Sorting Through The Value of Feed Additives

2019 Large Herd Conference—Reno.NV

Today's Program

- Feed additives status and selection
- Role of B-vitamins
- A look at bacterial DFM

Feed Additive Concepts

- Margins are tightly, pull out feed additives
- Less than 10 cents a cow per day
- Covers up poor management
- Additives as profit enhancing opportunities

2018 U.S. Feed Additive Use

2018 Hoard's Market Survey

Buffers	38
Yeast/yeast culture	29
Rumensin	24
Mycotoxin binders	24
Probiotics	11
Niacin	10
Omnigen	8
Don't use	7
Feed bunk stabilizer	2

2018 U.S. Silage Inoculant Use

2018 Hoard's Market Survey

Inoculant Usage	**36%**
Average Expenditure	**$6,087**
Corn silage	90%
Haylage	76%
High moisture corn	30%
Baled hay	13%

Roles of Feed Additives

Energy Balance
- Propylene Glycol
- Encapsulated Choline
- Niacin
- Calcium Prop
- Rumensin
- Bypass Fat
- Probiotics

Calcium Balance
- SoyChlor
- Biochlor
- Animate
- CaCl
- $MgSO_4$
- $CaSO_4$
- NH_4Cl

Immune Function
- Organic Selenium
- Vitamin E
- Organic TM
- BioMos
- Omnigen-AF
- Probiotics

Rumen Enhancers
- Yeast Fortifier
- DFM's
- Rumensin
- Buffers
- K-Carb
- Sugars
- Enzymes
- Amaferm
- Probiotics

Reproduction
- Bypass Fat – Repro Formulas
- B-carotene
- Organic Selenium

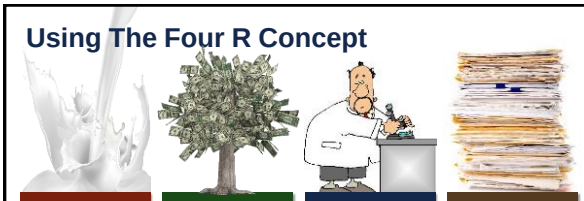
Foot Health
- Biotin
- Organic TM

Protein Efficiency
- Ultramet
- MicroAid

Mycotoxin Binders
- MTB-100
- Omnigen-AF
- Bentonite
- GeoBond

Courtesy of Vita Plus

Using The Four R Concept



Response
How does it work & will it work on your farm

Return
The benefit to cost ratio (>2:1)

Research
Impact and results

Records
On your farm

Benefit to Cost Ratios

Buffers	8 : 1
Biotin	7 : 1
Yeast products	5 : 1
Ionophores	5 : 1
Silage inoculant	3 : 1
Rumen protect choline	3 : 1

When Evaluating Research Ask for:

H_0 = null hypothesis

		Reality	
		H_0 = True	H_0 = False
Conclusion	H_0 = True	OK	Type 2 Error
	H_0 = False	Type 1 Error	OK

Type I and Type 2 Analysis

Meta-analysis

Type I and II Errors (Yeast Culture)

CORRECT	INCORRECT Type I Error ($0.01/cow/day)
INCORRECT Type II Error ($0.35/cow/day)	CORRECT

Monensin Meta Analysis Milk Performance

Duffield et al. 2008. JDS. 91:1347

36 Papers
71 Trials
9,677 Cows

Dry matter intake: - 0.67 lb
Milk yield: + 1.57 lb
Milk fat test: - 0.13%
Milk protein test: - 0.03%
Feed efficiency: + 2.5%
BCS: +0.03/+0.13 lb

Fatty acid milk composition
Short chain FA's: -1 to 12%
Linoleic: + 22%

Your Decision: Which Feed Additive(s)

Additives Recommended for Lactating Cows

- Rumen buffers
- Yeast culture/yeast products
- Monensin (Rumensin)
- Silage inoculants
- Biotin
- Organic trace minerals

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Hutjens Priority

1. Rumensin
2. Silage inoculants
3. Organic trace minerals (Zn, Se, Cr, & Cu)
4. Yeast and yeast culture
5. Sodium bicarb/S-carb
6. Biotin

Rumen impact

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Additives Recommended for Close Up Dry Cows

- Yeast culture/yeast products
- Monensin (Rumensin)
- Silage inoculants
- Organic trace minerals + chromium
- Anionic product
  (if DCAD is > +20 meq/kg or 2 meq/100 gm)

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Additives Recommended for Fresh Cows

- Rumen buffers
- Yeast culture/yeast products
- Monensin (Rumensin)
- Calcium supplement (bolus/drench)
- Silage inoculants
- Biotin
- Organic trace minerals + chromium
- Rumen protected choline

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Hutjens "As Needs" List

- Propylene glycol (300 to 500 ml)
- Calcium propionate (150 grams)
- Niacin (3 g protected; 3 g unprotected)
- Mycotoxin binders (clay mineral or yeast cell MOS compounds)
- Protected choline (15 g per day)
- Anionic products / salts (amount varies)
- Acid-based preservatives (baled hay & high moisture corn 0.5 to 1%)

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Hutjens' "Watch" List

- Essential oil compounds (0.5 to 1.5 g)
- Direct fed microbial products (probiotics)
- Feed enzymes (fiber and amylase)

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Role of B Vitamins

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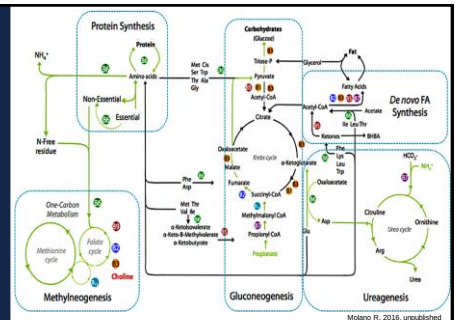
B Vitamins

- Essential nutrients for the dairy cow
- Involved in various metabolisms as enzymes cofactors (activators)



Molano R. 2016, unpublished

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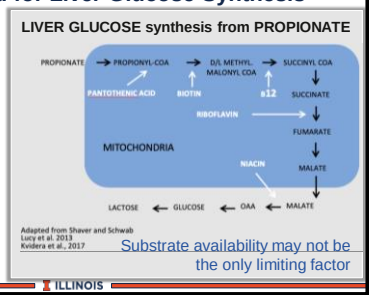
B Vitamins: Needed for Liver Glucose Synthesis

Glucose is needed for:

- Milk: 72g glucose /kg milk * 40 kg milk/day = 3 kg of glucose needed daily
- Oocyte: needed for quality
- Immune cells: main source of energy when activated, may need 2 kg/day



Substrate availability may not be the only limiting factor

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B Vitamins Needed During Different Periods

Vitamin	Estimated Requirement[1]	
	Lactation Period	Transition Period
Thiamin (mg)	Sufficient	Sufficient
Riboflavin (mg)	Sufficient	Not Sufficient
Pantothenic Acid	Not Sufficient	Sufficient
Pyridoxine (mg)	Not Sufficient	Sufficient
Niacin (mg)	Sufficient	Sufficient
Biotin (mg)	Not Sufficient	Sufficient
B_{12} (mg)	Borderline	Borderline
Choline (g)	Sufficient	Not Sufficient
Folic Acid (mg)	Not Sufficient	Not Sufficient

[1]Based on independant researches plus specific roles of B vitamins and choline

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B Vitamins: Rumen Degradation

Options

- Injection
  - Stressful, impractical and costly
- In the Diet
  - Protected from ruminal degradation
  - Best method

Vitamins	Ruminal Degradation/ Disappearance
Riboflavin	99%
Choline	99%
Niacin	98%
Folic acid	97%
Vitamin B12	80%
Pantothenic acid	78%
Thiamine	68%
Pyridoxine	63%
Biotin	60%

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Biotin

Improve hooves by reducing heel warts, claw lesions, white line separations, sand cracks, and sole ulcers; increase milk yield

Level: 10 to 20 mg/cow/day for 6 mo to 1 year

Cost: 4 to 8 cents/cow/day

Benefit to Cost Ratio: 4:1

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Ohio State Biotin Data (2001)

- 45 cows
- 14 days prepartum to 100 days postpartum
- No effect on DMI, body weight, or BCS

Level	Milk yield
None	37.0 kg (81.4 lb)
10 mg/day	37.9 kg (83.4 lb)
20 mg/day	39.8 kg (87.5 lb)

UW Trial - Treatments (mg/c/d)

	B	BBVIT 1x	BBVIT 2x
Biotin	20	20	40
Thiamin	0	150	300
Riboflavin	0	150	300
Pyridoxine	0	120	240
B12	0	0.5	1.0
Niacin	0	3000	6000
Pantothenic acid	0	475	950
Folic acid	0	100	200

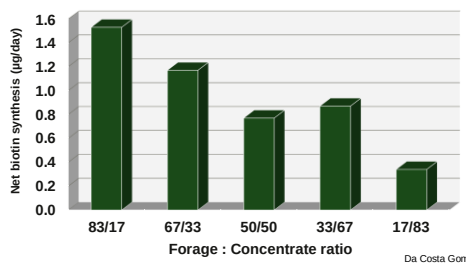
Control (C) was fed none for all of the above

UW Trial – Results

	C	B	BBVIT 1x	BBVIT 2x	SE
BW, lb	1456	1461	1452	1459	9
DMI, lb/d	55.0[b]	56.5[a]	55.0[b]	53.7[b]	0.9
Milk, lb/d	81.8[b]	85.6[a]	84.3[ab]	82.5[b]	1.8

[a,b] *Means in the same row with different superscripts differ (P<0.05)*

Synthesis of Biotin - an *in vitro* study



Da Costa Gomez et al., 1998

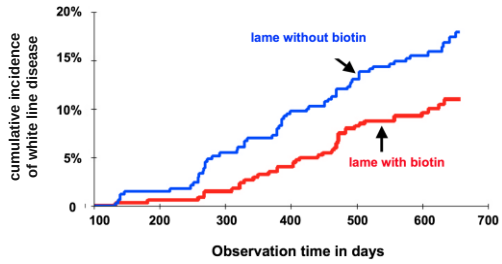
Influence of biotin on foot lesions
Clinical summary

Lesion	Reference	Biotin dose	Response
Sole ulcer	Hagemeister, (1996)	10 mg	Significant reduction in sole ulcers and heel erosion
	Lischer et al, (1996) Koller et al, (1998)	20 mg	New horn formed more rapidly Structure of new horn was improved
Digital dermatitis	Distl & Schmid, (1994)	20mg	20-37% lower incidence of "heel warts" in an 11 month study
Vertical fissures	Campbell et al, (1996)	10mg (Beef cows)	Incidence of sandcracks: Control 29.4% Treatment 14.3%

Influence of biotin on foot lesions
Clinical summary

Lesion / Study	Reference	Biotin dose	Response
White line Disease	Midla et al, (1998)	20 mg	Significant improvement in prevalence of white line lesions at 100 days of lactation
	Hedges et al, (2001)	20 mg	Biotin halved the risk of clinical lameness caused by white line lesions. Biotin supplemented animals required fewer repeat treatments (17.5% v. 30%)
Pasture fed Cattle	Fitzgerald et al, (2000)	20 mg	Supplemented herds had a significant reduction in lesions causing lameness

The influence of 20mg/day biotin supplementation on the incidence of clinical lameness caused by white line disease in dairy cattle (Hedges et al 2001)



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Rumen Protect B-Vitamins

Encapsulation: Not available in the rumen pH, but available in the lower gut at lower pH

Embedded: In lipid which is rumen inert ,but released in the lower gut when lipases break down to fatty acids to be absorbed.

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Niacin - 2015 ADSA Meetings

- Feeding 3.5 grams of rumen protected niacin (RPN)
- California field study with 672 Holstein cows
- 15 days prepartum to 150 days after calving
- Dry matter increased fresh cow pen (42.5 vs. 46.9 lb)
- Ketosis levels were reduced
- No impact on milk yield, milk components, or fertility
- Higher levels of RPN were not effective

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Guidelines for RPN

- 3 grams RPN for transition cows (7 grams lowered feed intake and response)
- 65% rumen protected
- Higher levels for heat stress reduction (15 to 19 grams per day)
- Cost is three cents per gram of RPN

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R.P. Choline Meta Analysis

Grummer, 2012

13 research studies

4.9 lb milk responses (P< 0.0001)

	Control	RPC
DMI (lb/day)	39.9	41.6
Milk (lb/day)	70.9	75.8
ECM (lb/day)	76.9	82.8
Protein (lb/cow)	2.30	2.47
Fat (lb/cow)	2.78	3.04

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Commercial Vitamin B Complex/Blend

Biotin	10 mg/day
Folate	2 mg/day
Pantothenic acid	120 mg/day
Pyridoxine	75 mg/day

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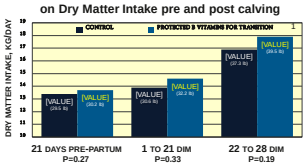
Protected B Vitamins Increased Dry Matter Intake

From 0.3 kg (0.7 lbs) up to 1 kg (2.2 lbs) more daily DMI during the transition period.

A previous study showed a 13.2% increase in daily DMI pre-partum (+1.44 kg or 3.2 lbs).

Improved Intake Means Improved Energy Balance

Effect of Protected B vitamins on Dry Matter Intake pre and post calving



[1] Protected Folic acid, B12, Riboflavin and choline

Individual DMI

Evans E. et al., 2006

Morrison et al., 2018

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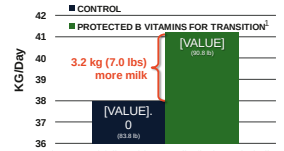
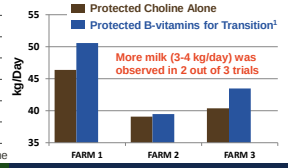
Protected B Vitamins: Increased Milk Production

Milk Production at First 3 Milk Tests



[1]protected folic acid, B12, riboflavin and choline

Milk Production At First Test



LESS LIVER TAG and more Dry Matter Intake MEANS more milk

Healthier Cows Make More Milk

Morrison et al., 2018

JefoTRR_1, 3, 3, 2012-2015
Commercial farms (herds of 1,150 to 1,500 dairy cows)

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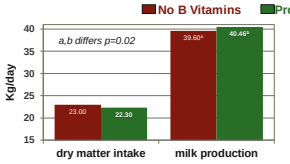
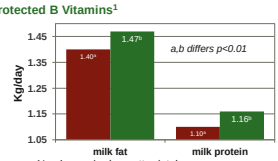
Protected B Vitamins: Improved Feed Efficiency

Effect on DMI & Milk Production



More Milk Per Kg of Dry Matter Intake

Effect on milk fat and protein yield



- No change in dry matter intake
- More milk (+0.9 kg) and components (fat: 0.07 kg, protein: 0.06 kg)
- Body condition score + 0.09 unit
- Feed efficiency increased by 5.2% (1.81 vs 1.72)

[1] Protected Folic acid, Pyridoxine, Pantothenic acid and Biotin

University of California, Davis, Sacadura et al. 2008

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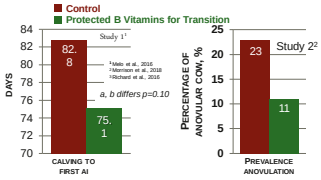
Protected B Vitamins: Effect on Ovulation

Both studies with healthy cows

- Study 1: Cows were bred 7.7 days earlier
- Study 2: 52% less anovular cows at 8 weeks after calving

Other study[3] using nutrigenomics showed: Dominant follicle preparing earlier for ovulation

Effect of Protected B Vitamin on Reproductive Performance



[1] Protected Folic acid, Riboflavin and Choline fed 18 days pre and 21 days postcalving at 100 g/cow/day

[1] Melo et al., 2016
[2] Morrison et al., 2018
[3] Richard et al., 2016

Did not differ statistically given group-level randomization

[2] Protected Folic acid, B12, Riboflavin and Choline fed 21 days pre and 21 days postcalving at 100 g/cow/day

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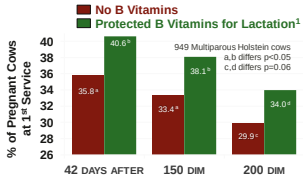
Protected B Vitamins: Improved Reproduction

Effect of protected B vitamins on first service conception rate



- Conception rate at first service increased by 13%
- More cows pregnant until 200 days in milk
- Culling rate reduced by 20%

Improved Reproductive Performance

[1] Protected Folic acid, Pyridoxine, Pantothenic acid and Biotin

University of California, Juchem et al., 2012

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Role of DFM / Probiotics

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Microorganisms in probiotic products (Holzapfel)

Lactobacillus	Bifidobacterium	Other LAB	Non-lactics
L. Acidophilus	*B.adolscentis*	*E. facecalis*	*Bacillus cereus*
L. Casei	*B. animalis*	*E. facium*	*Escherichia coli*
L. Crispatus	*B. bifidum*	*L. lactis*	*Propionibacterium*
L. Gallinarum	*B. breve*	*S. inulinus*	
L. Gasseri	*B. infantis*	*S. thermophilus*	
L. Johnsonii	*B. lactis*	*L. mesenteroides*	
L. Plantarum	*B. longum*	*P. acidilacti freudenreichii*	
Plus 3 more			

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Bacteria With Potential (Kung)

Source	Dose	Effect
M. Elsdenii	8.7×10^6	Lactic acid prevention
L. Acidophillis	1×10^9	Increase DM intake under stress
Propionibacteria	1×10^9	Increase feed efficiency high carbs
P. acidpropionici	1×10^9	Increase propionic acid
P. freudenrechii	na	Weight gain in calves
P. Freudenrichii + L. acidophilus	1×10^9 + 1×10^8	Improve feed efficiency

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Commercial Products

Hoards, 2018

Probios	28%
Rumen Booster	20%
Bio-Vet	15%
Priority One	7%
Lira Gold	7%
Bovamine	11%
Fastrack	4%
Performance	4%
Tri-Lution	6%
Tri-Mic	4%
Dairyman's Edge	2%
Other products	15%

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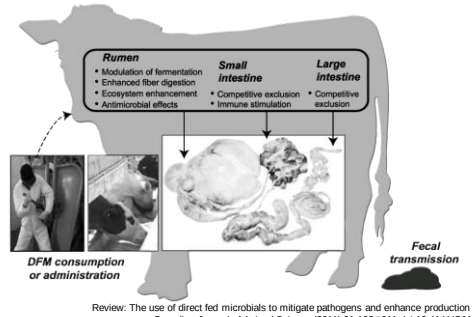
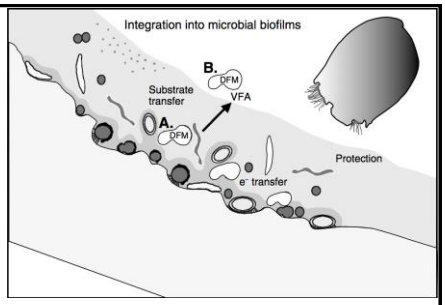


Review: The use of direct fed microbials to mitigate pathogens and enhance production in cattle Canadian Journal of Animal Science (2011) 91:193–211 doi:10.4141/CJAS10047

A. DFM integrate directly into the biofilm through the production of antimicrobials such as bacteriocins and organic acids

B. DFM may either utilize substrates associated with the fluid environment. Concept adapted from McAllister et al. (1994).



Review: The use of direct fed microbials to mitigate pathogens and enhance production in cattle Canadian Journal of Animal Science2011, 91(2): 193-211, 10.4141/cjas10047

A. Competition for nutrients that limit microbial growth

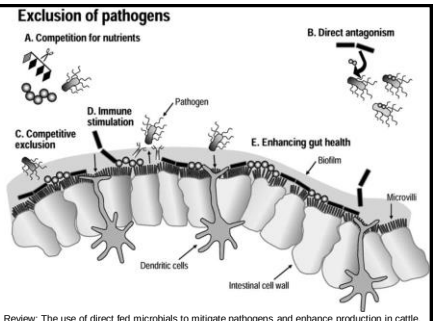
B. Direct antagonism through the production of antimicrobials

C. Competitive exclusion through occupation of specific binding sites

D. Stimulation of the immune response resulting in host-exclusion of the pathogen

E. Enhanced gut health through restoration of epithelial integrity.

Adapted from O'Toole and Cooney (2008).



Review: The use of direct fed microbials to mitigate pathogens and enhance production in cattle. Canadian Journal of Animal Science2011, 91(2): 193-211, 10.4141/cjas10047

Current Theme / Focus

- Stabilize rumen fermentation
  - Reduce diurnal variation
  - Maintain rumen pH above 5.8
  - Avoid production of trans acids
- "Control" lactic acid production
- Stimulate lactic utilizers via production of lactic acid
- Combination of products (bacteria, yeast products, and micronutrients)

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Primary role for supplemental DFM could be following periods of high stress, such as:

- Neonatal calves
- Post weaning
- Following shipping
- During periods of heat stress
- During the early postpartum period
- Following metabolic disorders

DIRECT FED MICROBIAL AND FUNGAL ADDITIVES IN RUMINANTS, S. Senthilkumar*, G. Thirumalaisamy M. Siva and P. Sasikumar

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Guidelines for DFM

- Add DFM to milk/milk replacer calf diets
- Continue to monitor product research
- Evaluate on-farm responses to DFM
- Determine the criteria of a DFM that you may consider
- May reduce the level of antibiotics needed

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Take Home Messages

- Feed additives can be an effective and economic additions to balanced rations
- Ask for research results
- Rumen protect B-vitamins may be needed
- Probiotics applications should be monitored
- Continue to monitor new research results

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