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AFLATOXINS

Aflatoxins are a group of poisonous chemicals that are produced by certain species of molds that can grow on food. Aflatoxins are among the most studied types of mycotoxins, which are fungal toxins produced by molds, yeasts, or mushrooms. Two species of fungus, *Aspergillus flavus* and *Aspergillus parasiticus*, can produce aflatoxins, although other types of fungi are also known to produce them. Foods in which aflatoxins are commonly found include corn, peanuts, rice, sorghum, dried fruit, tree nuts, and spices that have been stored under damp conditions. People who consume foods contaminated with aflatoxins can become ill with mild to serious liver disease. This entry describes the major aflatoxins that affect humans, aflatoxicosis and other effects, and efforts to prevent and monitor aflatoxins in the food supply.

Classification of Aflatoxins

The term *aflatoxin* refers to the fact that the first substance in this class of structurally related mycotoxins was recognized in peanuts that were contaminated with *A. flavus*. Today, there are approximately 16 known types of aflatoxins. The four major aflatoxins that cause illness in humans are designated B1, B2, G1, and G2, based on the color of florescence (B for blue and G for green) under ultraviolet light. A less toxic metabolite (the intermediates and products of metabolism) of aflatoxin (M1) is produced by farm animals that consume aflatoxin-contaminated feed. Dairy cows, for example, are able to convert B1 aflatoxin to M1 in their milk. Even though it is less toxic than the B1 parent compound, M1 in dairy milk can cause liver illness in humans, particularly among infants and children. In the United States and other developed countries, regular monitoring of the food supply and strict regulations on the concentration of aflatoxins allowed in animal feed and dairy milk have helped minimize aflatoxin-related illness.

Symptoms and Prevalence of Acute and Chronic Aflatoxicosis

Illness related to aflatoxin is referred to as *aflatoxicosis*. Acute aflatoxicosis can occur in humans and animals consuming high doses of aflatoxins over a short period of time. In humans, consumption of aflatoxin-contaminated food sometimes leads to severe liver injury and, rarely, death. Other symptoms include hemorrhage (bleeding), edema (swelling of body tissue), and changes in metabolism and nutrient absorption, which can lead to

malnutrition. As of 2014, the most recent outbreak—more than one case from a single food source—occurred in rural Kenya in 2004–2005, when 317 people became sick and 125 died of acute aflatoxicosis. The outbreak was traced to a supply of maize (corn) that had become contaminated with aflatoxins during storage under damp conditions. Documented outbreaks of acute aflatoxicosis in India (1974), Malaysia (1988), and Kenya (1982 and 2004–2005) indicate a mortality rate as high as 60%.

Chronic exposure to low or moderate amounts of aflatoxins—a more common problem than acute aflatoxicosis—can also cause liver and immune system problems in humans and animals. More important, certain aflatoxins, such as B1, are among the most potent carcinogens (cancer-causing substances) ever identified and are believed to contribute to liver cancer. Although the cause-and-effect relationship between aflatoxin consumption and liver cancer in humans is difficult to prove, long-term epidemiologic studies suggest a strong association. The risk of liver cancer appears to be much higher for people infected with hepatitis B, a virus that causes liver inflammation.

Prevention and Monitoring of Aflatoxins in the Food Supply

Food crops can become contaminated with aflatoxin-producing fungi during production, harvest, storage, transport, and processing, making it difficult to eradicate potential sources of contamination. Although the prevention of aflatoxin formation in the food supply chain is difficult, a number of strategies can be used to reduce the risk of contamination during agricultural production and storage. Common preharvest strategies include testing for toxin-producing molds on seeds or in storage containers, using genetically resistant varieties of crops, good agronomic practices (e.g., proper timing of irrigation and harvest), biological controls (application of atoxigenic strains of *A. flavus*), and chemical controls (application of fungicides). During harvest, controlling moisture content and minimizing exposure to mold spores can reduce the risk. During postharvest handling and storage, reducing moisture prevents or eliminates the growth of *A. flavus*. Industrial farming operations often use sophisticated equipment to mechanically dry crops and to regulate moisture content and temperature during storage. Farmers must consider differences in climate, weather, crop type and varieties, and postharvest infrastructure in customizing plans for preventing aflatoxin formation.

To limit human exposure, most developed countries routinely screen for the level of aflatoxins in agricultural crops and food products. Because these aflatoxins are considered unavoidable contaminants in the food supply, low levels are usually allowed in nuts, seeds, grains, and other agricultural products. In the United States, the Food and Drug Administration and the U.S. Department of Agriculture monitor food supplies to ensure compliance with strict regulatory limits first put into place in 1971. The U.S. Department of Agriculture's Grain Inspection, Packers and Stockyards Administration provides aflatoxin testing and certification services to farmers and food processors to ensure that agricultural products are not contaminated with levels of aflatoxins above the Food and Drug Administration cut points (20 parts per billion for raw peanuts and 100 parts per billion for corn used for animal feed). Foods contaminated with aflatoxins above the allowable limits must be reconditioned (cleaned, sorted, and retested) under strict guidelines before being allowed into the food supply. As a result, no outbreaks of acute aflatoxicosis have been recorded in the United States. Peanuts and other nuts for human consumption are among the most regularly tested crops in the United States today since they are likely to contain low levels of aflatoxins.

Today, aflatoxicosis is largely a problem in the developing world where many people produce and store their own foods. Inadequate drying of nuts and grains allows aflatoxin-producing fungus to contaminate homegrown crops. Aflatoxin levels in homegrown food sources are generally not monitored in developing countries, so an estimated 4.5 billion people globally may be chronically exposed to these toxins. While it is impossible to completely avoid exposure to low levels of

aflatoxins, consumers everywhere can reduce their risk by discarding nuts or seeds that are moldy, shriveled, or discolored.

Diana Caley and Marion Nestle

See also Dairy Industry; Food and Drug Administration (FDA); Food Safety; Hazard Analysis and Critical Control Point (HACCP)

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Agrarianism

When used in discussions of contemporary food issues, the term *agrarianism* most commonly refers to a cumulative mix of philosophy and ethics, political platform and critique, the social critique of industrialization, the environmental critique of industrial farming, and a prescribed normative way of life. It takes as its central premise that humans are inherently tillers of soil and that they need to produce and thus consume products of photosynthesis and their derivatives, including especially livestock, in order to survive. Given this human role and the 10,000-year history of humans as agriculturalists, agrarians believe that the healthiest way to produce food for land, soil, and culture, and the healthiest way to structure society, is as self-sufficient, internally reliant farming communities that are built around the art of agriculture. For contemporary agrarians, this art should ideally employ sustainable farming practices, and there is an implicit recognition that scale—of farm acreage, of human settlement patterns, and of consumptive lifeways—matters ecologically, politically, aesthetically, and culturally. Thus, ideal agrarian communities are smaller in scale, largely independent, and based on face-to-face interaction and sharing, and they cultivate the virtues of thrift, fidelity to place, ingenuity, independence, holism, and frugality. In its most recent manifestation, agrarianism criticizes industrial agriculture, industrial culture, and the politics of consumption and perceived corporate takeover of food supplies and politics that such industrial lifeways generate.

Evolution of the Concept

The term *agrarianism* itself is derived from *lex agraria*, an ancient Roman law that mandated the equal sharing and division of lands that were conquered by and thus belonged to the Roman Empire. This history hints of socialism, so that when the concept entered into mainstream political and cultural discourse in the 1700s and 1800s in the United States and Europe, there was concern about governmental interference with land ownership. A concern with land ownership is found in contemporary agrarianism, but it focuses on the perceived takeover of farmland by corporate agribusiness interests. Yet the larger point remains and has been present since the onset of agrarianism: shared ownership, and thus shared responsibility, in undertaking agriculture and in having farming act as the bedrock of civilization and society.

Hinted above is the recognition that the term has had varied meanings throughout Western history. These meanings have ranged from social and political opprobrium, especially in parts of the