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Jim Stack
University of Nebraska - Lincoln

Michael Carlson
University of Nebraska - Lincoln, mcarlson3@unl.edu

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Fumonisins in Corn

By Jim Stack, Extension Plant Pathologist
Mike Carlson, Analytical Chemist

During the past two years, millers have rejected some Nebraska food grade corn because it was contaminated with the mycotoxin fumonisin. A Nebraska Department of Agriculture survey in 2002 determined that approximately 40 percent of the samples from 29 counties exceeded the FDA action level for fumonisin in food grade corn, although none of the samples exceeded the action level for feed grade corn. Most of the contaminated samples and the highest levels of contamination were detected in corn from counties in the eastern half of Nebraska.

Cause and Occurrence of Fumonisin in Corn

Fumonisins are mycotoxins produced by the grain molds *Fusarium verticillioides* and *Fusarium proliferatum*. These fungi are commonly found in corn throughout the United States. Although a high percentage of the kernels may be colonized by these fungi, fumonisins are not always produced. Many factors, including environmental conditions and host susceptibility, determine the incidence and severity of grain mold and subsequent mycotoxin contamination. Conditions favoring production of fumonisin by *Fusarium* molds have not been clearly defined; however, periods of drought followed by cool, wet conditions during pollination and kernel development may favor production.

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 upon the magnitude of the exposure (duration and concentration), healthy animals can recover if the contaminated feed is removed from the diet.

Effects of Fumonisins on Plants, Animals, and Humans

Fumonisin B1 is extremely toxic to horses, moderately toxic to swine, weakly toxic to cattle, and has been associated with esophageal cancer in humans. Consequently, the Food and Drug Administration (FDA) recently established recommended action levels for fumonisins in human foods and animal feeds *(Table I)*. An action level is the maximum concentration of fumonisin in food or feed that presents no health hazard to humans or a designated animal species. Food or feed containing levels of fumonisin higher than the action level could pose a health hazard. The action level

Table I. Food and Drug Administration action levels for fumonisins in animal feeds.

Mycotoxin	*Action level* [a]	*Use*
total fumonisin	5 ppm[b] (no more than 20% of diet)	Equids (horses, mules, donkeys) and rabbits
	10 ppm (no more than 50% of diet)	Swine and catfish
	30 ppm (no more than 50% of diet)	Breeding ruminants, breeding poultry and breeding mink
	60 ppm (no more than 50% of diet)	Ruminants older than three months being raised for slaughter and minks raised for pelt production
	100 ppm (no more than 50% of diet)	Poultry being raised for slaughter
	10 ppm (no more than 50% of diet)	All other species or classes of livestock and pet animals

[a] ***Action level:*** the maximum concentration of fumonisin in food or feed that presents no health hazard to humans or designated animal species. Food or feed containing levels of fumonisin higher than the action level could pose a health hazard.
[b] ***ppm:*** the concentration of fumonisin in food or feed is expressed in units of parts per million.

for fumonisin is expressed in units of parts per million (ppm). The 5 ppm action level for fumonisin in food grade corn is the equivalent of one ounce of toxin in 12,500 pounds of grain. Dietary exposure recommendations usually consist of the action level for a specific mycotoxin; in the case of fumonisin the proportion of the diet that can contain contaminated feed also is included. For example, in a swine operation, animals can be fed grain that contains up to 10 ppm fumonisin as long as the contaminated grain comprises no more than 50 percent of the total diet. High concentrations of fumonisin often are found in corn screenings. Many millers have adopted a zero tolerance for fumonisin in food grade corn.

Plants

Fusarium grain mold is often, but not always, characterized by white streaks under the cap of the kernel. Infected kernels usually are scattered across the ear; however, colonized kernels do not always show evidence of the mold. Not all colonized kernels will have fumonisin. Colonized kernels with no visible symptoms of the mold may contain fumonisin.

Animals and Humans

Fumonisin causes different diseases in different animal species. In horses, it causes equine leukoencephalomalacia (ELE); the primary target is the brain. Once clinical signs become obvious, chances of recovery are slim. In pigs, it causes acute pulmonary edema; the lungs are the primary target. Clinical signs include labored or difficult breathing, weakness, and grayish-blue or slate colored skin or mucous membranes; other lung diseases also may cause these same symptoms. Once clinical signs become obvious, chances of recovery are slim. Pigs ingesting smaller amounts of fumonisin may perform poorly and develop icterus (pigmentation of tissues, membranes, and secretions with bile pigments). Skin, mucous membranes, secretions, and the whites of the eyes may be stained yellow. Ruminants do not appear to be adversely affected by fumonisin. Poultry are even more resistant to adverse health effects from fumonisin. Fumonisin may cause certain types of cancer in humans and is regarded as a potential carcinogen.

Treatment of affected animals is difficult because of the lag time between ingestion and onset of clinical signs. Prevention of exposure is the best management plan. Corn purchased as feed for pigs or horses should be analyzed for fumonisins as a condition of sale. Animals suffering from fumonisin poisoning may be treated symptomatically, but prognosis is usually poor.

Management Options to Minimize Fumonisin Contamination

Chemical

Fungicides are not currently used in Nebraska specifically for the management of *Fusarium* grain mold or for fumonisin contamination.

Host Plant Resistance

Although corn hybrids are reported to vary in susceptibility to *Fusarium* species, susceptibility to grain mold and fumonisin contamination are not characteristics listed in the seed catalogs.

Cultural

To minimize the risk of *Fusarium* grain mold and fumonisin contamination in corn, the following 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 18 percent within 48 hours after harvest. Maintain a storage temperature of less than 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 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. The need for bin sanitation is highest when the ability to maintain cool and dry storage conditions is lacking.
7. Have grain analyzed for fumonisin content. Proper protocols should be used to collect and ship grain samples to a lab for analysis.
8. Clean corn to remove damaged kernels. Do not use corn screenings for feed, especially to horses. Screenings may contain high concentrations of fumonisin.

The U.S. Food and Drug Administration (FDA) does not allow fumonisin-contaminated grain to be blended to reduce fumonisin concentration to more acceptable concentrations. Contact the Nebraska State Department of Agriculture at 402-471-2394 for further information. For sampling and testing information contact the nearest federal grain inspection service or Toxicology Laboratory, Veterinary Diagnostic Center, University of Nebraska, Lincoln (402-472-8459). For information on other mycotoxins, see “Grain Molds and Mycotoxins in Corn” (NU NebGuide G00-1408) and “Understanding Mold Toxins” (NU NebGuide G87-850).

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Elbert C. Dickey, Dean and Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.