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Dealing with Mycotoxin-contaminated Feeds at Feeding Time

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Under ideal conditions, livestock should be fed grains and byproducts that are "clean" (i.e., free of fungi and/or mycotoxins). Although feeding clean grains and byproducts is ideal, there are times when clean grains are not available locally and farm finances do not allow for substitution of home-harvested grain with purchased grain. When grains or feeds test positive for mycotoxins, there are several approaches that can be taken to reduce the toxic effects to livestock.

TYPES OF MYCOTOXINS

First and foremost, testing is important to determine what health threats are posed by the feed in question. There are three main groups of molds that affect livestock: Aspergillus, Fusarium, and Penicillium.

Aflatoxins are mycotoxins produced by molds of the genus Aspergillus. Four aflatoxins can be found in livestock feeds, namely B1, B2, G1, and G2. The most common and biologically active component is aflatoxin B1, a potent carcinogen. A liver metabolite of B1 called *aflatoxin M1* can show up in milk and is of concern to humans as it is also a potent carcinogen. The Fusarium type of molds produce deoxynivalenol , zearalenone, trichotecenes, and fumonisin.

High Penicillium counts are oftentimes seen in feeds such as corn grain and corn silage. According to the USDA, there are almost 100 Penicillium fungus species, but only 17 have been found to produce a mycotoxin of concern (USDA 2006). The main toxins are ochratoxin, patulin, PR toxin, mychophenolic acid, and roquefortine C. Their effect depends on the animal stress level and or the presence of other mycotoxins that may challenge the immune system.

Penicillin mold levels that are not normally of direct consequence can, under certain circumstances, result in damage to liver and/or kidneys in the presence of other mycotoxins. Furthermore, high levels of contamination may cause other non-metabolic related problems. One example is odd smells in feed that result in feed sorting, leading to acidosis and displaced abomasums in beef and dairy cattle. If high levels of Penicillium type molds are present, it would be advisable to run qualitative tests to determine if other toxins are also present.

Toxins such as Ochratoxin produced by Penicillium can pose problems for certain age groups in the dairy herd. Ochratoxin is usually degraded in the rumen, which reduces its toxic effects. With heavy grain supplementation, though, this toxin can remain in the rumen and appear in the blood. Ochratoxin is basically a kidney toxin. It is more toxic to young calves with less feed fermentation and microbial "detoxification"

in the rumen than in mature animals that have a fully functional rumen. It is advisable to limit feeding corn grain with high Penicillium levels for mature cows and avoid feeding it altogether to young stock.

Once the presence and concentration of mycotoxins have been determined, different practical approaches can be used to reduce their deleterious effects. The most common ones include: mold inhibitors (precautionary and before mold develops), fermentation enhancers (for high-moisture, fermented feeds), physical separation (discard grain fines), adsorbent agents (at feeding time), blending down with clean feedstuffs to get below problem level, and strategically feeding to certain production phases.

PREVENTING MYCOTOXIN TOXICOSIS

Mold inhibitors (e.g., propionic acid) and fermentation enhancers (e.g., bacterial inoculants) are effective and recommended at storage time. However, there is no point in adding these agents once grain or corn silage has been stored for some time and molds and mycotoxins have already developed. Hoffman and Combs (2009) suggest adding 10-20 lbs of actual propionic acid per ton of high-moisture corn, such as corn with 25% moisture or higher. Producers must keep in mind, though, that organic acid-treated grains can only be fed to livestock, and that treated grains cannot be marketed at the local elevator. Also, mold inhibitors will do nothing against mycotoxins already present at the time of application. It is crucial to avoid unnecessary exposure of grain and silage to air during storage and feed-out and best not to feed grains that show mold growth or have a musty smell. If there's no choice other than to feed the affected grain, it is important to dilute the affected grain with safer grain sources.

Discarding the fines in dry shelled corn stored in bins is an important approach to reduce mycotoxin concentration. Screening to remove fines can be an effective and practical way to reduce mycotoxin concentrations to levels that pose less of a risk. Research performed at the Virginia Polytechnic Institute (Harper et al. 2006) suggests that mechanical screening of corn can reduce aflatoxin concentration in contaminated corn. Samples from a bin were collected with a probe at depths of 3, 9, and 15 feet. The samples were mechanically shaken to separate fines from intact kernels. The aflatoxin concentration in the whole-kernel fractions was 86–89% lower than that in the fines. Total aflatoxin concentration and concentration in the fines was higher in samples collected at 3 feet than the samples taken at the other depths. The difference in aflatoxin concentration at different locations within a bin underscores the importance of getting representative samples when assessing mycotoxin concentrations.

Healthy dairy cows usually resist molds in feed unless they are immune-suppressed. Any stress that impairs the dairy cow immune function increases susceptibility to mycotoxicosis. Both aflatoxins and trychotecenes have demonstrated an effect on immuno-suppression. The effects that have been described are reductions in cellular protein synthesis, cell mediated immunity, and antibody production. It is thus very important to boost the immune system of the animal, aside from the actions taken to decrease the mycotoxin concentration. Boosting the immune system can be accomplished by reducing overall stress and by supplementing the diet with antioxidant compounds (e.g., selenium, vitamins A and E, beta carotenes, etc.) are potentially very efficacious because of their ability to act as superoxide anion scavengers (Galvano et al. 2001).

If aflatoxins become a problem, absorption of the toxin can be reduced by adding anti-caking agents such as sodium bentonite, hydrated sodium calcium aluminosilicates, or a modified yeast-cell-culture-based product to the grain. Adsorbent agents sequester the mycotoxins in feed, reducing the bio-availability of mycotoxins and increasing their excretion in feces (table 1). Advantages of adsorbent agents are their cost, safety, and ease of inclusion. However, clay-type binders appear to be effective against aflatoxins only, not other mycotoxins. Nevertheless, recent research conducted

at North Carolina State University (Whitlow 2008) showed that cows fed diets contaminated with 2.5 parts per million (ppm) DON and 0.27 ppm zearalenone produced 3.2 pounds more milk when the diet was treated with a clay adsorbent at a rate 0.5 lbs per cow daily.

Despite recent research demonstrating their use and effectiveness, adsorbent agents are not currently approved by the FDA to be used for that purpose.

REGULATORY ASPECTS

The FDA Center for Veterinary Medicine does not recognize the use of binding agents as safe. Furthermore, these products must be the subject of an approved food additive petition if they are intended (sold) to be used for this purpose. Clay-type products are generally recognized as safe by the FDA when used as anti-caking agents in animal feeds at levels not to exceed 2%. The concern of the FDA is that binding may not be uniform across different products, rendering them unsafe for consumption. An additional concern is that there is no certainty about what may happen to this binding once exposed to the acid environment in the stomach. If under these circumstances an un-binding did happen, the animal may excrete unsafe levels of mycotoxins in meat or milk products.

Table 1. Effect of commercial anti-caking agents on aflatoxin concentration in dairy cow diets

Commercial name	Active ingredient	% DMI	% adsorption*
[1]Flow Guard	sodium bentonite	1.0	65
1Astra-Ben-20®	sodium bentonite	0.05	61
1MTB-100®	esterified glucomannan	1.0	59
1Mycrosorb®	sodium bentonite	1.0	50
1RedCrown®	calcium bentonite	0.25	31
1SA-20®	activated carbon	-	NS
2Solis®	sodium calcium aluminosilicates	0.5	45
2NovasilPlus®	sodium calcium aluminosilicates	0.5	46

*All binding effects reported for aflatoxins; 1 Diaz et al. 2004.; 2 Kutz et al. 2009.

The FDA considers the deliberate mixing of adulterated food with good food for commercial purposes to be unlawful regardless of the contamination level. The Center for Veterinary Medicine may only permit blending under special provisions (requested by the state), such as unusual drought conditions. Permission is granted to the petition state, and the state's regulatory agents are in charge of monitoring the activities.

COMMENTS

The incidence of toxicity of mycotoxins can be different for ruminant and non-ruminant animals. Corn grain usually constitutes a larger portion of the diet of non-ruminants and can thus be the main culprit of a mycotoxicosis problem. Dairy cattle diets, on the other hand, are formulated using various feeds where shelled corn, high moisture corn, corn silage, and corn distillers grains can be supplemented at similar concentrations on a dry basis. This constitutes both an asset and a liability. On the one hand, using various feeds dilutes the incidence that a single infected feed poses on the overall diet (e.g., corn grain in swine diets); on the other hand, using various feeds increases the likelihood that other corn-based products can also contribute in significant amounts to a mycotoxin problem. This is the reason why the problem can be chronic (i.e., continuous intake of relatively small doses of toxin) in ruminants rather than acute (i.e., large intake of a high dose). Compared to non-ruminants, ruminants have the added advantage that the feeds go through a fermentation process in the pre-stomachs (e.g., rumen) that can reduce the pathogenicity of some mycotoxins.

TEN APPROACHES TO DEAL WITH MYCOTOXIN-CONTAMINATED FEEDS

1. Prevention is key. Add grain preservatives or inoculants when warranted. Clean bins from fines from the previous season before adding the new crop.
2. Use best management practices (i.e., adequate moisture at harvest, increase compaction, minimize air exposure) when harvesting, storing, and feeding-out forages.
3. Test grain to determine which molds and mycotoxins are present and, for mycotoxins, at what concentration.
4. Choose an approach that's feasible and eco-

nomically sound for your operation.
5. Screen the grain to reduce fines concentration and/or blend with clean grain.
6. Reduce overall animal stress levels by adequate management and comfort.
7. Include antioxidants like vitamin E and selenium in the diet.
8. Improve overall nutrition programs, focusing on protein, energy, and effective fiber, and use proven rumen fermentation enhancers.
9. "Dilution may be the solution": blend affected feeds with "clean" feedstuffs to achieve concentrations of mycotoxins below what are considered to be maximal safe concentrations.
10. Consider using anti-caking agents at feeding time.

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