

# Mycotoxins in Feed and Nutritional Disorders

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# Mycotoxins

- Mycotoxins are toxic products of fungal metabolism which occur in a wide variety of substances including animal feed and human food.
- Mycotoxins can cause human health problems and economic losses in livestock.
- The mycotoxins that are of primary significance in animal feeds are; aflatoxin, fumonisin, and the fusarial toxins (vomitoxin, zearalenone and T-2 toxin).

# Aflatoxin

- Aflatoxin is the most potent, naturally occurring carcinogen known to man.
- *Aspergillus flavus* and *Aspergillus parasiticus* are the two molds that are the major producers of aflatoxin.
- These two fungi are found everywhere in the world. They are soil-borne but have an affinity for the rich growth media provided by seeds.

# Aflatoxin

- These toxins are produced pre-harvest in the field and post-harvest in storage. Insect damage, mishandling or weather stress assists the fungi in invading the seed. These fungi require a temperature over 75°F and moisture greater than 14% to grow.
- Both fungi thrive in environments where the temperature is between 70° and 100°F and the moisture level is between 14% and 30%.
- A closed, poorly ventilated condition creates an ideal environment for these fungi to grow.

# FDA Concerns

- FDA's Center for Veterinary Medicine (CVM) is concerned about the potential animal and human health hazards from the use of aflatoxin-contaminated distillers grains as ingredients in animal feeds.
- Approximately 90% of the distillers grains produced in U.S. facilities are used in domestic animal feed.

# FDA Concerns

- Aflatoxins are not destroyed during ethanol production, but are concentrated in the distillers grains by-products where they may be present at **levels as high as three times that found in the corn or grain sorghum starting materials.**

Thus, distillers grains contaminated with aflatoxins can pose risks to the safety of animals consuming these products and with the widespread use of distillers grains in dairy cattle feed there is also a potential human safety concern due to aflatoxin residues in the milk.

# U.S. Food and Drug Administration Guidelines for Acceptable

## Levels of Aflatoxins in Food and Feed

- **Action Level (ppb) Commodity Species**
- 0.5 (Aflatoxin M1)<sup>a</sup> Milk Humans
- 20.0 Any food except milk Humans, Feed All species

### **Exceptions**

- 300.0 Cottonseed meal used in feed All species
- 300.0 Corn for Finishing beef cattle,
- 200.0 Corn for Swine (>100 lbs.)
- 100.0 Corn for Breeding cattle, breeding swine, and mature poultry

<sup>a</sup>Specifically for aflatoxin M1, a toxic metabolite of aflatoxin B1, that occurs in milk.

Source: *Cast 1989* from <http://www.oznet.ksu.edu/library/grsci2/MF2061.pdf>

# Aflatoxin

- Chronic poisoning, or aflatoxicosis, can result when low levels of toxin are ingested over a prolonged period of time.
- In general, affected livestock exhibit decreased growth rate, lowered productivity (milk or eggs), and **immunosuppression**, but **reduced growth rate** is considered the most common effect in farm animals.
- In young animals fed low levels of toxin, this may be the only detectable abnormality. The lack of other clinical signs frequently cause aflatoxicosis to remain undiagnosed, resulting in serious economic loss. Liver damage is also prevalent in chronic aflatoxicosis in all species, and at necropsy, the liver is usually pale to yellow.



# Aflatoxin

- Aflatoxin may suppress an animal's immune system, resulting in diseases that may be diagnosed as the cause of poor performance, when in fact the aflatoxin has caused the disease/poor performance. Some effects of aflatoxin ingestion that have been documented are liver damage, kidney and intestinal hemorrhage, and liver tumors. Substantial physical and economic loss can result in feeding livestock and poultry aflatoxin contaminated feed.
- Aflatoxin can also be metabolized by dairy animals, resulting in contaminated milk and dairy products.

# Deoxynivalenol: DON or Vomitoxin

- DON belongs to a class of mycotoxins referred to as trichothecenes.
- Deoxynivalenol (DON), commonly referred to as vomitoxin, is produced by *Fusarium* species. *F. graminearum*, a *Fusarium* species which causes root, stalk, and ear rots of corn and sorghum, and also causes scab in wheat and produces DON in all of these grains.

# Deoxynivalenol: DON or Vomitoxin

- General signs of toxicity in animals include weight loss, decreased feed conversion, feed refusal, vomiting, bloody diarrhea, severe dermatitis, hemorrhaging, decreased egg production, abortion, and death.
- Feeds containing more than 1 part per million (ppm) of DON may result in a reduction of feed intake and lower weight gain. Vomiting may occur in some cases.
- Swine appear to be most susceptible to DON, while cattle and poultry appear to be less susceptible to DON.

# U.S. Food and Drug Administration Guidelines for Acceptable Levels of DON in Food and Feed

5 ppm

- Grains and grain by-products destined for swine with the added recommendation that these ingredients not exceed 20 percent of their diet.
- Grains and grain by-products destined for all other animals with the added recommendation that these ingredients not exceed 40 percent of their diet.

# U.S. Food and Drug Administration Guidelines for Acceptable Levels of DON in Feed

10 ppm

- Grains and grain by-products destined for ruminating beef and feedlot cattle older than four months and for chickens.
- Recommendation that these ingredients not exceed 50 percent of the diet of cattle or chickens..

# T-2 toxins

- Also produced by *Fusarium* species, general signs of T-2 toxicity in animals include weight loss, decreased feed conversion, feed refusal, vomiting, bloody diarrhea, severe dermatitis, hemorrhaging, abortion, and death.
- In poultry, T-2 toxicity may produce lesions at the edges of the beaks, abnormal feathering, reduced egg production, eggs with thin shells, reduced bodyweight gain, and mortality.

# Fumonisin

- Fumonisin is produced by *Fusarium verticillioides*, *F. proliferatum* and other *Fusarium* species that typically occurs in corn.
- Fumonisin is reported to occur on visibly healthy grains. Of the currently identified fumonisins, B1, B2, and B3 are the most abundant in naturally contaminated foods and feeds and fumonisin B1 (FB1) generally comprises 75 percent of the total content.

# Fumonisin

- Horses appear to be most susceptible to fumonisin. This mycotoxin, when fed to horses, causes a unique neurotoxic syndrome called leukoencephalomalacia (ELEM). This disorder is characterized by liquefaction of the horse's brain. Neurotoxic symptoms include lowered feed consumption, lameness, oral and facial paralysis, seizures, and eventual death.
- It has been shown that the toxin is carcinogenic and also associated with pulmonary edema in swine.



# Fumonisin

- Fumonisin are reported to occur on visibly healthy grains.
- Fumonisin have not been regulated by the FDA or USDA. However, the American Association of Veterinary Laboratory Diagnosticians (1992) recommended 5 ppm for horses, 10 ppm for swine, and 50 ppm for cattle and poultry as maximum safe levels of FB1 on feeds.

## In Conclusion:

- Since not all infected feeds show visible signs, the only thing to do is test the feed.
- In cases where unexpectedly poor feed intake, feed efficiency, average daily gain, conception rates, or milk production are occurring, make sure to have feed tested.

# Metabolic and Nutritional Disorders

# Bloat

Excessive accumulation of gas in the rumen and reticulum

Symptoms:      distension of left side of the body wall  
                         death by asphyxiation

## Types of bloat:

### 1) Legume or pasture bloat

- high levels of certain proteins lead to development of frothy foam which inhibits rumination

### 2) Chronic bloat

- anatomical defect that prevents the release of fermentation gases

### 3) Feedlot bloat

- frothy – certain bacteria produce a slime which causes formation of foam
- gaseous – change in microbial populations which cause formation of foam

# Bloat

## Prevention:

- Pasture Management
- Bunk Management
- Diet Formulation

## Treatment:

- Bloat Guard (poloxalene) –surfactant which disrupts foam and allows for the escape of gases
- Drenching with fats/oils, however, this has a negative impact on digestion, and only works with frothy bloat.
- Trochar – puncture to release gases

# Acidosis/Founder

Low rumen and blood pH caused by rapid digestion of starch in grains, mostly due to poor control of feed intake in highly processed diets.

1. Chronic – animal is trying to cope with it ( no major problem)
  - most costly because undetected
2. Acute – severe case occurs quickly (grain engorgement)

# Acute Acidosis

## Cause:

Poor Bunk Management on high grain diets with wheat, barley, and steam flaked corn or milo causes an acid stress

Decrease protozoal and increase bacterial populations (*Streptococcus bovis*)  
lactate production (generation time = 6 minutes)

Decreased rumination (less saliva buffering)  
Low blood pH (interferes with O<sub>2</sub> transport and rupture of peripheral blood vessels)

# Symptoms of Acute Acidosis

Listlessness, anorexia, diarrhea, decreased blood bicarbonate, increase in blood lactate

## Prevention

- Increase frequency of feeding
- Increase roughage (lower fermentation rate)
- Gradual diet adaptation ( 10 d period)
- Feed Ionophores
  - Animals eat less at a meal, but more meals
  - Inhibit lactic acid producing organisms
- Feed Na<sup>+</sup> bicarbonate (Not my recommended option)
  - Somewhat effective in adaptation period with moderate energy diets, but decreases performance after that.



# Founder

- Side effect of acidosis
- Lactate in blood decreases circulation
- Abnormal clotting occurs especially in capillaries leading to hooves
- May cut off circulation in hoof causing irreversible damage

# Liver Abscesses

- Low ruminal pH caused by high carbohydrate diet
- Lesions in ruminal wall
- Bacteria leave rumen and migrate to liver where they establish colonies and infection which result in abscesses.

Cattle responses:

- depressed ADG (**sometimes**)
- lowered feed conversion

Normally found in 25% of all cattle slaughtered

Treatment:      Chlorotetracycline at 70 mg/hd/d

- reduces abscesses, improves performance and FC
- no effect on ruminal lesions

# Feedlot Polio

- Noninfectious neurological disease of ruminants
- Tissue thiamin and enzymatic activity is depressed
- Thiamin is needed in energy metabolism
- Ruminal microbes contain thiaminase which destroys structure
- Amprolium – coccidiostat (Corid) prevents absorption of thiamin
- Appears in cattle that are switched on feed and feed intake is reduced

Treatment:      i.v. thiamin HCL 2 ml/100#  
                         i.m. double dose

Symptoms:      Cattle drag their hooves when walking  
                         Cattle become stiff and have trouble standing  
                         Cattle eventually become paralyzed  
                         Death usually occurs within one day after paralysis

- No prevention for this disease

# Urinary Calculi (Urolithiasis)

The precipitation of mineral salts in the urinary tract.

- The calculi may be found in the kidney, ureters, bladder or urethra.
- Calculi are usually made up of Ca, Mg, ammonia and phosphate.
- Usually occurs when the Ca to P ratio is wide, or when the P content of the diet is higher than Ca content.
- The lower pH of the urine, the lower the incidence of urinary calculi.
- Feeding ammonium chloride or ammonium sulfate reduces the pH in the urine, and thus reduces the incidence of urinary calculi.
- They are more prevalent in sheep than in cattle.

# Listeriosis

## Circling disease

Cause: *Listeria Monocytogenes* bacteria

- Can multiply rapidly on silage and other feed stuffs when allowed to remain in feed bunks for over 24 hours, especially if it has gotten wet.
- pH of silage must be below 5.2 to inactivate *Listeria* bacteria
- Usually occurs 10-14 days following feeding of spoiled or poor quality corn silage
- Encephalitis results and permanent central nervous system damage results.
- Disease is nearly always fatal, with no satisfactory treatment.

Symptoms: Animals crowd into corners, along walls, and stand by water sources, they move in a circle (in the same direction) with heads often tilted