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Aspergillus flavus and Aflatoxins in Corn

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The severe weather conditions of the 2002 growing season resulted in an increase in the incidence and severity of aflatoxin contamination of both food grade and feed grade corn in Nebraska. A survey conducted in 29 counties by the Nebraska Department of Agriculture in 2002 determined that 1) 39 percent of the samples exceeded the U.S. Food and Drug Administration action level for aflatoxin in food grade corn; 2) none of the samples exceeded the FDA action level for aflatoxin in feed grade corn; and 3) 4 percent of dairy samples exceeded the FDA action level for aflatoxin in milk. In biased tests of grain suspected to be contaminated, the Lincoln Grain Inspection Service determined that 50 percent of 3500 samples from southeast Nebraska exceeded the FDA action level for aflatoxin in food grade corn, but less than 5 percent exceeded the action level for feed grade corn. At Federal Grain Inspection facilities in Fremont and Hastings 10-20 percent of the samples exceeded the FDA action level for aflatoxin in food grade corn. Most of the contaminated samples and the highest levels of contamination in all surveys were detected in corn from southeast Nebraska.

Cause and Occurrence of Aflatoxin in Corn

The mycotoxin called aflatoxin is produced by the grain mold *Aspergillus flavus*. Not all isolates of *A. flavus* produce aflatoxin and isolates that are capable of producing aflatoxin do not always synthesize the toxin. Many factors, including environmental conditions and host susceptibility, determine the incidence and severity of grain mold and subsequent mycotoxin contamination. Prolonged drought and high temperatures during the growing season favor the development of *A. flavus*, restrict the development of competitors of *A. flavus*, and inhibit normal pollination in the corn plant. This often leads to an increase in the extent and amount of aflatoxin contamination.

The species, age, and health of the animal as well as the level and duration of exposure to the mycotoxin will determine the magnitude of the effect of exposure. The effects can be subtle, including reduced weight gain and minor behavioral abnormalities such as feed refusal, or the effects can be severe, including reproductive dysfunction, organ failure, and death. Depending on the magnitude of the exposure (duration and concentration), recovery is possible for healthy animals if the contaminated feed is removed from the diet.

Although commonly found in Nebraska's corn crop, in most years the amount of aflatoxin is well below the action levels set by the FDA for both food grade and feed grade corn *(Table I)*. An action level is the maximum concentration of aflatoxin in food or feed that presents no health hazard to humans or a designated animal species. Food or feed containing levels of aflatoxin higher than the action level could pose a health hazard. The action level for aflatoxin is expressed in units of parts per billion (ppb). The 300 ppb action level for aflatoxin for finishing cattle is the equivalent of one ounce of toxin in 200,000 pounds of feed. High concentrations of aflatoxin may be found in corn screenings.

Table I. Food and Drug Administration action levels for aflatoxins.

Mycotoxin	*FDA tolerance*[a]	*Commodity and/or use*
aflatoxin M_1	0.5 ppb[b]	Milk
aflatoxin	20 ppb	Corn and other animal feeds and feed ingredients, excluding cottonseed meal, intended for immature animals
		Corn, cottonseed meal, and other animal feed ingredients intended for dairy animals, for animal species or uses not specified above, or when intended use is not known
		Foods (for humans)
	100 ppb	Corn intended for breeding beef cattle, breeding swine, or mature poultry
	200 ppb	Corn intended for finishing swine of 100 lbs or greater
	300 ppb	Corn intended for finishing (i.e. feedlot) cattle

[a]**Action level:** the maximum concentration of aflatoxin in food or feed that presents no health hazard to humans or designated animal species. Food or feed containing levels of aflatoxin higher than the action level could pose a health hazard. Action levels for aflatoxin were established by the U.S. Food and Drug Administration.
[b]**ppb:** the concentration of aflatoxin in food or feed is expressed in units of parts per billion.

Effects of Aflatoxins on Plants, Animals, and Humans

Plants

Aspergillus flavus grain mold on corn is often characterized by visible light green mold on the surface of the kernels. This surface mold can develop anywhere on the ear, but is most often observed at the base of the ear. Visible mold growth is not always evident on colonized kernels and not all colonized kernels will be contaminated with aflatoxin. However, colonized kernels with no visible mold may contain aflatoxin.

Animals and Humans

The disease caused by aflatoxin is called aflatoxicosis. Aflatoxicosis is neither infectious nor communicable; it cannot be spread from one animal to another or from one human to another. The primary target of aflatoxin is the liver. Depending on the duration of feeding on contaminated grain or food products and the amount of aflatoxin ingested, the liver may fail to function or liver cancer may develop. Recovery from liver failure depends on the extent of damage. If damage is not too extensive, full recovery can be expected if the contaminated feed or food products are removed from the diet.

In addition to the production of aflatoxin, Aspergillus species of mold can affect humans or animals in two other ways. Some people and animals are allergic to Aspergillus species and exhibit either acute or chronic reactions to the mold itself. Aspergillus molds can infect animals, including humans, with inadequate immune system function causing a disease called aspergillosis. It is an invasive disease of the lungs, although colonization of other organs can occur. Aspergillosis is a serious disease that is often fatal. Dust masks or respirators should be worn by grain handlers to minimize exposure to these fungi and to aflatoxin-contaminated dust.

Management Options to Minimize Aflatoxin Contamination

Chemical

Fungicides are not currently used in Nebraska specifically for the management of Aspergillus grain mold or for aflatoxin contamination.

Host Plant Resistance

Although corn hybrids are reported to vary in susceptibility to *A. flavus*, susceptibility to grain mold and aflatoxin contamination are not characteristics listed in the seed catalogs.

Cultural

To minimize the risk of *Aspergillus* grain mold and aflatoxin contamination in corn the following action steps should be taken:

1. Minimize plant stress during and after pollination.
2. Monitor storage facilities regularly to detect grain mold development. This requires a systematic sampling plan to account for the unique design characteristics of each storage facility.
3. Reduce grain moisture to less than 15 percent within 48 hours after harvest and maintain a storage temperature below 40°F. Good air circulation throughout the storage bin is important.
4. Minimize mechanical damage during harvest and postharvest handling.
5. Minimize insect damage during the growing season and during postharvest storage.
6. Clean storage bins thoroughly each season to remove old grain and residue. Grain mold fungi survive for long periods in storage bins; bins can be sanitized using a bleach solution (6 ounces of bleach per gallon of water). Storage bins with false floors may require additional effort to remove fines and broken kernels. Bin sanitation is especially important when the ability to maintain cool and dry storage conditions is lacking.
7. Have grain analyzed for aflatoxin content. Proper protocols should be used to collect samples and have them shipped to a lab for analysis.

Blending Grain

Generally, the FDA does not permit blending of aflatoxin-contaminated grain. During the summer of 2002, the Nebraska Department of Agriculture petitioned the FDA for permission to blend aflatoxin-contaminated corn. FDA did not object to the following limitations on blending in Nebraska. For more information and an update on the status of the blending allowance in Nebraska, call the Nebraska Department of Agriculture at (402) 471-2394.

1. Blending may occur only one time.
2. Aflatoxin content of the blended product must be determined.
3. A blended product marketed within Nebraska may be used for only two purposes, regardless of what aflatoxin content is achieved through blending.
   a. If aflatoxin content is less than 300 ppb, it may be used for finishing cattle.
   b. If aflatoxin content is less than 200 ppb, it may be used for finishing hogs or finishing cattle.
4. Blended product marketed outside Nebraska may be used for only one purpose, regardless of what aflatoxin content is achieved through blending. If the aflatoxin content is less than 300 ppb, it may be used for finishing cattle.
5. Blended grain must be labeled as blended and include aflatoxin content and the authorized end use.
6. Purchaser must be told that the product is blended and what the aflatoxin content of the blended product is.
7. Records of blending and sale(s) must be kept for at least one year.

For sampling and testing information contact the nearest federal grain inspection service or the Toxicology Laboratory, Veterinary Diagnostic Center, University of Nebraska, Lincoln (402-472-8459).

For information on other mycotoxins, see "Grain Molds and Mycotoxins in Corn" (Neb Guide G00-1408) and "Understanding Mold Toxins" (NebGuide G87-850).

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