From Field to Feeder – Dealing With Mycotoxins

saskatchewan pork industry symposium 2015

A World of Information

Denise Beaulieu, Prairie Swine Centre, Inc
November 17, 2015
What are mycotoxins?

- Secondary metabolites produced by moulds
- In Canada mycotoxins of concern are:
  - Trichothecenes
    - Deoxynivalenol (DON), Nivalenol (NIV), T-2 toxin and HT-2 toxin
  - Zearalenone (ZEN)
  - Fumonisins
  - Ochratoxin (ochratoxin A (OA))
  - Ergot
  - Aflatoxins (primarily in imported feeds)

Aspergillus, courtesy of Natacha Hogan
Effects of mycotoxins on animal health

• Primarily due to ingestion, but inhalation and skin exposure also problematic

• Symptoms are varied:
  – Feed refusal and vomiting (DON)
  – Reduced performance (DON, AF, T-2 toxin, OA)
  – Impaired reproductive function (ZEN, DON, T-2 toxin)
  – Kidney, liver, lung damage (OA, FB)
  – Compromised immune function (DON, AF, OA)

www.inspection.gc.ca
Fusarium

- Fusarium Head Blight (FHB)
  - disease caused by infection with Fusarium fungal species
  - bleached heads and shriveled chalky/pinkish kernels
  - F. graminearum most common in western Canada wheat
  - during infection, a variety of mycotoxins can be produced
Fusarium root rot on field pea

Bleaching caused by fusarium head blight in wheat

http://www.agriculture.gov.sk.ca/fusarium-head-blight
Prevalence of FHB in Saskatchewan Cereal Disease Surveys

FHB survey data published in Canadian Plant Disease Survey (http://phytopath.ca/publication/cpds/). Please note: 2015 data is preliminary (as of October 9, 2015), (courtesy of Dokken-Bouchard, Sk. Ag. Provincial Specialist, Plant Disease,)
Severity of FHB in Saskatchewan Cereal Disease Surveys

FHB severity (%) = 
[ % of spikes affected x mean proportion (%) of kernels infected ] / 100

FHB survey data published in Canadian Plant Disease Survey (http://phytopath.ca/publication/cpds/).
Please note: 2015 data is preliminary (as of October 9, 2015).
(courtesy of Dokken-Bouchard, Sk. Ag. Provincial Specialist, Plant Disease)
% Fusarium Damaged Kernels (FDK) is correlated with DON

CWSWS 2013

\[ \text{DON} = 1.431(\%\text{FDK}) + 0.0345 \]

\[ R^2 = 0.8396 \]
COMMON AND DURUM WHEAT GRAIN SAMPLES WITH *Fusarium*-damaged kernels across Saskatchewan in 2014

M.R. Fernandez¹, K. Hodne², A. Brown³, P. Stroppel³, E. Waechli³, B. Doig⁴, R. Kutchera⁵, F.L. Dokken-Bouchard⁶, and C.O. Peluola⁷

5-30%  
30-52%  
52-71%  
71-86%  
86-100%

Figure 2. Percentage common wheat samples, by RM, with *Fusarium*-damaged kernels.
If contamination is suspected

• Dilution is one solution – but need to accurately determine the degree of contamination

• **Sampling is the most important step**
  
  • The moulds are not necessarily evenly distributed throughout the load, bin etc
  
  • Prairie Diagnostic Services (PDS) Saskatoon, recommends a 200 g sample for every 200 kg
  
  • Blend these together, and then subsample
What’s 2 ppm?

- 2 Parts per million
- 2 mg/kg
- Or.. 2 inches in 16 miles
- Or… 2 cm in 10 km

- Or … 1 to 2 kernels of wheat per bushel
DDGS and other by-products

- Processing does not deactivate the mycotoxin
- Mycotoxins often concentrated in by-products
- Typically a 3x concentration in DDGS compared to the “parent” grain
- Screenings and other by-products up to 10X higher
If contamination is suspected:

What does the research tell us about feed processing, additives etc?
Deoxynivalenol (DON)

- Vomitoxin
- Produced by *Fusarium graminearum*
- Is commonly found in corn, barley, and wheat
- Develops in cool, damp weather
- Negative effects begin at 1 ppm
  - At 1.57 ppm decreased ADFI by 5.6 % and ADG by 4.9 % (Johnston et al. 2010)
  - At 5 ppm - feed refusal
  - At 10 ppm or more - weight loss or vomiting
The effects of pelleting, increased nutrient density, and a flow agent on growth performance of nursery pigs fed high levels of deoxynivalenol


- Pigs fed from 12 to 30 kg BW
- Negative control (NC) diets – 3 ppm DON
- Increased nutrient density
  - ME + 6%, TID lysine + 10%
- Flow agent
  - Defusion (DEF; Provimi)

**Conclusion:**
Neither DEF or increased nutrient density improved performance
Pelleting did have a positive impact
Evaluation of two mycotoxin mitigation strategies in grow-finish swine diets containing corn dried distillers grains with solubles naturally contaminated with deoxynivalenol

J. F. Patience,*2 A. J. Myers,* S. Ensley,† B. M. Jacobs,* and D. Madson†

*Department of Animal Science and †Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames 50011


• 115 barrows and gilts were fed corn, SBM diets containing DON contaminated DDGS from 24 to 110 kg BW.
• Diets were fed in 6 phases.
• Diffusion, (Akey, Inc.) and Integral (Alltech).
The effect of two mycotoxin binders on reversing the effects of DON in growing/finishing pigs

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>+ Diffusion</th>
<th>+ Integral</th>
<th>SEM</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, kg/d</td>
<td>0.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.66&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.69&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>ADFI kg/d</td>
<td>1.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.79&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.89&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.85&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>0.04</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>F/G</td>
<td>2.63&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.62&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.67&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>G/F</td>
<td>0.38&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.37&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.37&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>DON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 2</td>
<td>0.2</td>
<td>3.7</td>
<td>4.6</td>
<td>0.3</td>
<td></td>
<td></td>
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<tr>
<td>Phase 3</td>
<td>0.5</td>
<td>5.7</td>
<td>5.1</td>
<td>5.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase 5</td>
<td>0.7</td>
<td>5.2</td>
<td>4.5</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patience et al. 2014
Evaluation of two mycotoxin mitigation strategies in grow-finish swine diets containing corn dried distillers grains with solubles naturally contaminated with deoxynivalenol

J. F. Patience,* A. J. Myers,* S. Ensley,† B. M. Jacobs,* and D. Madson†

*Department of Animal Science and †Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames 50011


- 115 barrows and gilts were fed corn, SBM diets containing DON contaminated DDGS from 24 to 110 kg BW.
- Diets were fed in 6 phases.
- Diffusion, (Akey, Inc.) and Integral (Alltech).

Conclusion
A preservative blend (Diffusion) may be a suitable mycotoxin mitigation strategy
The efficacy of anti-mycotoxin feed additives in preventing the adverse effects of wheat naturally contaminated with *Fusarium* mycotoxins on performance, intestinal barrier function and nutrient digestibility and retention in weanling pigs

Bich Van Le Thanh¹, Martin Lessard², Younès Chorfi³, and Frédéric Guay¹,⁴

¹Department of Animal Sciences, Université Laval, Québec, Canada G1V 0A6; ²Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada (AAFC), Sherbrooke, Québec, Canada J1M 0C8; and ³Department of Veterinary Biomedicine, Université de Montréal, St-Hyacinthe, Québec, Canada J2S 7C6.

Received 29 August 2014, accepted 1 February 2015. Published on the web 10 March 2015.

CJAS 2015

- Piglets fed from 7 to 12 kg BW (14 d trial)
- DON contaminated wheat
- NC, 4 ppm
- 3 feed additives
  - Integral (glucomannon from yeast) Alltech
  - Biofix (a mixture of yeast, enzymes, bacteria and extracts), Biomin
  - MXM (aluminosilicate) Jefo
  - Defusion (blend of preservatives) Akey
Thanh et al. 2015

* P < 0.05
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  - MXM (aluminosilicate) Jefo
  - Defusion (blend of preservatives) Akey

**Conclusion**

- Only the Defusion restored growth to the PC
- Piglets fed DON had impaired jejunal morphology and reduced energy digestibility
What about physical removal?
3 barley samples (4.8, 9.8, 21.1 ppm DON) subjected to an abrasive pearling procedure for 0 to 120 seconds
Figure 2. Relationship between the percentage of barley mass remaining following pearling and the percentage of deoxynivalenol left in the sample. Data were fitted to a three parameter, exponential growth equation, $y = y_0 + ae^{bx}$, yielding the following parameter estimates (mean ± SEM): $y_0 = 7.36 ± 0.60$; $a = 0.0114 ± 0.003$; $b = 0.090 ± 0.003$; and $r^2 = 0.99$. 

House et al. 2003
Deoxynivalenol Removal from Barley Intended as Swine Feed through the Use of an Abrasive Pearling Procedure

JAMES D. HOUSE, *,+ Charles Martin Nyachoti, † and David Abramson $

Departments of Animal Science and Human Nutritional Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2 Canada, and the Cereal Research Centre, Agriculture and Agri-Food Canada, Winnipeg, Manitoba, R3T 2M9 Canada

• 3 barley samples (4.8, 9.8, 21.1 ppm DON) subjected to an abrasive pearling procedure for 0 to 120 seconds

**Conclusion**
Effective, but necessitates removal of a significant amount of the grain sample
Canadian Feed Research Centre
North Battleford, SK

BoMill TriQ 30

Dr. Tom Scott (retired)
University of Saskatchewan
BoMill TriQ 30

- NIR Transmittance
  - 18 measurements / seed
  - 30,000 seeds / sec (3MT/hr)
  - Initially:
    - Establishes variability in seeds
    - Produces 10 fractions of equal area under the distribution curve
    - These are measured and used to set limits for production of 3 fractions
Protein distribution in the sample and visual observations of the kernels

- Infected, fusariated and diseased kernel will come in the low protein fraction
- Immature kernel will come into the high protein fraction
- The main fraction typically consist of sound and healthy kernels
The future??

% Fusarium Damaged Kernels

- Unsorted
- Low CP <20%
- High CP

- Durum
- Soft White
- Red Spring
- Red Spring

0.7 0.0 0.3 0.0
Can we mitigate the negative effects of DON?
Spray Dried Animal Plasma (SDAP)

- Improves gut health
- Increased animal performance
Hypothesis

We hypothesized that SDAP and clays would mitigate effects of DON on animal growth performance and furthermore we hypothesized that these effects would be additive.

Assigned to diets 3 days post-weaning (6 kg BW) for a 21 d experiment.
Effect of DON (4 ppm), spray dried animal plasma (8%), and clays on average daily gains

<table>
<thead>
<tr>
<th></th>
<th>Day 0-3</th>
<th>Day 3-11</th>
<th>Day 0-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>DON</td>
<td>b</td>
<td>b</td>
<td>c</td>
</tr>
<tr>
<td>Clay</td>
<td>a</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>SDAP</td>
<td>c</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Clay+SDAP</td>
<td>b</td>
<td>b</td>
<td>a</td>
</tr>
</tbody>
</table>

a, b, c P-value < 0.05
Effect of DON grain, spray dried animal plasma, and clays on average feed daily intake

<table>
<thead>
<tr>
<th></th>
<th>Day 0-3</th>
<th>Day 3-11</th>
<th>Day 0-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>a, b, c</td>
<td>a, b, c</td>
<td>a, b, c</td>
</tr>
<tr>
<td>DON</td>
<td>b, ab</td>
<td>b, c</td>
<td>b, c</td>
</tr>
<tr>
<td>Clay</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>SDAP</td>
<td></td>
<td></td>
<td>a</td>
</tr>
<tr>
<td>Clay+SDAP</td>
<td></td>
<td></td>
<td>a</td>
</tr>
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</table>

a, b, c P-value < 0.05
## Intestinal Morphology

<table>
<thead>
<tr>
<th>Intestinal Parameter</th>
<th>Dietary Treatment</th>
<th>SEM</th>
<th>P-Values¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wheat</td>
<td>DON</td>
<td>Clay</td>
</tr>
<tr>
<td>Mucosal Thickness, μm</td>
<td>412</td>
<td>442</td>
<td>430</td>
</tr>
<tr>
<td>Villus Height (VH), μm</td>
<td>242</td>
<td>264</td>
<td>236</td>
</tr>
<tr>
<td>Crypt Depth (CD), μm</td>
<td>91ᵃ</td>
<td>94ᵃ</td>
<td>93ᵃ</td>
</tr>
<tr>
<td>VH to CD Ratio, μm/μm</td>
<td>2.74</td>
<td>2.88</td>
<td>2.60</td>
</tr>
</tbody>
</table>
Experiment was repeated with bovine plasma

- Diets contained about 7 ppm DON from naturally contaminated wheat
**Results**

**Average Daily Gain (Day 0-3)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADG (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.11</td>
</tr>
<tr>
<td>B</td>
<td>0.09</td>
</tr>
<tr>
<td>C</td>
<td>0.08</td>
</tr>
<tr>
<td>D</td>
<td>0.10</td>
</tr>
<tr>
<td>E</td>
<td>0.14</td>
</tr>
</tbody>
</table>

SEM = 0.04, P = 0.29

**Average Daily Gain (Day 0-25)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADG (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.42</td>
</tr>
<tr>
<td>B</td>
<td>0.40</td>
</tr>
<tr>
<td>C</td>
<td>0.38</td>
</tr>
<tr>
<td>D</td>
<td>0.39</td>
</tr>
<tr>
<td>E</td>
<td>0.42</td>
</tr>
</tbody>
</table>

SEM = 0.01, P = 11

**Treatment Codes**

- A = -DON, -SDBP
- B = +DON, -SDBP
- C = +DON, +2% SDBP
- D = +DON, +4% SDBP
- E = +DON, +8% SDBP
Results

Average Daily Feed Intake (Day 0-3)

- Treatment A: 0.62 kg/day
- Treatment B: 0.58 kg/day
- Treatment C: 0.56 kg/day
- Treatment D: 0.60 kg/day
- Treatment E: 0.67 kg/day

SEM = 0.1, P = 0.53

Average Daily Feed Intake (Day 0-25)

- Treatment A: 2.52 kg/day
- Treatment B: 2.37 kg/day
- Treatment C: 2.22 kg/day
- Treatment D: 2.37 kg/day
- Treatment E: 2.44 kg/day

SEM = 0.1, P = 0.28

A = −DON, −SDBP
B = +DON, −SDBP
C = +DON, +2% SDBP
D = +DON, +4% SDBP
E = +DON, +8% SDBP
Results

Research is ongoing to determine how plasma might be acting to mitigate the detrimental effects of DON and why results are inconsistent.
Conclusions- Mycotoxins

Feed additives “hold some promise” but results inconsistent

Solution

Dilution
Or feed to beef or poultry
ERGOT

- Claviceps purpurea
  - 6 different alkaloids
  - Vary in toxicity

- 2014 particularly bad year

- Rye
- Triticale
- Barley
- Wheat
- Grasses

Blakley et al. 2014
ERGOT

- Vasoconstrictor
- Agalactia (reduced or no milk)
- Reduced growth and feed intake
- Concern in feed-lots
Diets containing 3% sorghum ergot (16 mg alkaloids/kg) were fed to 12 sows from 14 d post-farrowing for 14 d. Compared to 10 control sows:

- Ergot fed sows:
  - had reduced weight-loss and feed intake
  - Reduced litter weight gain
  - Reduced plasma prolactin
  - 2 ergot sows stopped milking completely
Defining the tolerable level of ergot in the diet of weaned pigs

T. F. Oresanya¹,², J. F. Patience¹,⁵, R. T. Zijlstra¹, A. D. Beaulieu¹, D. M. Middleton³, B. R. Blakley⁴, and D. A. Gillis¹

CJAS 2003

- Ergot sclerotia separated from contaminated wheat using a gravity separator
- Added back to a basal diet
- Fed to newly weaned piglets (7 kg BW)
ADG, kg/d d0 to 28

Linear P < 0.01

ADFI, kg/d d0 to 28

Linear P = 0.02

G:F d0 to 28

Linear P = 0.03
Prolactin is important for milk production!

Oresanya et al. 2003
Defining the tolerable level of ergot in the diet of weaned pigs

T. F. Oresanya1,2, J. F. Patience1,5, R. T. Zijlstra1, A. D. Beaulieu1, D. M. Middleton3, B. R. Blakley4, and D. A. Gillis1

CJAS 2003

• Ergot sclerotia separated from contaminated wheat using a gravity separator
• Added back to a basal diet
• Fed to newly weaned piglets (7 kg BW)

Conclusion
Maximum tolerable level was 0.1 % (ADG) or 0.05% (ADFI) corresponding to 2.1 or 1 mg alkaloid/kg
Conclusions - Mycotoxins

Feed additives “hold some promise” but results inconsistent

Solution

Dilution
Or feed to beef or poultry
Conclusions - Ergot

Feed additives “hold some promise” but results inconsistent

Solution
Dilution
Or feed to beef or poultry
Conclusions- Ergot

Solution

Dilution
If absolutely necessary. Consider 0.1 or 0.05% by weight maximum in grow-finish.

0.00 to sows!
Legislated maximum tolerated levels of DON and aflatoxins and regulatory guidelines of ergot

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Swine</th>
<th>Beef</th>
<th>Dairy</th>
<th>Poultry</th>
</tr>
</thead>
<tbody>
<tr>
<td>DON (mg/kg, ppm)</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ergot alkaloids</td>
<td>4-6</td>
<td>2-3</td>
<td>??</td>
<td></td>
</tr>
<tr>
<td>Aflatoxins (µg/kg)</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>

Animal feed stuffs
20 ppb (0.02 mg/kg, or ppm)

www.inspection.gc.ca
Acknowledgements

Prairie Swine Centre, Inc. acknowledges program funding from Sask Pork, Alberta Pork, the Manitoba Pork Council, Ontario Pork and the Saskatchewan Agriculture Development Fund
Questions??
The effects of pelleting, increased nutrient density, and a flow agent on growth performance of nursery pigs fed high levels of deoxynivalenol


- Pigs fed from 12 to 30 kg BW
- Negative control (NC) diets – 3 ppm DON
- Increased nutrient density
  - ME + 6%, TID lysine + 10%
- Flow agent
  - Defusion (DEF; Provimi)
Fruge et al. 2011

ADG, kg/d

PC, meal
PC, pellet
NC, meal
NC, pellet
NC meal + DEF
NC pellet + DEF

ADFI, kg/d

G:F, kg/d

Fruge et al. 2011
Energy, %

Ca retention, g/d

P retention, g/d

Thanh et al. 2015
Distribution of Fusarium mycotoxins in wheat milling process

Cassiane Salete Tibola*, José Mauricio Cunha Fernandes, Eliana Maria Guarienti, Marcio Nicolau

Embrapa Wheat, Rodovia BR-285, Km 294 – C.P. 3081, Passo Fundo, RS, 99.001-970, Brazil
Effect of DON in diet on ADG weanling pigs

\[ y = -0.0214x + 0.578 \]

\[ R^2 = 0.1381 \]
Effects of DON contaminated corn DDGS and potential for mitigation by feed additives

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>DON, 4.6 mg/kg</th>
<th>SEM</th>
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<tbody>
<tr>
<td></td>
<td>Positive control</td>
<td>Negative control</td>
<td>Additive 1</td>
</tr>
<tr>
<td>BW, kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d 0</td>
<td>10.31</td>
<td>10.34</td>
<td>10.39</td>
</tr>
<tr>
<td>d 21</td>
<td>22.60&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.15&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.97&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>d 0 to 21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADG, kg</td>
<td>0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.42&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>ADFI, kg</td>
<td>0.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.69&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>G:F</td>
<td>0.66&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.59&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.60&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>F:G</td>
<td>1.53</td>
<td>1.72</td>
<td>1.68</td>
</tr>
</tbody>
</table>

1 Biofix (Biomin)
2 Cel-can (VAST Inc. IA)
3 Defusion Plus (Cargill, MN)

Frobose et al. 2015
<table>
<thead>
<tr>
<th>Ingredients % as fed</th>
<th>Control</th>
<th>DON</th>
<th>Clay</th>
<th>SDAP</th>
<th>SDAP+Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>50.833</td>
<td>28.833</td>
<td>28.633</td>
<td>27.810</td>
<td>27.610</td>
</tr>
<tr>
<td><strong>DON wheat (9.3 ppm)</strong></td>
<td>0.000</td>
<td>22.000</td>
<td>22.000</td>
<td>22.000</td>
<td>22.000</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>19.000</td>
<td>19.000</td>
<td>19.000</td>
<td>18.100</td>
<td>18.100</td>
</tr>
<tr>
<td>Whey Powder</td>
<td>11.700</td>
<td>11.700</td>
<td>11.700</td>
<td>11.430</td>
<td>11.430</td>
</tr>
<tr>
<td>Fish Meal</td>
<td>9.000</td>
<td>9.000</td>
<td>9.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Barley</td>
<td>4.900</td>
<td>4.900</td>
<td>4.900</td>
<td>5.800</td>
<td>5.800</td>
</tr>
<tr>
<td>Canola Oil</td>
<td>2.300</td>
<td>2.300</td>
<td>2.300</td>
<td>2.400</td>
<td>2.400</td>
</tr>
<tr>
<td>LS 20</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>Celite</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
<td>0.400</td>
</tr>
<tr>
<td>Binder (clay)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.200</td>
<td>0.000</td>
<td>0.200</td>
</tr>
<tr>
<td>SDAP</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>8.000</td>
<td>8.000</td>
</tr>
<tr>
<td><strong>Analyzed ppm</strong></td>
<td>0.000</td>
<td>3.2</td>
<td>3.6</td>
<td>4.2</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Implications

• SDAP
  – About $6.00 per kg
  – Added at 8% of ration, adds $480 per tonne!
  – But in the 1st week, consumption is less than 2 kg per pig, or about $1 pig

• A producer could use low-quality wheat with increased confidence
• “Safety factor”
• Increased survival, $6 per pig
Feeding sorghum ergot (*Claviceps africana*) to sows before farrowing inhibits milk production

JS KOPINSKI, BJ BLANEY, JA DOWNING, JF MCVEIGH and S-A MURRAY

Feeding sorghum ergot (*Claviceps africana*) to sows before farrowing inhibits milk production

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“...Sorghum ergot should not exceed 0.3% (1 mg alkaloid/kg) in diets of multiparous sows before farrowing, and should be limited to 0.1% for primiparous sows, or avoid completely...”
<table>
<thead>
<tr>
<th></th>
<th>Total Alkaloids mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oresanya et al. 2003</td>
<td>1880</td>
</tr>
<tr>
<td>Danicke &amp; Diers A 2013</td>
<td>165</td>
</tr>
<tr>
<td>Danicke &amp; Diers B 2013</td>
<td>378</td>
</tr>
</tbody>
</table>
Mycotoxins in feedstuff

- Chemicals produced in grain by specific moulds or fungi
- 300 to 400 identified
  - Only a few are detrimental to swine health and performance
- Factors affecting production of mycotoxins
  - Moisture level
  - Temperature
  - Availability of oxygen during storage
- Grain is vulnerable at all stages of production
Why are mycotoxins important?

**Mycotoxins** are important because they affect:

- animal productivity
- human health
- international trade

Cost of mycotoxins in Canada and US

~ $5 billion a year
Mycotoxins and world food supply

• 25% of world’s food crops are affected annually by variable levels of mycotoxins

• >100 countries have regulations regarding levels of mycotoxins in food and feed
Legislated maximum tolerated levels of aflatoxins and regulatory guidelines of other mycotoxins

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Commodity</th>
<th>Canada</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>DON (mg/kg)</td>
<td>Wheat for human</td>
<td>2</td>
<td>Finished wheat</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td></td>
<td>products</td>
</tr>
<tr>
<td></td>
<td>Diets for cattle &amp;</td>
<td>5</td>
<td>Cattle &amp; poultry</td>
</tr>
<tr>
<td></td>
<td>poultry</td>
<td></td>
<td>&lt;50% of diet</td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td>1</td>
<td>&lt; 20% of diet</td>
</tr>
<tr>
<td>Aflatoxins (μg/kg)</td>
<td>Animal feeds</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(.02 mg/kg)</td>
<td></td>
</tr>
</tbody>
</table>

Recommended tolerance levels

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Commodity</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergot</td>
<td>Swine</td>
<td>4 to 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(alkaloid)</td>
</tr>
<tr>
<td></td>
<td>Cattle</td>
<td>2 -3</td>
</tr>
</tbody>
</table>
Fusarium mycotoxins

- Deoxynivalenol
- Zearalenone (ZEA)
- Nivalenol (NIV)
- HT-2 and T2
Deoxynivalenol (DON)

- The most common of the Fusarium toxins
- Also called vomitoxin
- Often used as indicator of other toxins present
- Feed refusal and reduced performance
- Targets the GI tracts, immune system
- Swine most sensitive
- Regulatory guidelines for DON 1-5 ppm
Effects of pelleting on growth and feed intake of pigs from 24 to 50 kg BW fed high DON corn DDGS

<table>
<thead>
<tr>
<th>ADG</th>
<th>Meal</th>
<th>Pellet</th>
<th>DON</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg/d</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>4.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>3.9</td>
<td></td>
<td>3.9</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Frobose et al. 2011
Evaluating the Effects of an Algae-Modified Montmorillonite Clay in Diets Contaminated with Deoxynivalenol on Nursery Pig Growth Performance


- Pigs fed from 10 kg to 20 kg BW
- Negative control, 5 ppm DON
- Modified clay has increased surface area
The effects of DON and an algae modified clay* on growth, feed intake and feed efficiency of 21 to 45 kg pigs

Erceg et al. 2013
Evaluating the Effects of an Algae-Modified Montmorillonite Clay in Diets Contaminated with Deoxynivalenol on Nursery Pig Growth Performance


- Pigs fed from 10 kg to 20 kg BW
- Negative control, 5 ppm DON
- Modified clay has increased surface area

**Conclusion**
Including the modified clay product will not offset negative effects of DON
Mycotoxins and world food supply

- 25% of world’s food crops are affected annually by variable levels of mycotoxins
- >100 countries have regulations regarding levels of mycotoxins in food and feed
Variability of DON and moulds in feed (corn)

Corn had been mixed, and then sampled and several samples taken and composited into 11 single samples
Newly weaned piglets (about 8 kg BW) fed diets with 2 different ergot samples at 2 concentrations for 35 days
ADG, kg/d

- Control
- Ergot A 13.3 mg/kg
- Ergot A 33.5 mg/kg
- Ergot B 13.3 mg/kg
- Ergot B 33.5 mg/kg

ADFI, kg/d

G:F

Danicke and Diers 2013
Non-Homogenous and Homogenous Distribution

Adapted from Whitaker, 2005