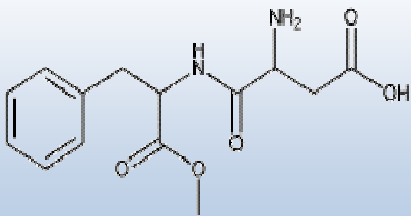


Aspartame in the Membrane

When aspartame was first discovered in 1965, many people believed that it would be the answer to their prayers. Who wouldn't want to eat guilt-free sweets? James Schlatter, a chemist with GD Searle & Company, was working in the laboratory and tasted his fingers to discover that they were sweet. His accidental discovery seemed to be just what many people were looking for¹. In 1981 the FDA approved aspartame for use in certain food products, and in 1982 the product made its first appearance in Diet Coke. Today, the product can be found in everything from diet carbonated sodas, to low calorie desserts, to breakfast cereal, and it has been slowly creeping into many other products for people who are craving "sweet" (but want to cheat).

Since its approval, Aspartame's producer,

Figure 1: The Structure of Aspartame



Monsanto, has vehemently defended the safety of its product, but some researchers say that aspartame is anything but safe. Almost as soon as aspartame was introduced, so began speculations about its safety and the possible effects it may have on human health. Some have speculated that aspartame may have a particularly

detrimental effect on brain chemistry (Humphries et. al, 2008). This paper examines the physiological processes of aspartame metabolism and the possible effects of high dosage aspartame usage on health, particularly brain chemistry.

Structure and General Metabolism

¹ The writer withholds judgment on the horrible lab technique would make tasting an unknown product seem like a good idea.

The structure of aspartame is presented in Figure 1. Aspartame is a methyl ester, comprised of two amino acids, phenylalanine and aspartic acid. The molecular formula for aspartame is $C_{14}H_{18}N_2O_5$, and the IUPAC name is N-(L- α -aspartyl)-L-phenylalanine, 1-methyl ester (Ekong).

Upon ingestion, aspartame is first hydrolyzed in the intestine by esterases and peptidases. This occurs in the gastrointestinal lumen (Magnuson et. al, 2007, p.645) and the hydrolysis produces three principle breakdown products: phenylalanine, aspartate, and methanol.

Phenylalanine

Approximately 50% of the breakdown product from aspartame is phenylalanine.² When phenylalanine is metabolized a small part is first hydroxylated and converted to tyrosine in the liver by hepatic phenylalanine hydroxylase (Magnuson, 2007, p. 700). The other portion remains unconverted to tyrosine. Humphries (2007) speculates that the portion of the amino acid which remains unconverted can cross the blood brain barrier intact (p.453). In order to do this however both fractions must bind to a large, neutral amino acid transporter (NAAT) which can carry them across the blood brain barrier (Humphries, 2007, p.454).

NAAT is also a transporter for other amino acids, including tryptophan, methionine, and the branched chain amino acids. Since all of these amino acids compete for the same transporter, large quantities of phenylalanine means that it will occupy the active sites on most molecules of the transporter, and levels of phenylalanine in the brain are likely to increase (Humphries, 2007, p.453).

² Phenylalanine is ketogenic and glucogenic (Ekong), meaning that it is an amino acid that can be used to form ketone bodies through ketogenesis or glucose through gluconeogenesis.

Aspartic Acid

Approximately 40% of aspartame's breakdown product is aspartic acid (Ekong, 2009). Aspartic acid is a non-essential amino acid which may be synthesized in the brain from glucose and other precursors (Magnuson et. al, 2007, p.648). It is metabolized within the enterocytes, absorptive cells lining the villi of the small intestines. Maher (1987) reported that is unlikely that aspartic acid is able to cross the blood brain barrier (p. 54). However, Vences-Mejia (2006) reported that aspartic acid can have an effect on neuronal enzymes (p. 456).

Methanol

Methanol is the final breakdown product of aspartame. Methanol forms about 10% of the breakdown product, and high levels of methanol have been associated with “vision disorders, headache, tinnitus, dizziness, nausea” and a host of other metabolic problems (Ekong, 2009). On first glance this may sound frightening; however, some fresh fruits and vegetables are also broken down to methanol (Muldoon, 1978, p. 1454). Methanol enters the bloodstream and is oxidized in the liver to formaldehyde (Magnuson, p.700). Formaldehyde may be further broken down into formate, a highly toxic substance which has been known to cause blindness (Humphries, p. 451).

Brain Chemistry

Amino acids like tyrosine and tryptophan, which are out-competed for position on NAAT upon ingestion of large quantities of aspartame, have important roles to play in maintaining brain chemistry. Some researchers have argued that when high quantities of phenylalanine are present after aspartame ingestion, the phenylalanine displaces precursors like tyrosine and tryptophan to

cross the blood brain barrier and causes drastic changes in the production of important neurotransmitters like dopamine and serotonin (Humphries, 2008, p. 451).

One consequence of lowered tyrosine levels is lower concentrations of dopamine in the brain (Humphries, 2007, p.454). The loss of dopamine is related to neurological disorders such as Parkinson's disease. Tryptophan is an important precursor in serotonin production. There is a well-documented link between reduced levels of serotonin in the brain and increased incidence of depression.

Vences-Mejia (2008) reported that aspartic acid is an excitatory neurotransmitter (p.453) which can lead to an increase in certain metabolizing enzymes in the brain. One of these enzymes is cytochrome P450. Cytochrome P450 plays a part in the "aromatization of androgens to estrogens" and the "formation of catechols, and it may also participate in the metabolism of other neurotransmitters" (Vences-Mejia, p. 454). The effect that this may have on overall neuronal function has yet to be determined.

Consumption of aspartame by rats has affected their learning behavior. In Guinea Pigs, aspartame ingestion during gestation disrupted odour-associative learning (Vences-Mejia, 2006, p. 453). And a recent study indicated another impairment by showing that that rats exposed to high amounts of aspartame took longer to find the reward in a t-maze (Vences-Mejia, 2006, p.453).

Conclusion

Many studies have been conducted in an attempt to prove or disprove the safety claims made by aspartame's producer, Monsanto; however, many scientists have argued that these tests are inconclusive because they have been conducted on animals and some studies overlook the

fact that the ways in which animals and humans metabolize aspartame is greatly different. Humphries (2008) reports that the most common animals used for aspartame testing are approximately 60 times less sensitive to aspartame as humans (p.458). Humans are 10-20 times more sensitive to methanol poisoning and humans are 8-10 times more sensitive to aspartic acid as animals (p.458).

As many as 92% of independently funded studies have shown that aspartame has at least the potential for adverse effects (Briffa, 2006, p. 309). However, the jury is still out. Responsible consumers should consider the risks before they crack the seal on that next can of diet bliss. As American waistlines continue to grow, so has the extensity of this potentially dangerous product. It is even slipping into places we might not otherwise expect to find it, including foods which are not explicitly labeled as “diet.” Magnuson (2007) reports that aspartame may be found in more than 6000 products (p. 354).

In 1993 Cypress Hill released a single about addiction: “Insane in the Membrane.” The title of this paper plays on the title of that song because aspartame addiction is a serious problem for many Americans. One group member raps about how his addiction is: “Makin’ my mind slow / That’s why I don’t mess with the big four-oh.”

The big four here are diet candy, diet baked goods, no-calorie table top sweeteners, and of course, diet carbonated beverages. If consumers are drinking aspartame in large quantities, it may indeed make the mind slow. The use of this chemical is controversial at best.

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