




Changes in Fermentation and Biohydrogenation Intermediates in Continuous Cultures Fed Corn Grain Differing in Rates of Starch Degradability

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Risk Factors for Milk Fat Depression

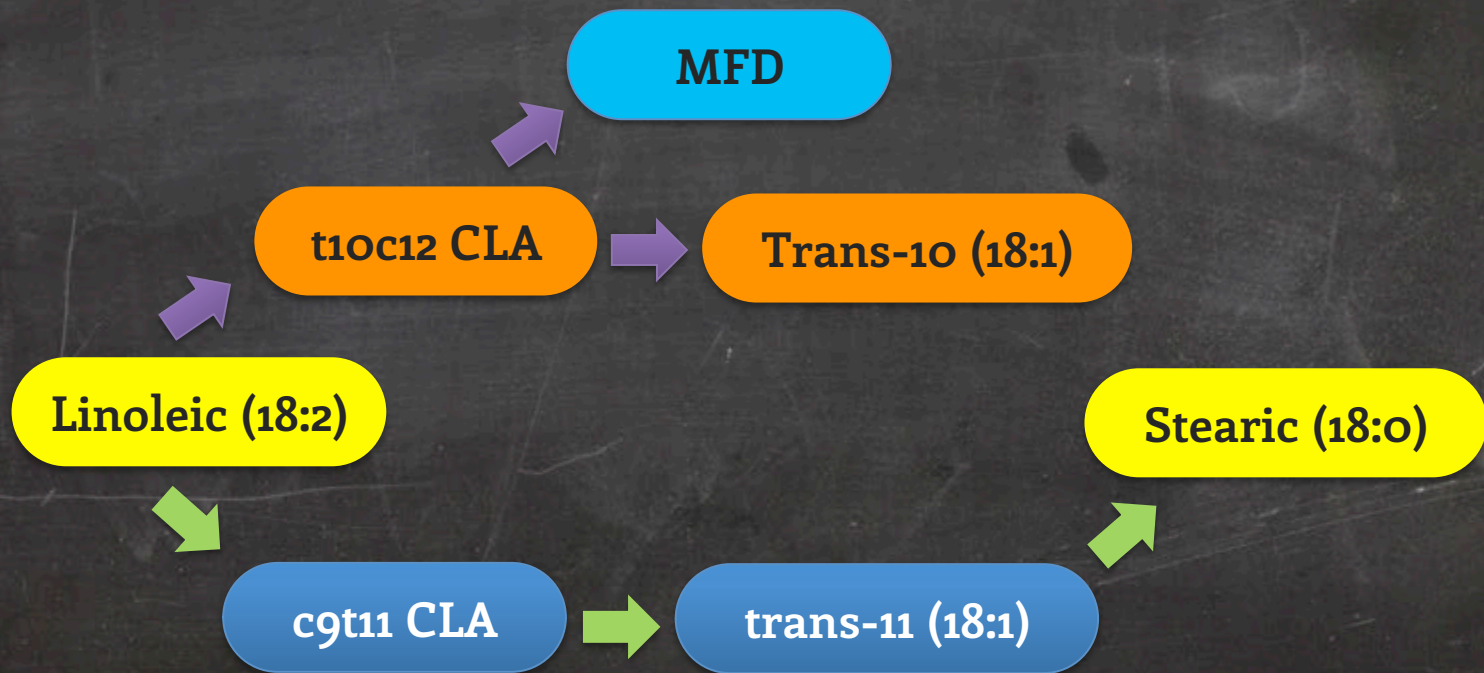
- Too much unsaturated fatty acids
- Rumen pH too low
 - Inadequate effective fiber
 - TMR mixing (sorting)
 - Overcrowding
- Too much starch
- High Rates of Starch Degradability?



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The Shift That Causes Milk Fat Depression

Shift in biohydrogenation intermediates!





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Objective

Determine if increasing rate of starch degradability increased the rumen production of CLA isomers responsible for MFD.

MFD

**↑ t10 18:1
t10c12 CLA**



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Comp. of Unprocessed & Processed Corn Sources

	Corn	
	Unprocessed	Processed
Laboratory 1 ^a		
Starch, % DM	83.1	83.2
7-h degrad., % of starch	49.3	79.4
Laboratory 2 ^b		
Starch, % DM	81.8	81.4
6.25-h degrad., % of starch	47.5	88.5

^a Cumberland Valley Analytical in Feb., 2014.

^b Calibrate[®] technologies courtesy of Dr. David Weakley



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Diet Composition

Ingredients, % DM	Low Fat (LF)	High Fat (HF)
Alfalfa pellets	32.9	31.8
Ground grass hay	16.6	16.1
Soybean meal	8.5	8.2
Soy hulls	8.7	8.4
Soybean oil	0	3.3
CORN	33.4	32.2
Fermenter input, g/d		
DM	52.0	54.7
CP	10.5	10.1
NDF	21.3	21.5
Fatty acids	1.01	2.73



Changes in Fermentation and Biohydrogenation Intermediates in Continuous Cultures Fed Corn Grain Differing in Rates of Starch Degradability Six Diets Varying in Fat and Corn Source

Corn, % DM	LF			HF		
	Low	Med	High	Low	Med	High
Unprocessed	33.4	16.7	0	32.2	16.1	0
Processed	0	16.7	33.4	0	16.1	32.2

Design/Analysis

- 2 x 3 factorial arrangement of treatments
 - 2 fat levels (0 and 3.3% DM)
 - 3 rates of starch degradability (low, medium, high)
- Randomized Block design (SAS ver. 9.2 using the Proc Glimmix procedure)
 - Fixed effects of fat, starch degradability & fat x starch degradability
 - Random effects of period and fermenter
- No fat x starch ($P > 0.15$) – show means for main effects
- Starch Degradability effect – linear and quadratic polynomials ($P < 0.15$)



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Methods: Fermenters

- Six dual-flow continuous fermenters (~ 800 mL)
- Stirred at 45 rpm to maintain stratification
- Fed 0800, 1600, and 2400 h
- 4 reps (10 d periods)
 - 7 d adaptation
 - 3 d collection
- Buffer pH adjusted for LF-LOW





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Fat Effects – Results of Adding Soy Oil

- Reduced Ac/Pr ($P < 0.05$)
- Increased mg/d outflow of 18:2 and 18:3 ($P < 0.05$)
 - Increased biohydrogenation % of 18:2 ($P < 0.05$)
- Increased mg/d outflow of intermediates
 - All t18:1 and CLA isomers ($P < 0.05$)
 - t10 18:1 and t10c12 CLA isomers



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Starch Degradability Effect on VFA & Digestibilities

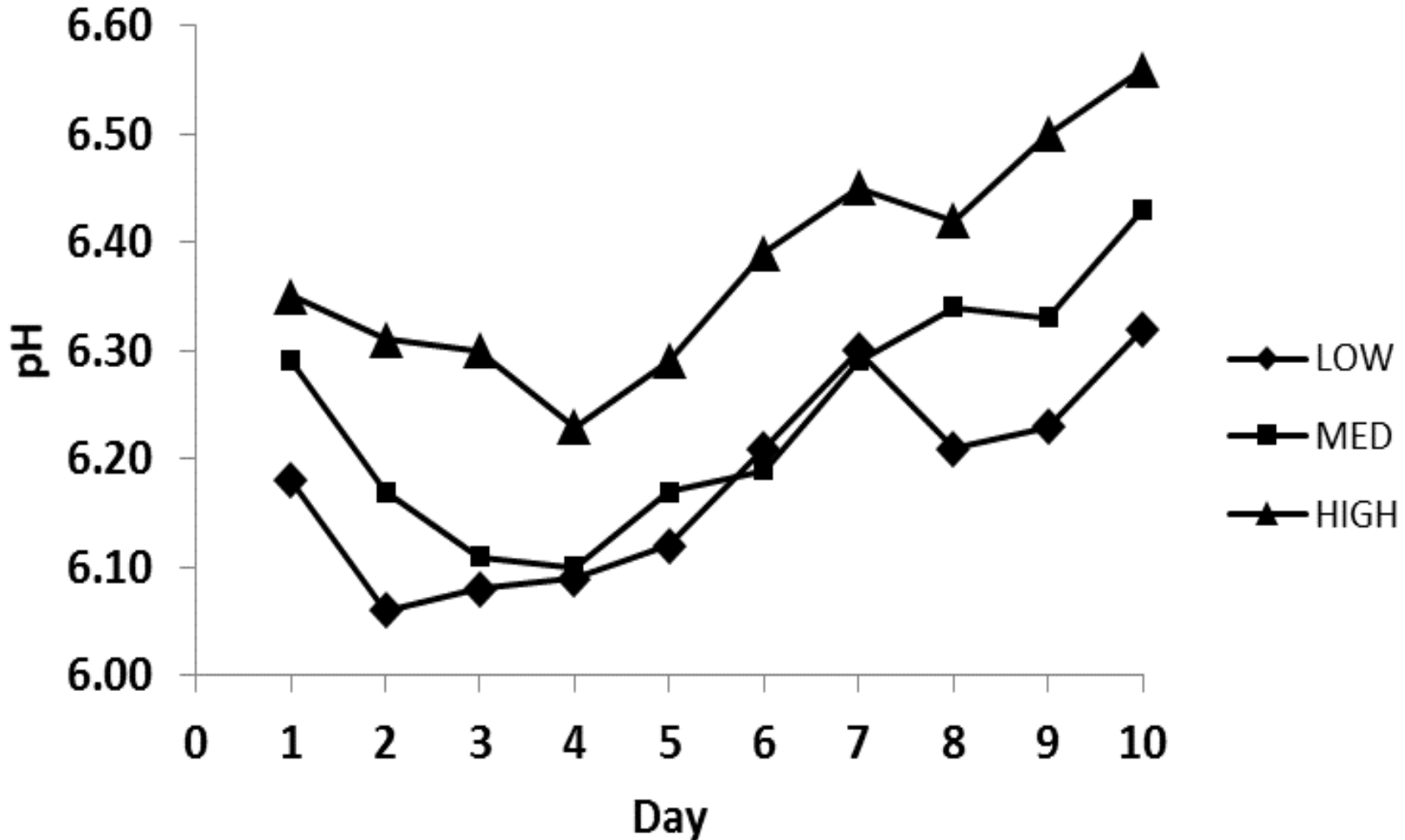
	Starch Effect					
	Low	Med	High	SEM	L ¹	Q
Acetate	48.7	50.6	53.9	1.5	0.10	0.05
Propionate	28.4	28.1	27.8	1.2	NS	NS
Ac/Pr	1.76	1.82	1.96	0.11	NS	NS
pH d 10	6.23	6.32	6.51	0.07	0.07	0.05
Digestibilities, %						
DM	49.6	48.4	47.2	3.4	NS	NS
ADF	39.8	34.0	45.6	5.6	0.04	NS

¹Denotes probabilities of a linear (L) or quadratic (Q) starch effect if P < 0.15



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Starch Degradability Effect on Culture pH by Day of Incubation





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Starch Degradability Effect on Biohydrogenation of 18:2 & 18:3

Flows, g/d	Starch Effect					
	Low	Med	High	SEM	L ¹	Q
18:2	161.5	240.4	239.1	28.6	NS	<0.01
18:3	30.4	42.3	40.4	4.8	NS	0.02
Biohydrogenation, %						
18:2	76.4	62.9	64.7	4.5	NS	<0.01
18:3	91.0	86.9	87.9	1.5	NS	0.02

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Starch Degradability Effect on Daily Outflow of *trans* C18:1 Intermediates

mg/d	Starch Effect					
	Low	Med	High	SEM	L ¹	Q
t ₉	12.7	13.1	12.4	1.5	NS	NS
t ₁₀	112.8	178.6	196.2	74.1	NS	NS
t ₁₁	132.6	73.4	62.2	17.7	NS	<0.01
t ₁₂	21.5	35.5	22.0	9.1	NS	NS

¹Denotes probabilities of a linear (L) or quadratic (Q) starch effect if P < 0.15



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Starch Degradability Effect on Daily Outflow of CLA Intermediates

mg/d	Starch Effect					
	Low	Med	High	SEM	L ¹	Q
c9t11 CLA	6.2	6.1	2.8	1.4	0.04	NS
t10c12 CLA	3.3	5.2	6.6	1.5	NS	0.08
% total FA	0.23	0.24	0.37	0.05	0.07	NS
% of total CLA	36.2	40.4	64.7	8.3	0.01	0.05

¹Denotes probabilities of a linear (L) or quadratic (Q) starch effect if P < 0.15



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Summary

- Increasing starch degradability while maintaining starch level
 - Increased pH and fiber digestibility
 - Reduced biohydrogenation of unsaturated fatty acids
 - Caused shift in intermediates that favored t10c12 CLA
 - Increasing fat level had more effect on CLA shift than starch degradability
- High Kd starch enhances t10c12 CLA in the rumen and is another risk factor for MFD



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