

Background on Carbohydrates & Sugars

Carbohydrates and Sugars

Carbohydrates are one of three basic macronutrients needed to sustain life (the other two are proteins and fats). They are found in a wide range of foods that bring a variety of other important nutrients to the diet, such as vitamins and minerals, phytochemicals, antioxidants, and dietary fiber. Fruits, vegetables, grain foods, and many dairy products naturally contain carbohydrates in varying amounts, including sugars, which are a type of carbohydrate that can add taste appeal to a nutritious diet.

Carbohydrate Classification

Carbohydrates encompass a broad range of sugars, starches, and fiber. The basic building block of a carbohydrate is a simple union of carbon, hydrogen, and oxygen. The chemical definition of a carbohydrate is any compound containing these three elements and having twice as many hydrogen atoms as oxygen and carbon.

Sugars in Foods

When people hear the word “sugar” they often think of the familiar sweetener in the sugar bowl. That sugar is sucrose and is the most familiar form of sugar to home bakers. But there are many types of sugars, which scientists classify according to their chemical structure. Sugars occur naturally in a wide variety of fruits, vegetables, and dairy foods. They can also be produced commercially and added to foods to heighten sweetness and for the many technical functions they perform, including: contributing to foods’ structure and texture, sweetening and flavor enhancement, controlling crystallization, providing a medium for the growth of yeast in baked goods, and preventing spoilage. The sweetening ability of sugar can promote the consumption of nutrient-rich foods that might not be otherwise. Some examples are a sprinkle of sugar added to oatmeal or adding sugar to cranberries in the juice-making process.

Sugars come in several forms, most containing approximately four calories per gram. Simple sugars are called monosaccharides, made up of single sugar molecules. Examples of these are glucose, fructose, and galactose. When two simple sugars are joined together by a chemical bond they are called disaccharides, the most common of which is sucrose or table sugar. Table sugar is made up of equal amounts of the simple sugars glucose and fructose, which are joined together by chemical bonds. Starches and fiber are made up of many simple sugars joined together chemically. Any carbohydrate that is made up of more than two simple sugars is referred to as a polysaccharide. Some common sugars found in foods are:

- **Corn Syrup:** Made from corn and usually 100% glucose. According to the Food and Drug Administration (FDA), “corn syrup” can be used to describe numerous corn-derived products.
- **Fructose:** A simple sugar found in fruits, honey, and root vegetables. It is used as a caloric sweetener, added to foods and beverages in the form of crystalline fructose (made

from corn starch), and it makes up about half the sugar in sucrose or high fructose corn syrup (see below). Fructose does not elicit a glycemic response so it sometimes has been used as a sweetener for foods intended for people with diabetes. However, because of concern about the effect of excessive use on blood lipids, the Academy of Nutrition and Dietetics does not recommend fructose as a sweetening agent for people with diabetes.

- **Galactose:** A simple sugar found in milk and dairy foods. Galactose and glucose form the disaccharide lactose.
- **Glucose:** The main source of energy for the body and the only used by brain cells. Glucose is produced when carbohydrates are digested or metabolized. Glucose is sometimes referred to as dextrose. Starch is comprised of long chains of glucose. Glucose makes up exactly half of the sugar in sucrose and nearly half of the sugar in high fructose corn syrup.
- **High Fructose Corn Syrup:** A mixture of glucose and fructose produced from corn. The most common form of high fructose corn syrup (HFCS) has 55 percent fructose and 45 percent glucose.
- **Lactose:** The sugar found naturally in milk, it is a disaccharide composed of one galactose unit and one glucose unit; sometimes called milk sugar.
- **Maltose:** A disaccharide composed of two glucose units. It is found in molasses and is used in fermentation.
- **Sucrose:** A disaccharide or double sugar made of equal parts of glucose and fructose. Known as table or white sugar, sucrose is found naturally in fruits and vegetables. Appearing most abundantly in sugar cane and sugar beets, sucrose comes from these foods for commercial use.

Sugar Alcohols

A sugar alcohol is neither sugar nor alcohol but is actually a carbohydrate with a chemical structure that partially resembles a sugar and partially resembles an alcohol. Another term for sugar alcohols is polyols. They are a group of caloric sweeteners that are incompletely absorbed and metabolized by the body and consequently contribute fewer calories than sugars. The sugar alcohols or polyols commonly used in the United States include sorbitol, mannitol, xylitol, maltitol, maltitol syrup, lactitol, erythritol, isomalt, and hydrogenated starch hydrolysates. Their caloric content ranges from .02 to 3 calories per gram compared to 4 calories per gram for sugars. Most sugar alcohols are less sweet than sucrose; maltitol and xylitol are about as sweet as sucrose.

Due to their incomplete absorption, the polyol sweeteners produce a lower glycemic response than glucose or sucrose and may be useful for people with diabetes. Sugar alcohol-sweetened products may have fewer calories than comparable products sweetened with sucrose or corn syrup and hence could play a useful role in weight management.

Carbohydrate and Sugars Consumption Recommendations

The Institute of Medicine's *Dietary Reference Intakes* (DRI) Report recommends that Americans get the majority of their daily calories from carbohydrates. The DRI Report established the Acceptable Macronutrient Distribution Range (AMDR) for carbohydrates as 45 to 65 percent of

daily calorie intake, a value that has also been recommended by the *2010 Dietary Guidelines for Americans*. Children and adults need a minimum of 130 grams of carbohydrates per day for proper brain function. The DRI for carbohydrates and sugars recommends a maximum intake level of 25 percent or less from added sugars.

Carbohydrates and Sugars in the Diet

- **Safety:** The Food and Drug Administration (FDA) has examined numerous sugars, including glucose, dextrose, fructose, sucrose, high fructose corn syrup, lactose, and maltose, and determined that they are “generally recognized as safe” (GRAS). According to the FDA, sugars for use in foods have a proven track record of safety based either on a history of use or on published scientific evidence, and can be used in food products without further FDA approval.
- **Metabolism:** Once ingested, most carbohydrates and complex sugars are broken down into the simple sugar glucose. However, in the digestion of sucrose, both glucose and fructose are released into the bloodstream. Glucose is the primary fuel utilized by the brain and working muscles. To protect the brain from a potential fuel shortage, the body maintains a fairly constant glucose level in the blood. Dietary glucose can be stored in the liver and muscle cells in units called glycogen. When the level of glucose in the blood starts to drop, glycogen can be converted to glucose to maintain blood glucose levels. Several hormones, including insulin, work rapidly to regulate the flow of glucose to and from the blood to keep it at a steady level. Insulin also allows the muscles to get the glucose they need from the blood supply. In the process of breaking down carbohydrates into glucose, the body is unable to distinguish between sugars that are added to foods and sugars that occur naturally in foods, since they are chemically the same.
- **Carbohydrates, Sugars, and Weight Control:** Calories are needed for normal body processes. However, people will gain weight when they eat more calories than they use up in daily activities and exercise. These excess calories can come from all macronutrients—fats, proteins, carbohydrates, and even alcohol. Carbohydrates or sugars eaten within daily calorie needs, by definition, do not cause weight gain. According to the *2010 Dietary Guidelines Advisory Committee Report*, “healthy diets are high in carbohydrates”—45-65% of calories should come from carbohydrates depending on activity level. The report also suggests added sugar intake be limited to 25% or less of total calories.
- **Diabetes:** Diabetes is a metabolic disorder that occurs when the body cannot regulate blood glucose levels properly. In diabetes, either the pancreas does not make enough insulin (type 1 diabetes) or the body cannot respond normally to the insulin that is made (type 2 diabetes). The causes of diabetes continue to be a mystery, although both genetics and environmental factors seem to play a role. Obesity and lack of exercise are important in susceptibility to type 2 diabetes. Interestingly, sugars are not “off limits” for people with diabetes. Current American Diabetes Association (ADA) nutritional recommendations do not provide specific guidelines for intake of sugars, except to note that sugars and other carbohydrates can be substituted for one another on a calorie-for-calorie basis. The ADA also recommends limits on dietary fat and dietary saturated fat for diabetics.

- **Glycemic Index:** Glycemic index (GI) is a research tool that measures how carbohydrate-containing foods affect blood glucose levels. It is calculated by having one or more people eat a specific amount of a single food [usually the amount of food containing 50 grams of digestible carbohydrates (total carbohydrate minus fiber)] and then measuring the change in blood sugar levels compared with the levels achieved after they have eaten a control food containing the same amount of digestible carbohydrates, such as white bread or glucose. The average change in blood sugar levels over a set period of time relative to the levels after consumption of the control food, usually white bread or glucose, is the food's glycemic index. According to the GI theory, the lower the GI number, the slower food is digested, allowing for glucose to be delivered more slowly to the bloodstream than with foods having a higher GI number. It can be very difficult to apply the glycemic index to foods consumed in the real world environment as GI can vary widely depending on the mixture of foods eaten, the ripeness of foods, the degree to which the foods are cooked, and other factors. Most scientists agree that more research is needed prior to recommending GI as a measure on which to base dietary recommendations for the general population.
- **Dental Health:** Sugars and cooked starches (e.g.: bread, pasta, crackers, and chips) are fermentable carbohydrates that contribute to the risk for dental caries. The degree of risk from a carbohydrate-rich food is related to several factors such as exposure time and frequency of consumption. However, risk can be decreased through several practices, the most important being proper oral hygiene and the use of topical fluorides, fluoridated toothpaste, and fluoridated water. Also important in reducing the risk of caries is eating a balanced diet in line with current dietary guidelines.
- **Sugars, Mental Performance, and Behavior:** Numerous studies with different populations show that sugar consumption does not affect hyperactivity, attention span, or cognitive performance in children.

The Bottom Line

As the main energy source for the body, carbohydrates are an important part of a healthful diet. Currently, experts agree that carbohydrates and sugars in foods and beverages can be enjoyed in moderation as part of a balanced diet and active lifestyle.

http://www.foodinsight.org/Resources/Detail.aspx?topic=Background_on_Carbohydrates_Sugars