

Alternatives to Sugar



- This ppt was set up especially for those BU readers who wish to lose weight or are trying to manage their diabetes, and are seeking sugar substitutes.
- Hope you will find it useful.

Alternatives to Sugar

- Almost everyone finds pleasure in sweet foods—after all, the taste preference for sweets is inborn.
- To a child, the sweeter the food, the better. In adults, this preference is somewhat diminished, but most adults still enjoy an occasional sweet food or beverage.
- **Because they want to control weight gain, blood glucose, and dental caries, many consumers turn to alternative sweeteners to help them limit kcalories and minimize sugar intake.**
- In doing so, they encounter two sets of alternative sweeteners: **artificial sweeteners and sugar replacers.**

Alternatives to Sugar

- **A. Artificial Sweeteners**
 - 1. Saccharin
 - 2. Aspartame
 - 3. Acesulfame-K
 - 4. Sucralose
 - 5. Neotame
 - 6. Tagatose
 - 7. Alitame and Cyclamate
 - 8. Acceptable Daily Intake
 - 9. Artificial Sweeteners and Weight Control
- **B. Stevia—An Herbal Alternative**
- **C. Sugar Replacers**

Artificial Sweeteners

- The Food and Drug Administration (FDA) has approved the use of several artificial sweeteners—saccharin, aspartame, acesulfame potassium (acesulfame-K), sucralose, and neotame.
- Two others are awaiting FDA approval—alitame and cyclamate. Another—tagatose—did not need approval because it is generally recognized as a safe ingredient.
- **These artificial sweeteners are sometimes called nonnutritive sweeteners because they provide virtually no energy.**
- Table H4-1 and the accompanying glossary provide general details about each of these sweeteners.

Sweeteners	Relative Sweetness ^a	Energy (kcal/g)	Acceptable Daily Intake	Average Amount to Replace 1 tsp Sugar	Approved Uses
Approved Sweeteners (Trade Name)					
Saccharin (Sweet 'n Low)	450	0	5 mg/kg body weight	12 mg	Tabletop sweeteners, wide range of foods, beverages, cosmetics, and pharmaceutical products
Aspartame (NutraSweet, Equal, NutraTaste)	200	4 ^b	50 mg/kg body weight ^c	18 mg	General purpose sweetener in all foods and beverages Warning to people with PKU: Contains phenylalanine
Acesulfame potassium or Acesulfame-K (Sunette, Sweet One, Sweet 'n Safe)	200	0	15 mg/kg body weight ^d	25 mg	Tabletop sweeteners, puddings, gelatins, chewing gum, candies, baked goods, desserts, beverages
Sucralose (Splenda)	600	0	5 mg/kg body weight	6 mg	General purpose sweetener for all foods
Neotame	8000	0	18 mg/day	0.5 µg	Baked goods, nonalcoholic beverages, chewing gum, candies, frostings, frozen desserts, gelatins, puddings, jams and jellies, syrups
Tagatose (NutraLose)	0.8	1.5	7.5 g/day	1 tsp	Baked goods, beverages, cereals, chewing gum, confections, dairy products, dietary supplements, health bars, tabletop sweetener
Sweeteners with Approval Pending					
Alitame	2000	4 ^e	—	—	Proposed Uses Beverages, baked goods, tabletop sweeteners, frozen desserts
Cyclamate	30	0	—	—	Tabletop sweeteners, baked goods

^aRelative sweetness is determined by comparing the approximate sweetness of a sugar substitute with the sweetness of pure sucrose, which has been defined as 1.0. Chemical structure, temperature, acidity, and other flavors of the foods in which the substance occurs all influence relative sweetness.

^bAspartame provides 4 calories per gram, as does protein, but because so little is used, its energy contribution is negligible. In powdered form, it is sometimes mixed with lactose, however, and a 1-gram packet may provide 4 calories.

^cRecommendations from the World Health Organization and in Europe and Canada limit aspartame intake to 40 milligrams per kilogram of body weight per day.

^dRecommendations from the World Health Organization limit acesulfame-K intake to 9 milligrams per kilogram of body weight per day.

^eAlitame provides 4 calories per gram, as does protein, but because so little is used, its energy contribution is negligible.

TABLE H4-1

Sweeteners

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Cyclamate	30	0	—		Tabletop sweeteners, baked goods

- Saccharin, acesulfame-K, and sucralose are not metabolized in the body; in contrast, **the body digests aspartame as a protein. In fact, aspartame yields energy (4 kcalories per gram, as does protein), but because so little is used, its energy contribution is negligible.**
- Some consumers have challenged the safety of using artificial sweeteners. **Considering that all substances are toxic at some dose, it is little surprise that large doses of artificial sweeteners (or their components or metabolic byproducts) have toxic effects.**
- **The question to ask is whether their ingestion is safe for human beings in quantities people normally use (and potentially abuse).**

Saccharin

- Saccharin, used for over 200 years in the United States, is currently used by some 50 million people—primarily in soft drinks, secondarily as a tabletop sweetener.
Saccharin is rapidly excreted in the urine and does not accumulate in the body.
- Questions about saccharin's safety surfaced in 1977, when experiments suggested that large doses of saccharin (equivalent to hundreds of cans of diet soda daily for a lifetime) increased the risk of bladder cancer in rats.
- The FDA proposed banning saccharin as a result. Public outcry in favor of saccharin was so loud, however, that Congress imposed a moratorium on the ban while additional safety studies were conducted.
- **Products containing saccharin were required to carry a warning label until 2001, when studies concluded that saccharin did not cause cancer in humans.**

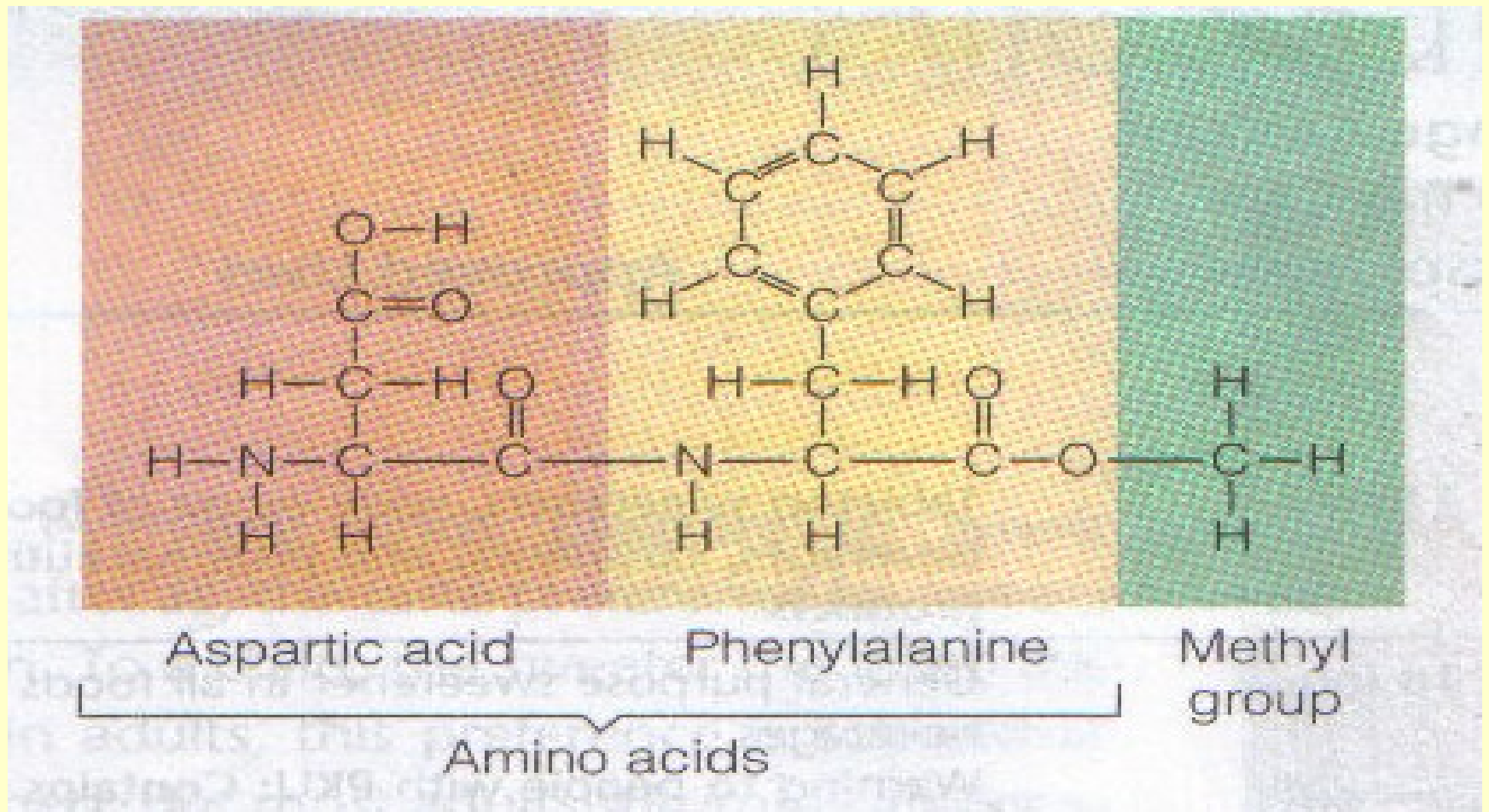
- **Does saccharin cause cancer? The largest population study to date involving 9000 men and women, showed that overall saccharin use did not increase the risk of cancer.**
- **Among certain small groups of the population, however, such as those who both smoked heavily and used saccharin, the risk of bladder cancer was slightly greater.** Other studies involving more than 5000 people with bladder cancer showed no association between bladder cancer and saccharin use.
- **In 2000, saccharin was removed from the list of suspected cancer-causing substances.** Warning labels are no longer required.
- **Common sense dictates that consuming large amounts of any substance is probably not wise, but at current, moderate intake levels, saccharin appears to be safe for most people. It has been approved for use in more than 100 countries.**

Aspartame

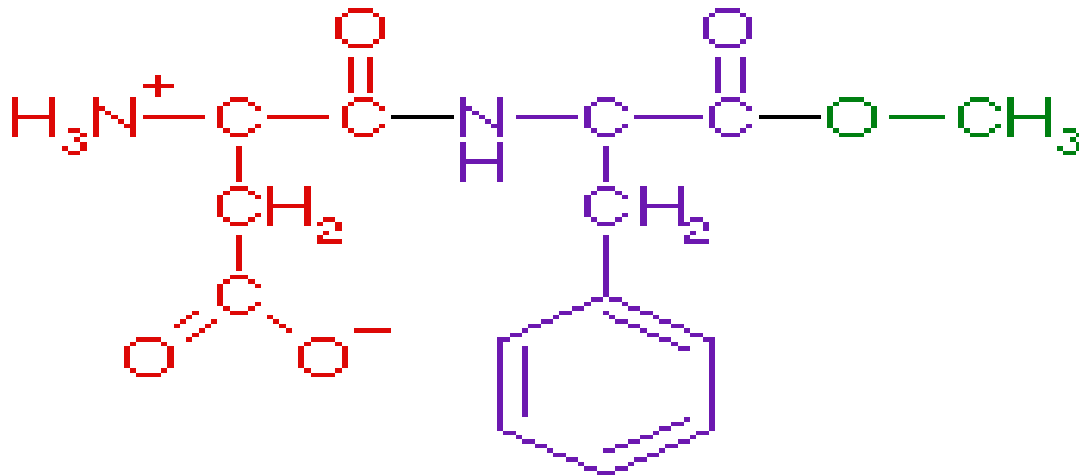
- **Aspartame** is a simple chemical compound made of components common to many foods: two amino acids (phenylalanine and aspartic acid) and a methyl group (CH₃). Its chemical structure is shown in the next slide
- The flavors of the components give no clue to the combined effect because one of them tastes bitter, and the other is tasteless, but the combination creates a product that is **200 times sweeter than sucrose**.
- This sugar substitute, sold commercially as **Equal and NutraSweet**, was hailed as the savior for dieters who for decades had put up with saccharine's unpleasant after taste.
- But there are quite a few problems with aspartame. **The first is phenylketonuria (PKU)**.
- Because this sweetener contributes phenylalanine, products containing aspartame must bear a warning label for people with the inherited disease phenylketonuria (PKU).
- People with PKU are unable to dispose of any excess phenylalanine. The accumulation of phenylalanine and its by-products is toxic to the developing nervous system, causing irreversible brain damage.

- For this reason, all newborns in the United States are screened for PKU. The treatment for PKU is a special diet that must strike a balance, providing enough phenylalanine to support normal growth and health but not enough to cause harm.
- The little extra phenylalanine from aspartame poses only a small risk, even in heavy users, but children with PKU need to get all their required phenylalanine from foods instead of from an artificial sweetener.
- The PKU diet excludes such protein- and nutrient-rich foods as milk, meat, fish, poultry, cheese, eggs, nuts, legumes, and many bread products. Consequently, these children have difficulty obtaining the many essential nutrients—such as calcium, iron, and the B vitamins—found along with phenylalanine in these foods.
- Children with PKU cannot afford to squander their limited phenylalanine allowance on the phenylalanine of aspartame, which contributes none of the associated vitamins or minerals essential for good health and normal growth.
- **Phenylketonurics should avoid aspartame because aspartame contains the amino acid phenylalanine.**
- **Aspartame, which contains phenylalanine, and products containing aspartame should be avoided by children with phenylketonuria**

Structure of aspartame



Aspartame (**NutraSweet**) consists of a methyl ester of L-aspartate and L-phenylalanine:



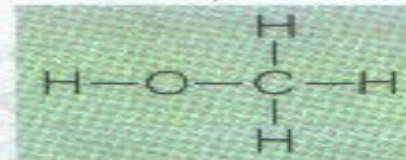
Aspartame

- In the digestive tract, enzymes split aspartame into its three component parts.
- The body absorbs the two amino acids and uses them just as if they had come from food protein, which is made entirely of amino acids, including these two.
- During metabolism, the methyl group momentarily becomes methyl alcohol (methanol)—a potentially toxic compound
- This breakdown also occurs when aspartame-sweetened beverages are stored at warm temperatures over time.
- The amount of methanol produced may be safe to consume, but a person may not want to, considering that the beverage has lost its sweetness.
- **In the body, enzymes convert methanol to formaldehyde, another toxic compound.** Finally, formaldehyde is broken down to carbon dioxide..

Metabolism of aspartame

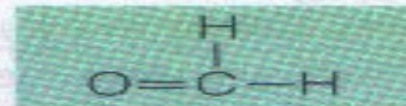


Methyl
group
hydrolyzed



Methanol

Oxidized



Formaldehyde

Oxidized



Carbon dioxide

- **Before aspartame could be approved, the quantities of *these products generated during metabolism had to be determined*, and they were found to fall below the threshold at which they would cause harm. In fact, ounce for ounce, tomato juice yields six times as much methanol as a diet soda.**
- A recent Italian study found that aspartame caused cancer in female rats and fueled the controversies surrounding aspartame's safety. Statements from the FDA and others, however, indicate that such a conclusion is not supported by the data. The only valid scientific concern is that for people with epilepsy, excessive intake of aspartame may decrease their threshold for seizures; this does not appear to be a problem when intakes are within recommended amounts.
- NOTE that other researchers consider aspartame to be harmful

- **Beyond PKU, several scientists believe that aspartame might cause altered brain function and behavior changes in consumers. And many people have reported the following side effects from aspartame:**
- **Fibromyalgia Syndrome and symptoms of Fibromyalgia**
- **Multiple Sclerosis symptoms**
- **Dizziness**
- **Headaches**
- **Menstrual problems**

Acesulfame-K

- Because **acesulfame potassium (acesulfame-K)** passes through the body unchanged, it does not provide any energy nor does it increase the intake of potassium.
- Acesulfame-K is approved for use in the United States, Canada, and more than 6 other countries

Sucralose

- Sucralose is unique among the artificial sweeteners in that it is made from sugar that has had three of its hydroxyl (OH) groups replaced by chlorine atoms. The result is **an exceptionally stable molecule that is much sweeter than sugar.**
- **Because the body does not recognize Sucralose as a carbohydrate, it passes through the GI tract undigested and unabsorbed.**

Neotame

- Like aspartame, **neotame** also contains the amino acids phenylalanine and aspartic acid and a methyl group. Unlike aspartame however, **neotame has an additional side group attached. This simple difference makes all the difference to people with PKU because it blocks the digestive enzymes that normally separate phenylalanine and aspartic acid. Consequently, the amino acids are not absorbed and neotame need not carry a warning for people with PKU.**

Tagatose

- The FDA granted the fructose relative **tagatose** the status of "**generally recognized as safe,**" making it **available as a low-kcalorie sweetener for a variety of foods and beverages.** This monosaccharide is naturally found in only a few foods, but it can be derived from lactose.
- Unlike fructose or lactose, however, 80 percent of tagatose remains unabsorbed until it reaches the large intestine, where bacteria ferment tagatose, releasing gases and short chain acids that are absorbed. **As a result, tagatose provides 1.5 kcalories per gram.**
- **At high doses, tagatose causes flatulence, rumbling, and loose stools; otherwise, no adverse side effects have been noted.**
- **In fact, tagatose is a prebiotic that may benefit health. Unlike other sugars, tagatose does not promote dental caries** and may carry a dental caries health claim.

Alitame and cyclamate

- FDA approval for **alitame** and **cyclamate** is still pending. To date no safety issues have been raised for alitame, and it has been approved for use in other countries.
- In contrast, cyclamate has battling safety issues for 50 years. Approved by the FDA in 1949, cyclamate was banned in 1969 principally on the basis of one study indicating that it caused bladder cancer in rats.
- The National Research Council has reviewed dozens of studies on cyclamate and concluded that neither cyclamate nor its metabolites cause cancer. The council did, however, recommend further research to determine if heavy or long-term use poses risks.
- Although cyclamate does not *initiate cancer*, it *may promote cancer* - development once it is started.
- The FDA currently has no policy on substances that enhance the cancer-causing activities of substances, but it is unlikely to approve cyclamate soon, if at all.
- Agencies in more than 50 other countries, including Canada, have approved cyclamate.

Acceptable Daily Intake

- The amount of artificial sweetener considered safe for daily use is the **Acceptable Daily Intake** (ADI). The ADI represents the level of consumption that, if maintained every day throughout a -person's life, would still be considered safe by a wide margin/
- It usually reflects an amount 100 times less than the level at which no observed effects occur in animal research studies.
- The ADI for aspartame, for example, is 50 milligrams per kilogram body weight. That is, the FDA approved aspartame based on the assumption that no one would consume more than 50 milligrams per kilogram of body weight in a day.
- This maximum intake is indeed high: for a 150-pound adult, it adds up to 97 packets of Equal or 20 cans of soft drinks sweetened only with aspartame

- The company that produces aspartame estimates that if all the sugar and saccharin in the U.S. diet were replaced with aspartame, 1 percent of the population would be consuming the FDA maximum.
- Most people who use aspartame consume less than 5 milligrams per kilogram of body weight per day. But a young child who drinks four glasses of aspartame-sweetened beverages on a hot day and has five servings of other products with aspartame that day (such as pudding, chewing gum, cereal, gelatin and frozen desserts) consumes the FDA maximum level.
- Although the intake presents no proven hazard, it seems wise to offer children other foods so as not to exceed the limit.
- The table in the next slide lists the average amounts of aspartame in some common foods.
- For persons choosing to use artificial sweeteners, the American Dietetic Association wisely advises that they be used in moderation only as part of a well-balanced nutritious diet.⁴
- The dietary principles of moderation and variety help to reduce the possible risks associated with any food.

TABLE H4-2**Average Aspartame Contents of Selected****Foods**

Food	Aspartame (mg)
12 oz diet soft drink	170
8 oz powdered drink	100
8 oz sugar-free fruit yogurt	124
4 oz gelatin dessert	80
1 packet sweetener	35

Artificial Sweeteners and Weight Control

- The rate of obesity in the United States, and other countries has been rising for decades. Foods and beverages sweetened with artificial sweeteners were among the first products developed to help people control their weight. **Ironically, a few studies have reported that intense sweeteners, such as aspartame, may stimulate appetite, which could lead to weight gain.** **Contradicting these reports, most studies find no change in feelings of hunger and no change in food intakes or body weight.** Adding to the confusion, some studies report lower energy intakes and greater weight losses when people eat or drink artificially sweetened products.⁵
- When studying the effects of artificial sweeteners on food intake and body weight, researchers ask different questions and take different approaches. It matters, for example, whether the people used in a study are of a healthy weight and whether they are following a weight-loss diet.
- Motivations for using sweeteners differ, too, and this influences a person's actions. For example, one person might drink an artificially sweetened beverage now so as to be able to eat a high-kcalorie food later. This person's energy intake might stay the same or increase.

- A person trying to control food energy intake might drink an artificially sweetened beverage now and choose a low-kcalorie food later. This plan would help reduce the person's total energy intake.
- In designing experiments on artificial sweeteners, researchers have to distinguish between the effects of sweetness and the effects of a particular substance.
- If a person is hungry shortly after eating an artificially sweetened snack, is that because the sweet taste (of all sweeteners, including sugars) stimulates appetite? Or is it because the artificial sweetener itself stimulates appetite?
- Research must also distinguish between the effects of food energy and the effects of the substance. If a person is hungry shortly after eating an artificially sweetened snack, is that because less food energy was available to satisfy hunger? Or is it because the artificial sweetener itself triggers hunger? Furthermore, if appetite is stimulated and a person feels hungry, does that actually lead to increased food intake?
- Whether a person compensates for the energy reduction of artificial sweeteners either partially or fully depends on several factors. **Using artificial sweeteners will not automatically lower energy intake; to control energy intake successfully, a person needs to make informed diet and activity decisions throughout the day**

Stevia—An Herbal Alternative

- The FDA has backed its approval or denial of artificial sweeteners with decades of extensive research.
- Such research is lacking for the herb **stevia**, a shrub whose leaves have long been used by the people of South America to sweeten their beverages.
- In the United States, stevia is sold in health-food stores as a dietary supplement.
- **The FDA has reviewed the limited research on the use of stevia as an alternative to artificial sweeteners and found concerns regarding its effect on reproduction, cancer development, and energy metabolism.**
- Used sparingly, stevia may do little harm, but the FDA could not approve its extensive and widespread use in the U.S. market. The European Union and the United Nations have reached similar conclusions.
- **In Canada, provisional guidelines have been adopted for the use of stevia as a medicinal ingredient and as a sweetening agent.**
- That stevia can be sold as a dietary supplement but not used as a food additive in the United States, highlights key differences in FDA regulations.
- Food additives must prove their safety and effectiveness before receiving FDA approval, whereas dietary supplements are not required to submit to any testing or receive any approval.

Sugar Replacers

- **Some "sugar-free" or reduced-kcalorie products contain sugar replacers.*** The term *sugar replacers* describes the sugar alcohols—familiar examples include erythritol, mannitol, sorbitol, xylitol, maltitol, isomalt, and lactitol—that provide bulk and sweetness in cookies, hard candies, sugarless gums, jams, and jellies.
- To minimize confusion, the American Diabetes Association prefers the term sugar replacers instead of "sugar alcohols" (which connotes alcohol), "bulk sweeteners" (which connotes fiber), or "sugar substitutes" (which connotes aspartame and saccharin).
- **These products claim to be "sugar-free" on their labels, but in this case, "sugar-free" does not mean free of kcalories. Sugar replacers do provide kcalories, but fewer than their carbohydrate cousins, the sugars.**
- **Because sugar replacers yield energy, they are sometimes referred to as nutritive sweeteners.**
- Table H4-3 includes their energy values, but a simple estimate can help consumers: divide grams by 2.
- **Sugar alcohols occur naturally in fruits and vegetables; manufacturers also use sugar alcohols as a low-energy bulk ingredient in many processed foods.**

TABLE H4-3**Sugar Replacers**

Sugar Alcohols	Relative Sweetness^a	Energy (kcal/g)	Approved Uses
Erythritol	0.7	0.4	Beverages, frozen dairy desserts, baked goods, chewing gum, candies
Isomalt	0.5	2.0	Candies, chewing gum, ice cream, jams and jellies, frostings, beverages, baked goods
Lactitol	0.4	2.0	Candies, chewing gum, frozen dairy desserts, jams and jellies, frostings, baked goods
Maltitol	0.9	2.1	Particularly good for candy coating
Mannitol	0.7	1.6	Bulking agent, chewing gum
Sorbitol	0.5	2.6	Special dietary foods, candies, gums
Xylitol	1.0	2.4	Chewing gum, candies, pharmaceutical and oral health products

^aRelative sweetness is determined by comparing the approximate sweetness of a sugar replacer with the sweetness of pure sucrose, which has been defined as 1.0. Chemical structure, temperature, acidity, and other flavors of the foods in which the substance occurs all influence relative sweetness.

- **Sugar alcohols evoke a low glycemic response. The body absorbs sugar alcohols slowly; consequently, they are slower to enter the bloodstream than other sugars.**
- **Side effects such as gas abdominal discomfort, and diarrhea, however, make them less attractive than the artificial sweeteners. For this reason, regulations require food labels to state "Excess consumption may have a laxative effect" if reasonable consumption of that food could result in the daily ingestion of 50 grams of a sugar alcohol.**
- **The real benefit of using sugar replacers is that they do not contribute to dental caries. Bacteria in the mouth cannot metabolize sugar alcohols as rapidly as sugar. They are therefore valuable in chewing gums, breath mints, and other products that people keep in their mouths for a while.**
- **The sugar replacers, like the artificial sweeteners, can occupy a place in the diet, and provided they are used in moderation, they will do no harm. In fact, they can help, both by providing an alternative to sugar for people with diabetes and by inhibiting caries-causing bacteria.**
- **People may find it appropriate to use all three sweeteners at times: artificial sweeteners, sugar replacers, and sugar itself.**