Aspartame Metabolism

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When aspartame is digested in the body, it is converted to three components: **aspartic acid**, **phenylalanine**, and **methanol**.

Aspartic acid (also called aspartate) is an amino acid that is present in every protein we consume, and in every protein in the human body. It is also an intermediate in metabolizing carbohydrates and other amino acids. The human body can make it from other substances if it needs to, and it can burn it for energy or convert it to fat if there is more than enough.

Phenylalanine is another amino acid that is present in all proteins. In contrast to aspartic acid, humans cannot produce it from other materials--we must get a certain amount of it every day in our diet, so it is classified as an essential amino acid. If we consume more than we need, we can burn the excess for energy, or store the extra calories as fat. Phenylalanine is only a concern for people with the rare genetic disorder phenylketonuria (PKU). People with PKU lack the enzyme to break down excess phenylalanine, so they must carefully monitor their intake. They still need a certain amount of it to make proteins, but they must be careful not to consume more than this amount.

Aspartic acid and phenylalanine do provide calories. In general, amino acids provide about 4 calories per gram, just like carbohydrates. Aspartame contributes calories to the diet, but it is about 180 times as sweet as sugar, so the amount needed for sweetening doesn't provide very many calories. For example, a 12 ounce diet soft drink might contain about 125 mg (0.125 gram) of aspartame, which would have less than 1 calorie. In contrast, a 12 ounce sugar-sweetened soft drink would have about 25 grams of sugar and about 100 calories.

What about the **methanol**? Isn't methanol poisonous? Methanol is present in a lot of fruits and fruit juices, partly in the form of methyl esters, including pectin. In the digestive system, many of these esters are hydrolyzed to release methanol. Your liver is equipped to handle methanol in this kind of quantity--it oxidizes the methanol to formaldehyde and then to formic acid, which is easily handled by the kidneys. The enzymes doing this are alcohol dehydrogenase and aldehyde dehydrogenase. The process is so efficient that you would have a hard time measuring any formaldehyde in your body. This is true whether you get the methanol from a glass of tomato juice (85 mg), apple juice (21 mg), or a can of diet cola (about 20 mg).

The adage among toxicologists is "the dose makes the poison"--vitamin A, iron, and selenium, to name a few, are required by the body but are toxic at too-high levels. Methanol becomes toxic when you start consuming large quantities, e.g., if you drink enough of it to become intoxicated. Now you overwhelm the amount of oxidative enzymes present in the liver, and measurable quantities of formaldehyde accumulate, and you generate enough formic acid to upset the acid-base balance of the body. But here we are talking about tens of grams of methanol, about a thousand times more than you could get by consuming tomatoes or apples or diet cola.

One of the internet myths is that fruit juices are different because they contain small amounts of ethanol, and the ethanol is an antidote to methanol poisoning. It is true that, in the case of a patient who has acute methanol poisoning, one of the treatments is to administer ethanol. The rationale is that the ethanol will compete with methanol for the attention of those oxidative enzymes, and you will get less formic acid [methanol oxidation product] and more acetic acid [ethanol oxidation product]; the human body can convert acetic acid to fat. You would not get enough ethanol in fruits and vegetables to have this kind of effect, so calling the ethanol in fruit juice an "antidote" is gross misrepresentation.

In principle, if you consumed thousands of cans of diet soft drink in an hour, you could get methanol poisoning, but the caffeine overdose would kill you first. The lowest reported lethal dose in humans for caffeine is 192 milligrams per kilogram of body weight; for methanol, it's 6422 milligrams per kilogram. A 12 ounce can of Diet Coke has 46 mg of caffeine and could produce 20 mg of methanol, so for a 150 pound adult, it would take 22,000 cans to produce a lethal dose of methanol, and only 300 cans to produce a lethal dose of caffeine.

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