MANAGING THE EFFECTS OF MOLDS AND MYCOTOXINS IN RUMINANTS

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CROP AND INGREDIENT RELATED FACTORS

Moldy feed and mycotoxins

Moldy feeds may contain mycotoxins but not at harmful levels. Molds may produce harmful levels of potent mycotoxins under certain circumstances. Molds always produce some mycotoxins.

Some key aspects to consider

1. Most of the vomitoxin produced is the result of conditions in the field. Zearalenone levels depend on field and storage conditions.
2. Fusarium fungus goes dormant at moisture levels below 18%. The fungus will continue to grow under poor storage conditions.
3. A temperature differential of 5°C or greater between the stored grain and ambient temperature will result in air convection currents, moisture movement and condensation and set up conditions for fungal growth in storage.

Some key practical recommendations

Recommendations made for corn by Ridgetown College may be useful here as well.

1. Harvest infected grain at higher moisture levels and artificially dry down as rapidly as possible. This will limit further fungal growth and deterioration of the grain.
2. Adjust the combine to screen out as much of the small, light kernels and fines as possible. These are the most highly contaminated part of the crop.
3. Grain could be screened again going into storage to further reduce the amount of more heavily contaminated material.
4. Dry the grain rapidly to limit / stop fungal growth.
5. Monitor the stored grain and aerate as required to prevent heating or moisture buildup. This will help maintain the present quality and reduce further deterioration.
6. Addition of mold inhibitors to stored grains will reduce the growth of toxin producing molds in the grain storage bin. Add an appropriate mold inhibitor (sodium or calcium propionate or organic acids) to stored grain to prevent further development of molds. - Add 0.2 to 0.25% to non-ensiled feeds with 14 - 17% moisture. Add 0.5 to 0.6% to non-ensiled feeds with 18 - 24% moisture (or follow the manufacturer's recommendations).

MOLD AND MYCOTOXIN EFFECTS ON CATTLE

Moldy feed and mycotoxins

Molds and mycotoxins have a number of harmful effects on ruminants. However, it is often difficult to clearly identify the problems and associate them with the presence of moldy feed. This is illustrated by the following two quotes. "Differences of opinion exist regarding the role of molds and mycotoxins in livestock problems basically because their effects on animal health and production are still in a grey area" (Seglar & Mahanna, 1995). "Mycotoxins can have a very pervasive, yet sub-clinical effect on both performance and health in ruminants that can easily go unnoticed. If you wait until clinical symptoms of mycotoxin problems are obvious, you no doubt waited too long". (Eng, 1995).
Effects of mold

The greatest emphasis with moldy feeds has been on the types and levels of mycotoxins present in the ration or ingredients. However, moldy feed with very low or undetected levels of mycotoxins may still be harmful and adversely affect production and health of livestock. While many silage molds appear to be harmless, others can have a marked detrimental effect on livestock consuming these contaminated feeds.

Moldy feeds are less palatable and may reduce dry matter intake. This in turn leads to a reduction in nutrient intake, reducing weight gains or milk production. Performance losses of 5 - 10% are typical with moldy feeds even in the absence of mycotoxins. Production losses are even greater with mycotoxin contamination, even when the mold is not readily visible.

Mold feed may have reduced digestibility and energy content may need to be adjusted down by 5%. Molds grow and propagate deriving energy from the feed's protein, fat and carbohydrate. Dietary fat in particular is reduced in moldy feeds. Book values for energy should be multiplied by 0.95 when substantial amounts of mold are present (ie. 95% of energy value). Some researchers suggest reducing energy by as much as 10% (ie. 90% of energy value).

Moldy feeds may cause health problems. Feeding moldy feeds increased mycotic abortions and respiratory disease. Feeding cattle moldy feeds is also hazardous to human health – farmer’s handling the feeds breath in mold spores and this may lead to farmer’s lung.

Effects of mycotoxins

The detrimental effects of mycotoxins, along with the molds, are more severe than the molds on their own. For example production losses are estimated to be greater than 10% under these circumstances. Some molds, such as corn smut (Ustilage maydis) are harmless to livestock while others have mild to severe effects when fed to cattle.

Initially, mycotoxins cause relatively minor problems. The reduction in performance may be negligible. Within days or weeks, the effects of continued mycotoxin consumption on performance (milk production or weight gains) becomes more pronounced. Cattle go off feed and ketosis and displaced abomasum problems may increase significantly with the consumptions of mycotoxins. Some animals develop diarrhea / intermittent diarrhea or have signs of haemorrhaging. There are also estrogenic effects; swollen vulvas and nipples; vaginal or rectal prolapses may occur. Reduced fertility and conception rates and abortions may also be evidence of cattle consuming mycotoxin contaminated feed. The effects of mycotoxins are amplified by production stress. High producing dairy cows and rapidly growing feedlot cattle are more susceptible to the effects of mycotoxins than low producing animals.

Key pointers indicating possible mold / mycotoxin problems in cattle

1. Palatability is reduced, in some cases markedly by the presence of mold. Dry matter intakes will be reduced. Initially there is slightly reduced feed intake but later a more severe drop in intake – possibly even feed refusal.
2. Molds directly or indirectly reduce animal performance. Production losses of 5 - 10 % (weight gains or milk production) are commonly observed.
3. Moldy feed appears to be associated with increased susceptibility to disease. Animals have higher incidence of health related problems, especially ketosis, displaced abomasum, retained placenta and metritis.
4. Moldy feed is associated with higher incidence of respiratory problems. (also farmers lung).
5. Cattle may have intermittent diarrhea, occasionally bloody or dark.
6. Moldy feed is associated with reproductive problems and failures. Higher incidence of silent heats, decreased conception rate and pregnant cows show heats.
7. Moldy feed increases the incidence of mycotic abortions.
8. Cattle often have a rough hair coat and have a generally unthrifty and undernourished appearance.
9. Moldy feed is more prone to heating in the bunk on feedout. Moldy feeds heat and deteriorate more rapidly reducing bunk life. Heating further depresses feed intake and makes animals more susceptible to digestive upset.

These symptoms are not unique to mold and mycotoxin problems. Herd problems need very careful evaluation and the help of the veterinarian is usually recommended.

**SAMPLING AND TESTING FOR MOLDS AND MYCOTOXINS**

*When to test for mycotoxins*

When moldy feeds are being fed and/or moldy feeds make up a significant proportion of the ration. When substantial changes in production and health are observed in a large proportion of the animals on feed. Decline in performance and health that cannot otherwise be explained and symptoms typical of the effects of mycotoxins are present.

*What to sample for mycotoxins tests*

Sample the total mixed ration or sample the grain and forages separately when cattle are fed conventionally. Sample individual suspect ingredients to establish which ingredients are contaminated.

*Problems with sampling for mycotoxin analysis*

Mycotoxins are often present in very small amounts (ppm and ppb). Mycotoxin content is not related to the amount of mold present. Mycotoxins are not necessarily evenly distributed in the affected feed. Isolated pockets may exist. Some mycotoxins could develop during lengthy transit to the laboratory. Get samples to the laboratory as soon as possible. Some mycotoxins continue to be produced in storage, particularly in poor storage conditions.

*Mold spore count tests*

Mold spore counts may underestimate the amount of mold present and be a poor indicator of the potential risk. However, mold spore counts can give some indication of the suitability of feed for livestock. There is some difference of opinion on what spore count constitute a safe / harmful level for livestock. There is no direct correlation between the presence and extent of mold contamination and mycotoxin levels. Consequently, mold spore counts are a less reliable measure of the potential harm that feedstuffs may pose.

<table>
<thead>
<tr>
<th>Spore count (cfu/g)</th>
<th>Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 - 500,000</td>
<td>Safe to feed to cattle</td>
</tr>
<tr>
<td>500,000 - 1,000,000</td>
<td>Considered relatively safe to feed</td>
</tr>
<tr>
<td>1,000,000 - 3,000,000</td>
<td>Reduce energy by 5%</td>
</tr>
<tr>
<td></td>
<td>Feed with caution</td>
</tr>
<tr>
<td></td>
<td>Dilute with “clean” feed</td>
</tr>
<tr>
<td>3,000,000 - 5,000,000</td>
<td>Reduce energy by 5%</td>
</tr>
<tr>
<td></td>
<td>Feed with caution, carefully observe to animals</td>
</tr>
<tr>
<td></td>
<td>Dilute at least 1:1 with “clean” feed</td>
</tr>
<tr>
<td>&gt;5,000,000</td>
<td>Discard the feed / silage.</td>
</tr>
</tbody>
</table>

(Adapted from Mahanna (Pioneer) ; Adams (Penn State))

**ACCEPTABLE LEVELS OF MYCOTOXINS IN FEEDS**

Fusarium fungus produces Deoxynivalenol (DON or vomitoxin), Zearalenone, T-2 toxin, HT-2 toxin, Fumonisin and Nivalenol.
**CFIA guidelines for DON (Vomitoxin) in animal feeds**

- pigs, calves, lambs, lactating cows and lactating ewes, 1 ppm in the diet,
- adult cattle, adult sheep and poultry, 5 ppm in the diet.

**FDA guidelines for DON (Vomitoxin) in feeds in the US**

- 10 ppm in grains and by-products fed to chickens, ruminating beef and feedlot cattle older than 4 months. Maximum ingredient level 50% of total ration. (ie. 5 ppm in the final ration).
- 5 ppm in ingredients for swine with a maximum inclusion rate of 20% of total ration. (ie. 1 ppm in the final ration).
- 5 ppm in ingredients for all other animals with a maximum inclusion of 40% of the ration. (ie. 2 ppm in the final ration).

Note that mycotoxin results may be expressed in a number of different ways. For example, ppm = mg/kg = ug/g. Some results may be expressed as ppb; 1,000 ppb = 1 ppm. Always check the dry matter basis on which the results are given - many cases this is as-fed. Correct for moisture level; eg. 1 ppm on 30% dry matter basis is 1 / 0.3 = 3.3 ppm DM.

**Penn State University guidelines on mycotoxin levels in feeds**

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Concern Level ppm</th>
<th>Potentially Harmful Cattle ppm</th>
<th>Swine ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DON/Vomitoxin</td>
<td>0.56</td>
<td>2.0 - 4.0</td>
<td>0.8 - 1.4</td>
</tr>
<tr>
<td>Major ingredient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRDM</td>
<td>0.56</td>
<td>1.0 - 2.0</td>
<td>0.6 - 1.0</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>0.56</td>
<td>5.6 - 10.0</td>
<td>1.1 - 5.6</td>
</tr>
<tr>
<td>Major ingredient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRDM</td>
<td>0.56</td>
<td>3.9 - 7.0</td>
<td>0.6 - 3.9</td>
</tr>
<tr>
<td>T-2 Toxin</td>
<td>0.25</td>
<td>0.7 - 1.5</td>
<td>0.7 - 1.5</td>
</tr>
<tr>
<td>TRDM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HT-2 Toxin</td>
<td>0.25</td>
<td>1.5 - 3.0</td>
<td>1.5 - 3.0</td>
</tr>
<tr>
<td>Fumonisin</td>
<td>5.0</td>
<td>8.0 - 10.0</td>
<td></td>
</tr>
<tr>
<td>TRDM (cattle)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes on the Penn State University table:**
- All levels are given on 100% dry matter basis
- TRDM = total ration dry matter
- **Concern level**: Indicates favourable conditions for mycotoxin production. May require further testing, especially if moderate symptoms are present. Limit the amount of suspect feed fed if performance and/or health symptoms persist. Discontinue use if severe production decreases occur and/or acute clinical symptoms appear.
- **Potentially Harmful**: Mycotoxins at these levels suggest toxin involvement in depressed performance and/or acute clinical symptoms. Discontinue feeding, at least temporarily, sample and test.

**ALLEVIATING MOLD AND MYCOTOXIN PROBLEMS**

Investigate and eliminate other possible causes of the problems experienced before concluding that molds and mycotoxins may be involved. If molds and mycotoxins are causing the problem(s), then expect improved production and/or health one to several weeks after corrective measures have been taken. Prolonged exposure to mycotoxins, weeks or maybe months, can lead to liver and/or kidney damage and lengthen the time taken for full recovery. **If you suspect molds and/or mycotoxins in any feedstuffs – take corrective measures as soon as possible.**
**Initial corrective steps**

If moderate effects on animals are noted, reduce the inclusion of the suspected feed by 50% in the ration. More serious effects on animals require that the suspect feed be discontinued for at least a week. If improvements are noted, have the feed tested, if positive discontinue use or have level of mycotoxin tested so that appropriate levels of the feed can be fed.

Clean moldy grains, removing fines and light-weight grains suspected of mycotoxin contamination. Adjust the energy levels of moldy feeds or light weight grains (5 - 10% lower) and reformulate rations.

Dilute contaminated feed with mold-free feed. This requires that the contaminated feed be analyzed so that it is adequately diluted in the final ration dry matter to ensure “safe levels” of mycotoxin for the particular class of animal.

Always check the basis on which results are given - often they are on a as-fed basis. Correct these to a dry matter basis so that comparison with table values and inclusion rates can be calculated.

eg. A "feed" with 65% moisture analyzed at 2.5 ppm DON as-fed.

\[
\frac{2.5}{0.35} = 7.1 \text{ ppm DON on a dry matter basis.}
\]

Calculate “safe level” as follows

\[
\text{Safe level in TRDM} = \frac{\text{level in feed DM}}{\text{x 100}} = \% \text{ maximum inclusion rate}
\]

As a quick guide, for lactating dairy cows that tolerate a maximum of 1 ppm DON, ingredient DON level of 5 ppm will reduce the maximum inclusion level to 20% of that ingredient in TRDM – assuming the rest of the ingredients are not contaminated. Similarly for feedlot cattle that tolerate a maximum of 5 ppm DON, ingredient DON levels at 12.5 ppm will reduce the maximum inclusion level below 40% of that feedstuff in TRDM.

Use the limits for the other toxins and follow the same calculations as above to determine if other toxins analyzed may be more limiting than DON on acceptable inclusion rates for feedstuffs.

Despite any of the above recommended levels or acceptable levels as calculated, palatability may be reduced lowering feed intakes. **Palatability may be the greatest determinant of an acceptable feeding rate or inclusion level in the ration.** If in doubt, err on the conservative side and watch for production, reproduction and health problems!

**Ration additive recommendations**

Increase contaminated feedstuff or grain levels gradually in the rations for animals. This allows some time to assess the possible effects of molds and / or mycotoxins. Reduce or stop feeding contaminated feeds if signs of mycosis or mycotoxicosis occur or persist. For example, start at 5% inclusion and increase gradually to the maximum inclusion calculated, all the time checking for adverse effects. Be aware that some of the adverse affects are insidious in nature.

Include **Integral** at 10, 20 or 30 grams / head / day depending on the severity of the problem. Another product on the market that has demonstrated success is Bio-Fix. The mode of action is different to that of Integral.
Alternatives to consider are an aluminosilicate, **ZMC 100 (170 – 230 g / head / day for the first two weeks and then 114 – 170 g / head / day)** or bentonite **(100 to 250 g / head / day)** in ruminant rations at 0.5% to reduce the effects of mycotoxins (or follow manufacturer's recommended rates). These compounds may bind mycotoxins in the digestive tract and reduce their absorption. Most effective against aflatoxin and to a lesser extent the other mycotoxins.

In an attempt to alleviate the effects of mycotoxins, increase the levels of Vitamins A, E and B1 and trace minerals Selenium, Zinc, Copper and Manganese. (Note any other considerations; for example, copper levels in sheep rations; Table 4 restrictions). There is some anecdotal evidence to suggest that trace mineral and vitamin levels should be increased by 20 – 25% in the presence of molds and mycotoxins in feed.

1. **Balance dairy rations using the Nutriplex Dairy Micro 2.5,** a good option when feeding moldy feedstuffs. For **beef cattle consider feeding Availa-4 at 7 g / head / day.**
2. Consider using one third to one half of the selenium as organic or chelated selenium source – **Selenium Enriched Yeast Premix for Livestock** (dairy).
3. Add **0.5 kg / MT of complete feed as Vitamin ADE Feed Service Pak for Livestock** to increase vitamin levels.

**Key potential problems**

Mycotoxins tend to be concentrated in the red-dog, husk, light grains, and broken kernels and levels may be as much as five times higher in the grain screenings compared to the grain.

Contaminated grains used in further processing and the fermentation industry pose a potential problem. These processes do not break down the mycotoxins and they are concentrated up by about 3 times in the by-products – Corn distillers grains and corn gluten feed.

**Mixing feed on farm**

If rations (TMR) on farm heat in the feed bunk then using Preserve or a mold inhibitor when mixing and feeding can help extend bunk life and prevent the rapid proliferation of molds and yeasts at feeding. There are a number of important pointers that help ensure efficacy.

1. **Dispersion is key.** The mold inhibitor must be completely and evenly dispersed in the feed to be most effective. Good mixing practices, for example, premixing with ground corn just prior to mixing the total mixed ration (TMR), will help ensure that producers derive the maximum benefit from the use of mold inhibitors.
2. **Effects of feed ingredients.** Some protein and mineral sources may reduce the effectiveness of the mold inhibitors. It is best to mix the mold inhibitor directly into the complete TMR rather than mix it into a concentrated mineral or protein supplement which may be stored for a protracted period of time before use in the final mix (TMR).
3. **Mold inhibitors and time dependence.** Mold inhibitors provide a period of no or very low mold growth in the feed mix. If a longer period of protection is required, increase the amount of mold inhibitor. The other option is to increase the frequency of mixing feed, if practical. We need to apply an amount of mold inhibitor that provides the desired protective effect.
Shur Gain has Mold Inhibitor (Preserve) to help prevent mold growth and spoilage. This is mixed at 1 kg / mt of wet TMR (as-fed). This can be increased up to 2 kg / mt of wet TMR to get the desired effect. However, there are situations where dilution of the moldy feed / forage may be the best choice. Mold inhibitors may still have to be used to maintain palatability and stop feed from heating in the bunk. The rate of forage removal from storage can markedly affect the rate and extent of deterioration in the bunk. In situations where this level of mold inhibitor addition does not provide the desired effect, it may be best to discard the forage.

It is very important to note that these products help prevent further mold growth and spoilage (heating) but do not address the concern that mycotoxins may be present in the feed. **We may get the cows to eat the feed a lot better, but we will not avoid the potentially harmful effects of any mycotoxins that are already present in these feeds.**

**BOTTOMLINE ON MOLDS AND MYCOTOXINS IN RUMINANT RATIONS**

Effects of molds and mycotoxins on ruminants are highly variable in practice. It is impossible to predict the effects that molds or mycotoxins are likely to have in an individual situation.

Ruminants are able to detoxify or transform mycotoxins to other metabolites, mostly but not always, less harmful. Ruminants are considered to be less sensitive and/or affected by molds and mycotoxins than swine. Ruminants are nevertheless susceptible to the deleterious effects of molds and mycotoxins in feed.

Young pre-ruminant and high producing cattle are the most susceptible to the effects of mycotoxins. It is generally recommended that pregnant animals not be fed moldy feed. In particular, dry and close-up dry cows must not be fed moldy feed.

Decreased feed intake, intermittent diarrhea, production losses of 5 - 10% and reduced reproductive performance are the most typical symptoms of a mold and mycotoxin problem.

**If molds and/or mycotoxins are present it is prudent to take steps to limit their potentially harmful effects on ruminants as soon as possible.**