Mycotoxins and their Effects on Cattle

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Mycotoxins are naturally occurring compounds produced by fungi growing on plants in the field or during storage periods. Even though toxigenic molds may grow under a given set of environmental conditions, they do not always produce mycotoxins. However, under the right conditions, mycotoxins can be generated fairly rapidly in the field or in storage. Mold identification can provide a direction to test for potential mycotoxins but does not confirm the presence or identification of a mycotoxin. Most mycotoxins can remain stable for years in feeds, and many survive ensiling and food processing. They can be concentrated several-fold in cereal by-products and typically concentrate threefold in distillers coproducts.

Aflatoxins can occur before harvest on starchy cereal crops (corn, cottonseed, and peanuts) or after harvest on stored commodities. Strains of *Aspergillus flavus* mainly produce aflatoxin B1, which is considered the most toxic and carcinogenic (cancer-causing) of the aflatoxins. Aflatoxins are potent liver toxins (hepatotoxins), immunosuppressants, carcinogens, and mutagens, and can cause important public health problems. For these reasons, many governments regulate the allowable concentrations of aflatoxins in animal feeds, human foods, and fluid milk. The FDA limits the amount of aflatoxin that can be found in lactating dairy cow feed to 20 ppb and the aflatoxin metabolite M1 to 0.5 ppb in milk. The level of aflatoxin allowed by the FDA in feed for non-lactating, breeding beef cattle is 100 ppb while feed for feedlot cattle may contain up to 300 ppb.

The clinical signs of aflatoxicosis are somewhat vague and become more pronounced at higher dietary levels (>500 ppb) and/or prolonged periods of time exposed to the contaminated feed. All animals are susceptible to aflatoxins, but the sensitivity varies between species. Young animals and monogastrics are more at risk for toxicosis. Signs in ruminants include:

1. Decreased performance-
    a. Reduced appetite, reduced feed efficiency, reduced weight gain
    b. Reduced milk production and potential for illegal milk residues
2. Signs of Liver Damage-
    a. Increased hepatic enzymes and bilirubin on serum chemistries
    b. Prolonged clotting times (hemorrhage/nosebleeds)
    c. Icterus (jaundice)
    d. Neurologic signs including depression, lethargy, ataxia (staggering), circling, recumbancy
3. Reduced immune competence-
    a. Vaccine failure or poor antibiotic response
    b. Decreased cell-mediated immunity, cytokine production, and nonspecific humoral factors such as complement, interferon, and some bactericidal serum components.
4. Abortion

    a. May cross the placenta and cause damage to fetal tissue
5. Death

Aflatoxin M_1 is the major excretion product in urine and milk and can be monitored for exposure. Aflatoxin M_1 appears quickly in milk and excretion in milk varies with animal species, individual, lactation status, and number of milkings after exposure. The dietary threshold for cows to excrete aflatoxin in milk is approximately 15 ppb; lactating cows consuming a diet with 20 ppb or less excrete less than 0.1 ppb in milk (US Food and Drug Administration [FDA] action limit is 0.5 ppb in milk). Aflatoxin M1 becomes undetectable in milk 2-4 days after aflatoxin-contaminated feeds are removed from the diet.

Veterinarians and nutritionists need to consider multiple sources of aflatoxins in rations and evaluate commodity storage conditions on the farm. In one field case, young calves (300-450 lbs) fed corn, whole cottonseed, gin trash, molasses, and mineral for several months started to show clinical signs of depression, lethargy , ataxia, poor performance, respiratory disease with poor treatment response, and death. Aflatoxin B_1 was detected in multiple samples of cottonseed between 96 and 1700 ppb, in 2 samples of gin trash at 110 and 857 ppb, and corn at 14 ppb. In these instances it is important to sample the final as-fed ration to determine the total level of aflatoxin the animal is consuming. Extremely high levels of aflatoxin B1 (>1000 ppb) may cause sudden or acute neurologic signs such as circling, depression, staggering, recumbency and death due to severe liver and brain damage. Diagnosis is based on clinical signs, laboratory tests indicating liver abnormalites, and toxic levels of aflatoxin present in the ration. An enlarged, fibrous liver is generally found on necropsy.

No specific treatment is available for aflatoxicosis beyond quickly removing the contaminated ration and replacing with an uncontaminated feed. Providing optimum dietary protein, vitamins, and trace elements may aid recovery, although some affected animals may not recover. Numerous products such as bentonite are marketed to sequester or bind mycotoxins and reduce absorption from an animal's gastrointestinal tract, although in the United States these agents can only be sold as anticaking or free-flow agents. The FDA has not licensed any product for use as a mycotoxin binder in animal feeds and extra-label use of feed additives is prohibited.

Other mycotoxins of concern in cattle are those produced by the *Fusarium* species of mold and include deoxynivalenol (DON or "vomitoxin"), zearalanone, and fumonisins. Ruminants are generally resistant to many of the negative effects of these mycotoxins because of their ability to degrade these compounds with the bacteria and protozoa found within the rumen. However, in large enough quantities, deleterious effects may occur. DON or "vomitoxin" is restricted by the FDA to 5 ppm or less in the final ration of dairy cattle over 4 months of age and 10 ppm in the grain (5 ppm in the finished feed) in beef cattle over 4 months of age. The primary clinical sign with DON is feed refusal but a drop in milk production, diarrhea, and immune system alterations may be noted. Zearalanone is associated with hyperestrogenism, enlarged genitalia and infertility although the effects in cattle are not fully understood. Mature cows appear to be more resistant to zearalanone toxicosis than heifers in research trials. No FDA guidelines have been established for tolerable zearalenone concentrations in finished

feed for ruminants. The University of Missouri at Columbia and North Dakota State University suggest limiting the level of zearalenone to <2-4 ppm in dairy cows and <5-10 ppm in beef cattle. Fumonisin B1 and B2 are mycotoxins cattle are more tolerant of than many other species. The FDA does have established tolerance levels of fumonisin in finished feeds of 30 ppm for ruminants over 3 months old and fed for slaughter, 15 ppm in ruminant breeding stock including lactating dairy cows, and 5 ppm for ruminants less than 3 months of age. Feeding large quantities has resulted in decreased feed intake, decreased milk production, and some mild liver lesions.

It is important when dealing with stressed feed ingredients to measure the concentration of mycotoxins present and to know the nutritional value of the feed. However, bear in mind that human exposure to high levels of mycotoxins - aflatoxin in particular – in grains and other crops can result in serious health problems. Any potentially contaminated grains or feeds should be handled with great care. Farmers, mill operators and others who routinely handle potentially contaminated feeds should always use protective gear such as gloves, dust masks, and coveralls. Once the feed is tested, producers then need to:

1. Keep the mycotoxin level as low as possible;
2. Keep the mycotoxin level under the regulatory action level for the given species and stage of production as aflatoxin residues can occur in multiple animal products from animals exposed to excessive amounts. Residues are especially important in milk and organ tissues, but can also be present in meat.
3. Compensate for differences in individual animals, sampling technique and “hot spots” by targeting total mycotoxin intake at less than the action or guidance level;
4. Remember if multiple mycotoxins are present in a feed, their adverse effects may be additive.

For the most up-to-date information regarding aflatoxins and other mycotoxins in corn, visit the UK website http://www.uky.edu/Ag/GrainCrops/corn_mycotoxins2012.html for a comprehensive collection of bulletins compiled by the experts. A link to the mycotoxin page can be found at www.askukyvet.com under “Alerts”.