Toxins in Feed Sources

Critical control points to prevent mycotoxin contamination

Pre-harvest
- Correct management of crop residues
- Crop rotation
- Selection of good quality seeds
- Reduction of plant density
- Balanced fertilization
- Preventive and accurate insect and fungal management

Harvest
- Appropriate harvesting time
- Appropriate harvesting equipment and procedures to minimize crop damage
- Removal of damaged and humid portions of crops

Storage
- Storing without delay in good storage facilities under moisture-, temperature-, humidity- and insect control
- Adding anti-fungal agents of low toxicity (such as propionic acid) or chemical preservatives

Processing
- Preventive approach: Quality control measures for incoming ingredients
- Addition of mold inhibitors in stored grains
- ‘Shot-gun’ approach: no mycotoxin testing, add toxin binders in feed

Best management practices to minimize impact of mycotoxins

- Adjust combine to discard lightweight and broken kernels. Separate rows at edge of field as they often have highest damage and toxin levels.
- Dry corn as quickly as possible to reduce further mold growth (need to dry to under 15% moisture). If toxins are present, dry to 13% or lower.
- Test corn at delivery. Allows for you to not accept corn with high toxin levels and to separate corn by toxin levels to allow blending and use in low risk pigs.
- Cleaning corn to remove broken, damaged kernels can lower toxin levels in the corn. Do not feed the screenings as they will have the highest toxin levels.
- If mold infected corn was stored in the bin previously, clean bins before refilling for long term storage.
- Mold inhibitors added when corn is placed into storage can limit further growth of molds, but will not lower toxins that are already present.
Primary Mechanisms Through Which Mycotoxins Affect Animals

- Reduction in feed intake
- Suboptimal nutrition
  - Reduce nutrient content of feed
  - Reduce nutrient absorption
  - Alter nutrient metabolism
- Suppress the immune system
- Hormonal effects (primarily estrogenic)
- Antibiotic effects
- Cellular death

Molds & Mycotoxins

- Two different issues
  - All molds aren’t bad
  - Molds aren’t the problem, mycotoxins are
  - Molds produce mycotoxins, which impact animal performance
  - Can be mycotoxins on wheat, barley, oats, corn

Factors affecting mold in corn

- Weather - probably #1 factor
  - temperature, humidity, rain, hail
- Kernel damage
  - insects, physical damage, quality factors
- pH level, oxygen, moisture migration
- Black light screening only detects live mold, not dead mold or mycotoxins
Mold is inhibited by:

- dryness (12-14% grain moisture)
- cold conditions (temps below 50 deg. F)
- proprionic acid, preservatives
  - make grain un-saleable
- ensiling properly

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### Introduction

#### Known vs. Postulated

<table>
<thead>
<tr>
<th></th>
<th>Known</th>
<th>Postulated</th>
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</thead>
<tbody>
<tr>
<td>Mold species</td>
<td>1,100</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Secondary metabolites</td>
<td>3,200</td>
<td>3,000,000</td>
</tr>
<tr>
<td>Mycotoxins</td>
<td>&gt; 300</td>
<td>30,000</td>
</tr>
</tbody>
</table>

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### Introduction

- Approximately 300 - 400 mycotoxins have been identified
  - Only a few cause detrimental effects when fed to livestock
    - Aflatoxin
    - Deoxynivalenol (vomitoxin)
    - Zearalenone
    - Fumonisin
    - Ochratoxin
    - T-2 toxin
    - Ergot
Maximum Tolerance Levels of Selected Mycotoxins

<table>
<thead>
<tr>
<th>TOXIN</th>
<th>Class of Swine</th>
<th>Maximum Level</th>
</tr>
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<tbody>
<tr>
<td>Aflatoxin</td>
<td>Breeding</td>
<td>100 ppb</td>
</tr>
<tr>
<td></td>
<td>Nursery</td>
<td>20 ppb</td>
</tr>
<tr>
<td></td>
<td>Growing</td>
<td>Not determined</td>
</tr>
<tr>
<td></td>
<td>Finishing</td>
<td>200 ppb</td>
</tr>
<tr>
<td>Vomitoxin (DON)</td>
<td>All classes</td>
<td>1 ppm</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>Breeding</td>
<td>2 ppm</td>
</tr>
<tr>
<td></td>
<td>Nursery</td>
<td>1 ppm</td>
</tr>
<tr>
<td></td>
<td>Growing</td>
<td>1 ppm</td>
</tr>
<tr>
<td></td>
<td>Finishing</td>
<td>3 ppm</td>
</tr>
<tr>
<td>Fumonisins</td>
<td>All classes</td>
<td>10 ppm</td>
</tr>
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Mycotoxin effects (Biomin website)

Methods of decontamination and detoxification of feed

1) Physical methods
   - Cleaning, mechanical sorting and preparation, washing, density segregation, thermal inactivation, irradiation, ultrasound, solvent extraction

2) Chemical methods
   - NH₄OH or Sulfites for DON, Ca(OH)₂ monomethylamine for AF, T-2, HT-2, DON, ZON

3) Biological methods
   - Binding by adsorptive materials, microbial inactivation by specific microorganisms or enzymes
**Vomitoxin (DON) and the 2015 Wheat Crop – Performance Impact**


- Reduces average daily feed intake (ADFI) and thus average daily gain (ADG)
  - Nursery pigs – 1 ppm reduces ADG by 7%
  - Finishing pigs – 1 ppm reduces ADG by approx. 3%

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**Vomitoxin (DON) and the 2015 Wheat Crop – Sampling**

- Concentrations of DON are expressed in PPM (1 ppm is similar to 1 kernel of wheat in 80 lbs.)

- Sampling is critical and more than one sample is recommended.
  - (As a Rule of Thumb: 4-5 probes per truck with samples from the entire depth. The center of the load will have the heavier kernels thus less DON and the outer portions of the load will have the lighter kernels and thus more DON.)
Vomitoxin (DON) and the 2015 Wheat Crop – Cause & Visual Indication

- Produced by fusarium head blight (scab)
  - Presence doesn’t mean DON is present
  - High level of scabby kernels means DON is likely present
  - A Canadian study separated kernels by appearance and found 1 ppm in the normal appearing kernels, 2-5 ppm in shriveled kernels, 174 ppm in chalky white kernels, and 274 ppm in pinkish kernels.

Vomitoxin (DON) and the 2015 Wheat Crop – Cleaning & Storage

- Cleaning
  - Kernels are typically lighter
  - Removed by airflow and screening
    - (example: 110 bushels being screened out of a 1,000 bushels lowered the DON level from 8 ppm to less than 2 ppm.)
  - Storage
    - Does not increase if moisture is below 22%
    - BE AWARE OF MOISTURE

Vomitoxin (DON) and the 2015 Wheat Crop – Feeding

- Feeding
  - Know the DON levels of the other ingredients being used in the diets
    - DDGS
    - Corn
  - There are additives promoted to lessen the effect of DON, but not all are effective.
  - Avoid lactation and nursery diets.
Vomitoxin level and commercial products on nursery pig ADG

<table>
<thead>
<tr>
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<th>ADG, lb</th>
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<tbody>
<tr>
<td>Positive Control</td>
<td>1.25</td>
</tr>
<tr>
<td>Negative Control</td>
<td>0.92</td>
</tr>
<tr>
<td>Biofix Plus</td>
<td>0.90</td>
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<tr>
<td>Cal-can + bentonite clay</td>
<td>0.92</td>
</tr>
<tr>
<td>Defusion Plus</td>
<td>1.03</td>
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Superscripts differ, P < 0.05
SEM = 0.032

4 ppm Vomitoxin diets
Barnes et al., 2010

Vomitoxin level and commercial products on nursery pig ADFI

<table>
<thead>
<tr>
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<th>ADFI, lb</th>
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<tr>
<td>Positive Control</td>
<td>1.97</td>
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<tr>
<td>Negative Control</td>
<td>1.59</td>
</tr>
<tr>
<td>Biofix Plus</td>
<td>1.51</td>
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<td>Cal-can + bentonite clay</td>
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<td>Defusion Plus</td>
<td>1.63</td>
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Superscripts differ, P < 0.05
SEM = 0.065

4 ppm Vomitoxin diets
Barnes et al., 2010

Vomitoxin level and commercial products on nursery pig Final BW

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<thead>
<tr>
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<tr>
<td>Positive Control</td>
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<td>Negative Control</td>
<td>42.2</td>
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<tr>
<td>Biofix Plus</td>
<td>41.8</td>
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<tr>
<td>Cal-can + bentonite clay</td>
<td>42.2</td>
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<tr>
<td>Defusion Plus</td>
<td>44.9</td>
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Superscripts differ, P < 0.05
SEM = 0.88

4 ppm Vomitoxin diets
Barnes et al., 2010
Vomitoxin level and commercial products on nursery pig ADG

<table>
<thead>
<tr>
<th>Treatment</th>
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<tbody>
<tr>
<td>None None</td>
<td>1.02</td>
</tr>
<tr>
<td>Defusion®</td>
<td>0.75</td>
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<tr>
<td>Integral®</td>
<td>0.80</td>
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<tr>
<td>Biofix®</td>
<td>0.74</td>
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<tr>
<td>Test Corn (2.0 ppm DON)</td>
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Superscripts differ, P < 0.05
SEM = 0.11

Mahan et al., 2010

Vomitoxin level and commercial products on nursery pig ADFI

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADFI</th>
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<tbody>
<tr>
<td>None None</td>
<td>1.50</td>
</tr>
<tr>
<td>Defusion®</td>
<td>1.19</td>
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<td>1.49</td>
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<tr>
<td>Biofix®</td>
<td>1.16</td>
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Superscripts differ, P < 0.05
SEM = 0.03

Mahan et al., 2010

Vomitoxin level and commercial products on nursery pig F/G

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<tr>
<th>Treatment</th>
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<tbody>
<tr>
<td>None None</td>
<td>1.48</td>
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<tr>
<td>Defusion®</td>
<td>1.60</td>
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<td>Integral®</td>
<td>1.64</td>
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<tr>
<td>Biofix®</td>
<td>1.64</td>
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<tr>
<td>Test Corn (2.0 ppm DON)</td>
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Superscripts differ, P < 0.05
SEM = 0.05

Mahan et al., 2010
Vomitoxin Summary and Future

- Defusion was the only commercial product to help mitigate the effects
- Pelleting or heat treatment can reduce vomitoxin levels
  - Sodium metabisulfite will reduce diet vomitoxin levels, especially in pelleted diets

Additives

- There are NO legally FDA approved mycotoxin binders
- Clay binders & anti-caking agents (bentonite, sodium aluminosilicates) will tie up alfatoxins, but ineffective against other mycotoxins like DON, zearalenone, fumonosin at typical inclusion levels
- They can also tie-up minerals and antimicrobials
Sampling for mycotoxins

- Min. 5 lb shelled or ground grain or DDGS
  - 10 lb is even better
  - Prefer to send in a cloth or paper bag
  - Additional toxins can form during transit in plastic bag (if high moisture)

- Needs to be below 18% moisture to test
  - if dry when received, fast turn-around (1-2 d)
  - if wet, lab must dry and test may be skewed
    - (add'l growth/toxin during transit, etc.)

Thank You!