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The Negative Effects of Sugar and Nonnutritive Sweeteners: Can We Have Our Cake and Eat It Too?

America has an undeniably large sweet tooth. It seems as though anywhere you go, you find some sort of sugary fare. The reason for this is simple: Sugar tastes good and, when consumed in moderation, is not bad to have in a balanced diet. However, when excess sugar is consumed on a regular basis, it can detrimentally affect the body, most noticeably through weight gain. As a result, people who are trying to lose weight or attempting to eat a healthier diet have begun to use nonnutritive sweeteners as an alternative to sugar, cutting back the calories and, hopefully, the fat. Ironically, however, these sweeteners which are meant to “save” people from unwanted calories are actually just as harmful to our bodies as sugar is. Nonnutritive sweeteners have been found to disrupt body chemistry, potentially cause cancer, and even trigger weight gain. The use of artificial sweeteners is not a valid alternative to eating sugar, but merely an equally unhealthy replacement to a destructive habit. This indulgence in artificial sweeteners adequately reflects the attitude of many of us Americans in desiring to do anything to satisfy our desires and pleasures without reaping the negative consequences. This, however, only momentarily delays the upcoming consequences and many times enhances them. Therefore, people should reduce the amount of sugar they consume rather than merely replace it with artificial sweeteners.

Sweeteners have been around for a long time. In ancient Biblical, Chinese, and Greek texts, honey, being the “first recorded sweetener,” is mentioned with a “positive connotation” (Bright, 3). For example, Deuteronomy 26:15 is one among many instances in which the long-awaited Promised Land is referred to as “a land that floweth with milk and honey” (*King James Version*). Honey, it seems, was prized for its sweet and delicate taste. However, with the discovery of sugar cane and sugar beets came the introduction of sucrose, a sweet “disaccharide composed of glucose and fructose” (ADA 5). Honey, though it is no longer the only available sweetener, is still commonly used and is said to be one of the healthiest sweeteners. This is because fructose, the main sweetening component in honey, does not enter the bloodstream as quickly as sucrose does, causing less of a blood sugar spike (ADA 5). Because the amount of fructose in honey exceeds the amount of glucose, honey does not make our glucose response as high as sugar cane or sugar beets do (ADA 5). Other nutritive sweeteners include polyols (sugar alcohols), which are naturally found in fruits, though they are synthesized when sold in food products (ADA 8). All these sugars are considered safe in a low dose; however, the trouble arises when people consume too much of them, as can be observed in America. In fact, according to the USDA, Americans consumed an average of 152.4 lbs. of sugar per capita in 2000 (8). This indicates that the average person consumed approximately 32-52 teaspoons of sugar each day, taking the chance of loss or spoilage into account (USDA 9).

The frightening aspect of these numbers lies in what sugar does to our bodies. According to Nancy Appleton, PhD, sugar throws off your body’s ability to function proficiently and can make one susceptible to cancer as well as other ailments, such as arthritis, asthma, gall and kidney stones, yeast infections, headaches, and food allergies to name a few (68-72). Habitual abuse of sugar intake can result in hypoglycemia, a tendency for blood sugar to be too low. This

happens when endocrine cells in your pancreas become over-stimulated and secrete too much insulin, causing blood glucose levels to drop (Appleton 60-62). On the other hand, high sugar intake can also cause diabetes if it exhausts your pancreas so that it produces too little insulin, resulting in high blood sugar (Appleton 62-65). Also, because sugar disrupts the balance of minerals in your body, such as the “calcium-phosphorous ratio,” it hinders the functions that keep your heart healthy, making you more susceptible to cardiovascular disease (Appleton 87-90, 22-23). In addition, sugar is an addictive substance, like alcohol or caffeine, and can even produce withdrawal symptoms in people who are accustomed to eating it regularly (Appleton 46-49).

The most obvious downfall of sugar is its high caloric content. Americans not only live a more sedentary lifestyle nowadays, they also consume more of sugar’s delicious calories. This naturally results in weight gain, which is why many overweight people lament their sweet tooth. But more than merely its high caloric content, sugar, specifically fructose, has been reported to reduce response to leptin, a hormone that tells your body it is satisfied (Shapiro 6). In her experiment, Alexandra Shapiro separated a group of rats into two groups, one of which was fed a fructose-free diet and the other a 60% fructose diet. After acclimation, both rats were fed high fat diets. The first group, which did not eat sugar, ate less of the high fat food and remained responsive to leptin. The second group, however, did not eat less and, therefore, gained weight. This experiment suggested that a diet high in sugar can, in fact, cause a person’s body to become unresponsive to leptin and, therefore, not know when to stop eating, resulting in substantial weight gain.

So what can a person do who wants to experience the pleasure of sweetness but does not want the negative results that accompany it? The discovery of artificial sweeteners provided a

seemingly wondrous answer, especially for those who were overweight or diabetic. Beginning with saccharine, which was patented by John F. Queeny in 1901, artificial sweeteners have grown more accepted and are now used in table top sweeteners, “light” foods, and beverages, especially diet sodas (Mitchell 104). There are five main FDA-approved artificial sweeteners that American consumers use: saccharine, aspartame, acesulfame-K, sucralose, and neotame (ADA 8).

Saccharine, a colorless crystalline, has no caloric effect on the body because it is incompletely absorbed by the small intestine and is not metabolized. Saccharine, also referred to as Sweet&Low®, is 200-700 times sweeter than sucrose and is not allowed by the FDA to surpass 12 mg per fluid ounce in any beverage (ADA 11). Aspartame, which was accidentally discovered in 1965, is used in NutraSweet® and Equal®. It actually contains just as many calories as sugar does yet because of its intense sweetness, being 160-220 times sweeter than sucrose, its caloric content is insignificant because so little is needed (ADA 9). The FDA has advised daily intake (ADI) of 50 mg per kg of body weight for aspartame (ADA 9). Acesulfame-K has sweetness 200 times stronger than that of sucrose and its ADI is 9 to 15 mg/kg (ADA 9). Acesulfame-K has an interesting ability to blend well with other artificial sweeteners and even aid in hiding any metallic aftertaste they may have (ADA 9). This sweetener is not metabolized either and leaves the body through the urinary tract still chemically intact (ADA 9). Sucralose, a newer nonnutritive sweetener used in Splenda®, has sweetness 600 times more concentrated than sucrose does and has an ADI of 15 mg/kg (ADA 11). Sucralose has been considered one of the best artificial sweeteners for its stability in baking and foods with a low pH. It is made from sucrose, but modified to keep the sweetness and extract the calories (Mitchell 131). The latest artificial sweetener the FDA has approved is neotame (ADA 8). Being 7,000 to 13,000 times

sweeter than sucrose, neotame is a more potently sweet nonnutritive sweetener that possesses a chemical structure similar to aspartame, though its ADI is only 18 mg/kg (ADA 10). Although there are many other artificial sweeteners available in the world, these five are the main ones seen and consumed in America as well as approved by the FDA.

Although these sweeteners have been declared harmless by the FDA and many other sources, experiments have been done that serve as evidence in favor of the idea that certain artificial sweeteners are carcinogenic. An experiment testing the genotoxicity of saccharine, acesulfame-K, and aspartame reveals that saccharine and acesulfame-K can induce DNA damage, a precursor to cancer (Bandyopadhyay 7). In this particular experiment, aspartame did not prove to induce as much damage as the other sweeteners did (Bandyopadhyay 7, 9). However, according to Morando Soffritti and his colleagues, aspartame has been found to have carcinogenic effects when consumed over a long period of time. Rats fed the average dose of aspartame for their entire lives were found to have more tumors, especially those related to leukemia (Soffritti et al. 3-4).

In addition to being a cancer hazard, nonnutritive sweeteners can actually trigger weight gain, the very symptom they were hoped to combat. This goes contrary to the common idea that, because artificial sweeteners do not contain calories, they are great tools that aid in weight loss. Studies, however, show that if young people consume a large amount of artificial sweeteners, their bodies are trained to not associate the taste of sweetness with energy as they should (Pierce, 10). In a normal body, when sugar is consumed, the intestines expect incoming calories and prepare for them. The body is expecting to burn the calories as well as signaling the brain that it needs less calories in the near future (Swithers and Terry 9, 11). However, artificial sweeteners give you the sweet taste without the calories, training your body to not expect the extra energy.

In addition, it tricks your body into consuming more food and not compensating for the extra calories. This, of course, induces weight gain when you eat nutritive sweeteners, since extra calories are added to your diet without being decreased elsewhere. Experiments have shown that rats that consume artificial sweeteners gain more weight than do rats on either a sweet-free diet or even a diet that included glucose (Swithers and Terry 10). If your body is trained to eat a certain amount of food with significantly less calories due to artificial sweeteners, you will continue to eat that same bulk even when a higher density of calories is present. This presents a significant problem, especially in regards to the obesity rate among the youth in America. If children learn to overeat when they are young, how are they to learn to exercise self-control later on without tremendous difficulty? It seems that parents would do their children a favor by not allowing them to consume so many nonnutritive sweeteners.

In addition, artificial sweeteners wreak chemical havoc on our bodily systems. Each of these artificial sweeteners is incompletely metabolized by our bodies and, like all additives and abusive chemicals, can wear down our bodies after a time. In this respect, aspartame may be the most harmful artificial sweetener. Aspartame is composed of two amino acids, phenylalanine and aspartic acid, as well as a small amount of methanol (Appleton 131). The body turns phenylalanine into tyrosine, another amino acid that aids in the production of thyroid hormones (Ehrlich). One of the hormones it produces is norepinephrine, which can affect your mood. This is why phenylalanine is sometimes prescribed to treat depression. However, when taken in large amounts, phenylalanine can be toxic. In addition, phenylalanine can cause “symptoms of anxiety, jitteriness, and hyperactivity in children” (Ehrlich). Aspartame may not produce large amounts of phenylalanine, but because this amino acid can be easily consumed through many other foods, it is possible to consume too much of it if one eats too much aspartame. In fact, pregnant women

are encouraged to avoid aspartame, as are people with mood disorders and phenylketonuria, a disorder that disallows the body to use phenylalanine (Ehrlich; Appleton 133). In addition to increasing phenylalanine, aspartame can also increase serotonin, a neurotransmitter in the brain that makes people feel happy. Levels of serotonin that are too high can disturb sleep and hunger (Appleton 132). These factors may cause one to wonder why aspartame is considered safe by the FDA, but one must keep in mind that many foods and most additives we consume are harmful to our bodies, yet are “safe” to eat in small amounts. The difficulty, however, lies in knowing how much is too much.

America consumes 50% of the world’s artificial sweeteners. These sweeteners can be found in packets labeled Splenda®, NutraSweet®, Equal®, Sweet ’N Low®, and others. They can also be commonly found in “light” foods, such as yogurts, ice creams, popsicles, cakes, cookies, cereals, and many other sweet-tasting products. The means in which Americans consume most of their artificial sweeteners, however, is through diet soda. In fact, Americans drink an average of half a gallon of diet soda per capita a year (Michaels 102). That’s approximately 1050 mg of aspartame per year or 20 mg per day. Taking into account those who choose not to drink diet beverages, this average is probably higher for the people who do. Yet 20 mg is merely the amount that comes from diet soft drinks alone. The number is probably much higher if you take into account other sources of artificial sweeteners. Because many people choose not to consume nonnutritive sweeteners, the people who do consume them may in fact be eating more of them than is averaged. However, despite many people’s desires to abstain from nonnutritive sweeteners, it is almost impossible now to do so. In fact, many people consume artificial sweeteners without even realizing it. Nonnutritive sweeteners are often found in mouthwashes, toothpastes, and pharmaceutical drugs in order to mask bitter tastes (Mitchell 80).

Because of the widespread use of nonnutritive sweeteners, it is difficult not only to avoid them, but also to regulate how much of them one is consuming.

The harmful effects of nonnutritive sweeteners are real and just as detrimental, if not more so, than sugar's. Both sweeteners, when consumed in excess, exhaust the body and trick it into gaining weight rather than losing it. The mass consumption of sugar and artificial sweeteners, though, does reveal a characteristic common among Americans that can be detrimental to physical, emotional, and spiritual health. People want the pleasure of sweetness but not the negative repercussions. Some people respond by merely ignoring the issue; they continue to consume large amounts of sugar without looking ahead at the consequences that will surely come. Other people react by replacing some, if not most, of the sugar they consume with artificial sweeteners, which, ironically, are even worse for your body. So what can people do? For those who are trying to lose weight or even merely eat a healthy diet, it would be wise to cut back tremendously on sugar intake and avoid artificial sweeteners altogether.

Nowadays, unfortunately, unhealthy foods, especially sugar, are less expensive than healthy foods. A meal of hot dogs is cheaper than one of fresh vegetables, rice, and chicken. Likewise, snack cakes and candy are cheaper than whole wheat bread and fresh fruits. But if Americans chose to make wiser decisions and, instead of spending a little here and a little there on sugar and artificial sweeteners, saved their money for the foods that would nourish their bodies, would it be enough to change the food industry? If sales for sugar and highly processed foods dropped dramatically for long enough, would the boycott be enough to encourage businesses to aim for their customers' satisfaction *and* health? The answer may be yes, but, sadly, it is unlikely that this would happen. It seems the majority is too addicted to sugar, to the easy way out, and to their own pleasures. Paul explains this very concept in Philippians 3:18-19,

when he says, “For many walk, of whom I have told you often, and now tell you even weeping, that they are the enemies of the cross of Christ: Whose end is destruction, whose *god is their belly*, and whose glory is in their shame, who mind earthly things,” (emphasis added). The point he is trying to make is that human beings naturally want to please themselves; they want to do what feels good at the time as well as eat what feels good at the time, often without much thought to the future. If we choose, however, to look at the natural consequences of our actions and make the right choices in avoiding them, we may give up a moment of pleasure, but we save ourselves a future of grief. So it is with the food we eat. Instead of trying to find ways to skirt around the negative consequences, we must, if we truly care about our physical and psychological health, look at the facts honestly and make choices accordingly.

Therefore, instead of escaping the consequences of sugar by eating artificial sweeteners, people should avoid sugar and its non-caloric counterparts as much as possible. We should stop trying to find a way around the natural laws of food and science and instead work with them. We will find that if we do so our health will be in much better condition and our minds will be better equipped to put wise choices into action.

Works Cited

“Position of the American Dietetic Association: Use of Nutritive and Nonnutritive Sweeteners.”

Journal of the American Dietetic Association 104.2 (2004): 255–75. *Academic Search Complete*. EBSCO. Web. 12 Nov. 2010.

Appleton, Nancy. *Lick the Sugar Habit*. Garden City Park, NY: Avery, 1996. Print.

Bandyopadhyay, Atrayee, Sarbani Ghoshal, and Anita Mukherjee. “Genotoxicity Testing of Low-Calorie Sweeteners: Aspartame, Acesulfame-K, and Saccharin.” *Drugs & Chemical Toxicology* 31.4 (2008): 447–57. *Academic Search Complete*. EBSCO. Web. 10 Nov. 2010.

Bright, Graham. “Low-Calorie Sweeteners – From Molecules to Mass Markets.” *Low-Calorie Sweeteners: Present and Future Volume 85*. Ed. Corti, A. New York: Karger, 1999. 3–9. *Stetson University Library*. Web. 4 Nov. 2010.

Ehrlich, Steven D. “Phenylalanine.” *University of Maryland Medical Center*. University of Maryland Medical Center, 8 June 2009. Web. 18 Nov. 2010.

King James Version. Nashville: Thomas Nelson Publishers, 2005. Print.

Michaels, Jillian and Mariska van Aalst. *Master Your Metabolism*. New York: Crown Publishers, 2009. Print.

Mitchell, Helen. *Sweeteners and Sugar Alternatives in Food Technology*. Stetson University

Library. Wiley, 1 Apr. 2010. Web. 14 Nov. 2010.

Pierce, W. David, et al. "Overeating by Young Obesity-Prone and Lean Rats Caused by Tastes

Associated with Low Energy Foods." *Obesity* 15.8 (2007): 1969–79. *PsycINFO*.

EBSCO. Web. 21 Nov. 2010.

Shapiro, Alexandra, et al. "Fructose-Induced Leptin Resistance Exacerbates Weight Gain in

Response to Subsequent High-Fat Feeding." *American Journal of Physiology: Regulatory, Integrative & Comparative Physiology* 64.5 (2008): R1370–75.

Academic Search Complete. EBSCO. Web. 21 Nov. 2010.

Soffritti, Morando, et al. "Life-Span Exposure to Low Doses of Aspartame Beginning during

Prenatal Life Increases Cancer Effects in Rats." *Environmental Health Perspectives*

115.9 (2007): 1293–97. *Academic Search Complete*. EBSCO. Web. 12 Nov. 2010.

Swithers, Susan E., and Terry L. Davidson. "A Role for Sweet Taste: Calorie Predictive

Relations in Energy Regulation by Rats." *Behavioral Neuroscience* 122.1 (2008): 161–

73. *PsycARTICLES*. EBSCO. Web. 19 Nov. 2010.