Artificial Sweeteners

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Introduction

Artificial sweeteners are zero- or low-calorie compounds used to sweeten foods and drinks. They can be anywhere from 200 to 20,000 times sweeter than sugar. Initially, their intended use was to promote weight loss and still allow people to eat their favorite sweet foods, but as the use of artificial sweeteners has increased over the years, so have their health concerns.

Common Artificial Sweeteners

The most common artificial sweeteners consumed in the United States (and which have been approved by the Food and Drug Administration) are aspartame, acesulfame potassium, sucralose, and saccharin.

Aspartame (Nutrasweet®, Equal®, and Sugar Twin®) is the most popular low-calorie sweetener in the United States and has been incorporated into thousands of products including sodas, frozen desserts, dairy products, medications, and breakfast cereals.[1] Unlike many calorie-free sweeteners, aspartame contains the same number of calories per gram as sugar, but very little is needed because it is 200 times sweeter than sugar.[2]

Sucralose (Splenda®) is not digestible and therefore calorie-free. It has become a popular alternative to sugar for people with diabetes. Most is excreted through the feces, and some is absorbed into the blood and excreted in the urine.[3]

Saccharin (Sweet 'N Low®, Sweet Twin®, and Necta Sweet®) is also calorie-free and about 300 times sweeter than sugar. It cannot be metabolized by the body and gets excreted in the urine.[2]

Acesulfame potassium "Ace-K" (Sunett®, Sweet One®) is about 200 times sweeter than sugar and is commonly used in sodas. Ace-K is not metabolized but is absorbed into the blood, though it has not been found to affect blood potassium levels.[2]

Health Effects of Sweeteners

Cardiovascular Disease

We know that added sugars increase a person's risk of cardiovascular disease (CVD). What's less clear is whether artificial sweeteners are beneficial or not, including when used to replace sugar.[4]

There have been many studies that seem to indicate a link between sugar-sweetened beverages (SSBs) and cardiovascular disease. A large review of studies published in 2021 found that both SSBs and artificially sweetened beverages (ASBs) increased the risk of heart disease by 17%.[5] Another study found that those consuming the most artificial sweeteners had a 9% higher risk of CVD than those who didn't consume any. Aspartame and acesulfame potassium were found to increase the risk of stroke and coronary heart disease.[6] However, after controlling for body mass index (BMI), the risk disappeared in most of these studies. This could be because people who are already at high risk of disease may consume SSBs more often to try to lose weight (what we call reverse causation).

Another large study of women found that more than two ASBs per day increased their risk of ischemic stroke, but only when those women had a BMI of 30 kg/m^2 or greater. This trend was inconsistent across ethnic groups, and once again researchers couldn't rule out reverse causation.[7]

Weight Loss

The World Health Organization (WHO) did a deep dive on the research on artificial sweeteners, looking at nearly 150 studies. Their thorough review found that artificial sweeteners seemed to help people lose weight and reduce their BMI in the short term (seven days to three years), but that longer term (eight months to 10 years) they could increase the risk of obesity and high BMI.[8] In 2023, the WHO recommended against the use of artificial sweeteners to manage weight or to prevent other chronic diseases.[9] Although artificial sweeteners may be associated with short-term weight loss, several large-scale prospective cohort studies have found a link between chronic artificial sweetener use and weight gain.[10] This is supported by interventional studies suggesting that artificial sweeteners don't help reduce weight when used alone and may even contribute to higher calorie intake. When the brain recognizes a sweet flavor but doesn't receive the expected calories from that food, it activates a food-seeking pathway, sometimes causing people to consume more than if they hadn't had the artificial sweetener.[10]

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Ultimately, the best way to understand weight loss requires looking at the whole diet, not just one food. Artificial sweeteners may help people resist processed foods that are high in sugar and calories, and low in healthful nutrients, thus improving the diet overall. A whole food, plant-based diet that doesn't rely on artificial sweeteners may be the most effective way to achieve and maintain a healthy body weight.[11]

Diabetes and Blood Sugar Control

People at risk of type 2 diabetes might reasonably conclude that replacing sugar with artificial sweeteners is a better way to enjoy sweetened foods. Research shows that there are still risks associated with artificial sweeteners, however. A meta-analysis found that for every serving of sugar consumed per day, risk of diabetes went up by 27%. Every serving of artificial sweetener also increased a person's risk, even if by less (13%).[5] Another experiment found that obese participants who consumed sucralose 10 minutes before consuming a sugary drink had higher blood sugars after the sweet drink than they would have otherwise.[12] This may be due to changes in the microbiome, metabolism, and insulin secretion after consumption of artificial sweeteners.[13]

Data from several large cohort studies have shown that people who drank one or more beverages with artificial sweeteners per day were more likely to have type 2 diabetes. However, most of this was explained by higher BMI and total energy intake, and the artificial sweeteners may not have been the culprits.[14,15,16] Reverse causality is likely at play again, too: People already at high risk of obesity, diabetes, and other diseases probably use artificial sweeteners more than low-risk people as a dieting aid.

The bottom line is that for people who are in the habit of drinking sodas or other high-sugar beverages, reducing intake is a better option than replacing them with artificially sweetened drinks.[17] The very best option for preventing and even reversing diabetes is a whole food, plant-based diet that minimizes all sweeteners and is rich in fiber, complex carbohydrates, and plant-based protein.[18]

Cancer

There have not been many studies that clearly link artificial sweeteners to cancer. Saccharin and sucralose have both shown almost no evidence of causing cancer, and only one study of acesulfame has been done (suggesting a very small increase in overall cancer risk). Aspartame has received more attention. One review paper found no association between aspartame and cancer and couldn't explain how aspartame would cause cancer.[19] Another review of studies found that aspartame slightly increased rates of bladder cancer, but reduced rates of ovarian and pancreatic cancers, though researchers graded these as a very low certainty of evidence.[20]

In 2023, the International Agency for Research on Cancer (IARC) named aspartame as a group 2B carcinogen, meaning there is limited or inadequate evidence that it causes cancer in humans. Coffee and cell phones are also in this category.[21] The IARC category does not explain how dose influences risk, nor does it specify the extent to which aspartame increases a person's risk. The Joint Expert Committee on Food Additives (a group connected with the WHO and the United Nations Food and Agriculture Organization), however, has set an acceptable daily aspartame limit at 40 milligrams for each kilogram of body weight.[22] For a 70-kilogram (or 154-pound) adult, this would be 2,800 milligrams. If the average diet soda contains less than 200 milligrams, the person would need to drink 14 cans each day to reach their limit, and probably much more to cause cancer.

Digestion

Artificial sweeteners have been shown both to promote inflammation and to negatively affect a person's gut. They do this by causing changes to the bacteria in the intestine.[23] This is especially true of sweeteners like sucralose that are not absorbed and travel to the lower intestines where they can harm gut bacteria.[24] Even absorbable artificial sweeteners like aspartame have been linked to gut bacteria changes.[25] People with a sensitive digestive system, irritable bowel syndrome, or inflammatory bowel disease may want to steer clear of artificial sweeteners to help avoid uncomfortable symptoms. Research shows that gut bacteria can bounce back to normal after stopping artificial sweetener intake.[26]

Conclusion

While some research has shown mixed results, artificial sweeteners may pose risks including higher blood sugars and risk of diabetes, heart disease, and higher calorie intake possibly leading to weight gain. While artificial sweeteners in moderation may pose minimal risk, water and other unsweetened beverages like tea should be the drink of choice for optimal health.

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