Dairy Research Summary

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Mycotoxins: Recognizing and Managing

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Wikipedia defines a mycotoxin as "a toxic secondary metabolite produced by organisms of the fungi kingdom" including mushrooms, yeasts and molds. Fungi or their spores can be found virtually everywhere and when growth conditions are ideal they will grow rapidly into colonies capable of producing toxins. While molds can often be visually detected and are generally harmless, mycotoxins produced by molds can be of great concern.

Thousands of mycotoxins have now been identified but not all are toxic to every animal that consumes them. In fact, there are only a handful of mycotoxins with known negative effects to dairy cows found in grains and forages. Negative effects range from acute symptoms of severe illness that appear very quickly to long term chronic or cumulative effects on health, including the induction of cancers and immune deficiencies.

Fungi that produce mycotoxins fall into two groups: those that invade before harvest and those that invade after harvest. Pre-harvest invaders include *F. graminearum* (DON), *F. moniliform* (fumonisin) and sometimes *A. flavus* (aflatoxin). *A. flavus* is typically found colonizing in aging or stressed plants before harvest, predisposing it to mycotoxin contamination after harvest.

Extreme mold growth can have obvious negative effects including changes in color, consistency and odor, which can lead to undesirable feeds. Nutritionally, mold growth can reduce the energy, protein and vitamin content potentially resulting in decreased performance, especially in high producing cows in early lactation. It is essential to minimize any mold growth during the growing season and while in storage.

There are many field conditions that influence the growth of molds and the production of mycotoxins, including moisture, temperature and the presence of fungal spores. Additionally, stress factors like drought, poor fertilization, high plant density, weeds, insects or mechanical damage from events like hail or lodging can weaken the plant's natural defense and promote mold colonization and growth. While the mechanism of resistance is not well understood, a strategy that has shown promise for reducing mycotoxin levels in small grain crops is the use of a combination of resistant cultivars and fungicides. This has proven especially effective in the case of DON contamination. Other management practices include minimizing lodging, and careful management of crop residues and crop rotation. Crop residues may be of significant importance as increased DON concentrations have been documented in no-till or reduced tillage systems in comparison to clean tillage systems. Additionally, crops rotations that include small grains following corn or small grains planted continually can also increase the risk.

During harvest, efforts should be made to crop affected sections separately. In a field infected with Fusarium Head Blight (FHB results in DON or vomitoxin production), it is possible to adjust the combine to blow out damaged kernels which are lighter than healthy kernels. After harvest, storage conditions dictate whether fungi will continue to grow and/or produce mycotoxins. Moisture and storage temperature are crucial. Fungi can not grow in properly preserved feeds, so immediate efficient drying of grains (<15%) and maintenance of the dry state is an effective control against fungal growth. When necessary, grains should not be stored undried for longer than three days to prevent further contamination.

Mold can grow in hay at moistures of 13% to 15% making it difficult to make hay dry enough to prevent mold growth. Dry down can be improved by increasing ventilation, leaving air spaces between bales, reducing stack sizes, altering stacking directions, and avoiding wet products in the same area.

As for ensiled forages, according to the Canadian Grains Commission, mycotoxin "levels peak two to three weeks prior to seed maturity". Therefore timing of harvest can affect the level of mycotoxin in the forage. Additionally, careful ensiling will prevent further mold development, although it will not destroy any mycotoxin already present. Good silaging practices include harvesting at the proper moisture content, chopping to a uniform length, filling the silo/bunk rapidly, packing sufficiently, using an effective fermentation aid and covering completely. Essentially the goal is to reduce the pH quickly and eliminate oxygen effectively to reduce mold growth and mycotoxin production.

Unfortunately mycotoxins are not uniformly dispersed through a field, a silage pit or a bin. They occur in "hot spots" which can make detection very difficult. Even with perfect sampling procedure, it is possible to get a low or safe lab test result in feed that actually contains dangerously high levels of a mycotoxins. Alternatively, it is possible for a lab test to indicate dangerously high levels when the feed could be relatively safe. Therefore, sending samples to a lab can provide misleading information.

Mycotoxins are measured in very low concentrations, either in parts per million (ppm) or parts per billion (ppb). This adds to the difficulty in achieving accurate analysis and quantification. To demonstrate, there are approximately 13,960 kernels in 1 pound of wheat. One ppm is equal to 1 kernel in 71.6 pounds or 1.2 bushels of wheat. One ppb is 1000 times smaller, so there would be 1 kernel in 71,600 pounds or 32.5 tonnes of wheat. It may be easier to find a needle in a haystack!

As mycotoxins are heat stable, chemical substances, not living organisms like the fungi that produce them, they cannot be "killed". At this time there is no proven treatment to both neutralize a mycotoxin and leave the integrity of the feed intact. Adding an adsorbent or binder to contaminated feed has been reported to increase milk production, feed intake and reproductive performance. Research continues on

enzyme products that can break down the toxins. Since mycotoxin lab results are not reliable, a common recommendation is to monitor animal performance for the following symptoms of mycotoxin issues:

- Variable manure consistency ranging from very loose and bubbly to firm with undigested fiber or grain
- Rough hair coat
- Increased incidence of retained placenta and displaced abomasum
- Poor conception rates
- Abortions
- Udder edema
- Irregular feed intake
- Irregular milk production

If cows exhibit any of these signs, add a mycotoxin binder or enzyme product to the feed. If the problem goes away in 4 to 5 days, it is likely a mycotoxin in the feed has been controlled with the feed additive. If the problem persists, it may not be a mycotoxin issue but needs further investigation by a nutritionist or veterinarian.

The quantity of mycotoxin necessary to produce negative effects varies by toxin, and can even vary by cow within a herd. Stress can influence an animal's response to mycotoxins. A stressed cow in severe negative energy balance or in poor housing conditions can react negatively to very low mycotoxin levels where well managed cows have tolerance. To determine the amount of risk posed by a specific mycotoxin, the level of contamination in the feed and the total amount consumed must be considered. The following table outlines the mycotoxins that can affect dairy animals and the recommended maximum concentrations:

Mycotoxin	Commodity	Fungal Source	Effects	Maximum Feeding Guidelines for Dairy Diets
Aflatoxin	Corn, Wheat Barley	*Aspergillus*	Residues in milk, immune suppression, liver damage, decreased feed intake and milk production, diarrhea, weight loss, respiratory disorders, hair loss, acute mastitis, birth of small and unhealthy calves	20 ppb

Deoxynivalenol (DON) or Vomitoxin	Wheat, Barley, Corn, Grain silage	*Fusarium*	Reduced milk production, reduced feed intakes, poor performance, immune suppression	6 ppm
Fumonisin	Corn	*Fusarium*	Lower milk production, reduced feed consumption	5 ppm
Trichothecenes (T-2/HT-2)	Corn, Wheat, Oats, Barley	*Fusarium*	Gastroenteritis, intestinal hemorrhages, bloody diarrhea, edema, dermatitis, feed refusal, reduced milk production, reduced immune response	1.5 ppm
Zearalenone	Corn, Wheat, Barley, Silages	*Fusarium*	Reproductive issues including infertility, decreased conception rates, abortions	7 ppm
Ergot Alkaloids	Rye, Wheat, Grasses	*Fusarium*	Agalactica, anorexia, lameness, abortions, loss of hooves or tails, nervous syndromes	< 1 ppm

References:

North American Miller's Association (NAMA); www.namamillers.corg

Food and Agriculture Association of the United Nations (FAO); www.fao.org/

Grains Canada Commission (CGC); www.grainscanada.gc.ca

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