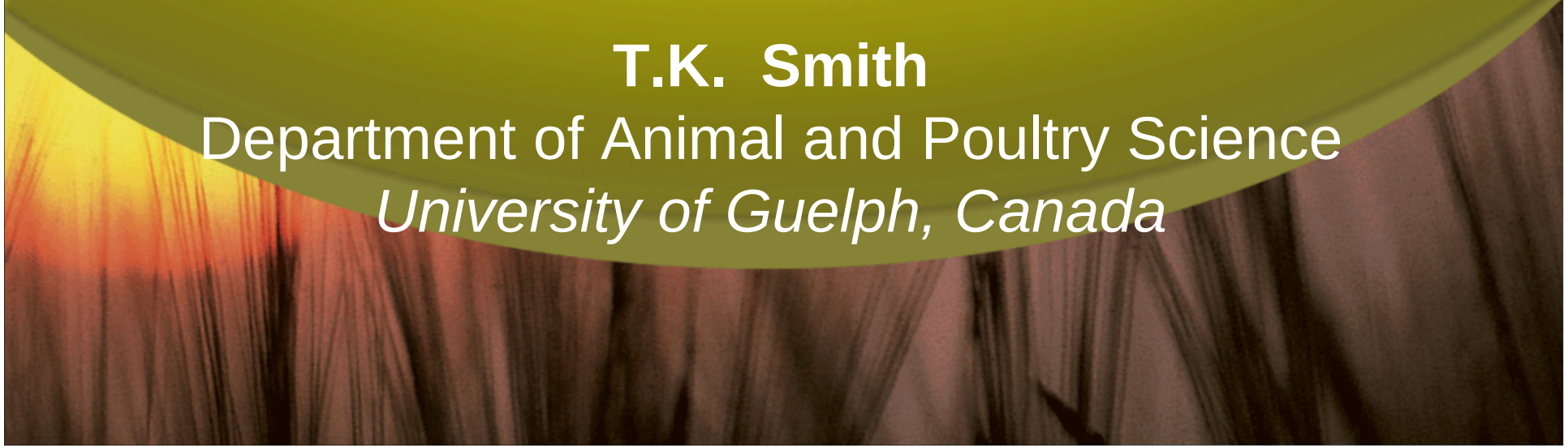
Significance Of Feed-Borne *Fusarium* Mycotoxins On Livestock Health And Reproduction



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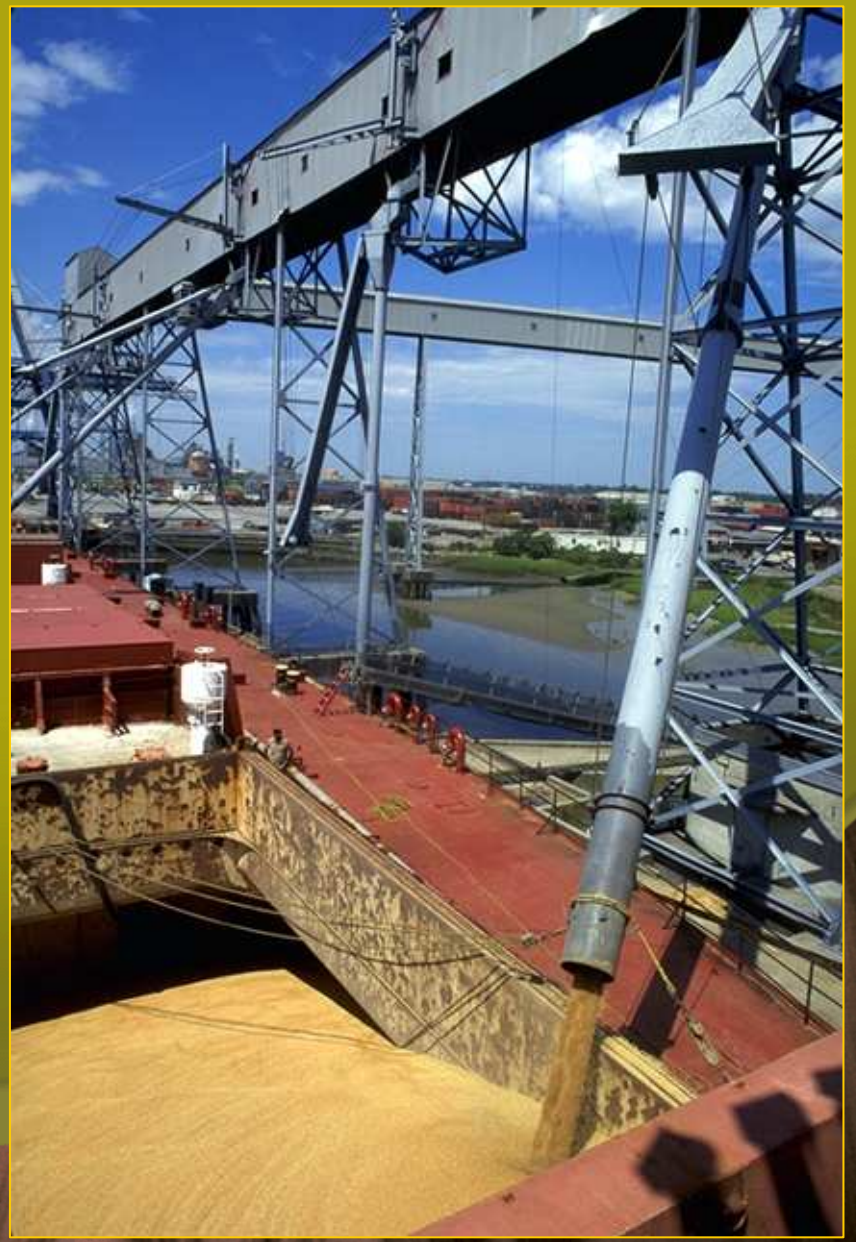
INTRODUCTION

- Global climate change has resulted in unusual weather patterns.
- Drought, flooding and temperature extremes increase the chance of mycotoxin contamination of feed grains.

INTRODUCTION

- Increased global trading of feed grains increases the chance that blends of grains will result in combinations of mycotoxins in a given diet .



INTRODUCTION

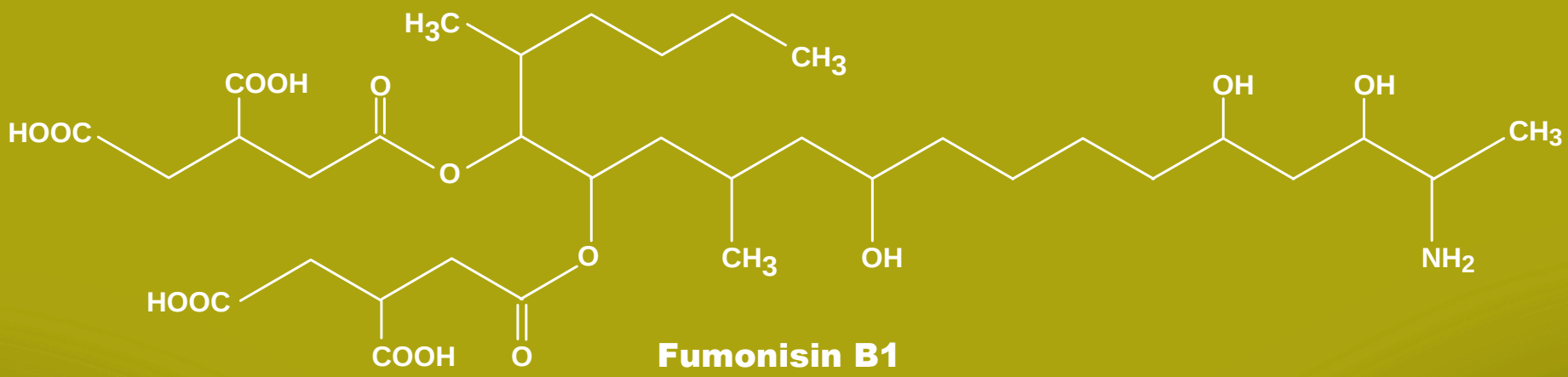
- **The most commonly found mycotoxins include aflatoxin and the *Fusarium* toxins.**
- **Analytical procedures for aflatoxin are well established.**
- ***Fusarium* mycotoxins are more difficult to analyze for due to the large number of compounds, with widely varying chemical structures. It is necessary to use DON as a marker compound.**

INTRODUCTION

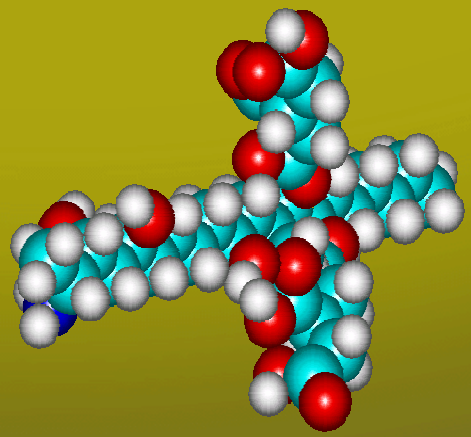
- The presence of biologically active but non detectable glucose conjugates of DON have been reported in naturally-contaminated corn and wheat from Slovakia.
- The fraction of total DON represented by the glucose conjugate is up to 30%.
- Berthiller et al., 2005. J. Agric. Food Chem. *53*: 3421-3425.

Fusarium Mycotoxins

- Swine and horses are the most sensitive species.
- Poultry are more resistant but can have altered metabolism and specific lesions.
- Ruminant animals are the most resistant but effects can still be seen on reproduction and milk production.

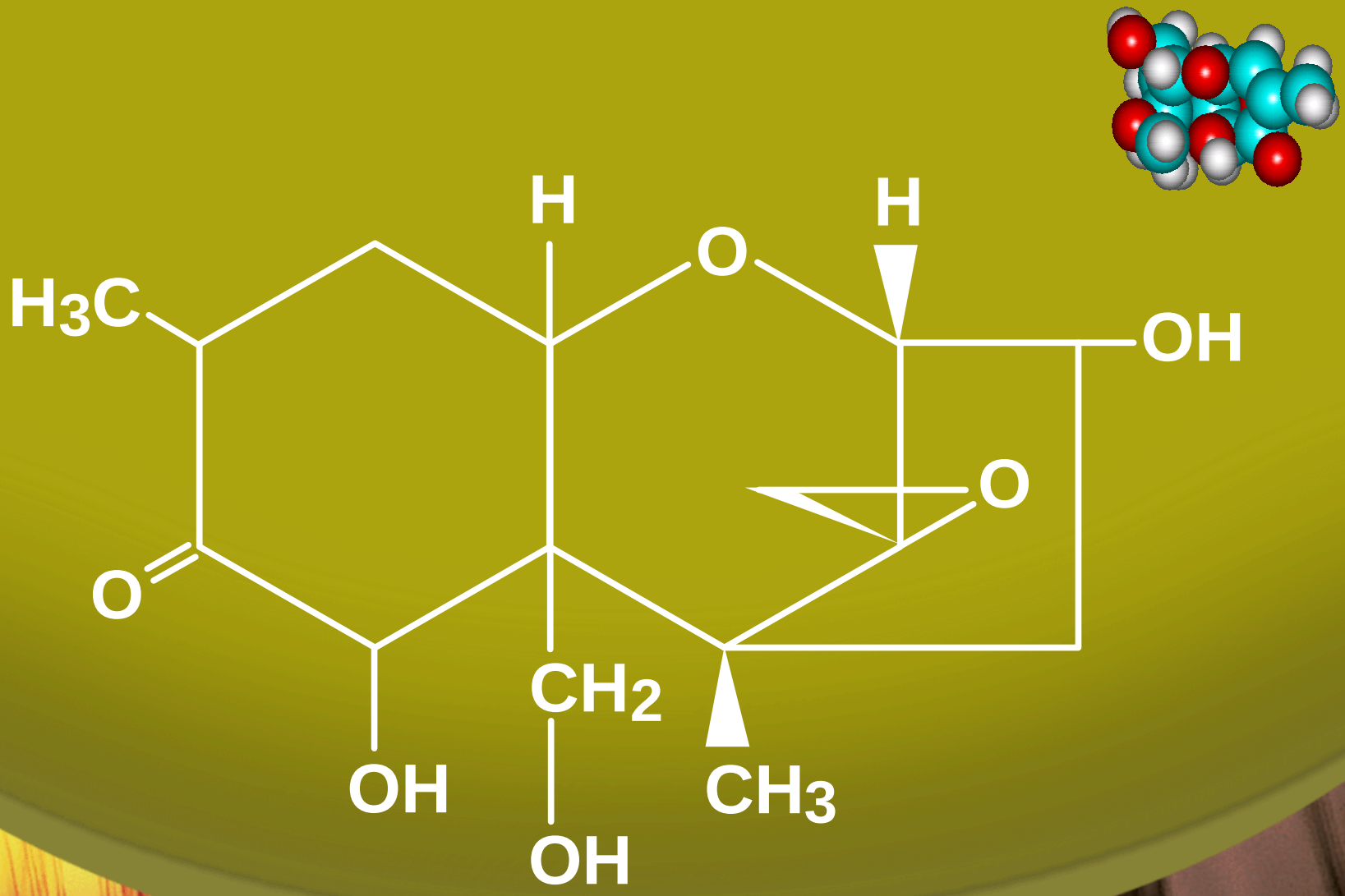


Fumonisin B1



The Fumonisins

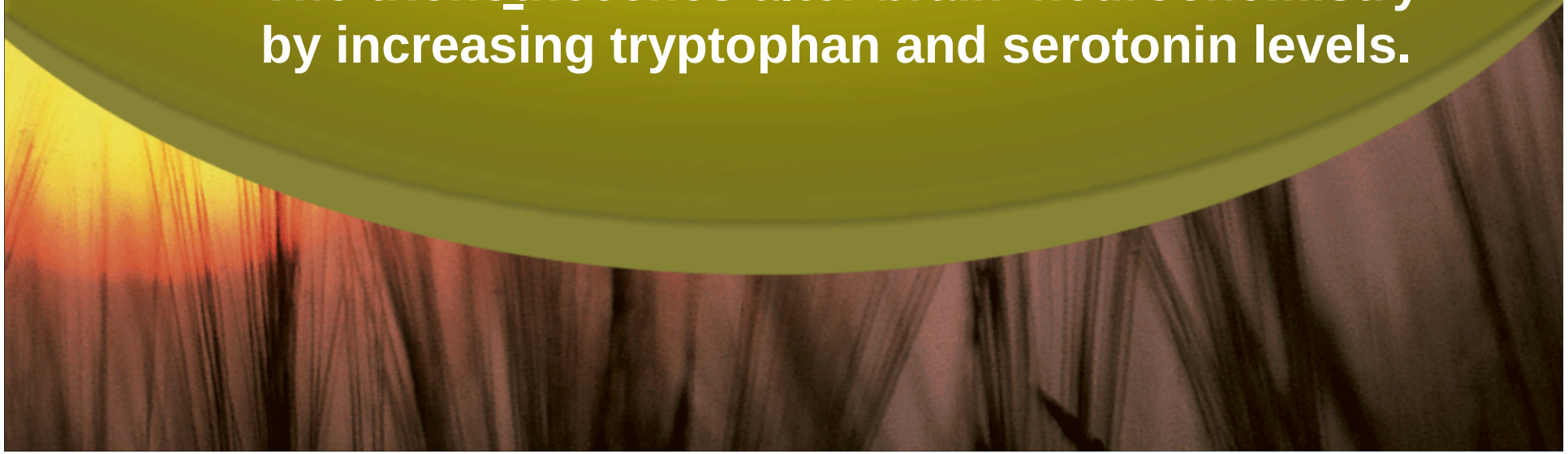
- Fumonisins can inhibit synthesis of membrane lipids.
- This can result in ELEM in horses and reduced milk production and liver damage in dairy cows.
- The amount of fumonisin required to produce this syndrome is about 3 ppm in horses and 200 ppm in dairy cows.
- Corn and corn screenings are a major source of fumonisins.



Deoxynivalenol

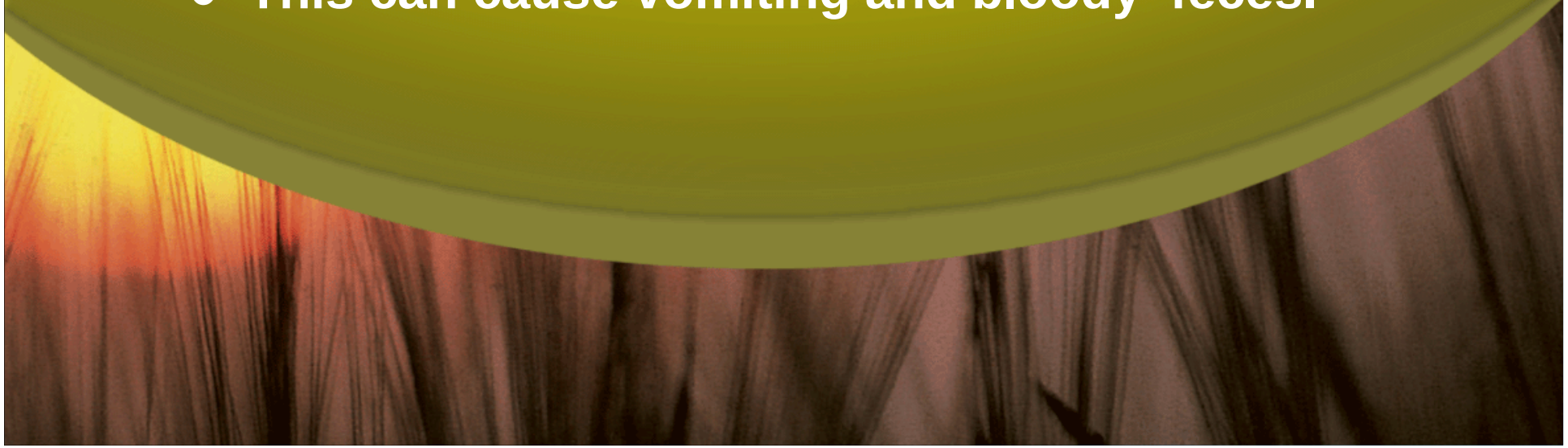
The Trichothecenes

- The trichothecenes are a family of more than 100 structurally-related toxins.
- The trichothecenes are feed refusal toxins.
- The most common is deoxynivalenol (DON, vomitoxin).
- The trichothecenes alter brain neurochemistry by increasing tryptophan and serotonin levels.



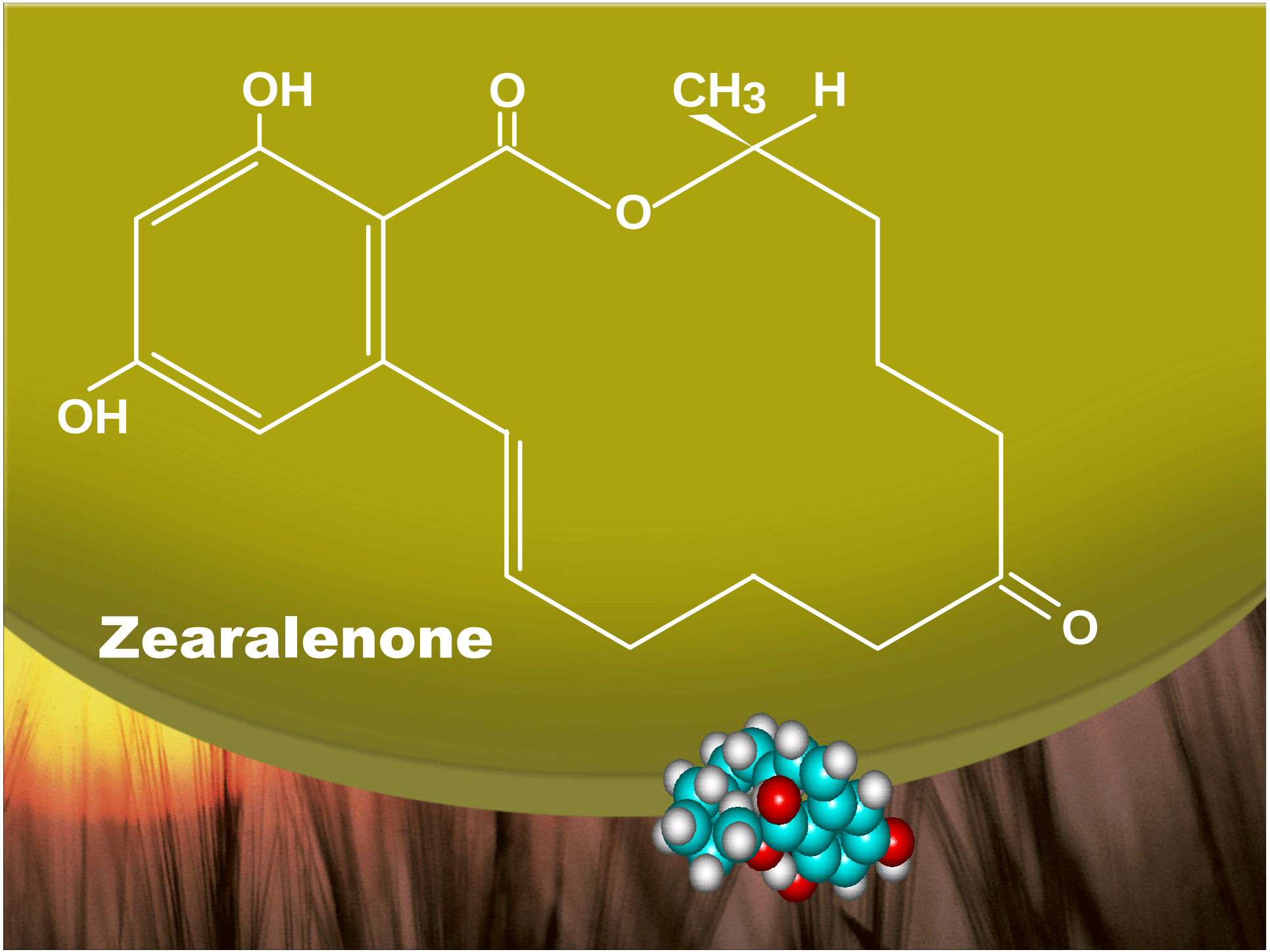
The Trichothecenes

- The trichothecenes are dermal necrotic agents and inhibit cellular protein synthesis.
- The trichothecenes cause hemorrhaging of the intestinal tract and this can lead to a malabsorption syndrome.
- This can cause vomiting and bloody feces.



The Trichothecenes

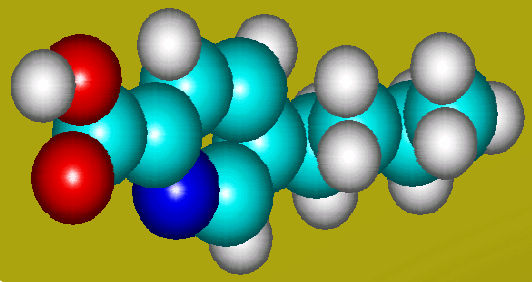
- The trichothecenes are immunosuppressive.
- This makes animals susceptible to secondary mycotoxic diseases.
- This may be due, in part, to the inhibition of immunoglobulin synthesis.

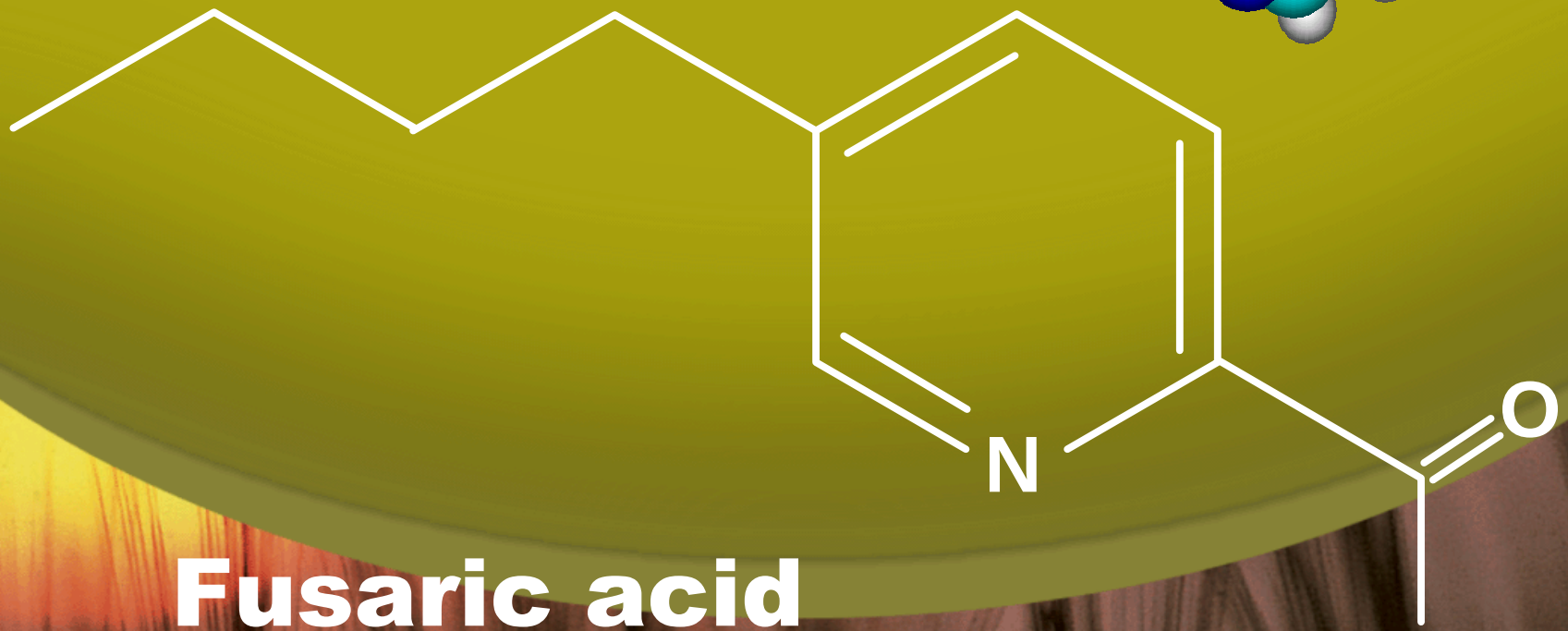

OH
O
CH3
H
O
OH
O
Zearalenone

Zearalenone

- Zearalenone is an estrogenic *Fusarium* mycotoxin.
- Zearalenone can bind to estrogen binding sites and cause enlargement of the uterus and rectal and vaginal prolapse.
- Zearalenone causes abortions and infertility.

Fusaric Acid
(5-butylpicolinic acid)

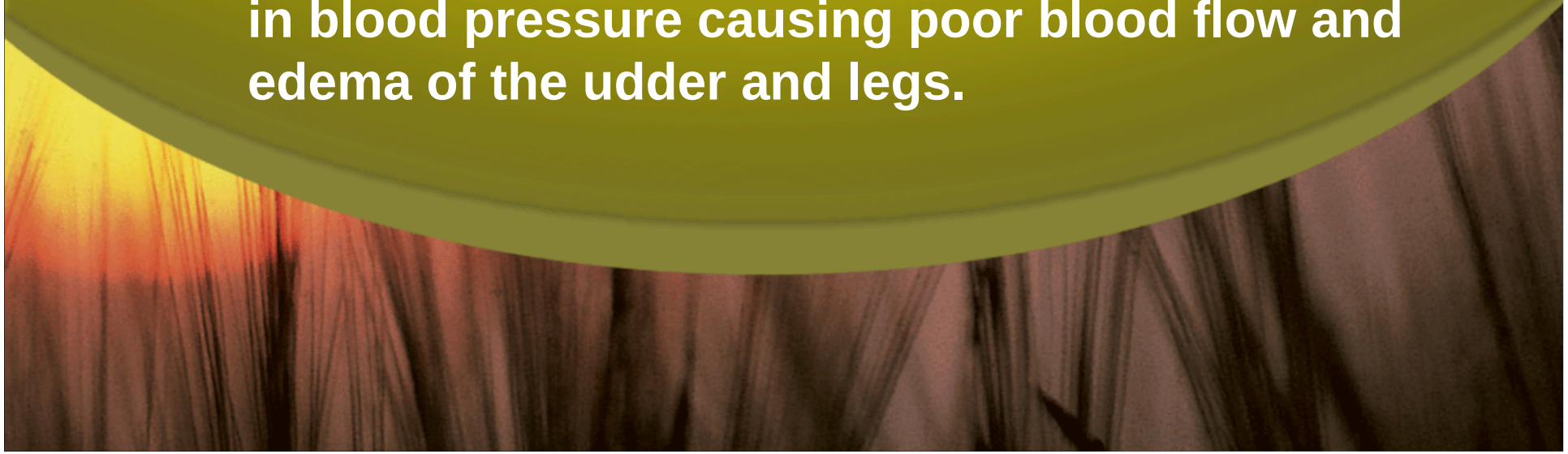




Fusaric acid

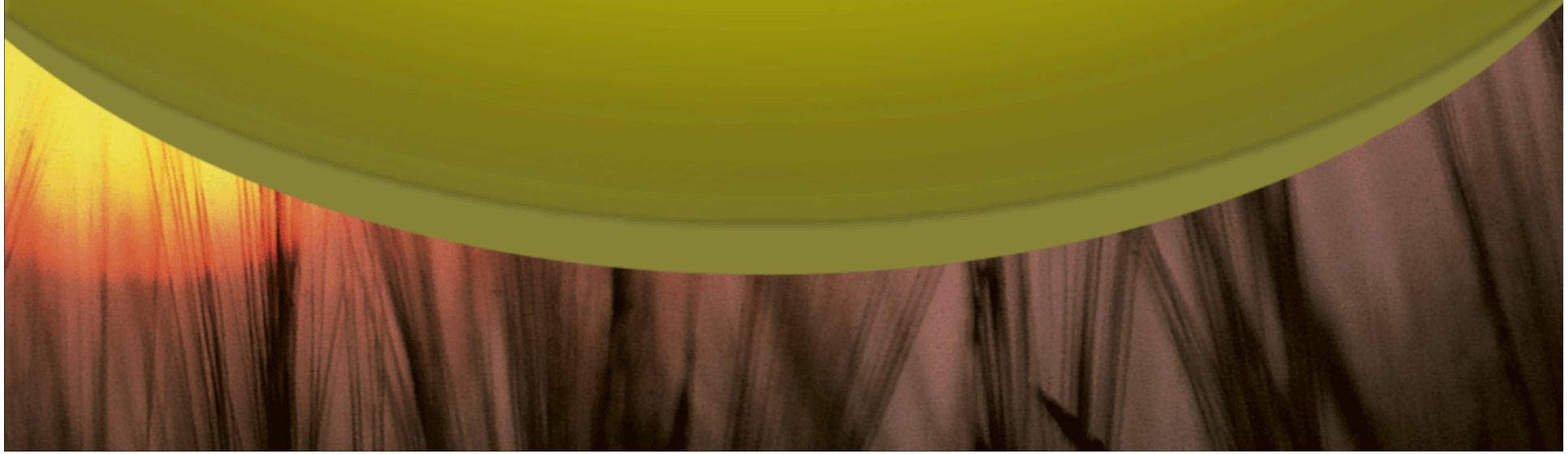
Fusaric Acid

- Fusaric acid has low acute toxicity but is pharmacologically active.
- Fusaric acid inhibits the enzyme dopamine-beta-hydroxylase which catalyzes the conversion of dopamine to norepinephrine.
- The physiological effect of fusaric acid is a drop in blood pressure causing poor blood flow and edema of the udder and legs.



Fusaric Acid

- Fusaric acid also increases brain concentrations of tryptophan and serotonin.
- Fusaric acid and vomitoxin act synergistically to reduce feed consumption and trigger vomiting, loss of muscle coordination and lethargy.



Fusaric acid content of cereal grains and whole feeds[a]

Feedstuff	n	Fusaric acid (mg/kg)
Whole feeds	8	35.8
Dry corn	16	11.8
High-moisture corn	4	26.4
Wheat	8	11.6
Barley	2	12.2

[a]*From Smith and Sousadias, 1993. J. Agr. Food Chem 41:2296.*

STRATEGIES FOR PREVENTING MYCOTOXICOSES

- Dilution with sound grain.
- Diversion to less susceptible species.
- Processing methods such as cleaning.
- Physical treatments such as heat.
- Use of *mold inhibitors* such as propionic acid.
- Use of enzymes.
- Mycotoxin adsorbents.

Mycotoxins In Dairy Feeds And Forages

Effect of feeding *Fusarium* mycotoxin-contaminated feeds to lactating dairy cows

-18 mid-lactation Holstein dairy cows (6 cows per diet) were fed TMR containing naturally-contaminated corn, wheat , hay and silage with 3.6 ppm DON (dry matter basis) for 56 days.

-Body weight, milk production, SSC, blood chemistry, hematology and Ig were measured.

-Koresteleva et al., 2007, J. Dairy Sci. : *in press*

Effect of feeding *Fusarium*-mycotoxin contaminated feeds to lactating dairy cows

Diet	Feed Intake (kg/cow/day)	Milk Prod. (kg/cow/day)	SCC (sc/ml x 10^3)
Control	48.5	30.0	64.56
Contaminated	49.5	34.0	57.25
Contaminated + 0.2% Polymer	44.4	28.9	40.88

Effect of feeding *Fusarium*-mycotoxin contaminated feeds to serum composition of lactating dairy cows

Diet	IgA (g/L)	Urea (mmol/L)	Globulins (g/L)
Control	0.35[a]	5.3[a]	40[a]
Contaminated	0.16[b]	6.3[b]	48[b]
Contaminated + 0.2% Polymer	0.27[a]	5.5[a]	45[a,b]

FEEDING BLENDS OF CONTAMINATED GRAINS

Broiler Breeders:

- **Broiler breeder hens were fed a blend of contaminated wheat and corn for twelve weeks.**
- **Diets contained deoxynivalenol, fusaric acid, zearalenone and 15-acetyl DON.**
- **Yegani et al., 2006. Poult. Sci. 85: 1541**

Effect Of *Fusarium* Mycotoxins On Performance Of Broiler Breeder Hens

Egg Production (%)

Diet	Month 1	Month 2	Month 3
Control	87.7[a]	85.3[a]	79.8[a]
Contaminated	81.3[a]	81.3[a]	78.8[a]
Contaminated+	86.7[a]	84.7[a]	86.7[a]

Effect Of *Fusarium* Mycotoxins On Performance Of Broiler Breeder Hens (Month 1)

Diet	Shell Thickness (um)	Early Embryonic Mortality (%)	Hatch. (%)
Control	32.1[a]	5.4[a]	76.5[a]
Contaminated	30.1[b]	21.5[b]	68.7[a]
Contaminated+	31.5[a]	2.3[a]	89.2[a]

Effect Of *Fusarium* Mycotoxins On Performance And Metabolism Of Laying Hens

- SCWL laying hens fed blends of naturally-contaminated wheat and corn containing: DON, 15-acetyl DON, Zearalenone, Fusaric Acid.
- Feeding period of three months.
- Chowdhury and Smith. 2004. Poult. Sci. 83:1849

Effect Of *Fusarium* Mycotoxins On Performance Of Laying Hens

Feed Consumption (g/hen/d)

Diet	Month 1	Month 2	Month 3
Control	119[a]	120[a]	117[a]
Contaminated	106[b]	127[b]	132[b]
Contaminated+	114[a]	124[a]	121[a]

Effect Of *Fusarium* Mycotoxins on Performance of Laying Hens

Feed Efficiency

(feed consumption/egg mass)

Diet	Month1	Month2	Month3
Control	1.88	1.92[a]	1.90[a]
Contaminated	1.94	2.29[b]	2.23[b]
Contaminated+	1.90	2.10[a,b]	1.94[a]

Effect Of *Fusarium* Mycotoxins on Performance of Laying Hens

	Egg Production (%)		
Diet	Month 1	Month 2	Month 3
Control	95[a]	90[a]	90
Contaminated	81[b]	82[b]	84
Contaminated+	90[a]	89[a,b]	87

Effect Of *Fusarium* Mycotoxins On Blood Chemistry Of Laying Hens

Uric Acid (umol/L)

Diet	Month 1	Month 2	Month 3
Control	376[a]	392[a]	390[a]
Contaminated	1009[b]	1154[b]	1030[b]
Contaminated+	499[a]	539[a]	487[a]

Effect Of Feeding Blends Of Grains Naturally-Contaminated With *Fusarium* Mycotoxins On Biliary Immunoglobulin A In Laying Hens

Diet	Biliary Immunoglobulin A (mg/ml)
Control	53.72[a]
Contaminated	44.08[b]
Contaminated +	56.34[a]

[a,b] Means within a column without a common superscript differ significantly (P< 0.05)

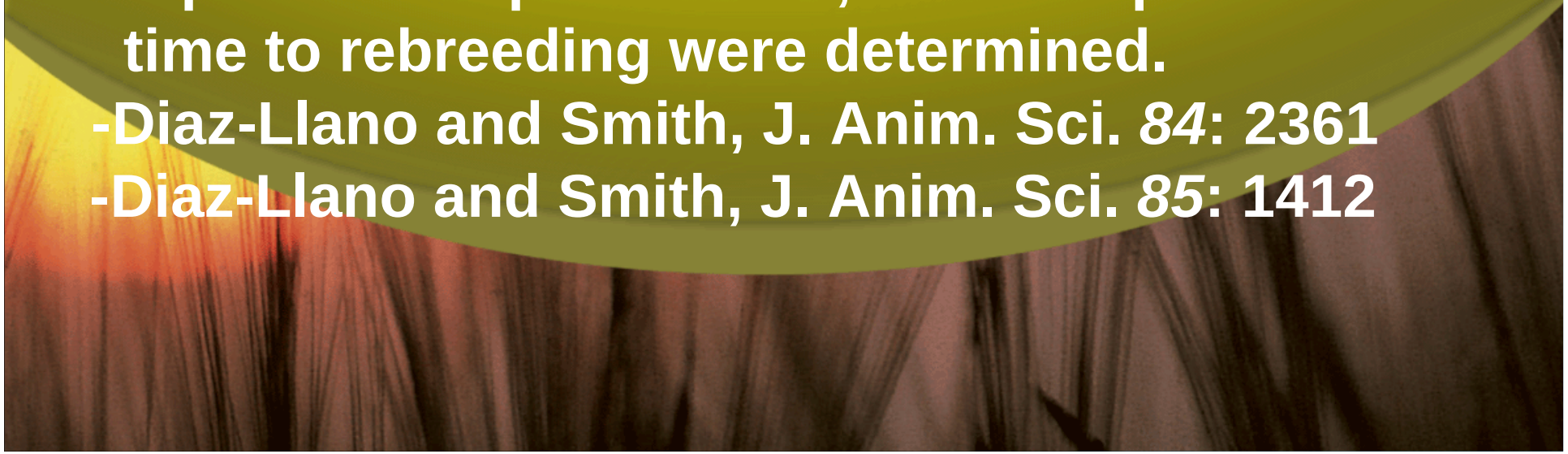
Effect of feeding blends of *Fusarium* mycotoxin-contaminated grains to gestating and lactating sows

-Gestating an lactating sows (12 per diet) were fed combinations of contaminated grains for 21 days prepartum and 21 days postpartum.

-Growth, feed consumption, blood chemistry, reproductive parameters, milk composition and time to rebreeding were determined.

-Diaz-Llano and Smith, J. Anim. Sci. *84*: 2361

-Diaz-Llano and Smith, J. Anim. Sci. *85*: 1412

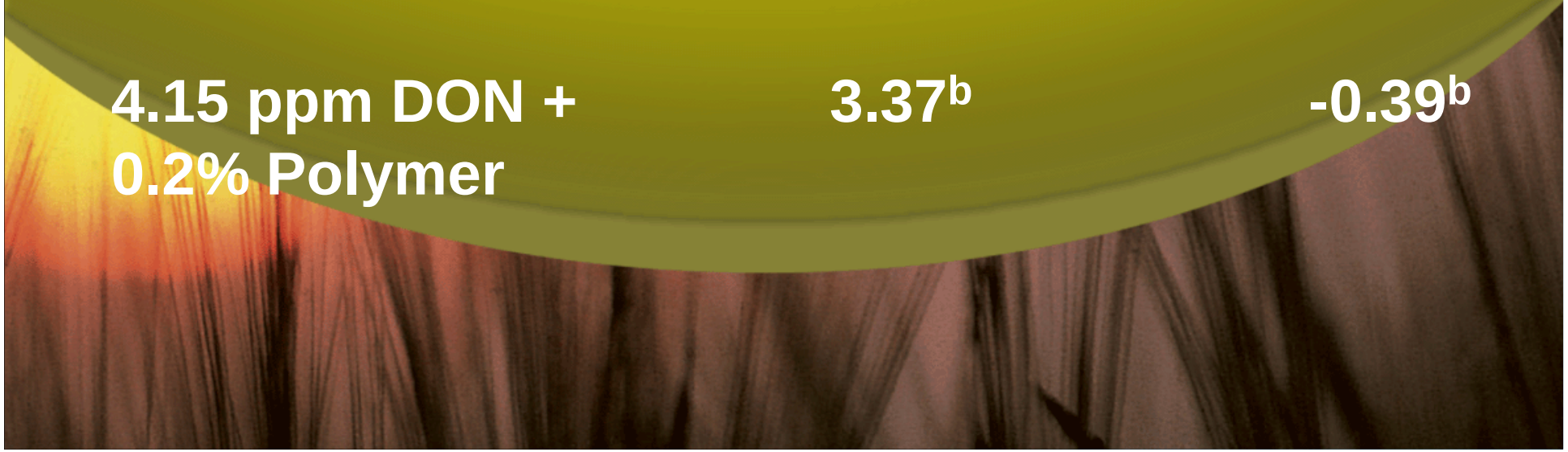


Effect of feeding blends of *Fusarium* mycotoxin-contaminated grains on feed intake and weight gain of sows prepartum

Diet	Intake (kg/day)	Gain (kg/day)	FCR (kg/kg)
Control	2. 41	1.14[a]	0.473[a]
4.15 ppm DON	2.12	0.62[b]	0.292[b]
4.15 ppm DON + 0.2% Polymer	2.15	0.80[a,b]	0.372[a,b]

Effect of feeding blends of *Fusarium* mycotoxin-contaminated grains on feed intake and weight gain of lactating sows

Diet	Intake (kg/day)	Gain (kg/day)
Control	4.98[a]	0.11[a]
4.15 ppm DON	3.49[b]	-0.61[b]
4.15 ppm DON + 0.2% Polymer	3.37[b]	-0.39[b]



Effect of feeding blends of *Fusarium* mycotoxin-contaminated grains on piglets born alive

Diet	Stillbirths (%)	Piglets / litter	W to E (d)
Control	6.27^{bc}	8.18^{a}	6.33
4.15 ppm DON	15.52^{ac}	8.55^{a}	15.00
4.15 ppm DON + 0.2% Polymer	4.6^{b}	11.24^{b}	15.33

OVERALL CONCLUSIONS

- The feeding of blends of grains contaminated with *Fusarium* mycotoxins can alter metabolism and productivity of dairy cows, poultry and pigs.
- This can lead to significant financial losses for producers.
- Such losses can be prevented by the use of a suitable mycotoxin adsorbent.