Dairy Cattle Feeding-Related Issues With 2009 Corn Crop

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Harvest & Storage Issues

- **Wet Corn**
- **Mold/Mycotoxins**
- **Yeast**

Harvest & Storage Options

- Snaplage (SNG)
- High-Moisture Shelled Corn (HMSC)
- Dry Shelled Corn (DSC)

Table 1. High Moisture Corn Storage in Conventional, Bunker, Bag, and Oxygen Limiting Silos

	Corn Kernel Moisture, %		
Conventional Top Unloading Silos, Bunkers, and Silo Bags			
	Minimum	Desired	Maximum
Ear Corn	26	32-36	40
Shelled Corn	26	28-32	36
Bottom Unloading Oxygen Limiting Silos			
	Minimum	Desired	Maximum
Ear corn-rolled*	26	28-32	36
Shelled corn	24	26-28	32

**OL Silo with Forage Unloader*

Source: Rankin, 2009

High-Moisture Corn Storage Options

- Lactobacillus buchneri (LBUC) or combination inoculant
- Propionic Acid (PROP)
- Mixed Organic Acid (MOA) Product
- Anhydrous Ammonia or Aqua-Ammonia

Table 2. Recommended application rates of propionic acid to preserve high moisture corn

Corn moisture %	Lbs. propionic acid to apply per 1000 lbs. wet corn[1]		
	--------------------Months corn to be stored---------------------		
	6	9	12
20	3.3 - 5.0	4.0 - 6.0	5.0 – 7.5
25	5.0 - 6.5	6.0 - 8.5	7.5 – 10.0
30	6.5 - 8.5	8.5 - 11.0	10.0 – 12.5
35-40	8.5 - 10.5	11.0 - 14.0	12.5 – 15.0

[1]Use lower rate for well-mixed corn and higher rate if acid and grain cannot be well-mixed.

Source: Rankin, 2009

Harvest & Storage Comments

- Advantage of DSC is mold/yeast shut down, can exclude fines, & can dilute easily
- Advantage of SNG was could get it off wetter
- HMSC is the intermediate solution
  - Leave the cob in field!
  - 35% kernel moisture less risky than 40%, i.e. yeast/ethanol issues
  - Relying on low pH (inoculant can help) & oxygen exclusion
  - If wet HMSC/yeast of more concern than mold, then LBUC or MOA likley to be more effective than PROP
  - Plan storage so that worst corn can be fed before spring/summer
  - Coarse roll (2,500 micron MPS) best on wet HMSC

Potential Feeding Issues

- **DSC**
  - Reduced test weight
  - Mold/Mycotoxins

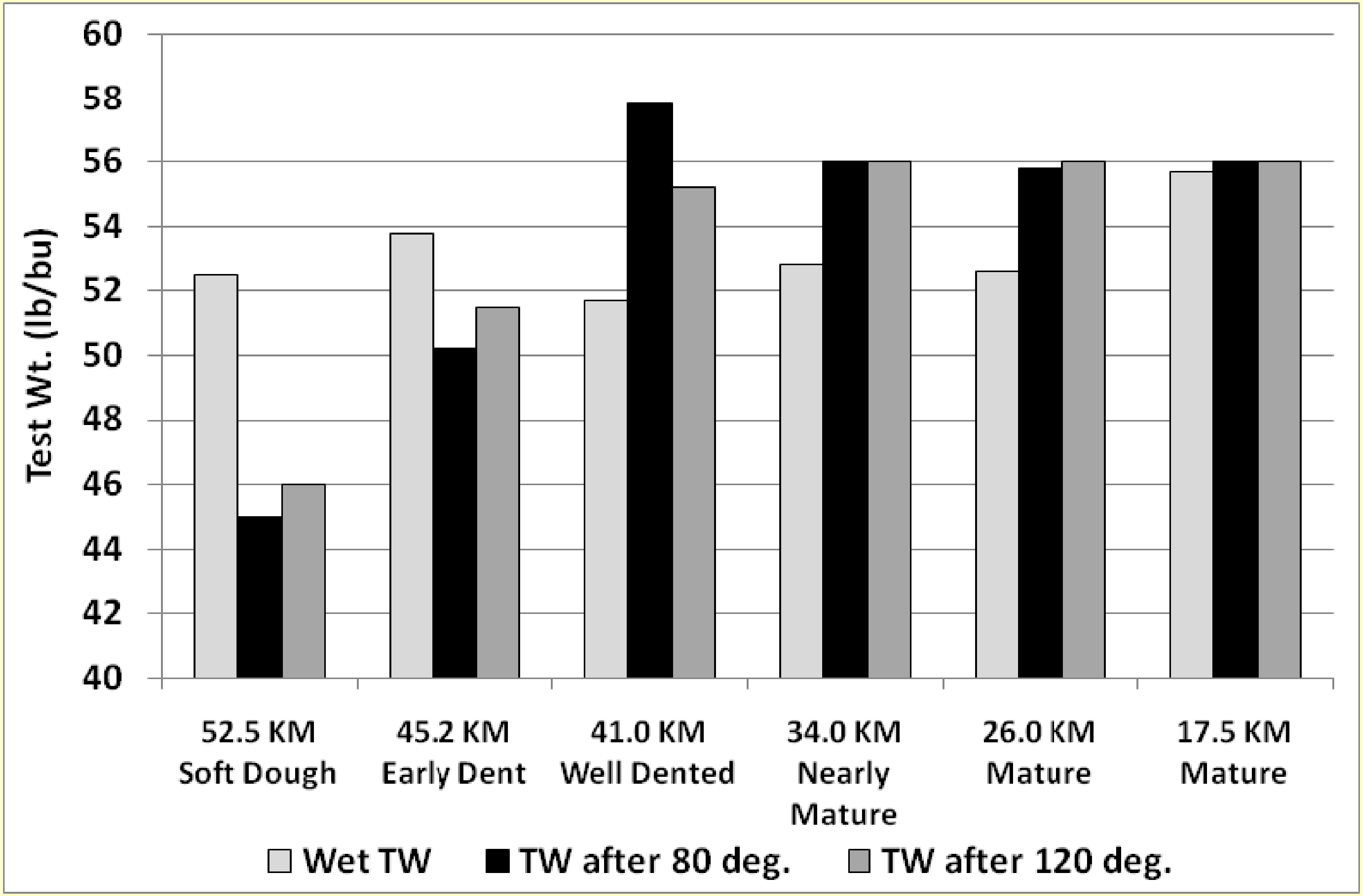


Figure 1. Wet and dry test weights for grain harvested at soft dough through mature kernel stages and dried to 15.5% moisture at 80 or 120 degrees (Hicks, 2004)

Source: Rankin, 2009

DSC Feeding Considerations

- <50 lb./bu. test weight, discount normal DSC energy value by 5%
- Feed by weight not volume
- Test for nutrient composition including starch content, have labs estimate the energy value using summative energy equations, & adjust ration
- Test for mycotoxins
  - Dilute, use binders, target groups, discard as necessary

Potential Feeding Issues

- **HMSC**
  - Reduced starch content
  - Fast rate & high extent of ruminal starch digestion
  - Yeast/ethanol fermentation
  - Poor aerobic stability during feed-out
  - Mold/Mycotoxins

Potential Feeding Issues

- **SNG**
  - Reduced starch content
  - Increased NDF content
  - Increased variability in starch, NDF & energy contents
  - Fast rate & high extent of ruminal starch digestion
  - Yeast/ethanol fermentation
  - Poor aerobic stability during feed-out
  - Mold/Mycotoxins

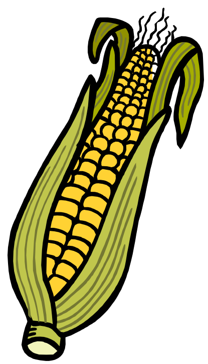
HMSC & SNG Diagnostics

- **Testing**
  - Nutrient composition including starch & NDF contents
  - Labs estimate energy value using summative energy equations
  - Particle size
  - Fermentation profile
  - Mycotoxins

HMSC & SNG Feeding Considerations

- **Adjust ration based on nutrient composition, energy value & particle size**
  - May require partial substitution with DSC, but feed-out rate must be adequate
  - May require using more dietary buffer
  - May require using byproduct fiber sources
- **Determine & monitor corn DM content to adjust as-fed corn feeding rate, so that desired amount of DM fed**
- **If bunk stability poor, may require back-end use of TMR preservative products**
- **Depending on results of mycotoxin tests, dilute, use binder, target groups, discard as necessary**

UW Feed Grain Evaluation System



SOIL and FORAGE ANALYSIS LABORATORY

2611 East 29th Street, Marshfield, WI 54449

Phone 715-387-2523 ext 4 Fax 715-387-1723

Acct # 1

Date 3/1/2009

UW-Feed Grain Evaluation System

Comments: Example High Moisture Grain

Grain Type
- Dry or HM Corn: x
- Small Grain:
- Sorghum Milo:
- Steam Flaked Grain:

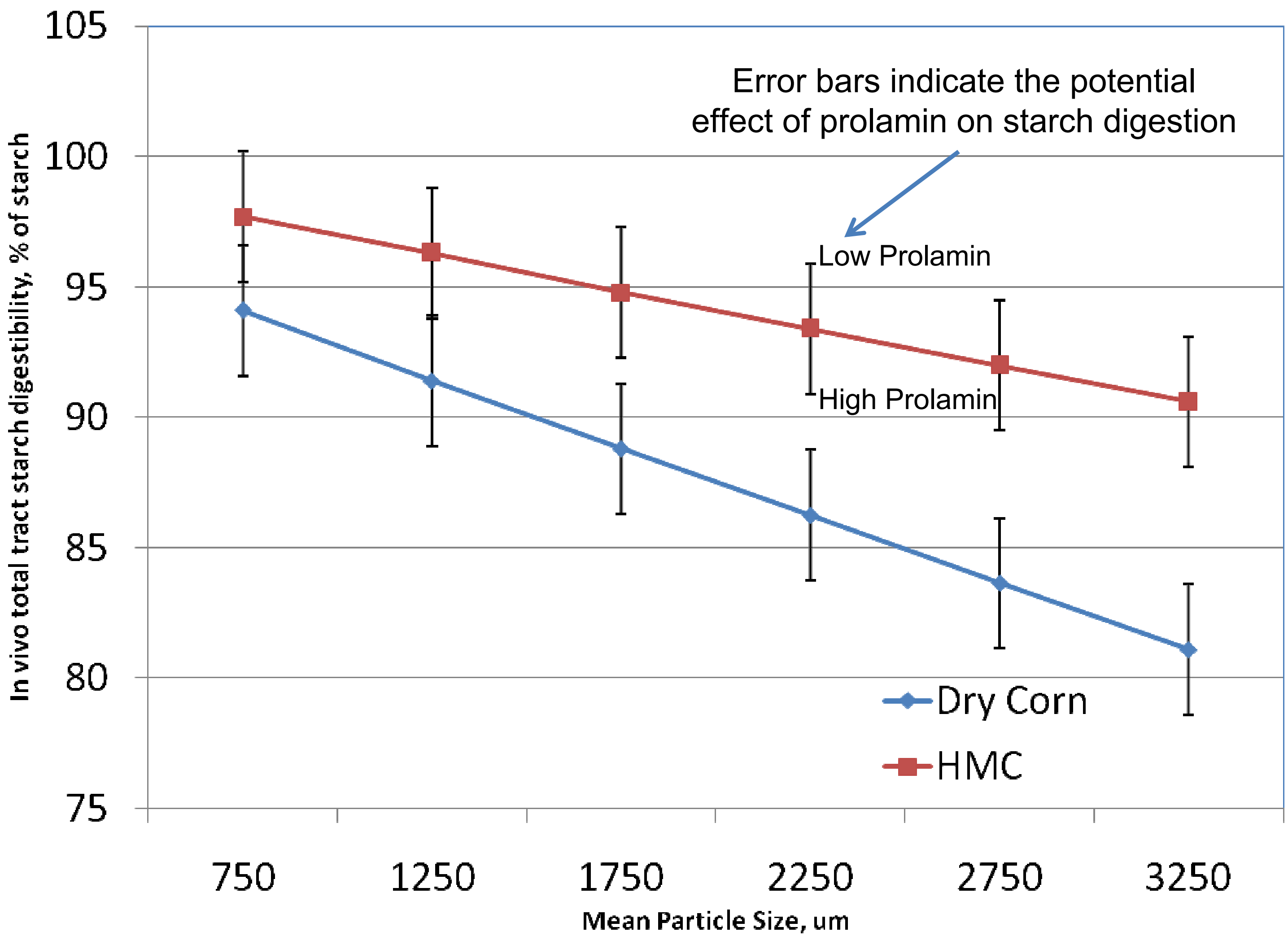
Lab Number: 1

Sample Description:

Item	Abbrev	Unit	Result	Method [1]
Dry Matter	DM	% as fed	70.0	WC
Moisture		% as fed	30.0	C
Protein Fractions				
Crude Protein	CP	% of DM	9.1	WC
Prolamin Protein		% of DM	2.3	WC
Prolamin Protein		% of Starch	3.3	WC
Fiber Fractions				
Neutral Detergent Fiber	aNDF	% of DM	8.4	WC
Starch				
Starch		% of DM	68.9	WC
Mean Particle Size	MPS	microns	2000	WC
Processing Classification			Med-Coarse Grind	
Relative Grain Quality	RGQ		174	C
Carbohydrates and Fats				
Non Fiber Carbohydrate	NFC	% of DM	76.3	C
Nonstarch NFC		% of DM	7.4	C
Fat		% of DM	4.2	WC
Energy Calculations:				
Total Digestible Nutrients, 1X	TDN	% of DM	89.9	C
Net Energy Lactation, 3X	NE_L	Mcals/lb	0.91	C
Net Energy Maintenance	NE_M	Mcals/lb	0.98	C
Net Energy Gain	NE_G	Mcals/lb	0.67	C
Metabolizable Energy, 3X	ME	Mcals/lb	1.42	C

Macro Minerals, % of DM				Micro Minerals, % of DM			
Phosphorus	P		wc	Iron	Fe		wc
Calcium	Ca		wc	Manganese	Mn		wc
Potassium	K		wc	Zinc	Zn		wc
Magnesium	Mg		wc	Copper	Cu		wc
Sodium	Na		wc				
Chloride	Cl		wc	Ash		2.0	wc
Sulfur	S		wc				

[1] WC = wet chemistry; NIR = near infrared spectroscopy; NR = not requested; NA = not available; C = calculated



Error bars indicate the potential effect of prolamin on starch digestion
Low Prolamin
High Prolamin
Dry Corn
HMC
In vivo total tract starch digestibility, % of starch
105
100
95
90
85
80
75
750
1250
1750
2250
2750
3250
Mean Particle Size, um

Corn Ear Molds and Mycotoxins in the Field

Paul Esker
Field Crops Extension Plant Pathologist
UW-Madison

Phone: 608-890-1999
Email: esker@wisc.edu
http://www.uwex.edu/ces/croppathology
http://www.plantpath.wisc.edu/soyhealth
http://thesoyreport.blogspot.com

Fusarium Ear Rot

- *Fusarium moniliforme, F. proliferatum, F. subglutinans*
- Symptoms variable – depends on genotype, environment, disease severity
- Most common: individual or groups of infected kernels – scattered randomly on ear
- Whitish pink to lavender growth on kernels
- Growth frequently found at tip of ear where damage may have occurred
- Asymptomatic kernels

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Cladosporium Ear Rot

- *Cladosporium herbarum, C. cladosporoides*
- Dark, greenish black, blotched, or streaked kernels
- Growth looks similar to Trichoderma (requires microscopic examination to distinguish)
- Scattered across ear
- When ear completely colonized, ears are dark and lightweight
- Often associated with insect injury and **frost damage**

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Gibberella Ear Rot

- *Gibberella zeae*
- Same organism that causes Fusarium head blight in wheat
- Also called red rot
- Reddish mold that appears at tip and grows down the ear
- If infection early, entire ear may rot and have pinkish mycelium – husks will adhere tightly to ear
- Typically rare to see entire ear colonized

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Diplodia Ear Rot

- *Stenocarpella maydis*
- Widespread reports from states south of WI
- Thick, white mold that usually starts at base of ear – infect kernels appear "glued" to husk
- Ear may be shrunken, lightweight, and turn grayish brown
- Black pycnidia can be seen on kernels, cobs, husks, and rotted stalks

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Trichoderma Ear Rot

- *Trichoderma viride*
- Dark green to dark bluish green fungal growth
- On and between kernels
- Often covers entire ear
- Associated with injury to developing ear

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Penicillium Ear Rot

- *Penicillium oxalicum*
- Infection typically occurs where ears damaged
- Powdery green or blue fungal growth on and between kernels
- Most often at tip
- Infected kernels can become streaked or bleached
- Grain stored at high moisture may result in "blue eye" – blue discoloration of embryo
- In silage, *P. roqueforti* is a common fungus (different)

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Primary Toxigenic Molds and Mycotoxins

* Those with adsorbent data

Fusarium

*Deoxynivalenol
*Zearalenone
*T-2 Toxin
*Fumonisin
*Moniliformin
Nivalenol
*Diacetoxyscirpenol
Butenolide
Neosolaniol
*Fusaric Acid
Fusarochromanone
Wortmannin

Aspergillus

*Aflatoxin
*Ochratoxin
*Sterigmatocystin
Fumitremorgens
Fumigaclavines
Fumitoxins
*Cyclopiazonoic Acid
Gliotoxin

Penicillium

*Ochratoxin
PR Toxin
Patulin
Penicillic Acid
Citrinin
Penetrem
*Cyclopiazonic acid

	Known	Postulated
Mold Species	1,100	1,500,000
Secondary Metabolites	3,200	3,000,000
Mycotoxins	>300	30,000

Stachybotrys: Stachybotryotoxin

Lupinosis

Claviceps & Fescue Alkaloids: *Ergots

Loco Weed: *Swainsonine

Source: Whitlow, NCSU

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http://www.das.psu.edu/researchextension/dairy/nutrition/pdf/mold.pdf

Mold and mycotoxin problems in livestock feeding

Richard S. Adams, Kenneth B. Kephart, Virginia A. Ishler, Lawrence J. Hutchinson[1], and Gregory W. Roth[2]

[1]Department of Veterinary Science
[2]Department of Agronomy

Table 4. Guide for interpretation of mycotoxin tests in livestock feeds

Mycotoxin	Concern[a] Level	Potentially Harmful[b] Cattle	Swine	Horse
Aflatoxin[c]	ppb	ppb	ppb	
Major ingredient				
Air-dried[d]	20	20-300	20-100	
Dry Matter	22	22-333	22-111	
TRDM[e]	20-40	20-132	20-102	
Zearalenone	ppm	ppm	ppm	
Major ingredient				
Air-dried	.50	5.0-9.0	1.0-5.0	
Dry matter	.56	5.6-10.0	1.1-5.6	
TRDM[a]	.56	3.9-7.0	.6-3.9	
DON/Deoxynivalenol	ppm	ppm	ppm	
Major ingredient				
Air-dried	.50	4.5-11.0	.7-1.3	
Dry matter	.56	5.0-12.0	.8-1.4	
TRDM	.56	2.5-6.0	.6-1.0	
DAS, ppm				
TRDM[a]	.25	.7-1.5	.4-1.0	
T-2, ppm				
TRDM	.25	.7-1.5	.7-1.5	
HT-2, ppm				
TRDM	.25	1.5-3.0[f]	1.5-3.0[f]	
Ochratoxin, ppm				
TRDM[d]	.25	5.0-9.0[f]	.7-1.5[f]	
Fumonisin, ppm				
Major ingredient				
Air-dried	1.0-3.0	6.0-10.0	10.0	6.0-10.0
Dry matter	1.1-3.3	6.7-11.1	11.1	6.7-11.1

[a] Level indicating possible favorable conditions for mycotoxins and probable need for further testing of all feeds or the TMR. Pending further tests, negative

Table 2-16. Directory of mycotoxin laboratories

The following laboratories can offer qualitative and quantitative analysis for mycotoxins that include but are not limited to aflatoxins, DAS, fumonisin, ochratoxins, T-2, vomitoxin, and zearalenone. Contact individual laboratories directly for information about prices and services, sample submission, and other details.

Covance Laboratories 3305 Kinsman Boulevard Madison, WI 53707 (608) 241-4471	Midwest Laboratories 13611 B Street Omaha, NE 68144 (402) 334-7770	Veterinary Diagnostic Labs Iowa State University 1600 South 16th Street Ames, IA 50011 (515) 294-1950
Centralia Animal Disease Laboratory Illinois Department of Agriculture 9732 Shattuc Road Centralia, IL 62801-5858 (618) 532-6701	Romer Labs, Inc. Attn: Analytical Services 1301 Stylemaster Drive Union, MO 63084-1156 (636) 583-8600	Veterinary Medical Diagnostic Laboratory 1600 East Rollins Columbia, MO 65211 (573) 882-6811
Dairyland Laboratories 217 East Main Street Arcadia, WI 54612 (608) 323-2123	Veterinary Diagnostic Laboratory North Dakota State University 174 Van ES Hall Fargo, ND 58105 (701) 231-8307	Woodson-Tenent Laboratories 3507 Delaware Avenue P.O. Box 1292 Des Moines, IA 50313 (515) 265-1461

Source: Esker, UW, 2009

Additional Commercial Feed Labs Offering Mycotoxin Testing

Rock River Laboratory, Inc.
710 Commerce Drive
P. O. Box 169
Watertown, WI 53094-0169
920.261.0446
www.rockriverlab.com

Dairy One Forage Lab Services
730 Warren Rd., Ithaca, NY 14850
www.dairyone.com

AgSource Soil and Forage Laboratory
106 North Cecil Street
Bonduel, WI 54107
agsource.crinet.com

Cumberland Valley Analytical Services, Inc.
P. O. Box 669
Maugansville, MD 21767
www.foragelab.com

http://www.ces.ncsu.edu/disaster/drought/Mycotoxin-Review.pdf

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Mold and Mycotoxin Issues in Dairy Cattle: Effects, Prevention and Treatment

L. W. Whitlow and W. M. Hagler, Jr.

Lon_Whitlow@ncsu.edu, Box 7621
North Carolina State University, Raleigh, NC 27695

Summary

- Molds are filamentous (fuzzy or dusty appearing) fungi that occur commonly in feedstuffs, including roughages and concentrates.
- Molds can infect dairy cattle causing a disease referred to as mycosis. A mycosis is most likely when cows may be immune suppressed during stressful periods. A mycosis can occur in various locations such as the lungs, mammary gland, uterus or intestine. An intestinal infection may result in hemorrhagic bowel.
- Molds may also affect cattle by producing poisons called mycotoxins that affect animals when they consume contaminated feeds resulting in a mycotoxicosis.
- Molds are present throughout the environment and therefore, mycotoxins can be formed on crops in the field, during harvest, or during storage, processing, or feeding.
- Mold spores are in the soil and in plant debris lying ready to infect the growing plant in the field.
- Mold growth and the production of mycotoxins are usually associated with extremes in weather conditions

Source: Hoffman, UW, 2009

Mycotoxin Binding Agents

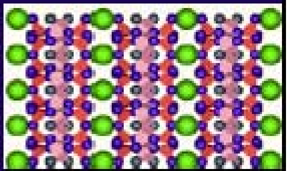
- Activated carbon
- Aluminosilicates
  clay, bentonite, zeolite
- Complex indigestible carbos
  cellulose, yeast cell walls, glucomannans
- Synthetic polymers

- Limited Data
- Positive Field Experience
- Do not Universally Bind All Mycotoxins

	Alumniosilicate Binding Capacity	
	Product A	Product B
Aflatoxin	100	89
DON	3	14

% Mycotoxin absorbed in aqueous solution

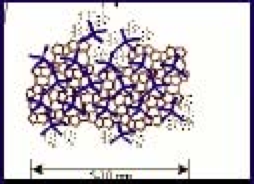
Examples of Mycotoxin Adsorbents



Montmorillonite, Beloit College

Silicate Products

- Phyllosilicates (silicate sheets)
  - Clays - Montmorillonite, bentonite, smectite (HSCAS), sepiolite
- Tectosilicate (silicate frameworks)
  - Zeolites
    - Clinoptilolite



Zeolite, U. Mich.

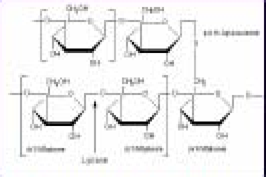
Chemically treated silicates

Carbon Products

- Activated or superactivated charcoal

Activated charcoal, OHSU

Glucan products

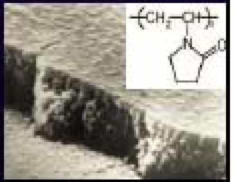


Yeast 1,3 *B* Glucan - Sigma

Inorganic polymers

- Cholestyramine
- Polyvinylpyrrolidone (PVP)

Cholestyramine
IBSMedical.com



PVP -Kansai U.-Japan

Source: Whitlow, NCSU

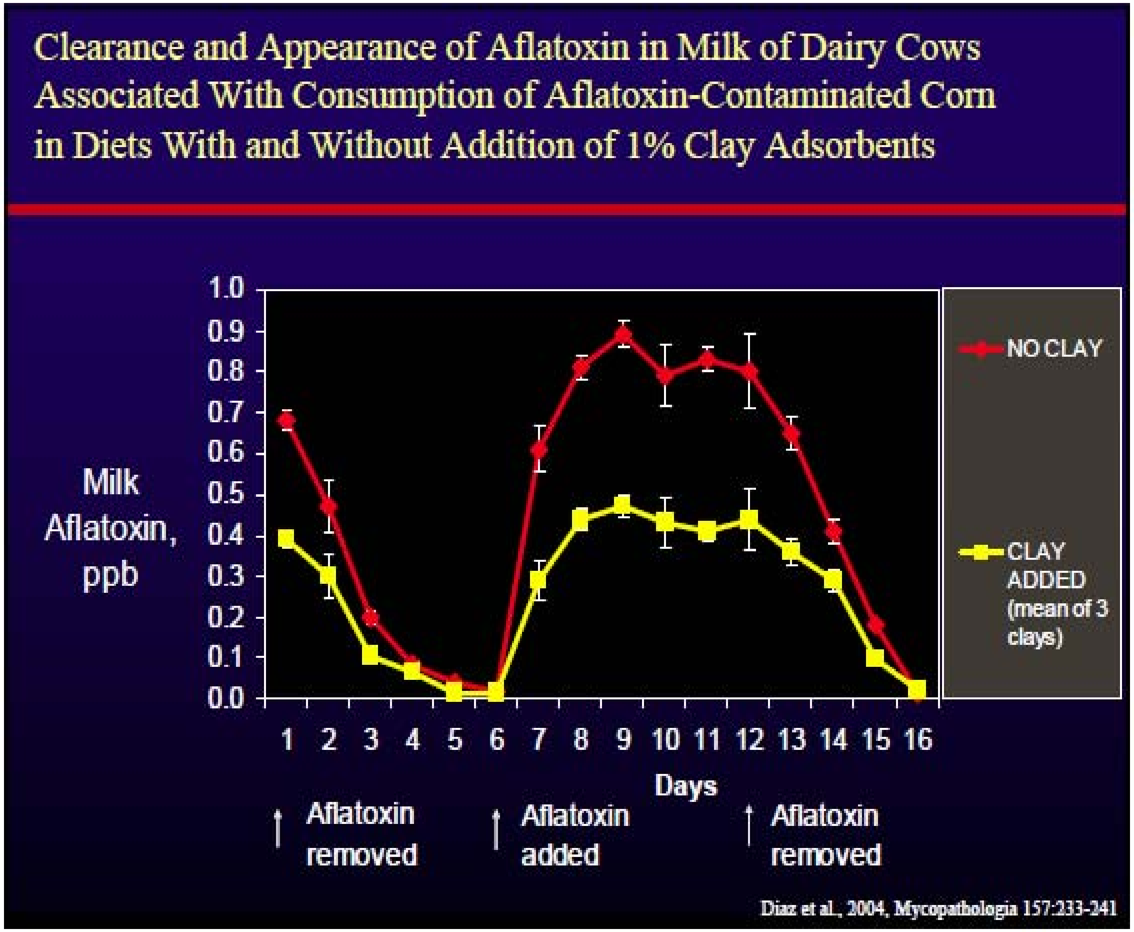
Determination of Mycotoxin Adsorption

Effect of pH on *in vitro* adsorption of mycotoxins by a clay

Toxin	pH 3	pH 7	pH 10.1
	(% Adsorption)		
Aflatoxin B1	99.5	82.2	97.0
Deoxynivalenol	73.5	30.8	20.6
Zearalenone	34.8	42.8	100.0
T-2 toxin	20.2	25.2	74.4
Fumonisin B1	94.4	0	0

Hagler, NCSU

Source: Whitlow, NCSU



Source: Whitlow, NCSU

Effect of “Glucans” on Aflatoxins Across Species

Toxin	Amount ppm	Adsorbent	Animal	Response	Effective	Reference
AF	2	0.05 & 0.1% of prod	Broilers	Improved gain and hematological parameters	Y	Basmacioglu et al., 2005
AF	2	0.05 -.1% of product	Broilers	Protection of organ toxicity	Y	Karaman et al, 2005
AF	1	0.2% of product	Broliers	Improved immunity, Not gain	Y	Santin et al, 2003
AF	5	0.1% yeast	Broliers	Improved BW & organ wt.	Y	Stanley et al., 1993
AF	2	0.1% of product	Chicken	Reduced effects	Y	Girish & Devegowda, 2004
AF	2.5	0.1% Yeast	Quail	Growth increase 40%	Y	Parlat et al., 2001
AF	5	S. cerev.	Quail	Improv. gain, intake, F/G, egg prod. & egg wt.	Y	Yildiz et al., 2004
AF	N/A	glucan product	Cows	No reduction of AF in milk	N	Bluthgen & Schwertfeger, 2000
AF	0.055	0.05% of product	Cows	Reduced milk AF by 60%	Y	Diaz et al., 2004
AF	0.170	0.5% of product	Cows	No reduction of AF in milk	N	Stroud et al., 2006

Positives: 7/9 Overall

Source: Whitlow, NCSU

Effect of "Glucans" on Other Mycotoxins Across Species

Mycotoxin	Amount ppm	Adsorbent	Animal	Response	Effective	Reference
Fumonisin	200	Glucomannan	Mink	No effect	N	Bursian et al., 2004
Moniliformin	20	Glucomannan	Mink	No effect	N	Bursian et al., 2004
T-2 toxin	1	0.1% of product	Chicken	Reduced effects	Y	Girish & Devegowda, 2004
ZEN	30	Glucomannan	Mink	No effect	N	Bursian et al., 2004
Ergot alkaloid	3	0.5% Yeast	Broilers	Improved BW, intake, prevented liver enlargement	Y	Deo, et al., 1999
Ergot alkaloid	3	0.5% of product	Broilers	Improved BW, intake, prevented liver enlargement	Y	Deo, et al., 1999
Aurofusarin	26.4	0.1% of product	Quail	Good protection	Y	Dvorska et al., 2003
Ochratoxin	2.5 - 10	Glucomannan	Mink	No effect	N	Bursian et al., 2004
Ochratoxin	0.5	0.1% of product	Chicken	No protection	N	Santin et al., 2002
Ochratoxin	N/A	yeast	Pigs	No effect	N	Bauer, 1994

Positives: 0/1 FB, 0/1 MON, 1/1 T-2, 0/1 ZEN, 2/2 EG, 1/1 AU, 0/3 OA, 4/10 Overall

Source: Whitlow, NCSU

Summary (Positive Responses/Trial Observations)

Mycotoxin	Carbon	Glucan	Clay	Zeolite	Chol	PVP	Bacteria	Clay/Enzy
AF	6/8	7/9	35/35	11/16		1/2		
STG			1/1					
CPA			0/2	0/1				
DON			0/1					
ZEN	1/1	0/1	1/2	2/3				
T-2	3/3	1/1	0/5	0/1				
DAS			0/1					1/1
FB	0/1	0/1	0/1		1/1			
MON		0/1						
AU		1/1						
"*Fusarium*"		5/9	1/2	0/1				0/2
AF + "*Fusar.*"		2/2	1/1				1/1	
OA	1/2	0/3	0/5	0/1	0/1			
OA + AF			0/1					
Ergot		2/2	2/2	2/2				
SW			0/1					

Response > 1/2 in Yellow

Source: Whitlow, NCSU

Summary - Evaluation of Mycotoxin Adsorbents *In Vivo*

Responses to adsorbents correlate across species

Some adsorbents are mycotoxin specific

No adsorbent has been effective across all mycotoxins

Adsorption varies within adsorbent types

Data are most abundant for silicates…and with aflatoxin

Little data for inorganic polymers: PVP and cholysteramine

Research on bacterial adsorption is beginning & promising

Other methods are receiving attention, i.e., enzymes,
… but are not yet proven

Source: Whitlow, NCSU

Dealing with High Yeast Levels in High Moisture Corn and Corn Silage

Matt Glewen, Limin Kung, R.D. Shaver, and P.C. Hoffman

Potential Situation

- Cool growing season and resulting late harvest create conditions that are highly unfavorable for bacteria species responsible for the fermentation and preservation of high-moisture corn and corn silage

- Resulting fermentation may be slow thereby providing an excellent environment for various yeast species which include the nonfermenting species Cryptococcus, Thadotorala, and Sporabolomyces as well as Candida and Hansenula which can metabolize lactic acid

Mechanism

- High endemic yeast populations are ensiled

- During slow fermentations, moderate growth of yeast occurs until oxygen is expired in the silage
- At feedout, yeasts are re-exposed to oxygen
- Yeast growth becomes exponential

- Lactic acid is consumed
- Heating occurs
- Silage acids are volatized
- Silage pH rises
- Molds with low oxygen requirements (Mucor) invade the silage
- Aerobic instability

Yeast Count Interpretations

- Aerobic stability deceases as yeast counts increase

- Well-preserved feed will normally have yeast counts less than 10,000 cfu/g. At this level, feed will be aerobically stable for 120-140 hours

- At 1 million cfu/g, aerobic stability will decrease to 40 hours

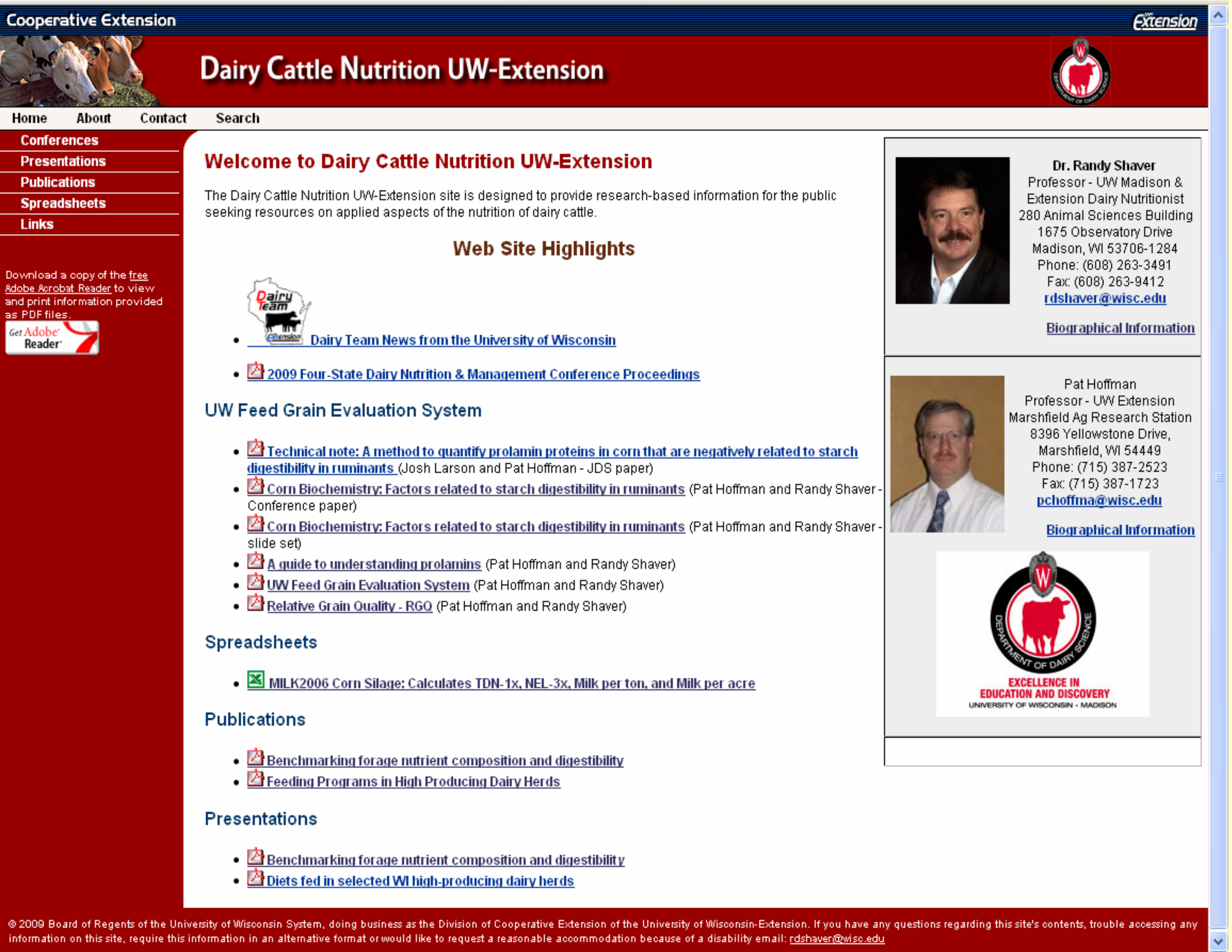
- Yeast counts of 25 - 50 million can occur in inadequately fermented feed. Due to the fact that oxygen can penetrate the silage face up to 2 feet during feedout, removal rates are seldom great enough to stay ahead of exponential yeast growth

Possible Solutions at Feedout

- Discontinue feeding aerobically unstable feed during warm weather and concentrate feedout in colder weather
- The feedout face should be a smooth surface that is perpendicular to the floor and sides in the bunker or pile
- Remove 6 to 12 inches per day or more in cold months; 12 to 18 inches per day or more in warm months
- Minimize the time between silage or high moisture removal and feeding
- Discard any visibly moldy feed
- If free of mycotoxins, consider feeding the feed to as many livestock groups as possible at higher inclusion rates in the diet to increase silo feedout rates
- Consider using TMR preservative products

Visit UW Extension Dairy Cattle Nutrition Website

http://www.uwex.edu/ces/dairynutrition/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Welcome to Dairy Cattle Nutrition UW-Extension

The Dairy Cattle Nutrition UW-Extension site is designed to provide research-based information for the public seeking resources on applied aspects of the nutrition of dairy cattle.

Web Site Highlights

- Dairy Team News from the University of Wisconsin
- 2009 Four-State Dairy Nutrition & Management Conference Proceedings

UW Feed Grain Evaluation System

- Technical note: A method to quantify prolamin proteins in corn that are negatively related to starch digestibility in ruminants (Josh Larson and Pat Hoffman - JDS paper)
- Corn Biochemistry: Factors related to starch digestibility in ruminants (Pat Hoffman and Randy Shaver - Conference paper)
- Corn Biochemistry: Factors related to starch digestibility in ruminants (Pat Hoffman and Randy Shaver - slide set)
- A guide to understanding prolamins (Pat Hoffman and Randy Shaver)
- UW Feed Grain Evaluation System (Pat Hoffman and Randy Shaver)
- Relative Grain Quality - RGQ (Pat Hoffman and Randy Shaver)

Spreadsheets

- MILK2006 Corn Silage: Calculates TDN-1x, NEL-3x, Milk per ton, and Milk per acre

Publications

- Benchmarking forage nutrient composition and digestibility
- Feeding Programs in High Producing Dairy Herds

Presentations

- Benchmarking forage nutrient composition and digestibility
- Diets fed in selected WI high-producing dairy herds

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