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SUGAR SUBSTITUTES

A Comparison of Non-Nutritive Sweeteners

Saccharin: The oldest of the sugar substitutes, its discovery dates back 100 years. Saccharin, also known as "Sweet N Low", is a petroleum derivative. Its relative sweetness: 300 times sweeter than sucrose (table sugar). It is not metabolized by the body and is excreted, unchanged, by the kidneys. It is chemically stable when exposed to heat and solution. It can have a bitter aftertaste at high concentrations. The FDA proposed a ban on saccharin in 1977 because of some research suggesting it to be a weak carcinogen in animals. However, public outcry and questionable study techniques prevented it from ever being banned in the U.S. Currently, saccharin is considered safe with over twenty years of research to prove it.

Aspartame: Best known as "NutraSweet" and "Equal", this protein-based non-nutritive sweetener was approved in 1981 as a tabletop sweetener and in 1983 as a carbonated beverage additive. It is a dipeptide of L-aspartic acid and L-phenylalanine methyl ester. It is metabolized in the intestine to aspartate, phenylalanine, and methanol. Individuals with a rare genetic metabolism disorder known as phenylketonuria (PKU) cannot metabolize the amino acid phenylalanine. Infants are tested for PKU at birth to prevent mental retardation. Therefore, Aspartame-containing products include a warning label for these individuals. Its relative sweetness: 180-220 times sweeter than sucrose. It is not stable when exposed to heat for prolonged periods, so it is not a good option for baking. A 1996 paper suggested its link to an increased incidence of brain tumors, but a review by the FDA (U.S. Food and Drug Administration) and CDC (Centers for Disease Control) found no symptoms clearly related to aspartame consumption.

Sucralose: Marketed under the brand name of "Splenda", it was approved by the FDA in 1998 for use in 15 food categories. It is a derivative of sucrose, created by selective chlorination of hydroxyl groups. It's relative sweetness: 600 times sweeter than sucrose. Along with its intense sweetness, it is heat-stable and dissolves well in solution.

Acesulfame-K: It was discovered in 1967, but not approved for use in beverages until 1998. Like saccharin, it passes unchanged through the body and is excreted by the kidneys. "Sunette" is the trade name for "Ace-K", and tabletop sweeteners using this are "Sweet One" and "SwissSweet". Its relative sweetness: 200 times sweeter than sucrose. Of interest to the food industry, it has long-term stability and is not changed with heat. It also blends well with other sweeteners, allowing manufacturers to blend two or more sweeteners and obtain the desired sweetness using less total product.

Neotame: The FDA has approved Neotame, made by the "NutraSweet" company, as a general purpose sweetener. Unlike its earlier counterpart aspartame, it is water-soluble, free flowing (as a table top sweetener) and heat-stable. Its relative sweetness: 7,000-13,000 times sweeter than sucrose. The FDA is said to have reviewed more than 113 animal/ human studies before giving approval for its use.

Cyclamate: Discovered in 1937 and approved for use in 1951, cyclamate was originally classified as a "drug" until its status changed to that of "food additive" in 1958. It was withdrawn from the market in 1969

because of a possible causal role in bladder cancer of test mice. Its relative sweetness: 30 times sweeter than sucrose. It is chemically stable and boosts the sweetness of other sugar substitutes. FDA approval is still pending.

Alitame: A protein-based sweetener formed from amino acids L-aspartic acid and D-alanine. FDA approval is pending. Its relative sweetness: 2,000 times sweeter than sucrose.

Polyols & Sugar Alcohols

Sugar alcohols are types of polyols formed from the partial breakdown and hydrogenation of edible starches, sugar alcohols are sweet, but contribute only about 2 calories of energy per gram of product. Sorbitol, mannitol, and xylitol are commonly used sweetening substitutes in products such as chewing gum and candies. They also provide desired bulk to some foods. They do not have the cavity-promoting features of sugars but can result in GI upset and diarrhea if taken in large enough quantities. Sugar alcohols also result in a lower rise in blood glucose and insulin levels when compared with sugars and other carbohydrates. They are also used in food products as alternatives to sugars since they contribute minimal calories and minimally affect blood glucose levels.

The Current Controversy:

Dr. Adam Drewnowski, Center for Public Health Nutrition at the U. of Washington director, published a study in the European Journal of Clinical Nutrition with Dr. F. Bellisle which concluded that "Low calorie and non-calorie sweeteners in beverages and foods can help people reduce their calorie (energy) intakes." "Every dietary guideline these days tells us to bulk up, hydrate and consume foods with fewer calories but more volume" **"**Replacing sugar with low-calorie sweeteners is a common strategy for facilitating weight control. By providing sweet taste without calories, intense sweeteners help lower energy density of beverages and some foods. But are the energy reduction goals, in fact, achieved? The uncoupling of sweetness and energy, afforded by intense sweeteners, has been the focus of numerous studies over the past two decades. There are recurring arguments that intense sweeteners increase appetite for sweet foods, promote overeating, and may even lead to weight gain."

It is possible that consumption of non-caloric sweeteners is related to an increased consumption of other calories. A recent study of 27 rats, showed that the animals who ate yogurt sweetened with non-calorie saccharin ended up eating more and gaining more weight than animals consuming yogurt sweetened with glucose. Studies of this nature keep the "nutritive" versus "nonnutritive" controversy alive. Study author, Susan Swithers of Purdue University, is quoted as saying, "It seems to be a subconscious process based on automatic estimations of how much energy certain foods will provide." "For example, a sweet taste might be a sign that "calories are coming and I should prepare my body for the arrival of those calories. However, when the sweetness is not followed by a lot of calories, the body's digestive system gets confused, and the metabolism rate does not gear up as much the next time sweetness is tasted."

In reference to this article, Lyn Nabors (president of the Calorie Control Council trade group) stated that the study had no basis in science. "Artificial sweeteners can help people lose weight", she said. "The scientific community firmly believes that "calories in, calories out is what makes a difference. The recommendation is that you reduce calories and exercise if you want to lose weight."

Beth Hubrich, registered dietitian with the Calorie Control Council, states that the causes of obesity are multi-factorial. "Although surveys show that there has been an increase in the use of sugar-free foods over the years, portion sizes of foods have also increased, physical activity has decreased, and the overall calorie intake has increased."

Regarding the question of whether one or more of the available "sugar substitutes" causes increased cancer risk, The National Cancer Institute made this summary statement: "There is no clear evidence that the artificial sweeteners on the market in the United States are related to cancer risk in humans." You can read more details about studies on each of the marketed sugar substitutes at the National Cancer Institute's website listed in the "Additional Reading & Resources" section.

A Word About "Nutritive Sweeteners"

Unlike "nonnutritive sweeteners, "nutritive sweeteners" refer to sweetening products that contribute calories and carbohydrates to the diet. They are generally used as alternatives to table sugar (i.e. sucrose). Sugars, as well as "nutritive sweeteners", generally contribute 4 calories of energy per gram. "Nutritive sweeteners" include: fructose, corn syrup, honey, molasses, fruit juice, fruit juice concentrate, dextrose, maltose, high fructose corn syrup (HFCS) and hydrogenated starch hydrolysates.

Additional Reading & Resources

- http://www.news-medical.net/?id=35135
- http://www.cancer.gov/cancertopics/factsheet/Risk/artificial-sweeteners
- http://www.nature.com/ejcn/journal/v61/n6/abs/1602649a.html
- http://www.medicinenet.com/script/main/art.asp?articlekey=20867
- http://www.beverageinstitute.org/healthcare_professionals/pdf/low_calorie_sweetener_fact_sheet.pdf

European Journal of Clinical Nutrition (2007), 61, 691-700; F. Bellisle, A. Drewnowski. "Intense Sweeteners, Energy Intake and the Control of Body Weight."