Troubleshooting milk fat challenges on commercial dairy farms

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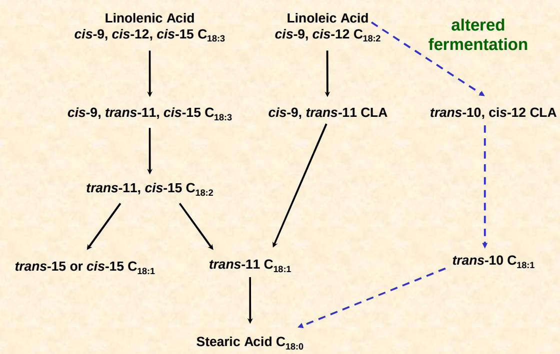
DBM 0021b

Rumen Biohydrogenation



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How do we find and troubleshoot ruminal outflow of 1 to 2 grams of a specific MFD-causing fatty acid????

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Factors that affect substrate supply and availability

- Linoleic acid (C18:2) supply and availability in the rumen
- CPM-Dairy predictions of linoleic acid intake from high corn silage-based lactating diets can approach or exceed 400 to 500 g/d
- Whole cottonseed contributes to high linoleic acid intakes, but has variable effects on milk fat
  - Contributions to peNDF? FA composition? True ruminal availability?
- Ready availability of low-cost byproducts from corn (distillers) or other sources
  - Tremendous variation in fat content within and among production plants
- Any processing method that will increase ruminal availability of unsaturated FA

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Factors that result in an altered ruminal environment

- Dynamics of rumen pH as a balance of
  - Acid production from ruminally fermentable CHO
    - *Dietary CHO profile and Kd of fractions as affected by source, processing, and moisture*
  - Buffer production from salivary and dietary sources
    - *peNDF supply and source*
  - Rate of removal of acids through absorption or passage
  - Feeding management and environmental/facility effects
    - *Mixing, DM changes, feeding frequency, stocking density, heat stress, stall usage, etc.*

J Dairy Sci 80:1447-1462 (1997)
Proceedings from Cornell Nut Conf 49-60 (2005)
J Dairy Sci 88:625-631 (2005)

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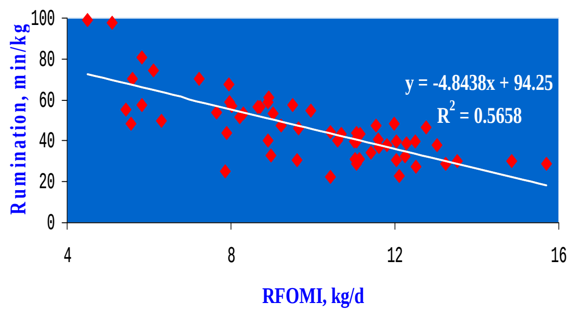
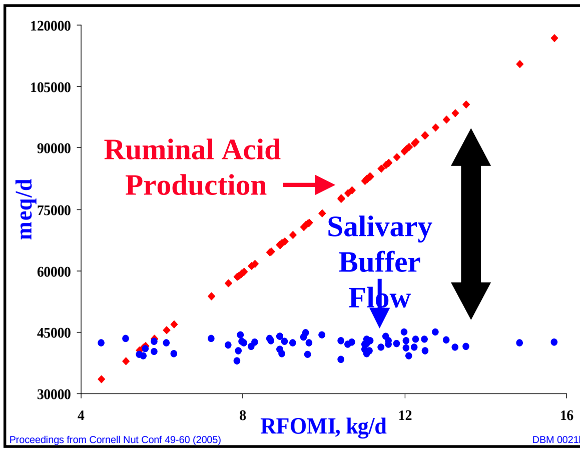
Rumen Environment

- Changes in rumen pH are most likely associated with MFD because they cause a change in the bacterial population favoring those that have alternative BH pathways
- Despite our general understanding of these factors, the degree and duration of low ruminal pH required to cause sufficient flux of PUFA through alternative pathways of BH is not known
- Acidosis is NOT a prerequisite for MFD to occur
  - In most situations rumen health appears excellent and there are no overt signs of ruminal acidosis
  - Harvatine and Allen (2006) reported increased duodenal flow of BH intermediates and MFD with no change in ruminal pH measured every 5 seconds over 4 d

Rumination per kg RFOMI vs. RFOMI



Proceedings from Cornell Nut Conf 49-60 (2005)



Proceedings from Cornell Nut Conf 49-60 (2005)

Overcrowding & Rumination

- **0 vs 30% overcrowding of stalls and manger[1]**
  - **switchback design**
- **% cows ruminating in overcrowded group averaged 28% (high of 32%)**
- **% cows ruminating with no overcrowding was 37% (high of 55%)**

Courtesy: Dr. R. Grant of the Miner Institute

[1]Dairy Housing & Equipment System. NRAES-129 Ithaca, NY 325-330 (2000)

Feeding pattern case study

- ~ 400 cow dairy in western NY
- Herd is split between robot pens and conventional freestall pens
- Cows in robot pens must go through robot in order to access TMR (average 2.8 times/day through robot)
- Major issue – cows in robots consistently running lower components than cows in conventional freestall
- Cows in both barns fed same forages, same grain mix (robot cows also getting grain in robot), with very similar overall formulation
- Corn silage had very high acetic acid content (~ 3 to 4%; more on that later)
- Several ration adjustments had been made in an effort to improve butterfat (including removing Rumensin and adding straw)

Rations for conventional and robot freestall barns (lbs DM)

Ingredient	Conventional	Robot
Corn silage	14.6	14.0
Haylage, 3rd cut	13.7	13.5
Sugar blend	0.96	0.70
Chopped straw	1.15	1.38
Dairy grain	19.6	10.8
Robot pellet	---	8.1
Total	50.0	49.2

Key ration parameters from CPM Dairy

Parameter	Conventional	Robot
Forage NDF, %	25.0	25.1
peNDF, %	23.4	24.0
Lignin, %	3.6	3.7
NFC, %	41.0	38.6
Starch, %	22.9	20.0
Sugar, %	5.3	5.2
Soluble fiber, %	9.0	9.7
Crude fat, %	4.6	4.5
C18:2 intake, g/d	333	327
C18:1T duod flow, g/d	70.4	67.5

By PEN	%COW	#COW	Av MILK	Av LACT	Av DIM	Av PCTF	Av PCTP
1	13	53	87	2.3	182	3.2	2.9
2	14	56	81	2.4	186	3.5	2.9
3	14	55	84	2.1	187	3.2	2.9
4	14	55	70	2.3	171	3.3	2.9
5	45	178	73	2.6	143	3.9	2.8
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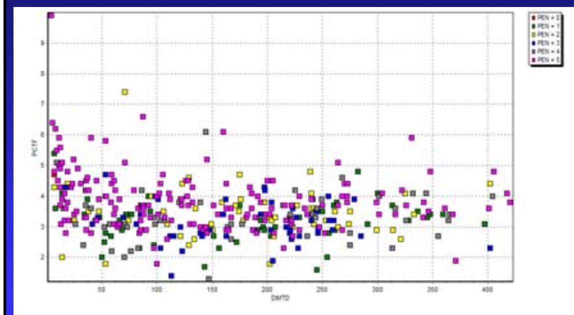
Total	100	397	77	2.4	164	3.5	2.9



Assessment

- Interaction of a number of different factors (ration, high acetic acid corn silage), but primary trigger was variation in feeding behavior / intake patterns because of robotic milking strategy
- First strategy – replace finely ground full-fat roasted soy in both dairy grain and robot pellet with expeller soybean meal
- Second strategy – shift forage proportions to decrease high acetic corn silage
- Third strategy – change robot pellet from a grain mix to alfalfa pellets and make TMR match conventional freestall TMR

Other factors that may contribute to an "altered" ruminal environment conducive to production of MFD-causing FA

- Off-fermented feeds, particularly high acetic corn silage??
- High mold and yeast counts on ensiled forages??
- Mycotoxins??
- All require controlled study – anecdotal evidence only
- Some evidence that Vitamin E (10,000 to 12,000 IU/d) may help to prevent isomerase shift[1]

[1]Pottier et al., J Dairy Sci 89:685-692 (2006)

Factors that influence biohydrogenation rate

- Anything that slows rates of biohydrogenation at different steps may result in more passage of FA intermediates that cause MFD from the rumen
- These do not cause milk fat problems, but will amplify the effecf of an existing ruminal condition on milk fat
  - Monensin
  - Fish fatty acids (last step of biohydrogenation)

TABLE 3. Effect of ionophores on rates of formation of biohydrogenated products from linoleic acid infused continuously into fermenters[1] (n = 2).

Fatty acid	Additive[2] Control	MON	NIG	TET	SE
	(mg/L per h)				
$C_{16:0}$	2.2	2.7	2.3	1.3	0.46
$C_{18:0}$	7.5[a]	1.4[b]	1.5[b]	0.9[b]	0.57
Total $C_{18:1}$	6.0	7.4	7.3	5.3	1.04
trans-$C_{18:1}$	4.2	4.1	4.0	3.7	0.94
cis-$C_{18:1}$	1.7[d]	3.4[c]	3.4[c]	1.6[d]	0.50

[a,b]Means within a row without a common superscript differ ($P < 0.05$).

[c,d]Means within a row without a common superscript differ ($P < 0.10$).

[1]Based on the hourly addition of 13.8 mg of $C_{18:2n\text{-}6}$ to 700 ml of ruminal culture.

[2]MON = Monensin (2 μg/ml of culture), NIG = nigericin (2 μg/ml of culture), and TET = tetronasin (2 μg/ml of culture).

Monensin slows down rates of biohydrogenation

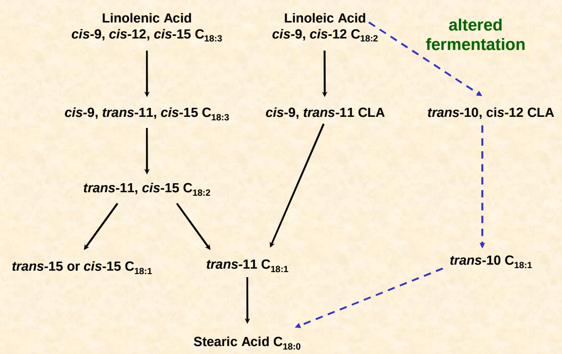
Fellner et al., J Dairy Sci 80:921-928 (1997)

Fat Supplements

- Increasing the dietary supply of oleic acid (e.g.from tallow, or palm FA distillate), will not directly increase the rumen outflow of 18:2 intermediates because these fat supplements supply very little PUFA
  - Under some circumstances we can feed high levels of oleic acid without inducing MFD
- In some circumstances, it would appear that the increase in unsaturated load from increasing oleic acid supply is sufficient to alter BH to favor the production of *trans*-10, *cis*-12 CLA and related intermediates from the PUFA already in the diet

Lock et al.,Proceedings from Cornell Nut Conf 75-85 (2006)

Rumen Biohydrogenation



Factors that influence rate of passage

- DMI (also relationship with buffer production per kg of RFOM already discussed)
- High forage diets (highly digestible forage)
- High consumption of free choice salt or bicarb and relationship with water intake and increased liquid rate of passage?
- Require controlled study

Field study on milk fat depression and Rumensin

- Project leaders: Dr. Daryl Nydam and Dr. Tom Overton
- Objectives:
  - Establish risk factors that contribute to MFD in herds feeding Rumensin
  - Evaluate bulk tank milk fatty acid profile to determine relationships of MFD with specific fatty acid intermediates
  - To evaluate bulk tank milk FA profiles as a diagnostic test for MFD
  - Gain better sense of ration variables related to CPM Dairy fat submodel and MFD
- Goal: Characterize herds in the Northeast and Upper Midwest that are feeding Rumensin and either having or not having milk fat issues

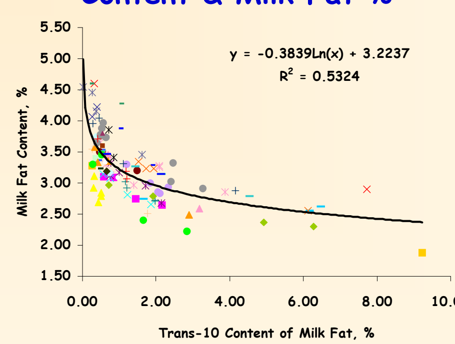
Elanco Study # T1F360503

Ongoing field study on milk fat depression and Rumensin (continued)

- Data collection:
  - Herd management and facility characterization (questionaire)
  - Diet composition (ingredient and nutrient) and group DMI estimates
  - Sample of high group TMR
  - Sample of silage components of high group TMR
  - Bulk tank milk sample for FA profile

Elanco Study # T1F360503

Relationship Between Milk t10 18:1 Content & Milk Fat %



Euro Fed Lipid Congress, Abstact, Madrid, Spain (10/2006)

Summary

- Altered ruminal biohydrogenation of unsaturated fatty acids combined with ruminal dynamics that cause passage of specific intermediate fatty acids to the intestine results in low milk fat test
- Risk factors for reduced milk fat
  - Supply and availability of linoleic acid
  - Altered ruminal environment (pH; perhaps also caused by problems with ensiled feeds)
  - Compounds that affect biohydrogenation rates (Rumensin, fish FA as examples)
  - High rates of passage
- Most often not one factor, but an INTERACTION AMONG MANY FACTORS, responsible for milk fat problems

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