A Little Fresh Air

Fungal Toxins and Silage
Is There A Problem?

- **Protocol**
  - DON, 15-ace-DON, ZEA
  - In wheat, corn, hay
  - CON 500 ppb DON in TMR
  - TOX 3.5 ppm DON, 240 ppb ZEA*

- **6 cows/treatment**

- **Serum variables**
  - Urea
  - IgA
  - Album./Glob ratio

* Zea in hay!

Is There A Problem?

Recovery of Mycotoxins (% of samples)

<table>
<thead>
<tr>
<th></th>
<th>DON</th>
<th>ZEA</th>
<th>Mycophenolic Acid</th>
<th>Roquefortine C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>60</td>
<td>30</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>For</td>
<td>40</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Ens BP</td>
<td>30</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

CS = corn silage, compound feed, and commodity samples
For = forages
Ens BP = Ensiled by-products

Note: test panel of 20 mycotoxins: AFB1,2,G1,2; OA; T-2; HT-2; 3- and 15-ace-DON; DAS; sterigm; fusar-X; ergotamine; penicillinic acid; fumonisin B1,2

Is There A Problem?

Amounts of Mycotoxins (ppb)

<table>
<thead>
<tr>
<th>DON</th>
<th>ZEA</th>
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<tr>
<td>Mycophenolic Acid</td>
<td>Roquefortine C</td>
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Note: concerns of toxicity to large animals of mycophenolic acid and roquefortine is increasing. The latter is produced by a micro-aerophilic *Penicillium* mold routinely isolated from corn silage.

Silage

- **Regardless of type of container**
  - Ensiling depends upon mechanical action for initial exclusion of oxygen
Silage

• **Expected sequence**
  – Materials for ensiling
    • Chopped at proper time
  – Blown into silo
    • Weight of material and/or of equipment compresses mass and excludes most oxygen
  – Rapid microbial activity
    • Consuming remaining oxygen
    • Lowering pH (to 3.5-4.3)
  – Temperature 10-20°F of ambient
    • Warmer > O₂ penetration
Molds Isolated From Silage

• **Common molds**
  - Aspergillus spp.
  - Fusarium spp.
  - Penicillium spp.

• **Less common**
  - Absidia, Arthrinium, Alternaria
  - Bysoclamys, Baccharis
  - Monascus, Mucor, Myrothecium
  - Scopulariopsis
  - Trichoderma

• **Toxins of Interest**
  - Aflatoxin, T-2 toxin, DON, zearalenone, fumonisin, ochratoxin A, aflatrem
  - DAS, MAS, citrinin, patulin, fusarins, fusaric acid, cyclopiazonic acid
  - Pencillinic acid, PR toxin roquefortine C, mycophenolic acid, penetrrem,agroclavine, festuclavine, roridins, verrucarins, alternariol
  - Unknowns (e.g. Absidia)
### Real World Dairy Rations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeasts (misc.)</td>
<td>120,000,000</td>
<td>cfu/gm</td>
</tr>
<tr>
<td><em>Mucor racemosus</em></td>
<td>5,000</td>
<td>cfu/gm</td>
</tr>
<tr>
<td><em>Absidia corymbifera</em></td>
<td>1,700,000</td>
<td>cfu/gm</td>
</tr>
<tr>
<td><em>Penicillium roquefortii</em></td>
<td>700,000</td>
<td>cfu/gm</td>
</tr>
<tr>
<td><em>Fusarium spp.</em></td>
<td>0</td>
<td>cfu/gm</td>
</tr>
<tr>
<td>Deoxynivalenol (DON)</td>
<td>2,500 ppb</td>
<td>ng/g</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>500 ppb</td>
<td>ng/g</td>
</tr>
</tbody>
</table>

**A. corymbifera**: Aw 0.90; infection, abortion in cattle

**P. roquefortii**: Aw 0.82; micro-aerophilic; acid tolerant; 5 toxins, 2 alkaloids
Molds/Toxins in Silage

• **At ensiling**
  - Some toxins are present in the materials ensiled
  - Mold/spores present as well

• **Post-ensiling**
  - Trapped small air pockets...
  - Minor air infiltration into the container
  - Poor cutting or removal technique with additional infiltration

• **24-48 hrs enough for toxic loads to form**
Is CA Different?

• **Why the question?**
  - Routine testing yields little in the way of common toxins
    - **DON, T-2 toxin, zearalenone, AF**
  - But dairy herds experience the same problems that relate to mold toxins as other areas of the US

• **What are the differences?**
  - Climate
  - Possibly materials used
  - Adjacent agriculture
Is CA Different?

- **Climate**
  - Lower relative humidity
  - $A_w$ may be lower than for other areas?
  - Alters mold profile

- **Constituents**
  - Use of “other” ingredients

- **Adjacent agriculture**
  - Fruits, nuts
  - Enriched mold flora specific to those commodities
Masked Mycotoxins

• Antibody in test recognizes a very specific chemistry

DON-specific Aby
Masked Mycotoxins

- Plants add ‘sugar’ (e.g., glucose) to detoxify
- Chemistry is changed – toxin is “masked”
Masked Mycotoxins

- **Molds also produce ‘alternative’ forms**
  - Addition of –OH or other moieties
- **DON congeners, e.g.**
  - 3-acetyl-DON
  - 15-acetyl-DON
- **Also hidden from standard DON antibody**
- **Both (congeners & glycosides) require extra hydrolysis**
Masked Mycotoxins

- Found for most common mycotoxins
- Rapid tests may underestimate total toxin level by 50 – 125%
- A “less than 150 ppb DON” could mean 300 or more effective DON is present
Prevention? Control?

• Only real solutions open to dairymen on the silage side are
  – Best ingredients into the ensiling process
  – Best maintenance of silage storage
  • Bird damage, mechanical, etc.
  – Best management of silage
  • Cutting quality

• Dairyman’s best options are to
  – Presume presence of toxins
  – Watch cow symptoms carefully
  – Additives which aide the cow in combating toxins
## Control: ‘09 Test

### Quantitative Results (Dry Matter Basis)

<table>
<thead>
<tr>
<th>MYCOTOXIN</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aflatoxin</td>
<td></td>
<td>ppb</td>
</tr>
<tr>
<td>Vomitoxin (DON)</td>
<td>687.0</td>
<td>ppb</td>
</tr>
<tr>
<td>T-2 Toxin</td>
<td>&gt;25</td>
<td>ppb</td>
</tr>
<tr>
<td>Zearalenone</td>
<td>&gt;50</td>
<td>ppb</td>
</tr>
<tr>
<td>Fumonisin</td>
<td></td>
<td>ppm</td>
</tr>
<tr>
<td>Ochratoxin</td>
<td></td>
<td>ppb</td>
</tr>
</tbody>
</table>
Control?

- Control is with the host animal!
  - Test, but
  - Watch the signs in the cows
  - Use measures appropriate to the issue!
  - If you don’t have high AF, why use a clay?
  - If you don’t know that ALL others are low, why use a yeast?
  - Use a truly broad spectrum approach
Summary—Just A Little Fresh Air

- Based on mold cultural features, silage should be a toxin-safe feedstuff.
- However, complete anaerobiosis is not achieved.
- Minor leakage-infiltration of air yields mold ‘hot spots’ with substantive toxin accumulations.
- Best practices for silage and reinforcement of cows’ natural defenses are the best control.
Thank You!