soaking maize in water containing sulphur dioxide. The soaking softens the corn and the sulphur dioxide prevents possible fermentation. It is then crushed and passed to water tanks where the germ floats off. The mass is then ground fine and, still in a semi-fluid state, passed through silk screens to remove the skin particles. After filtration, the product, which is almost 100% starch, is dried.

Cornstarch in cold water is insoluble, granular, and will settle out if left standing. However, when cornstarch is cooked in water, the starch granules absorb water, swell, and rupture, forming a translucent thickened mixture. This phenomenon is called *gelatinization*. Gelatinization usually begins at about 60°C (140°F), reaching completion at the boiling point.

The commonly used ingredients in a starch recipe affect the rate of gelatinization of the starch. Sugar, added in a high ratio to the starch, will inhibit the granular swelling. The starch gelatinization will not be completed even after prolonged cooking at normal temperature. The result is a filling of thin consistency, dull colour, and a cereal taste. Withhold some of the sugar from the cooking step in such cases, and add it after gelatinization of the starch has been completed.

Other ingredients such as egg, fat, and dry milk solids have a similar effect. Fruits with high acidity such as rhubarb will also inhibit starch setting. Cook the starch paste first and add the fruit afterward.

In cooking a filling, about 1.5 kg (3 1/3 lb.) of sugar should be cooked with the water or juice for every 500 g (18 oz.) of starch used as a thickener. Approximately 100 g (4 oz.) of starch is used to thicken 1 L of water or fruit juice. The higher the acidity of the fruit juice, the more thickener required to hold the gel. Regular cornstarch thickens well but makes a cloudy solution. Another kind of cornstarch, waxy maize starch, makes a more fluid mix of great clarity.

Pre-gelatinized Starches

Pre-gelatinized starches are mixed with sugar and then added to the water or juice. They thicken the filling in the presence of sugar and water without heating. This is due to the starch being precooked and not requiring heat to enable it to absorb and gelatinize. There are several brands of these starches on the market (e.g., Clear Jel), and they all vary in absorption properties. For best results, follow the manufacturer's guidelines. Do not put pre-gelatinized starch directly into water, as it will form lumps immediately.

Note: If fruit fillings are made with these pre-cooked starches, there is a potential for breakdown if the fillings are kept. Enzymes in the uncooked fruit may “attack” the starch and destroy some of the gelatinized structure. For example, if you are making a week’s supply of pie filling from fresh rhubarb, use a regular cooked formula.

Arrowroot

Arrowroot is a highly nutritious farinaceous starch obtained from the roots and tubers of various West Indian plants. It is used in the preparation of delicate soups, sauces, puddings, and custards.

Agar-Agar

Agar-agar is a jelly-like substance extracted from red seaweed found off the coasts of Japan, California, and Sri Lanka. It is available in strips or slabs and in powder form. Agar-agar only dissolves in hot water and is colourless. Use it at 1% to make a firm gel. It has a melting point much higher than gelatin and its jellying power is eight times greater. It is used in pie fillings and to some extent in the stiffening of jams. It is a permitted ingredient in some dairy products, including ice cream at 0.5%. One of its largest uses is in the production of materials such as piping jelly and marshmallow.

Algin (Sodium Alginate)

Extracted from kelp, this gum dissolves in cold water and a 1% concentration to give a firm gel. It has the disadvantage of not working well in the presence of acidic fruits. It is popular in uncooked icings because it works well in the cold state and holds a lot of moisture. It reduces stickiness and prevents recrystallization.

Carrageenan or Irish Moss

Carrageenan is another marine gum extracted from red seaweed. It is used as a thickening agent in various products, from icing stabilizers to whipping cream, at an allowable rate of 0.1% to 0.5%.

Gelatin

Gelatin is a glutinous substance made from the bones, connective tissues, and skins of animals. The calcium is removed and the remaining substance is soaked in cold water. Then it is heated to 40°C to 60°C (105°F 140°F). The partially evaporated liquid is defatted and coagulated on glass plates and then poured into moulds. When solid, the blocks of gelatin are cut into thin layers and dried on wire netting.

Gelatin is available in sheets of leaf gelatin, powders, granules, or flakes. Use it at a 1% ratio. Like some of the other gelling agents, acidity adversely affects its gelling capacity.

The quality of gelatin often varies because of different methods of processing and manufacturing. For this reason, many bakers prefer leaf gelatin because of its reliable strength.

Gum Arabic or Acacia

This gum is obtained from various kinds of trees and is soluble in hot or cold water. Solutions of gum arabic are used in the bakery for glazing various kinds of goods, particularly marzipan fruits.

Gum Tragacanth

This gum is obtained from several species of *Astragalus*, low-growing shrubs found in Western Asia. It can be purchased in flakes or powdered form. Gum tragacanth was once used to make gum paste and gum paste wedding ornaments, but due to high labour costs and a prohibitive price for the product, its use nowadays is uncommon.

Pectin

Pectin is a mucilaginous substance (gummy substance extracted from plants), occurring naturally in pears, apples, quince, oranges, and other citrus fruits. It is used as the gelling agent in traditional jams and jellies.

X

Water

Learning Objectives

- Identify and describe the types and properties of water used in the food service industry
- Describe the function of water in baking

Water performs many important roles in baking, ranging from the formation of solutions in combination with sugar or milk powder to the formation of the structure of bread dough in combination with flour. Pure water is an odourless and tasteless liquid. It is a compound consisting of two parts hydrogen and one part oxygen.

Generally speaking, water that is fit to drink is acceptable for use in baking, although water in different areas will differ considerably in both pH and mineral content. Absolutely pure water can be obtained only by distillation. Relatively bacteria-free water is obtained by boiling.

67.

Water Hardness and pH

Water is classified as either soft or hard:

- Soft water contains relatively few minerals and lathers easily.
- Hard water is rich in minerals such as calcium and magnesium, which is the cause of “scale” in kettles.

Water hardness is usually expressed as the number of parts per million (ppm) of calcium carbonate present in the water (see Table 19).

Table 19 Water hardness (in ppm of calcium carbonate)

Type of Water	Hardness
Soft water	10–50 ppm
Slightly hard water	50–100 ppm
Hard water	100–200 ppm
Very hard water	Over 200 ppm

Regions with soft water (1 ppm to 50 ppm) include the Pacific Northwest from Oregon up through British Columbia. The hard water regions (100+ ppm) include the Canadian Prairies, the U.S. Midwest, and the southwestern states of New Mexico and Arizona. In a sense, the hardness of water is the other side of the coin to alkalinity. In general terms, rainy climates such as the Pacific Northwest have acid water. Rain leaches out much of the mineral ions in the soil, replacing them with hydrogen ions. The result is that the water is rich in hydrogen and thus acidic (soft). The reverse is the case in the dry regions, where moisture evaporates, leaving the minerals intact. The result is water rich in minerals and thus alkaline (hard). Note that this explanation is a simplification as other factors such as the type of bedrock have an effect on water hardness as well.

The acidity or alkalinity of all substances, water in this case, is measured in terms of an index number and expressed as pH = hydrogen ion concentration. The scale ranges between 0 and 14. For baking, the ideal is water with a pH of just below 7.

pH above 7 = alkaline

pH of 7 = neutral

pH below 7 = acid

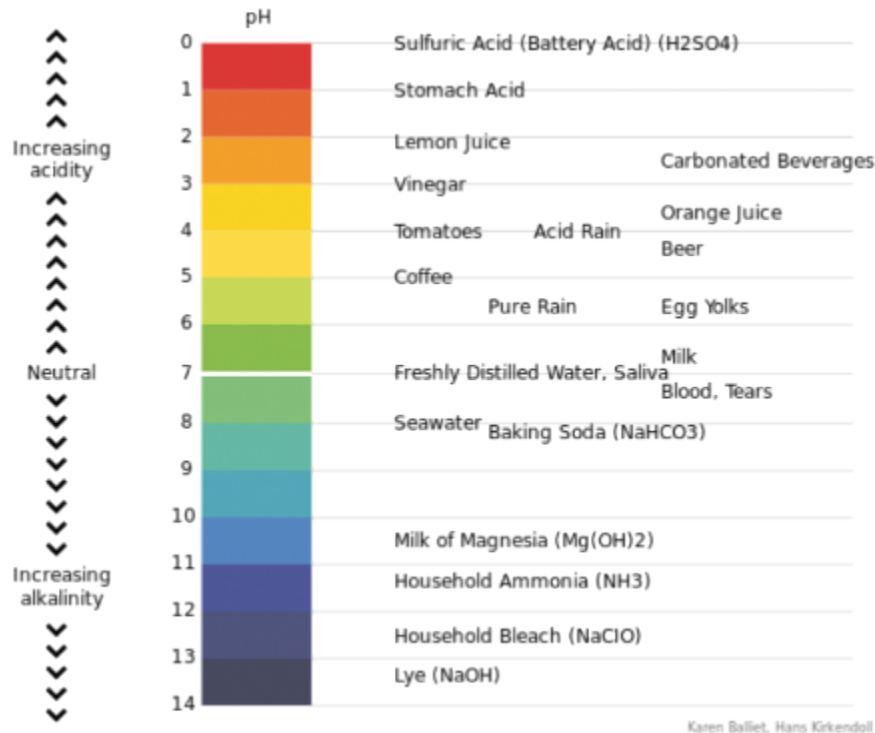


Figure 23. pH scale. [Image Description]

Effects on Baking

Most municipal supplies of water contain chlorine, which is used to ensure the purity of the water. Some cities add fluoride to their water supply to stop tooth decay. Neither chlorine nor fluoride is present in large enough quantities to affect dough in any way. In addition, most municipal water is treated to reduce excessive acidity, since this could be corrosive for the water lines. It is therefore unlikely that bakers using municipal water need to be concerned about extremely acidic water.

Soft water is another matter, as it can lead to sticky dough. An addition of yeast food, or a reduction in dough water, will help. Alkaline water tends to tighten the dough and retard fermentation, since enzymes work best in slightly acidic dough.

If there is a possibility of water problems, a sample should be forwarded to a laboratory for a complete analysis.

Image Descriptions

Figure 23 long description: A visual representation of pH with values indicated for common substances. The acidic range is the following: pH 0 is sulfuric acid (battery acid); pH 1 is stomach acid; pH 2 is lemon juice; pH 2.5 is carbonated beverages; pH 3 is vinegar; pH 3.5 is orange juice; pH 4 is tomatoes and acid rain; pH 4.5 is beer; pH 5 is coffee; pH 5.5 is pure rain and egg yolks; and pH 6.5

is milk. Saliva and freshly distilled water are neutral at pH 7. The alkaline range is the following: pH 7.2=5 is blood and tears; pH 8 is seawater; pH 8.2 is baking soda; pH 10.5 is milk of magnesia; pH 11.5 is household ammonia; pH 12.5 is household bleach; pH 13.5 is lye. [\[Return to Figure 23\]](#)

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XI

Salt

Learning Objectives

- Describe the production and properties of salt
- Describe the function of salt in baking

Historically, salt was a prestigious commodity. “The salt of the earth” describes an outstanding person. The word *salary* comes from the Latin *salaria*, which was the payment made to Roman soldiers for the purchase of salt. In Arabic, the phrase translated as “there is salt between us” expresses the covenant between humans and the divine. Though no longer a valuable commodity in the monetary sense, salt is still valuable in the sense of being crucial to human health.

Salt can be found deposited in Earth’s layers in rock salt deposits. These deposits formed when the water in the oceans that covered Earth many millions of years ago evaporated. The salt was then covered by various types of rocks.

Common salt (sodium chloride) is 40% sodium and 60% chloride. An average adult consumes about 7 kg (15 lb.) per year.

Today, we have three basic methods of obtaining salt from natural sources:

1. Mining rock salt
2. Extracting salt from salt brines created by pumping water into underground salt deposits
3. Evaporating salt water from oceans, seas, and salt lakes

68.

Functions of Salt in Baking

Salt has three major functions in baking. It affects:

- Fermentation
- Dough conditioning
- Flavour

Fermentation

Fermentation is salt's major function:

- Salt slows the rate of fermentation, acting as a healthy check on yeast development.
- Salt prevents the development of any objectionable bacterial action or wild types of fermentation.
- Salt assists in oven browning by controlling the fermentation and therefore lessening the destruction of sugar.
- Salt checks the development of any undesirable or excessive acidity in the dough. It thus protects against undesirable action in the dough and effects the necessary healthy fermentation required to secure a finished product of high quality.

Dough Conditioning

Salt has a binding or strengthening effect on gluten and thereby adds strength to any flour. The additional firmness imparted to the gluten by the salt enables it to hold the water and gas better, and allows the dough to expand without tearing. This influence becomes particularly important when soft water is used for dough mixing and where immature flour must be used. Under both conditions, incorporating a maximum amount of salt will help prevent soft and sticky dough. Although salt has no direct bleaching effect, its action results in a fine-grained loaf of superior texture. This combination of finer grain and thin cell walls gives the crumb of the loaf a whiter appearance.

Flavour

One of the important functions of salt is its ability to improve the taste and flavour of all the foods in which it is used. Salt is one ingredient that makes bread taste so good. Without salt in the dough batch,

the resulting bread would be flat and insipid. The extra palatability brought about by the presence of salt is only partly due to the actual taste of the salt itself. Salt has the peculiar ability to intensify the flavour created in bread as a result of yeast action on the other ingredients in the loaf. It brings out the characteristic taste and flavour of bread and, indeed, of all foods. Improved palatability in turn promotes the digestibility of food, so it can be said that salt enhances the nutritive value of bakery products. The lack of salt or too much of it is the first thing noticed when tasting bread. In some bread 2% can produce a decidedly salty taste, while in others the same amount gives a good taste. The difference is often due to the mineralization of the water used in the dough.

69.

Types of Salt

Mined Rock Salt

In some countries, salt is mined from salt beds approximately 150 m to 300 m (490 ft. to 985 ft.) below Earth's surface. Sometimes, impurities such as clay make it impossible to use rock salt without purification. Purification makes it possible to get the desired flavour and colour, thus making it edible. Edible salt is highly refined: pure and snow white.

Salt from Salt Brines

Salt can also be mined from natural salt beds by using water to extract the salt in the form of a brine, which saves having to construct a mine. Holes are drilled approximately 20 cm (8 in.) in diameter until the salt deposits are reached. A pipe is then driven into the salt beds and another pipe is driven inside the larger pipe further into the deposits. Pressurized water is forced through the outer pipe into the salt beds, and then pumped back out through the smaller pipe to the refineries. Through separation of the impurities, eventually all water in the brine will evaporate, leaving crystallized salt, which then can be dried, sifted, and graded in different sizes.

Ocean, Sea, and Lake Salt

In some countries, especially those with dry and warm climates, salt is recovered straight from the ocean or salt lakes. The salt water is collected in large shallow ponds (also called *salt gardens*) where, through the heat of the sun, the water slowly evaporates. Moving the salt solution from one pond to another until the salt crystals become clear and the water has evaporated eliminates impurities. The salt is then purified, dried completely, crushed, sifted, and graded.

70.

Using Salt in Fermented Doughs

The average amount of salt to use in dough is about 1.75% to 2.25% based on the flour used. Some authorities recommend that the amount of salt used should be based on the actual quantity of water used in making the dough, namely about 30 g per L (1 oz. per qt.) of water.

During the hot summer months, many bakers find it advantageous to use slightly more salt than in the winter as a safeguard against the development of any undesirable changes in the dough fermentation. Salt should never be dissolved in the same water in which yeast is dissolved. It is an antiseptic and dehydrates yeast cells and can even kill part of them, which means that less power is in the dough and a longer fermentation is needed. In bread made by the sponge dough method and in liquid fermentation systems, a small amount of salt included in the first stage strengthens the gluten.

71.

Storing Salt

Salt is very stable and does not spoil under ordinary conditions. However, it may have a slight tendency to absorb moisture and become somewhat lumpy and hard. Therefore, it is advisable to store it in a clean, cool, and dry place. Inasmuch as salt can absorb odours, the storage room should be free from any odour that might be taken up and carried by the salt.

72.

Key Takeaways

Key Takeaways

- Salt is a naturally occurring substance and is mined, extracted from brines, or produced from evaporating seawater.
- Salt has many important functions in baking, such as:
 - Enhancing flavour
 - Controlling normal fermentation with manufactured yeast
 - Controlling unwanted fermentation and acidity
 - Improving fermentation tolerance
 - Strengthening gluten
 - Giving finer grain to bread
 - Helping create good crust colour

XII

Spices and Other Flavourings

Learning Objectives

- Describe the basic principles of taste and flavour
- Identify and describe spices and other flavourings used in the food service industry
- Describe the production and properties of spices and other flavourings
- Describe the function of spices and other flavourings in baking

Food touches all of the senses. We taste, we smell, we see colour and shape, we feel texture and temperature, and we hear sounds as we eat.

All of these elements together create a palette with an infinite number of combinations, but the underlying principles that make food taste good are unchanged.

- Variety and diversity in textures and the elements of taste make for interesting food.
- Contrast is as important as harmony; but avoid extremes and imbalance.

73.

Herbs

Herbs tend to be the leaves of fragrant plants that do not have a woody stem. Herbs are available fresh or dried, with fresh herbs having a more subtle flavour than dried. You need to add a larger quantity of fresh herbs (up to 50% more) than dry herbs to get the same desired flavour. Conversely, if a recipe calls for a certain amount of fresh herb, you would use about one-half of that amount of dry herb.

The most common fresh herbs are basil, coriander, marjoram, oregano, parsley, rosemary, sage, tarragon, and thyme. Fresh herbs should have a clean, fresh fragrance and be free of wilted or brown leaves. They can be kept for about five days if sealed inside an airtight plastic bag. Fresh herbs are usually added near the completion of the cooking process so flavours are not lost due to heat exposure.

Dried herbs lose their power rather quickly if not properly stored in airtight containers. They can last up to six months if properly stored. Dried herbs are usually added at the start of the cooking process as their flavour takes longer to develop than fresh herbs.

74.

Seasoning and Flavouring

Many ingredients are used to enhance the taste of foods. These ingredients can be used to provide both seasoning and flavouring.

- *Seasoning* means to bring out or intensify the natural flavour of the food without changing it. Seasonings are usually added near the end of the cooking period. The most common seasonings are salt, pepper, and acids (such as lemon juice). When seasonings are used properly, they cannot be tasted; their job is to heighten the flavours of the original ingredients.
- *Flavouring* refers to something that changes or modifies the original flavour of the food. Flavouring can be used to contrast a taste such as adding liqueur to a dessert where both the added flavour and the original flavour are perceptible. Or flavourings can be used to create a unique flavour in which it is difficult to discern what the separate flavourings are. Spice blends used in pumpkin pies are a good example of this.

Knowing how to use seasonings and flavourings skilfully provides cooks and bakers with an arsenal with which they can create limitless flavour combinations.

Flavouring and seasoning ingredients include wines, spirits, fruit zests, extracts, essences, and oils. However, the main seasoning and flavouring ingredients are classified as herbs and spices.

Knowing the difference between herbs and spices is not as important as knowing how to use seasonings and flavourings skilfully. In general, fresh seasonings are added late in the cooking process while dry ones tend to be added earlier. It is good practice to under-season during the cooking process and then add more seasonings (particularly if you are using fresh ones) just before presentation. This is sometimes referred to as “layering.” When baking, it is difficult to add more seasoning at the end, so testing recipes to ensure the proper amount of spice is included is a critical process.

75.

Elements of Taste

Essentially there are a handful of elements that compose all of the taste profiles found in the foods we eat. Western definitions of taste conventionally define four major elements of taste:

- Salty
- Sweet
- Sour
- Bitter

Asian cultures have added the following to the list:

- Umami (literally “pleasant savoury taste”)
- Spiciness
- Astringency

Foods and recipes that contain a number of these elements in balance are generally those that we think of as tasting good.

76.

Flavourings in Baking

Flavours cannot be considered a truly basic ingredient in bakery products but are important in producing the most desirable products. Flavouring materials consist of:

- Extracts or essences
- Emulsions
- Aromas
- Spices

Note: Salt may also be classed as a flavouring material because it intensifies other flavours.

These and others (such as chocolate) enable the baker to produce a wide variety of attractively flavoured pastries, cakes, and other bakery products. Flavour extracts, essences, emulsions, and aromas are all solutions of flavour mixed with a solvent, often ethyl alcohol.

The flavours used to make extracts and essences are the extracted essential oils from fruits, herbs, and vegetables, or an imitation of the same. Many fruit flavours are obtained from the natural parts (e.g., rind of lemons and oranges or the exterior fruit pulp of apricots and peaches). In some cases, artificial flavour is added to enhance the taste, and artificial colouring may be added for eye appeal. Both the Canadian and U.S. departments that regulate food restrict these and other additives. The flavours are sometimes encapsulated in corn syrup and emulsifiers. They may also be coated with gum to preserve the flavour compounds and give longer shelf life to the product. Some of the most popular essences are compounded from both natural and artificial sources. These essences have the true taste of the natural flavours.

Aromas are flavours that have an oil extract base. They are usually much more expensive than alcoholic extracts but purer and finer in their aromatic composition. Aromas are used for flavouring delicate creams, sauces, and ice creams.

Emulsions are homogenized mixtures of aromatic oils and water plus a stabilizing agent (e.g., vegetable gum). Emulsions are more concentrated than extracts and are less susceptible to losing their flavour in the oven. They can therefore be used more sparingly.

77.

Condiments

The wide variety of condiments available to flavour and season foods provides cooks and bakers with almost innumerable opportunities to create tasty and interesting dishes. It must be reinforced that the condiment is there to enhance the dish, not to overwhelm and mask the taste of poor quality or bad foods. Common condiments are hot sauces, Worcestershire sauce, etc.

78.

Spices

Spices are aromatic substances obtained from the dried parts of plants such as the roots, shoots, fruits, bark, and leaves. They are sold as seeds, blends of spices, whole or ground spices, and seasonings. The aromatic substances that give a spice its particular aroma and flavour are the essential oils. The flavour of the essential oil or flavouring compound will vary depending on the quality and freshness of the spice.

The aromas of ground spices are volatile. This means they lose their odour or flavouring when left exposed to the air for extended periods. They should be stored in sealed containers when not in use. Whole beans or unground seeds have a longer shelf life but should also be stored in sealed containers.

Allspice

Allspice is only one spice, yet it has a flavour resembling a blend of cloves, nutmeg, and cinnamon. At harvest time, the mature (but still green) berries from the allspice trees (a small tropical evergreen) are dried in the sun. During drying they turn reddish-brown and become small berries. The berries are about 0.6 cm (1/4 in.) in diameter and contain dark brown seeds.

Allspice is grown principally in Jamaica and to a lesser degree in Mexico. Allspice is available whole or ground. Bakers usually use ground allspice in cakes, cookies, spices, and pies.

Anise

Anise is the small, green-grey fruit or seed of a plant of the parsley family. The plant grows to a height of 45 cm (18 in.) and has fine leaves with clusters of small white flowers. It is native to Mexico and Spain, with the latter being the principal producer. Anise seeds are added to pastries, breads, cookies, and candies.

Caraway

Caraway is the dried fruit or seed of a biennial plant of the parsley family, harvested every second year, primarily in the Netherlands. It is also produced in Poland and Russia. The many-branched, hollow-stemmed herb grows up to 60 cm (24 in.) high and has small white flowers. Caraway is a small crescent-shaped brown seed with a pleasant aroma but somewhat sharp taste. Although it is most familiar in rye bread, caraway is also used in cookies and cakes.

Cardamom

Native to India, Sri Lanka, and Guatemala, cardamom is the fruit or seed of a plant of the ginger family. The three-sided, creamy-white, flavourless pod holds the tiny aromatic, dark brown seeds. It is available in whole and ground (pod removed). Cardamom in ground form flavours Danish pastries and coffee cakes, Christmas baking, and Easter baking such as hot cross buns.

Cinnamon

Cinnamon comes from the bark of an aromatic evergreen tree. It is native to China, Indonesia, and Indochina. Cinnamon may be purchased in ground form or as cinnamon sticks. Ground cinnamon is used in pastries, breads, puddings, cakes, candy, and cookies. Cinnamon sticks are used for preserved fruits and flavouring puddings. Cinnamon sugar is made with approximately 50 g (2 oz.) of cinnamon to 1 kg (2.2 lb.) of granulated sugar.

Cassia

Cassia, sometimes known as Chinese cinnamon, is native to Assam and Myanmar. It is similar to cinnamon but a little darker with a sharper taste. It is considered better for savoury rather than sweet foods. It is prized in Germany and some other countries as a flavour in chocolate.

Cloves

Cloves are the dried, unopened buds of a tropical evergreen tree, native to Indonesia. The flavour is characterized by a sweet, pungent spiciness. The nail-shaped whole cloves are mainly used in cooking, but the ground version of this spice heightens the flavour of mincemeat, baked goods, fruit pies, and plum pudding.

Ginger

Ginger is one of the few spices that grow below the ground. It is native to southern Asia but is now imported from Jamaica, India, and Africa. The part of the ginger plant used is obtained from the root. Ground ginger is the most commonly used form in baking — in fruitcakes, cookies, fruit pies, and gingerbread. Candied ginger is used in pastries and confectionery.

Mace

Originating in the East and West Indies, mace is the fleshy growth between the nutmeg shell and outer husk, yellow-orange in colour. It is usually sold ground, but sometimes whole mace (blades of mace) is available. Mace is used in pound cakes, breads, puddings, and pastries.

Nutmeg

Nutmeg is the kernel or seed of the nutmeg fruit. The fruit is similar to the peach. The fleshy husk, grooved on one side, splits, releasing the deep-brown aromatic nutmeg. It is available whole or ground. Ground nutmeg is used extensively in custards, cream puddings, spice cakes, gingerbread, and doughnuts.

Poppy Seed

Poppy seed comes from the Netherlands and Asia. The minute, blue-grey, kidney-shaped seeds are so small they seem to be round. Poppy seeds are used in breads and rolls, cakes and cookies, and fillings for pastries.

Sesame or Benne Seed

Sesame or benne seeds are the seeds of the fruit of a tropical annual herb grown in India, China, and Turkey. The seeds are tiny, shiny, and creamy-white with a rich almond-like flavour and aroma. Bakers use sesame seeds in breads, buns, coffee cakes, and cookies.

Vanilla

The Spaniards named vanilla. The word derives from *vaina*, meaning pod. Vanilla is produced from an orchid-type plant native to Central America. The vanilla beans are cured by a complicated process, which helps explain the high cost of genuine vanilla. The cured pods should be black in colour and packed in airtight boxes. Imitation vanilla extracts are made from a colourless crystalline synthetic compound called vanillin. Pure vanilla extract is superior to imitation vanilla. Artificial vanilla is more intense than real vanilla by a factor of 3 to 4 and must be used sparingly.

To use vanilla beans, split the pod down the middle to scrape out the seeds. The seeds are the flavouring agents. Alternatively, the split pod can be simmered in the milk or cream used in dessert preparation. Its flavouring power is not spent in one cooking and it can be drained, kept frozen, and reused. A vanilla bean kept in a container of icing sugar imparts the flavour to the sugar, all ready for use in cookies and cakes.

Vanilla extract is volatile at temperatures starting at 138°C (280°F) and is therefore not ideal for flat products such as cookies. It is suitable for cakes, where the interior temperature does not get so high.

Vanilla beans and vanilla extract are used extensively by bakers to flavour a wide range of desserts and other items.

79.

Alcohol and Spirits

Alcohol itself does not contribute to the flavour of foods; only the main flavour component of the liquors or liqueurs does. Care should be taken to evaporate the alcohol fully or it may leave a bitter aftertaste in the dish.

Many bakers and pastry chefs use spirits to impart flavour. Two categories are of interest to the pastry chef: brandies and liqueurs. Their origin, the ingredients used to flavour them if any, the alcohol content, and the sugar content help differentiate these products.

- Brandy usually has an alcohol content ranging from a minimum of 40% to a maximum of 55%. Brandy derives from wine, usually white wine. Another classification of brandies made from fruits other than grapes is called *eau-de-vie* and includes Calvados (apple), Kirsch (cherry), and Williams (pear).

Liqueurs are mixtures of fine spirits, brandy, sugar, and flavouring. In Canada, they usually have an alcohol content ranging from 17% to 40% and at least 10% sugar. Because they are volatile substances that vaporize when heated, they should be used mainly for drenching cakes or flavouring creams and icings.

Note: Alcohol content is measured in Canada by volume. Water is 0%; pure alcohol is 100%. In the United States, the term *proof* is used. One degree proof is one-half a degree of alcohol by volume. Thus, 80 proof in the U.S. is equivalent to 40% by volume in Canada.

Since flavouring materials have a limited storage life, it is wise to buy a minimum at any one time. Protect all flavours from light and store in airtight containers. Flavourings lose their strength when stored too long. Protect liquid flavour from light, store in amber bottles, and keep bottle tops tight to avoid loss of flavour strength.

80.

Key Takeaways

Key Takeaways

- Spices and flavours are essential to give interest to baked products. They must be used with discretion, as too much flavour is worse than no flavour at all.
- Different types of flavouring materials must be used in different dosages.
- All spices and flavourings are volatile and must be kept sealed and protected from light.

XIII

Fruit

Learning Objectives

- Identify and describe fruits used in the food service industry
- Describe the production and properties of fruits
- Describe the function of fruits in baking

Fruit is nutritious and adds variety in taste and appearance to many baked products. It functions in two ways:

- As a flavouring ingredient
- As a decorative topping

Fruit is available in a wide variety of forms:

- Fresh
- Frozen
- Canned and bottled
- Preserved
- Partially dried
- Candied

81.

Fresh Fruit

The wide range of taste and colour makes fresh fruit appealing. What is more irresistible than a fresh strawberry tart? However, fresh fruit has its disadvantages:

- It requires more handling. Fruit such as kiwi and banana must be peeled and cut to size.
- It is prone to spoilage due to enzyme activity and moisture level.

Fresh fruit is used as:

- An ingredient (e.g., bananas or blueberries in cakes and muffins)
- A topping for fruit flans, tarts, and cakes
- A filling along with cream in jelly rolls, layer cakes, and mousse cakes
- In sauces or coulis to accompany cheesecakes or plated desserts

Here are some tips when using fresh fruit:

- Certain fruits such as pineapple have enzymes that counteract gelatin setting.
- Fresh fruit oxidizes and changes colour when exposed to air. Peeled apples may be immersed in slightly acidified water (lemon juice) to prevent this. Prolonged soaking leaches out nutrients.
- Some fruit is better broken into small pieces or puréed to minimize browning in baked products. Bananas fall into this category.
- Excess fruit, even bananas, can be frozen. In the case of bananas, freeze them in the skin, defrost and use in banana muffins or cakes; there will be some discoloration but not objectionably so in this type of product.
- When used as a topping on flans and tarts, fresh fruit is usually glazed thinly to prevent oxidation and impart a brilliant shine.

82.

Frozen Fruit

Many fruits freeze well and are convenient for the baker, with the disadvantage of having an associated energy cost.

- Frozen blueberries have less tendency to break down and discolour the batter when worked into quick bread recipes.
- Certain frozen soft fruit such as raspberries can be partly thawed in the cooler and used on fresh fruit flans and tarts. Strawberries, however, don't work well, becoming too soft.

83.

Canned or Bottled Fruit

Canned or bottled fruit has the following advantages:

- Products have a long shelf life.
- Products are convenient. (Think of the time saved by using solid-pack apples.)
- They require no energy costs.
- Some juice may be beneficial, for example, in mixes leavened by sodium bicarbonate, where the acid in the juice/syrup reacts with the bicarbonate. Crushed pineapple in muffins is an example of this.

Keep in mind that if the canned or bottled fruit is packed in syrup, the syrup may have variable ratios of sugar. Most of today's canning uses low sugar levels. When using fruit as a topping, be sure to drain it well.

84.

Partially Dried Fruits

Partially dried fruits have the advantages of long shelf life and reduced bulk. Care must be taken to seal well when not in use, as the fruit can go dry and hard when exposed to air.

Raisins are the dominant partially dried fruit in baking and are used in:

- Pies and squares
- Bread and buns
- Cakes and pastries

Raisin is the commercial name given to sun-dried or mechanically dried grapes. Drying reduces the moisture content, simultaneously resulting in increased sugar content. It is the greater sugar content that preserves the fruit against bacterial attack.

The United States accounts for about one-third of the world's raisin production, heavily centred in the San Joaquin Valley in California. Well over 90% of these are the Thompson seedless variety.

Dark raisins are dried in the sun over a period of 8 to 14 days. Golden raisins undergo a different process and are never allowed to dry in the sun. The steps for golden raisins are:

- Dipping in caustic solution to remove the waxy bloom and cause cracks to form, speeding up the escape of moisture
- Washing to remove the caustic solution
- Travelling through ovens where sulphur dioxide treatment preserves the colour
- Going through a final oven drying to complete drying
- Inspecting and fumigating to prevent insect infestation
- Packaging

Conditioning Raisins

There are two methods of conditioning raisins:

- They are soaked in tepid water at about 27°C (80°F) for five minutes, and then drained for one hour
- They are covered with water at about 27°C (80°F) and immediately drained without soaking. They are then set aside, covered, and left for a few hours. The raisins will slowly take up the

moisture.

The second method is preferred because no sugar is lost from the fruit. In both cases, there is a moisture gain of about 10%. Bakers may choose to condition batches of raisins sufficient for a few days' or a week's supply.

Raisin Varieties Used in Bakeries

There are four main varieties of raisins used in bakeries:

- **Thompson:** Seedless, thin-skinned, and available in suntan or golden yellow colour, they are a popular ingredient in the production of light fruitcakes.
- **Sultanas:** A lot like Thompson raisins except, but these are round in shape and have a trace of small edible seeds. They are firm with a tart flavour and are used in breads, buns, cakes, puddings, mincemeat, etc.
- **Currants:** Originating in Greece where they are called the “raisin of Corinth,” these raisins are now grown in California as the Black Zante currant. Currants are very small seedless raisins and have a very tangy flavour that is different from other raisins. (They are occasionally confused with black currants, which are a different berry, also with a tart flavour.) Bakers use them in buns, fruitcakes, and puddings.
- **Muscats:** Called “Muscat of Alexandria,” they were brought to California from Egypt in 1851. They are very large with a high sugar content and are famous for their flavour. They are sold as regular muscats or seeded muscats in which the seeds have been removed with special machines. They mush easily, don't hold their shape well, and are therefore not well suited for use in bread and buns but are excellent for use in pie fillings, mincemeat, and puddings.

Storing Raisins

Natural raisins packed in bulk fibre cases can be stored for several months at room temperature without any noticeable loss in flavour or colour if protected against insects. The humidity level (ideally relative humidity of 50%) is important and the raisins should be sealed well between uses. If the humidity increases too much, raisins will start to “sugar”; that is, sugar crystals will develop on the exterior surface (similar to the sugar bloom on chocolate candies). This does not mean that the fruit is unusable.

Apart from raisins, other dried fruits are widely available and can be treated and used in much the same way.

85.

Preserved Fruit

Two forms of preserved fruit are available:

- Jams and jellies cooked with high ratios of sugar. They have the advantage of a long shelf life.
- Fruits that may be partly cooked, such as pie fillings, with relatively moderate levels of sugar and set with starch. These keep well in the cooler but will ferment over time if carelessly handled. They are used as:
 - Fillings and toppings for cookies and flans (e.g., Linzer torte)
 - Fillings in pies and tarts
 - Fillings in puff pastry items
 - Fillings in sponge cakes, for flavour and variety
 - Toppings and/or fillings in sweet dough items

86.

Candied Fruit

Glacé Cherries and Other Fruits

The steps for processing glacé fruit are as follows:

- Blanching (and bleaching in the case of cherries): Bleaching cherries is done mainly to give them a uniform colour and also to enable the manufacturer to offer different colours.
- Boiling in a sugar syrup consisting of 30% glucose and 70% sucrose: The sugar concentration is increased gradually, from a 14% sugar level to close to 70%.
- The presence of glucose in the syrup prevents crystallization in the finished product. The sugar content is responsible for preservation.

Glacé Peel

Glacé peel, which is made from the rind of oranges, lemons, and grapefruits, goes through the same process as glacé fruit. Glacé peel is a by-product in the manufacturing of fruit juices, and is sold as candied lemon or orange peel, or mixed candied peel.

There are many different varieties of glacé fruits under many different brand names on the market. They vary in price according to their mix, the more expensive ones consisting mainly of fruit and cherries while the cheaper ones containing a lot of peel and increasing amounts of candied rutabaga. The cheapest variety of “peel” consists entirely of diced rutabaga.

Other Candied Products

Angelika, used more in Europe than in North America, is the stem of a rhubarb-like plant. When fresh, the candied stem is a pleasant green and is cut into thin diamonds to simulate leaves on pastries and cakes. Mentioned earlier in this book was the marrons glacés, an expensive item and in the showcase of every fine pastry shop in Italy. Flower petals such as rose and violet have syrup dribbled over them to preserve them and to make a beautiful and unusual decoration on petits fours.

87.

Key Takeaways

Key Takeaways

- Bakers use fruits to increase the variety and appeal of their products. Fruits add colour and flavour, and are generally highly nutritious.
- When used as ingredients in cakes and quick breads, fruits retain moisture and prolong keeping quality.
- Raisins in particular improve the nutritional value of baked goods and have a mould-retarding effect in bread.

For more information on fruit, consult the following websites:

- [BC Farm Fresh](#)
- [BC Tree Fruits](#)

Key Terms

acids

Substances with a pH less than 6; the lower the pH the more acidic.

alkaline

Having a pH greater than 7.

bloom

A whitish coating that can appear on the surface of chocolate. This effect is one of the main concerns in the production of chocolate. There are two types of bloom: fat bloom, arising from changes in the fat in the chocolate, and sugar bloom, formed by the action of moisture on the sugar ingredients.

brown sugar

A blend of sucrose, molasses, and molasses-flavoured syrup that is used for its distinctive flavour and for colouring.

calorie

The energy needed to raise the temperature of 1 kilogram of water by 1 °C.

caramelization

The development of colour in certain foods by heating until the natural sugars brown.

carbohydrate

Any of many organic compounds made with a 2:1 ratio of hydrogen to oxygen, including simple and complex sugars, starches, and cellulose.

certified organic

Determined by the government to be free of chemical additives.

chlorophyll

The green pigment found in algae and plants.

cholesterol

A sterol found in all animal tissues and animal fats. There are two types: low density lipoproteins (LDL or “bad” cholesterol) and high density lipoproteins (HDL or “good” cholesterol).

conching

A process that refines pressed cacao into chocolate by rolling and heating to evenly distribute the cocoa butter.

conversion

The process of changing a complex sugar to a simple or invert sugar, such as the work done by bees in converting nectar to honey by means of an enzyme or the conversion of starch (a

polysaccharide) to glucose by means of an acid or enzyme.

couverture

A term used for higher quality chocolates, usually containing a high percentage of cocoa butter.

dextrose (glucose)

A sugar produced from grain, with a sweetness level somewhat lower than sucrose. It is available dry or in liquid form as thick syrup. (Bakers are more familiar with the liquid form.) Dextrose is fermentable by yeast and soluble in water. Compared to sucrose, dextrose has a lower solubility and is the sugar of choice for donut finishing.

disaccharide

A form of sugar in which two molecules of simple sugar are bonded together in a more complex form of molecule. Sucrose is the commonest form of disaccharide. Disaccharides have to be broken down into simpler sugars to be used by either the body's stomach enzymes or the yeast enzymes in dough.

disc separator

A machine designed to remove oversized and undersized grain from a batch.

enrich

To add extra nutrients during processing.

flour stream

Term for the exact chemical composition and quality of flour that comes out of a particular sieve in a mill.

fructose

A simple sugar found in fruits and honey.

genetically modified

Having genetic material that has been artificially altered so as to produce a specific characteristic.

gliadin

One of the main structural proteins found in wheat and some other grains that forms gluten in combination with glutenin.

gluten

A protein composite present in cereal grains, especially wheat, but also found in barley, oats, and rye. Composed mainly of two proteins, gliadin and glutenin. Gluten contributes to elasticity and texture in bread doughs and other products containing wheat.

glutenin

One of the main structural proteins found in wheat and some other grains that forms gluten in combination with gliadin.

homogenized milk

Milk that has been processed so that the fat droplets are evenly dispersed and the cream does not separate. In Canada, homogenized milk also refers to milk that contains 3.25 g per 100 g milk fat,

which is known as whole milk in the U.S.

honey

An invert sugar (i.e., a monosaccharide) made by bees from flower nectar and used as a sweetener for its distinctive flavour. It is hygroscopic (i.e., keeps products moist). Components of honey are levulose and dextrose (and a tiny fraction of sucrose).

hygroscopic

Able to attract moisture from the air. This is typical of most simple sugars, such as glucose and honey.

invert sugar

A simple form of sugar obtainable naturally (e.g., honey) or artificially by conversion of sucrose. It stays liquid and is prized for its moisture retention capabilities.

lactose

A sugar naturally occurring in milk and other dairy products.

levulose

A simple sugar or monosaccharide that is formed by the inversion of sucrose and also exists naturally in honey.

lipids

A group of naturally occurring molecules that include fats, waxes, sterols, fatty acids, fat-soluble vitamins, and cholesterol.

maillard reaction

A chemical reaction between amino acids and sugars that contributes to the browning of foods.

maize

Another word for “corn.”

middlings

Bran, germ, and other coarse particles.

monosaccharide

A simple molecule of carbon, hydrogen, and oxygen, such as levulose, fructose, or glucose, that is easily fermentable.

nutrient

Something found in food that nourishes living beings. Nutrients include proteins and vitamins.

pH

A measure of acidity and alkalinity. The lower the pH, the more acidic the substance, and the higher the pH, the more alkaline. Substances with a pH above 7 are considered alkaline, and substances with a pH below 7 are considered acidic. Substances with a pH of 7 are considered neutral.

pasteurization

The exposure of food to temperatures high enough to destroy harmful microorganisms.

pentosans

A class of carbohydrates found in rye flour.

photosynthesis

The process by which plants use energy from sunlight to produce their own food.

plansifter

A machine composed of stacked sieves that separates stalks of grain into different streams based on size.

polysaccharides

Complex units of carbohydrate, such as starch or cellulose, that are decomposable into more simple sugars

powdered sugar

Sugar that has been ground into a fine powder and is used to make icing.

protein

Element in plant or animal tissue supplying essential amino acids to the body.

raw sugar

The brown sugar received at the mill from the source country. It has been somewhat refined, but still has considerable impurities.

sodium

An essential nutrient that regulates blood volume, blood pressure, osmotic equilibrium, and pH. Most of the sodium in the diet comes from salts and processed foods.

sucrose

“Ordinary” sugar; a disaccharide. It is the most familiar form of sugar and comes in various sizes of granulation.

sweetness equivalent

A measurement of the sweetness of sugar compared to sucrose, which is rated at 1.00. Anything with a higher number is sweeter than sucrose, and anything with a lower number is less sweet.

temper

1. To add a hot liquid to egg yolks slowly so as not to cook the yolks too quickly.
2. To allow an item to soften slightly by coming to room temperature slowly.
3. To heat and cool couverture to create a crystal structure that will result in shiny and crisp finished chocolate.
4. To add water to a dry grain and let it rest before milling so as to toughen the bran and soften the endosperm.

trans fat

A polyunsaturated fatty acid that has been converted from its natural form by hydrogenation and is

used in the manufacture of shortenings.

wheat shorts

Fine bran particles, germ, and a small portion of floury endosperm particles as separated in the usual processes of commercial flour milling

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List of Links by Chapter for Print Users

This page contains a list of links to external resources referenced in this book for people who are using a print version. Links are listed by the chapters in which they appear and are listed alphabetically. Internal links are not included in this list.

Accessibility Statement

- Contact us (<https://open.bccampus.ca/contact-us/>)
- Download this book in another file format (<https://opentextbc.ca/ingredients/>)
- Report an Open Textbook Error (<https://open.bccampus.ca/use-open-textbooks/reporting-an-open-textbook-error/>)
- Web version of Understanding Ingredients for Canadian Baker (<https://opentextbc.ca/ingredients/>)

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- Adoption of an Open Textbook (<https://open.bccampus.ca/use-open-textbooks/tell-us-youre-using-an-open-textbook/>)
- BCcampus Open Education (<https://open.bccampus.ca/>)
- British Columbia Ministry of Advanced Education, Skills & Training (<https://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/advanced-education-skills-training>)
- Creative Commons licence (<https://creativecommons.org/licenses/>)
- Hewlett Foundation (<http://www.hewlett.org/programs/education/open-educational-resources>)

Grains and Flours

- *Agricultural Growth Act* (<http://foodsecurecanada.org/resources-news/news-media/bill-c-18-agricultural-growth-act>)
- Agriculture and Agri-Food Canada (<http://www.agr.gc.ca/eng/home/?id=1395690825741>)
- American Institute of Baking (<http://www.aibonline.org/aibOnline/en/>)
- Anita's Organic Mill (<http://anitasorganic.com/>)
- *Canada Grain Act* (<http://www.grainscanada.gc.ca/legislation-legislation/act-loi/cga-lgc->)

eng.htm)

- Canada Grain Regulations – Section 5 (https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._889/page-1.html#h-6)
- Canadian Grain Commission (<https://www.grainscanada.gc.ca/en/>)
- Chapter 17 of the Grain Grading Guide (<https://www.grainscanada.gc.ca/en/grain-quality/official-grain-grading-guide/17-corn/grading.html>)
- Chapter 7 of the Grain Grading Guide (<https://www.grainscanada.gc.ca/en/grain-quality/official-grain-grading-guide/07-oats/grading.html>)
- Characteristics and end uses of Eastern and Western wheat (<http://www.grainscanada.gc.ca/wheat-ble/classes/classes-eng.htm>)
- Daybreak Mill (<http://www.daybreakmill.com/about-daybreak>)
- Fieldstone Organics (<http://fieldstoneorganics.ca/contact/index.php>)
- G3 Canada (<http://www.g3.ca/>)
- Grain Grading Guide (<https://www.grainscanada.gc.ca/oggg-gocg/ggg-gcg-eng.htm>)
- Health Products and Food Branch of Health Canada (<https://www.canada.ca/en/health-canada/corporate/about-health-canada/branches-agencies/health-products-food-branch.html>)
- Information about whole grains (<https://www.canada.ca/en/health-canada/services/canada-food-guide/resources/healthy-eating-recommendations/eat-a-variety/whole-grain/get-facts.html>)
- National Farmers Union (<http://www.nfu.ca/about/about-national-farmers-union>)
- Nunweiler’s (<http://www.nunweilersflour.com/about>)
- *Nutrition and Labelling for the Canadian Baker* (<http://opentextbc.ca/nutrition/>)
- Quality of Western Canadian Wheat [PDF] (<https://grainscanada.gc.ca/en/grain-research/export-quality/cereals/wheat/western/2012/2012-quality-report.pdf>)
- True Grain (<http://www.truegrain.ca/index.php/true-grain-mill2-2/our-grains>)
- Urban Grains (<http://www.urbangrains.ca/about>)

Sweeteners in Baking

- *Food and Drug Regulations* (http://laws-lois.justice.gc.ca/eng/regulations/c.r.c.,_c._870/index.html)
- *Food and Drugs Act* (<http://laws-lois.justice.gc.ca/eng/acts/f-27/>)
- Health Canada webpage Sugar Substitutes (<http://www.hc-sc.gc.ca/fn-an/securit/addit/sweeten-edulcor/index-eng.php>)
- Information on sugar substitutes and their relative sweetness (<http://www.sugar-and-sweetener-guide.com/sweetener-values.html>)

- *Nutrition and Labelling for the Canadian Baker* (<http://opentextbc.ca/nutrition/>)
- The Faces of Business: Mapleside Sugar Bush (<https://www.youtube.com/watch?v=OFIj4pMYpTQ>)

Fats and Oils

- Canada's Food Guide (<http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php>)
- Cancer (<http://www.phac-aspc.gc.ca/cd-mc/cancer/index-eng.php>)
- Heart disease (<https://www.canada.ca/en/public-health/services/diseases/heart-health/heart-diseases-conditions/about-heart-diseases-conditions.html>)
- Hydrogenated vegetable oil (http://en.wikipedia.org/wiki/Hydrogenated_vegetable_oil)
- Link between trans fats and adverse health effects (https://en.wikipedia.org/wiki/Trans_fat#Health_risks)
- Monoglycerides (<http://en.wikipedia.org/wiki/Monoglyceride>)
- *Nutrition and Labelling for the Canadian Baker* (<http://opentextbc.ca/nutrition/>)
- Obesity (<http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/obes-eng.php>)
- Palm oil (http://en.wikipedia.org/wiki/Palm_oil)
- Smoke point (http://en.wikipedia.org/wiki/Smoke_point)
- Type 2 diabetes (<http://healthycanadians.gc.ca/health-sante/disease-maladie/diabete-eng.php>)

Eggs

- Egg Regulations (http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._284/page-1.html)

Dairy Products

- Canadian Food Inspection Agency web page about HHST processing (<http://www.inspection.gc.ca/food/requirements/preventive-controls-food-businesses/dairy-products/hhst-esl/eng/1539632249860/1539711207517#a3>)
- Cream with 5% to 6% fat (<http://www.dairygoodness.ca/cream/types-of-cream/5-or-6-light-cream-or-cream-and-milk-blend-for-coffee>)
- Recipe that calls for country cream (<http://bcdairy.ca/milk/recipes/cream-of-squash-soup>)

Chocolate and other Cocoa Products

- Canadian Food Inspection Agency (<http://www.inspection.gc.ca/eng/1297964599443/1297965645317>)

- *Food and Drugs Act* (http://en.wikipedia.org/wiki/Food_and_Drugs_Act)
- Video on the chemistry of chocolate (<http://science360.gov/obj/video/27d931d9-c33c-45c6-adac-aa0a42f04ad6/chemistry-chocolate>)

Fruit

- BC Farm Fresh (<http://www.bcfarmfresh.com>)
- BC Tree Fruits (<http://www.bctree.com>)

Versioning History

This page provides a record of edits and changes made to this book since its initial publication. Whenever edits or updates are made, we make the required changes in the text and provide a record and description of those changes here. If the change is minor, the version number increases by 0.1. However, if the edits involve substantial updates, the version number goes up to the next full number. The files on our website always reflect the most recent version, including the Print on Demand copy.

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Version	Date	Change	Details
1.01	October 24, 2015	Book added to the B.C. Open Textbook Collection.	
2.01	June 13, 2019	Entire book revised for accessibility. New theme applied. Applied a number of changes as part of a project to standardize BCcampus-published books.	Accessibility remediation: <ul style="list-style-type: none">• Image descriptions added.• Tables reformatted for accessibility.• Link text edited to be descriptive.• Headings added.• Added an Accessibility Statement Standardization project: <ul style="list-style-type: none">• Added additional publication information.• Updated copyright information.• Added a Versioning History page.• Renamed the “About the Book” section to “About BCcampus Open Education” and updated the content. Other changes: <ul style="list-style-type: none">• Numbered chapters• Added pop-up definitions for key terms in webbook• Moved media attributions to end of each section
2.02	June 15, 2023	Error correction	In Enzymes , “The protein makes the gluten more elastic ” was changed to “The protein makes the gluten more extensible .”