Mycotoxins in Grain

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Outline

• What are mycotoxins?
• Why are mycotoxins a concern?
• How do mycotoxins impact the grain processing industry?
• Some of the research being done on mycotoxins.
What are mycotoxins?

• ‘myco’ comes from the Greek ‘mykes’, meaning *mushroom* or *fungus*.
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• Mycotoxins are chemicals produced by fungi, which are toxic to people, animals, and/or plants.

• A variety of chemical, produced by a variety of different fungi, are all referred to as ‘mycotoxins’.
What are mycotoxins?

- Not all fungi that grow on grain produce mycotoxins.
Why are mycotoxins a concern?

- Toxic effects on people and animals.
- Only very small quantities are needed (parts-per-million or parts-per-billion).
- Typically not degraded during food processing.

- *Heavily contaminated grain should not enter the food or feed supply!*
Why are mycotoxins a concern?

• Aflatoxin
  • A potent liver carcinogen
  • In livestock, lowers breeding efficiency, birth weights, growth rates, egg production
  • Toxin passes into milk
Why are mycotoxins a concern?

- **Ochratoxin**
  - Damaging to kidneys
  - Fat-soluble and not readily excreted
  - Among livestock, primarily affects poultry and swine
Why are mycotoxins a concern?

- Vomitoxin
  - Also known as deoxynivalenol (DON)
  - Causes loss of appetite, feed refusal and vomiting
Why are mycotoxins a concern?

• Zearalenone
  • Mimics the hormone estrogen
  • Causes a variety of health problems related to the reproductive system
  • Swine are particularly sensitive
Why are mycotoxins a concern?

• Fumonisin
  • Interferes with biosynthesis of sphingolipids (an important component of the brain and nerves)
  • Particularly toxic to horses, causing ‘blind staggers’ disease
Why are mycotoxins a concern?

- Ergotamine / ergot alkaloids
  - Causes blood vessel constriction, leading to swollen limbs, gangrene, internal bleeding
  - Can lead to abortion
  - Fungal structures mixed with grain, rather than in the grain itself
Why are mycotoxins a concern?

Effects of Mycotoxins

ZEN, DON, T-2, DAS, Ergots
- Decreased hatchability
- Decreased egg production
- Ovarian cysts
- Embryonic loss
- Delayed sexual maturation

OTA
- Kidney damage
- Increased water consumption

AFB₁, FUM, T-2, DON, DAS, NIV, OTA
- Fatty liver
- Immunosuppression
- Inhomogeneous flocks
- Impaired feathering
- Organ damage
- Impaired performance
- Impaired intestinal health

T-2, HT-2, NIV, DAS, DON, AFB₁, Ergots
- Oral and dermal lesions
- Inflammation of mucous membrane of oral cavity
- Respiratory difficulties

T-2, DON
- Gizzard lesions
- Feed refusal
- Decreased feed intake
- Diarrhea
- Vasoconstriction (necrosis)

EGG:
AFB₁, OTA, T-2, DON, ZEN
- Residues
- Poor egg shell quality
- Blood and meat spots
- Creamy yolk

For further information about mycotoxins please visit www.mycotoxins.info

mycofix.biomin.net

DON – Deoxynivalenol
ZEN – Zearalenone
AFB₁ – Aflatoxin B₁
FUM – Fumonisins
T-2 – T-2 Toxin
HT-2 – HT-2 Toxin
NIV – Nivalenol
DAS – Diacetoxyscirpenol
OTA – Ochratoxin A
Ergots – Ergot Alkaloids
How do mycotoxins impact the grain processing industry?

- Poor storage can exacerbate a mycotoxin problem
- However, accumulation often happens mainly in the field, before harvest
How do mycotoxins impact the grain processing industry?

- Mycotoxin content is a component of grain quality
  - Assessed by testing
    - Sampling methods
    - Measurement methods
How do mycotoxins impact the grain processing industry?

- Several mycotoxins exist in a range of chemical variants
  - Implications for testing

\[ \text{Glucosyltransferases} \quad \text{in planta} \]
How do mycotoxins impact the grain processing industry?

- Several mycotoxins exist in a range of chemical variants
  - Profile of mycotoxins present in a region can change over time (e.g., with introduction of foreign fungi)

![Chemical structures of mycotoxins](image-url)
How do mycotoxins impact the grain processing industry?

• Mycotoxin content is a component of grain quality
  • Which downstream customers and processes are concerned with this aspect of grain quality?
  • Different customers may have more or less stringent requirements for tolerable mycotoxin concentrations
How do mycotoxins impact the grain processing industry?

- Food and Drug Administration *advisory* levels for *vomitoxin*:
  - 1 ppm:
    - immature animals, dairy animals, or destination unknown
  - 5 ppm:
    - breeding cattle/swine, or mature poultry
  - 10 ppm:
    - finishing swine > 100 pounds
How do mycotoxins impact the grain processing industry?

• Food and Drug Administration action levels for aflatoxin:
  • 20 ppb: immature animals, dairy animals, or destination unknown
  • 100 ppb: breeding cattle/swine, or mature poultry
  • 200 ppb: finishing swine > 100 pounds
  • 300 ppb: finishing beef cattle
How do mycotoxins impact the grain processing industry?

• Weather conditions can strongly influence mycotoxin levels across an entire region... but different conditions are required for different toxins
  • Vomitoxin is a larger problem when conditions are humid and wet during flowering & grain fill
  • Aflatoxin and fumonisins will be a larger problem when conditions are hot and dry during grain fill
How do mycotoxins impact the grain processing industry?

• Early alert to potential mycotoxin issues
  • Communication with other grain handlers in the region
  • Routine monitoring of incoming loads
How do mycotoxins impact the grain processing industry?

- Cleaning grain may be possible & effective in some cases
How do mycotoxins impact the grain processing industry?

- Blending is sometimes used to reduce mycotoxin concentrations below tolerable maximums
  - Blending is generally not permitted for aflatoxin
Mycotoxins are toxins produced by molds (fungi) and can accumulate in crops, where they pose health hazards to humans and animals. Mycotoxins are estimated to affect 25% of the world’s crops and cost US agriculture approximately $1 billion each year.
What research is being done on mycotoxins?

• Current research in the Mycotoxin Prevention & Applied Microbiology research unit:
  • Faster/cheaper/better methods for detecting mycotoxins
  • How and why do different species and strains of fungi vary in their capacity to produce mycotoxins?
  • How do environmental factors impact mycotoxin accumulation?
  • Can other microorganisms be used to reduce mycotoxin contamination?
What research is being done on mycotoxins?

• Because many mycotoxin issues arise in-field, the grain processing industry benefits from research targeting the production setting
Mycotoxin Prevention and Applied Microbiology Unit

Host Plant Susceptibility

Weather

FHB Mycotoxins

Detection

Microbiome

Fusarium Fungal Pathogen

Virulence
USDA Agricultural Research Service locations performing research related to mycotoxins

- **Tuscon**: Fumonisin, Vomitoxin, Zearalenone detection (all)
- **New Orleans**: Aflatoxin
- **Athens**: Genetics, Ecology, Biocontrol, Breeding
- **Dawson**: Aflatoxin in peanuts

**Mycotoxins in tree nuts**

**Aflatoxin**
- Biocontrol

**Fumonisin**

**Aflatoxin in peanuts**
- Genetics
- Ecology
- Biocontrol
- Breeding
For more information:

• Federal Grain Inspection Service
  • Performance verified testing kits
  • (Government reorganization recently moved them into the Agricultural Marketing Service)
Questions?

We’d love to hear from you Re: research directions that would be the most impactful for your industry!

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