

Molds and Mycotoxins

Mycotoxins are produced by actively growing mold. Molds can be present and growing without mycotoxin formation, and mycotoxins can be present even though mold growth is not readily visible. There are over 500 different mycotoxins. Prevention of mycotoxin formation is key since there are no full-proof ways to completely overcome the problem once mycotoxins are present. Most mycotoxin-producing molds belong to one of three genera - *Aspergillus*, *Fusarium*, and *Penicillium*. A few of the more common molds found in grain and the mycotoxins associated with them are listed in Table 1.

Table 1. Common molds and mycotoxins found in feedstuffs fed in the Midwest

| Mold | Mycotoxins | Upper Limit |
|------------------------------|--------------------------------|-------------------|
| <i>Aspergillus Flavus</i> | Aflatoxin | 20 ppb |
| <i>Aspergillus Ochraceus</i> | Ochratoxin | |
| <i>Fusarium Tricinctum</i> | T-2 Toxin | |
| <i>Fusarium Foseum, F.</i> | Zearalenone Vomitoxin (DON) | 6000 ppb 6 ppm |

Information provided by Dairyland Laboratories

At present only aflatoxin is regulated in animal feeds. FDA mandates that Aflatoxin can occur at no more than 20 ppb in dairy feeds and 0.5 ppb in milk.

Prevention and Control

Molds require several basic conditions to establish colonies and grow. Specific conditions will vary considerably between mold species. Mold growth requirements include:

- Organic Matter (nutrient source)
- Oxygen
- Moisture
- Proper pH
- Proper Temperature

Mold contamination can occur at several stages, pre or post harvest, during processing, transport or storage. As with any potential disease-causing organism, prevention rather than treatment, is the preferred method when dealing with mold.

Pre-harvest conditions that can predispose plants to mold infestation are obviously the most difficult to control, and include any condition that imposes a stress and thus reduces plant vigor. Environmental conditions that will increase the likelihood of mold growth include damp weather, high temperatures, insect damage, hail damage and drought conditions. Plant factors that may encourage mold growth include poor variety resistance to mold growth, poor fertility, high stand density, and weed competition.



Harvest for Grain

During harvest, broken or damaged materials, crop and weed residues, and high moisture plant parts should be removed. Cleaning the grain through proper screening can greatly reduce mold growth. Grain handling and storage can have a profound impact on mold growth. Any process that results in breaking the seed coat will increase the amount of readily available nutrients for mold growth. In particular, grinding greatly increases the possibility of mold growth. It is recommended not to grind and store feed for long periods of time. Proper drying, as soon as possible, to proper moisture levels is also important. Improper aeration, drying grain at too high of temperatures, or failing to maintain uniform temperatures in grain drying bins can contribute to a mold problem.

For grains and forages stored in silos, any practice that does not allow for the rapid elimination of oxygen will contribute to a mold problem. This includes poor silo structure, improper packing of silage, not following recommended crop moistures, slow silo filling, and failing to seal the silo properly.

Mold Detection

Feed appearance is not necessarily a good indicator of mold or mycotoxin contamination. However, some feed signs that may indicate the presence of mold include:

- Caking or lumping of feed
- Poor feed flow out of bins
- Moldy, musty or mildew smell in the grain
- Grain is warm or there are signs of heating
- Dark or water damaged color
- Obvious mold growth

Accurate estimates of mycotoxin concentrations in feed can be expensive and difficult. The following procedures should be helpful in determining if a mold problem is present.

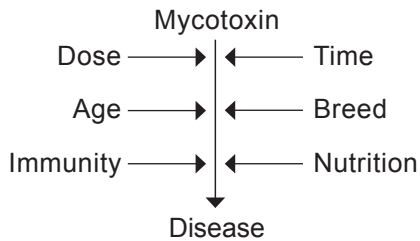
- Sample and test suspicious feeds for mycotoxins. Feeds should be probed in multiple locations and composited. Ideally, submit frozen sample to a commercial lab. Identify the type of mycotoxins present; not all molds produce harmful toxins.
- Elisa testing is accurate for dry grains. Mycotoxin positive forages and ensiled grains should be confirmed with gas chromatography (GC), high pressure liquid chromatography (HPLC) or thin layer chromatography (TLC).
- If there is a question on whether a mold induced mycotoxin problem exists (or the severity of the problem), remove 100% of the suspect feed from the diet. Mycotoxin induced problems generally are rectified in 1-3 weeks if contaminated feed is removed completely from the diet.
- The use of the black light test is a good initial screening procedure, but it can give false positive readings. The black light is only helpful in detecting mold that produces aflatoxins.



Mold Symptoms and Recommendations

Feed that is contaminated with mycotoxins can obviously have significant effects on animal health and productivity. Often symptoms are attributed to other causes and may be subtle. Individual animals will respond to mold differently. Several factors having an influence on the degree of disease expression the animal are shown in (Figure 1).

Figure 1.



A few of the more common disease symptoms follow:

- Decreased feed intake and efficiency
- Mastitis flare-ups
- Liver or kidney damage
- Birth of small, weak calves
- Decreased milk production
- Embryonic death, abortions
- Weight loss
- Poor conception, ovulation
- Respiratory disorders
- Nervous system dysfunction
- Intermittent diarrhea
- Suppression of immunity
- Tumors
- Rough haircoat
- Anemia
- Death

Mold appears to exert its effects in feeds through five primary mechanisms:

- A change in the vitamin content of the feed
- A change in the amino acid content
- A reduction of feed energy
- The creation of mycotoxins
- Immune system suppression

It has been suggested that the rumen has the ability to detoxify compounds produced by molds. Very limited information is available to support this claim and current research has variable results. If in fact the rumen does have detoxifying effects on mycotoxins, to what extent is rumen metabolism or the bacterial environment compromised?



Recommendations

If a mold problem is suspected there are some procedures that may help alleviate problems. Possible courses of action include:

- Dilution of problem feeds is an obvious method of reducing the ingestion of mycotoxins. This can be accomplished by blending with “clean” grains or by physical removal of the grain from the diet.
- Thoroughly clean and screen all suspect grains to separate any broken kernels and foreign material. Damaged grain and screenings are typically more likely to harbor high levels of mycotoxins.
- Using anti-fungal (organic acids) such as propionic acid will prevent existing mold spores from growing. Preventing mold growth eliminates the chance of added toxins, although mycotoxins existing prior to the acid addition are active and potentially harmful. Acids must be handled with care.
- Flame-roasting will reduce many mycotoxin producing spores; however, roasting has minimal impact on the mycotoxins present prior to roasting. Shrink and processing costs should be considered.
- If mycotoxin contaminated feeds must be fed, avoid lactating cows, young animals, breeding animals, and monogastrics if possible. Older ruminants, such as feedlot steers, offer the best opportunity to get rid of toxin inoculated feeds. Adjust feed intake and grain energy values downward.
- Research suggests nutrient requirements are increased in animals stressed by the feeding of harmful mycotoxins. Animal performance may improve with additional supplemental vitamins A, E, and thiamin. Likewise, added zinc, copper, selenium, yeast, and protein may be beneficial.

Table 2. Mold identification

| Mold | Color | Toxin Producer | Comments |
|---------------------|------------------------|---|---|
| <i>Penicillium</i> | Green to green-blue | Yes - Ochratoxin, Citrinin, Patulin | Several potential toxins associated with certain species. Most common toxin producer in silage. |
| <i>Aspergillus</i> | Yellow-green | Yes - Aflatoxin, Ochratoxin | Found in drought, heat-stressed conditions or insect-infested fields |
| <i>Fusarium</i> | White to pinkish-white | Yes - Zearalenone, Vomitoxin (DON), T-2 Toxin, Fumonism | Common in cold, wet seasons. Certain strains produce extremely potent toxins. |
| <i>Mucor</i> | White/gray | None | Found especially in sealed corn. Grows at low temperatures. Also found in manures and soils. |
| <i>Rhizopus</i> | Black/white | None | Requires high moisture and an advanced decay mold. Common bread mold. |
| <i>Cladosporium</i> | White | None | Produces yeast-like symptoms. Grows at low temperatures. |

Reference: Dr. Bill Mahanna, “Prevention And (If Necessary) Management of Moldy Silage.”



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Table 3. Interpretation guidelines for mold counts

| Mold Count | Guideline |
|---------------------|--------------------------------|
| 10-10,000* | Relatively Safe |
| 10,000-100,000* | Transition Zone |
| 100,000-10,000,000* | Caution Advised |
| Over 10,000,000* | Feeding May Not Be Recommended |

*col/g (colonies per gram)

Information provided by Dairyland Laboratories

Table 4. Mycotoxins and their effects on animals

| Toxin | Mold Species Producing Toxin | Agricultural Commodity Most Affected | Susceptible Animals | Biological Effect |
|-------------|--|--|--|---|
| Aflatoxin | <i>Aspergillus flavus</i> , <i>Aspergillus parasiticus</i> | Cereal grains, peanuts, soybeans, tree nuts, milo, copra, cottonseed | All animals and humans | Hepatotoxin, carcinogenic, reduced growth rate, loss of appetite, hemorrhages, increased susceptibility to other diseases |
| Zearalenone | <i>Fusarium graminearum</i> , <i>Fusarium tricinctum</i> , <i>Fusarium oxysporum</i> | Corn, barley, hay, milo | Swine, rabbits, chickens, turkeys, poults, lambs, cattle | Hyperestrogenism, rectovaginal prolapse, enlarged vulva, pseudopregnancy, enlarged mammary gland, hypertrophy of nipples, infertility, reduction of litter size, weak piglets |
| T-2 Toxin | <i>Fusarium tricinctum</i> , <i>Fusarium avenaceum</i> , <i>Fusarium solani</i> , <i>Fusarium graminearum</i> , <i>Fusarium nivale</i> , <i>Fusarium lateritium</i> | Cereal grains, hay | Cattle, young calves, chickens, ducklings, turkeys, geese, swine | Hemorrhages, inflammation of the digestive tract, vomiting, feed refusal, loss of appetite, decrease in milk production |
| Vomitoxin | <i>Fusarium graminearum</i> | Cereal grains | Swine, chickens, cattle, dogs, cats | Vomiting, feed refusal, diarrhea, weight loss, low feed conversion |
| Fumonisin | <i>Fusarium moniliforme</i> , <i>Fusarium proliferatum</i> | Cereal grains, corn | Horses, swine, humans, cattle | Equine Leukoencephalomalacia (ELEM), Porcine Pulmonary Edema (PPE), Esophageal Cancer (EC) |
| Ochratoxin | <i>Aspergillus ochraceus</i> , <i>Penicillium viridicatum</i> | Corn, oats, soybeans, buckwheat, barley, peanuts | Cattle, swine, chickens, ducklings, humans | Hepatotoxin, nephrotoxin, abortion, reduction in growth, delayed sexual maturity, lower rate of egg production |

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Collecting and Sending a Sample

Take a composite from several locations across the face of the silage by thoroughly mixing several hundred pounds of silage. Gather a well-mixed composite sample. For grains and byproducts probe as much of the total inventory as possible. Package the sample in a gallon size ziplock bag. Send the sample early in the week on ice. Do NOT mail the sample on Friday or Saturday.

Recommended Laboratories:

Dairyland Laboratories
217 E. Main St.
Arcadia, WI 54612
608-323-2123

K-Testing Laboratory, Inc.
365 South Main Street
Memphis, TN 38103
901-525-0519
(Cottonseed) 701-231-8307

Veterinary Diagnostic Lab
North Dakota State University
Van Es Hall
PO Box 5406
Fargo, ND 58105

Summary

The presence of molds and mycotoxins in feeds and their effects in dairy cattle is obvious cause for concern. Prevention of mycotoxin formation is essential, since once it exists there are few ways to remove its presence in feed.

References

Seagor, WI. 1998. Molds and Mycotoxins in Ensiled Forages. 4 States Applied Nutrition Conference, March 5-6, 1998, p. 71-80.

