

MYCOTOXINS COMMONLY FOUND IN IOWA

The purpose of this paper is to provide information about mycotoxins commonly found in Iowa, including their sources, conditions favoring production, health effects, and recommendations for use of contaminated feed.

General Information:

Mycotoxins are secondary metabolites of fungi that are toxic to other life forms. More than 250 mycotoxins have been detected, but relatively few are considered to be important to animal health.

Mycotoxin prevalence and concentration are sporadic and vary annually, even in the same location. Production is affected by local weather patterns, crop damage and production practices. They may be produced pre- or post-harvest.

Mycotoxins known to occur in Iowa are aflatoxins, dicoumerol, ergot and endophyte-infected tall fescue, vomitoxin, and zearalenone. They are mostly found in grain, including corn, wheat, milo, rye, and oats. They may be found in silages or other feeds which contain grain. With the exception of sweet clover and fescue, they are rarely found in forages.

Health effects:

Since there are many kinds of mycotoxins, which differ from each other, they produce many different kinds of diseases, called mycotoxicoses. Some cause liver disease, others diseases of the alimentary canal, others of smooth muscles, and others of kidneys. Mycotoxicoses are not contagious. Effects of the mycotoxins known to occur in Iowa are described in Table 1.

Detection of mycotoxins:

Detection of mycotoxins in feeds can aid in the prevention and diagnoses of mycotoxicoses. Usually, tissues are not analyzed for mycotoxins by veterinary diagnostic toxicology laboratories.

Chemical analysis is the best way to find mycotoxins in feed. Screening methods are commonly used to rapidly detect mycotoxins. Positive results obtained by most screening methods do not prove the presence of mycotoxins, so positive results should be checked using methods that can prove their presence. Consult the laboratory you use for mycotoxin analysis for details about its practices.

Screening for mycotoxins in feeds by black light (ultra-violet light) is not reliable. Detection is based upon the fluorescence of chemicals indicative of the presence of mycotoxins, which occurs when the black light shines on them. Most mycotoxins do not fluoresce. Those that do may cause adverse health effects at concentrations too low to be detected by the black light. Chemicals that are not mycotoxins may also fluoresce, causing false positive results.



1



Sampling for analysis:

Mycotoxins are not evenly distributed in feeds. Some areas may contain very high concentrations, other areas may contain no detectable amounts. So detection in feeds depends upon the quality and quantity of sample provided for analysis. The sample should reflect all of the feed available at the time the problem occurred. The longer sample is collected after onset of animal health problems, the more likely the feed from which the sample is collected will not be characteristic of the feed being eaten at the time the problem began. And, the smaller the sample collected and provided for analysis, the more likely mycotoxin contamination will be missed.

Sampling based upon visible presence of molds does not always provide a sample that contains mycotoxins. The presence or absence of visible mold growth are not reliable indicators of the presence or absence of mycotoxins. Very moldy feed may not contain any detectable amounts of known mycotoxins, while good looking feed may contain very high concentrations.

It is best to collect a sample during movement of the feed, like when augering it from the storage bin into a grain truck. Collect small amounts over the entire time the feed is being moved, so that at least 5 pounds, and as much as 10 pounds, have been collected. Otherwise, probe sampling may be used. Collect probe samples from as many areas of the feed as practical.

Dry samples are preferred for transport to the laboratory. Mold may grow on wet sample, especially if the sample is placed in a plastic bag. Oven-dry specimens to less than 13% moisture for best preservation. Ship samples in paper or cloth bags.

Use of mycotoxin-contaminated feeds:

It is always safest not to use moldy or mycotoxin-contaminated feeds. Even if no detectable amounts of known mycotoxins are found in moldy feed, as yet unknown mycotoxins may be present which cannot be detected. It is best to NEVER use corn screenings for horses. Corn screenings are very likely to contain toxic concentrations of fumonisins.

If mycotoxin-contaminated feed must be used, feed it to animals that are least sensitive to its adverse health effects, or blend it with clean feed to reduce the concentration to acceptable levels. Generally, ruminants are least affected by mycotoxins. Avoid use for any breeding or gestating animals. Requirements or recommendations for mycotoxin content of feeds may be found in Table 2.

If mycotoxin-contaminated feed is to be blended, then the mycotoxin content of the “clean” and mycotoxin-contaminated feeds must be known. The following formula may be used to calculate the amount of clean feed necessary to make feed containing acceptable mycotoxin concentrations.

$$x = (C-L)/(H-L)$$

x = fraction of the mycotoxin-contaminated feed in the blended feed

C = mycotoxin concentration desired in the blended feed

H = mycotoxin concentration in the contaminated feed

L = mycotoxin concentration in the clean feed (hopefully, L = 0)

Chemicals which are supposed to bind mycotoxins, are available. The binder is mixed in with the mycotoxin-contaminated feed so it can bind mycotoxins, reducing or preventing absorption into the body. The theory upon which binding is based is sound, however efficacy for all mycotoxins in any feed for all animals is uncertain. The binders may also prevent the absorption of nutrients in the feed, too. We urge caution regarding their use.

TABLE 1: MYCOTOXINS COMMONLY FOUND IN IOWA GRAINS AND THEIR HEALTH EFFECTS

Mycotoxin	Source	Substrates	Conditions favoring production	Effects	Remarks
Aflatoxins (B ₁ , B ₂ , G ₁ , G ₂)	<i>Aspergillus flavus</i> , <i>Aspergillus parasiticus</i>	Grains: corn, milo, cotton seed, peanuts	78°F - 90°F (ideal), down to 55°F; kernel damage; high humidity or grain moisture.	Acute: liver toxin, evidence of liver pathology including depression and anorexia.. Chronic: depends upon species, but includes anorexia, poor growth, anemia, ascites, steatorrhea.	The first mycotoxin characterized. More of a problem in states SE of Iowa, especially in the SE part of the US. Chronic exposure can produce liver cancer.
Dicoumerol	<i>Penicillium</i> spp., <i>Humicolor</i> spp., <i>Mucor</i> spp.	Sweet clover hay (<i>Melilotus</i>)	Unknown	Massive hemorrhages, internally and subcutaneously	Does not occur in other forages.
Ergot	<i>Claviceps purpurea</i> ,	Rye, barely, wheat, oats	Warm, humid conditions	Dry gangrene in extremities: lameness, swelling of feet and fetlocks, necrosis of ears, feet, tail; increased body temperature & heat intolerance; increased pulse and respiration; anorexia. Swine: agalactia.	Ergot alkaloids are similar to LSD. A central nervous syndrome may occur.
	<i>Neothyphodium coenophialum</i> (<i>Acremonium coenophialum</i>)	Tall fescue (<i>Festuca arundinaceae</i>)	Endophyte	Fescue foot , a dry gangrene of extremities. Bovine fat necrosis: in SE US, large masses of hardened fat in abdominal cavity. Cattle summer slump or summer syndrome: lowered weight gain and milk production, reduced reproductive performance, agalactia, heat intolerance	Fungus is found in leaves and seeds.
Fumonisin (B ₁ , B ₂ , B ₃ .)	<i>Fusarium moniliforme</i> , <i>Fusarium proliferatum</i>	White & yellow corn	Not well defined; drought during growing season followed by cool, wet conditions during pollination and development	Horses: equine leukoencephalomalacia (ELE). Swine: respiratory syndrome, icterus, weight loss, reduced feed intake. Ruminants: anorexia and mild weight loss on diets with up to 200 ppm fumonisins, no deaths, no other significant or persistent signs. Poultry: when consuming feed containing 200 - 400 ppm may develop inappetence and skeletal abnormalities. More resistant than mammals.	
Mycotoxin	Source	Substrates	Conditions favoring production	Effects	Remarks

TABLE 1: MYCOTOXINS COMMONLY FOUND IN IOWA GRAINS AND THEIR HEALTH EFFECTS

Vomitoxin (deoxynivalenol, DON)	<i>Fusarium roseum</i>	Corn, milo, wheat, rye, barely, other cereal crops	Alternating cool and warm temperatures; wet period during flowering	Swine: associated with feed refusal, resulting in decreased weight gain. Cattle: no apparent adverse health effects	Often occurs with zearalenone
Zearalenone	<i>Fusarium roseum</i> (<i>Fusarium graminearum</i>), <i>Fusarium moniliforme</i>	Corn, wheat, barley, milo, oats	High moisture content (> 22%); alternating high and low temperatures during the maturing and harvesting stage (45°F - 70°F)	Functions as a weak estrogen. It does not cause abortions. Swine: <u>females</u> , hyperestrogenism, nymphomania; anestrus, pseudopregnancy; <u>immature males</u> , feminization, reduced libido, retarded testicular development; <u>mature males</u> , no effects < 200 ppm. Cattle: little effects; vaginal secretions, vaginitis, mammary enlargement.	Mold infection commonly called "pink ear rot" or "scab." Often occurs with DON (deoxynivalenol, vomitoxin) Cattle are not very sensitive to zearalenone.
Vomitoxin (deoxynivalenol, DON)	<i>Fusarium roseum</i>	Corn, milo, wheat, rye, barely, other cereal crops	Alternating cool and warm temperatures; wet period during flowering	Swine: associated with feed refusal, resulting in decreased weight gain. Cattle: no apparent adverse health effects	Often occurs with zearalenone

TABLE 2: ACTION OR RECOMMENDED CONCENTRATIONS OF MYCOTOXINS IN ANIMAL FEEDS

Mycotoxin	Commodity	Animal	Concentration	Remarks	Reference
Aflatoxin	Corn, peanut products	Finishing (feedlot) beef cattle	300 ppb		FDA/ORG CPG 7126.33, Sec 683.100
		Breeding beef cattle, breeding swine, mature poultry	100 ppb		
		Finishing swine > 100 lb	200 ppb		
	Corn, peanuts products, other animals feeds or feed ingredients, excluding cottonseed meal	Immature animals	20 ppb		
	Cottonseed meal	Beef, cattle, swine, poultry (regardless of age)	300 ppb		
	All feeds or feed ingredients	Dairy animals, animal species not listed above, uses not listed above, intended use unknown	20 ppb		
Dicoumerol	Sweet clover hay	All	< 20 ppm	20 - 30 ppm may cause toxicosis after consumption for 3 months; > 60 ppm may cause toxicosis after 2-3 weeks.	Oswailer (1996) <i>Toxicology, The National Veterinary Medical Series for Independent Study</i> , Williams & Wilkins, Media, PA: 398.
Ergot	Barley	All	≤ 0.1% ergot sclerotia	Some references indicate adverse health effects may occur at concentrations beginning at 0.1 % sclerotia in the diet.	7 CFR 810
	Mixed grains		Predominately wheat or rye: ≤ 0.3% Other mixed grains: ≤ 0.1%		
	Oats		≤ 0.1%		
	Rye		≤ 0.3%		
	Triticale		≤ 0.1%		
	Wheat		≤ 0.05%		

TABLE 2: ACTION OR RECOMMENDED CONCENTRATIONS OF MYCOTOXINS IN ANIMAL FEEDS (continued)

Mycotoxin	Commodity	Species	Concentration	Remarks	Reference
Fumonisin	Corn & Corn by-products	Equids (horses)	5 ppm (\leq 20% of diet)	Most toxic to horses	US FDA, Final Guidance, Nov 9, 2001
		Swine & catfish	20 ppm (\leq 50% of diet)		
		Breeding ruminants, breeding poultry; lactating dairy animals, laying hens	30 ppm (\leq 50% of diet)		
		Ruminants \geq 3 months old raised for slaughter	60 ppm (\leq 50% of diet)		
		Poultry raised for slaughter	100 ppm (\leq 50% of diet)		
		All other species or classes of livestock or animals	10 ppm (\leq 50% of diet)		
Vomitoxin (deoxynivalenol, DON)	Grain & grain products	Swine & other animal species, except cattle & chickens	Swine: 5 ppm (\leq 20% of diet). Other species: 5 ppm (\leq 40% of diet).		FDA advisory
		Ruminating beef and feedlot cattle older than 4 months, chickens	10 ppm (\leq 50% of diet).		
Zearalenone	Diet	Prepubertal gilts	< 1 ppm		Osweiler (1996) <i>Toxicology, The National Veterinary Medical Series for Independent Study</i> , Williams & Wilkins, Media, PA: 421.
		Sexually mature sows, bred sows	< 3 ppm		
		Young boars	< 20 ppm		
		Mature boars	< 200 ppm		
		Virgin heifers	< 10 ppm		