Managing Mycotoxin Problems on Dairy Farms

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**Introduction:** Molds grow in the field, in storage or during feeding. Mycotoxins are poisons that are produced by some molds. In the U.S.A., mycotoxins are rigorously regulated, such that human exposure is limited. However, mycotoxins routinely occur in feeds. Localized weather conditions make certain mycotoxins worse in some places and in some years.

Dairy producers constantly deal with some amounts of mycotoxins. Even well-managed and highly productive herds can have mycotoxin problems. While mycotoxins can cause severe acute problems, in most cases, mycotoxins cause chronic issues that result in a less milk, digestive problems, more disease and higher culling rates. Several excellent reviews including mycotoxin concerns for ruminant animals are available (Coppock, R.W. and Jacobsen, B.J., 2009; Fink-Gremmels, J., 2008; Gallo, A., et al., 2015; Jouany, J.P., et al., 2009; Mostrom, M.S. and Jacobsen, B.J., 2011; Riet-Correa, F., et al., 2013; Rodrigues, I., 2014; Zaki, M.M., et al., 2012; Whitlow, L.W. and W.M. Hagler, Jr. 2010).

**Mycotoxins:** While there are over 1000 known mycotoxins and related metabolites (Brase et al., 2009), there are about 50 to 100 which are known to have caused or believed to have the potential to cause disease in humans or vertebrate animals (Frisvad et al., 2006). Most are produced by *Aspergillus*, *Fusarium, Penicillium, Claviceps* and *Stachybotrys* molds.

Table 1. A list of some important mycotoxins grouped by major producer

| *Aspergillus* | *Fusarium* | *Penicillium* |
|---|---|---|
| Aflatoxins (AF) | Butenolide | PR toxin |
| Cyclopiazonic acid (CPA) | Fumonisins | Mycophenolic acid |
| Cytochalasin A | Deoxynivalenol (DON) | Roquefortine C |
| Gliotoxin | (3 or 15)-acetyl-deoxynivalenol | Citrinin |
| Ochratoxin A (OTA) | T-2 toxin | Penicillic acid |
| Sterigmatocystin | HT-2 toxin | Penitrem A |
| Verrucologen | Diacetoxyscirpenol (DAS) | Secalonic acid D and F |
| Fumitremorgins | Zearalenone | Ochratoxin A (OTA) |

*Claviceps* and *Neotyphodium* produce ergot alkaloids
*Stachybotrys* produce satratoxins and atranones

**Mycotoxin Effects:** The general effects of mycotoxins include:

- Lower or inconsistent feed intake, sometimes off feed
- Poor feed efficiency, unthriftiness
- Digestive disorders, rumen upsets, intestinal lesions, diarrhea
- Production losses
- Nervous disorders, tremors, flightiness, unsteadiness
- Reproductive disorders, lower conception, embryonic losses
- Poor fresh cow transition
- Increased disease (immune suppression), increased culling and death rate
- Symptoms associated with opportunistic diseases

Many other symptoms have been reported, some of which may be dependent on exposure to specific mycotoxins, on an interaction of multiple mycotoxin(s) and on opportunistic diseases. Digestive disorders and an increase in disease incidence are the major consequences.

**Prevention:** Molds can grow and produce mycotoxins in the field, in storage or during the feeding process. Management practices and processes to reduce mold growth and mycotoxin formation have been reviewed (Atanda et al., 2012; Hagstrom et al., 2012; Luo et al., 2018).

**Preharvest:** Prevention starts in the field with practices to reduce plant stress. The two primary factors increasing mold in the field are water stress (either drought or excess rain) and insect damage. Management factors to reduce plant stress and thus the potential for mold are:

- Selection of plant varieties with fungal resistance,
- Timely planting when weather conditions create less stress
- Proper tillage
- Crop rotation (continuous corn or corn following small grains promote fungal disease)
- Good soil fertility
- Irrigation
- Insect control
- Fungicide use
- Timely harvest (when crop is mature)
- Minimization of trash and broken kernels in grain

**Postharvest:** At harvest, mold spores and mycotoxins are usually present. Proper storage management can reduce additional growth of molds and formation of mycotoxins.

Dry feeds should be stored dry; below 15% moisture. Molds can grow at lower moistures when storage temperature is high. Spots of high moisture and subsequent mold growth can result due to moisture migration. This can occur when there is a sizable difference in day and night temperatures. Aeration can help reduce moisture migration and reduce temperatures. Control of insects, rodents and other pests is important. Storage facilities should be well cleaned after use. Mold inhibitors such as organic acids and other chemicals can reduce mold growth.

Silage and other fermented feeds may have the most problems with molds and mycotoxins. Cheli, F. et al., 2013; Ogunade, I.M. et al., 2018; Tangni, E.K. et al., 2013; Wambacq, E., et al., 2016). The ensiling process is never perfect, and silages often contain areas of deterioration, along with unwanted bacteria, yeasts and molds. Silage, and other wet feeds, must be managed to minimize exposure to air. The often-cited recommendations for making good silage can help prevent mold growth and mycotoxin formation (Kung and Nylon, 2001; Woolford, M.K., 1984). These recommendations generally include:

- Choose adapted varieties with genetic resistance to fungal disease
- Plant at dates to reduce plant stress
- Harvest at proper state of maturity and moisture
- Fill the silo fast, with time for packing
- Proper chop length and processing (good packing and air elimination)
- Pack to achieve a high density (eliminates air)
- Cover well (oxygen barrier plastics and enough weight to prevent air exposure)
- Effective additives such as fermentation aids and/or mold inhibitors
- Manage the feeding face (remove silage as used and at a rate to prevent spoilage)
- Discard the spoilage

Silages most likely to mold are:

- High starch: HM corn, corn silage, small grain silages
- Stressed in the field – affected with fungal disease at harvest
- Dry, mature, late harvest
- Poorly packed and covered -aerated
- Poorly fermented
- Slow feed-out - aerated
- Moved and repacked - aerated
- Fed during spring warm-up and summer – warmer weather
- Prolonged poor storage
- Intermediate feeding piles

**Diagnosis:** Evaluation of the herd can provide clues to a mycotoxin involvement. A process of elimination can be helpful. Diagnosis is hindered due to multiple mycotoxins, mycotoxin interactions, lack of specific symptoms, lack of animal biomarkers and feed sampling difficulties. The following points can help make a presumptive diagnosis.

- Effects are general, chronic and variable, depending on specific mycotoxin(s) involved
- General symptoms are present (as listed above under effects)
- Symptoms can result from any opportunistic disease, occurring because of mycotoxin induced immune suppression
- Disease incidence increases, despite having good health mgt. and veterinary care.

- Veterinary therapy results in little or no improvement in problems.
- Crops showed signs of fungal field diseases (stalk rot, ear rot, scab).
- Crops were weather stressed or harvested late (after maturity or over-wintered).
- Feed(s) show evidence of deterioration/molding (musty odor, off color, lumps, heating).
- Tested feeds contain excessive molds and marker (typical) mycotoxins, but results can be error prone due to sampling issues.
- Cows respond to removal/dilution of contaminated feed.
- Cows respond to use of products that reduce mycotoxin effects.

**Treatments:** When a mycotoxin problem arises, these actions can reduce toxic effects. Use of multiple supportive therapies improves the likelihood for maintaining healthy, productive cows.

- Minimize animal stress
- Remove or dilute contaminated feeds
- Ensure feed palatability to encourage intake
- Use mold inhibitors: such as organic acids
- Add extra nutrients: protein, energy (fat)
- Maximize nutritional antioxidants: Vit E, Vit A, carotene, Cu, Zn, Mn, Se, and others
- Enhance rumen fermentation: effective fiber, buffers, direct-fed microbials
- Support gut health: yeast products, probiotics
- **Support immunity: immune modulator products***
- **Deactivate the mycotoxins: adsorbents, binders or enzymes*#**

***Important mitigation products are immune modulators and mycotoxin adsorbents.**
**#The FDA has not approved any products for claims for deactivating mycotoxins.**

Immune modulators are very important parts of a mitigation strategy. A primary effect of mycotoxins is to cause immune suppression and increased disease. Improving immunity can help the mycotoxin-exposed cow resist disease that might otherwise produce extensive harm.

Mycotoxin binders* have been shown in research to significantly reduce animal exposure to mycotoxins and thus reduce toxicity. FDA has not approved mycotoxin binders.

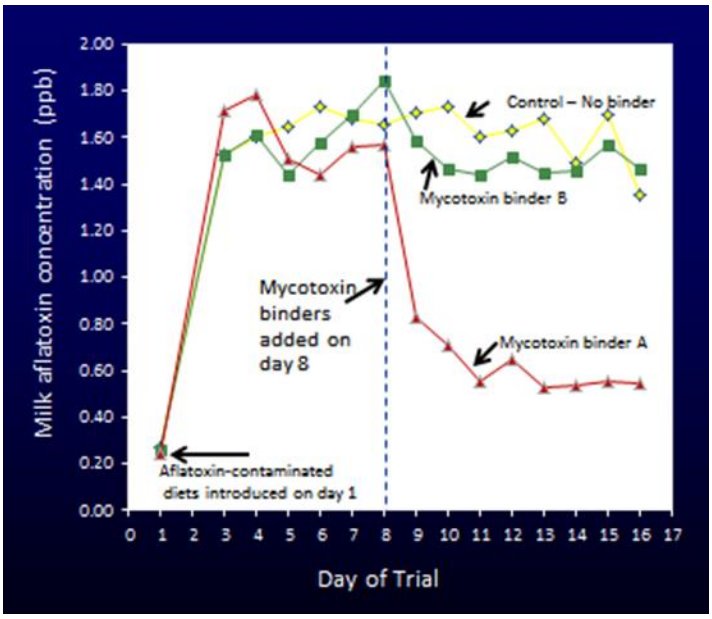
A mycotoxin binder is added to feeds in small amounts. The binder adsorbs mycotoxins, helps prevent mycotoxin absorption across the gut (into the blood supply) and results in mycotoxin elimination into the manure. Even though a mycotoxin is present in the feed, the mycotoxin binder reduces animal exposure and toxicity.

Mycotoxin binders include several types of products including silicates (bentonites, zeolites, smectites, and other clays), yeast products, bacterial products, activated carbons, chitinous products and ion-exchange resins (Boudergue, C. et al., 2009; Kolosova, A. and Stroka, J., 2011). Silicate products are the most thoroughly studied. Selection of effective products must be

based on *in vivo* research. This is because chemical composition or *in vitro* evaluations have shown poor correlations with *in vivo* binding results.

The following (figure 1) shows an example of research where dairy cattle were fed aflatoxin-contaminated diets over a 16-day period. When aflatoxin was fed, there was an aflatoxin residue in milk. In this example, two different mycotoxin binders were added to respective diets on day 8 and cows continued to consume aflatoxin. Cows receiving no binder or mycotoxin binder-B continue to have a high aflatoxin residue in their milk. On the other hand, those cows receiving mycotoxin binder-A had a dramatic decline in milk aflatoxin residue. While binding is not absolute, milk aflatoxin levels can be greatly reduced.

Figure 1. Aflatoxin residues in milk in relation to time when aflatoxin is introduced into the diet and when mycotoxin binders are added to the diet. Binder-A effectively reduced aflatoxin concentration in milk, while binder-A showed no effect with results not significantly different from the treatment with no added binder (adapted from: Kissell et al., 2012).




**Summary:**

- Mycotoxin occurrence is routine - especially in forages
- A diverse array of multiple mycotoxins occurs
- Chronic toxicity (resulting from long-term, low level intake) is most critical
- Symptoms are diverse, resulting from a cascade of events
- Symptoms include: digestive upsets, low feed efficiency, production loss, poor reproduction, increased disease and higher culling rates
- Disease therapy and vaccines are less effective
- Diagnosis is difficult – a mycotoxin cause may not be apparent
- Mycotoxin exposure may be an undiagnosed but key reason for problems

- Immune stimulants, adsorbents and mold inhibitors are important treatments
- Other management practices can be preventive and supportive

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