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Effect of feeding potassium carbonate on milk fatty acids in early lactation cows

J. Harrison, R. Kincaid, E. Block, and T. Jenkins

Required Nutrient by Animals

- Intracelluar cation of body tissues
- Nerve Impulse transmission
- Enzyme reactions
- Cardiac, skeletal, and smooth muscles
- Maintenance of normal kidney function

DCAD: Role in Metabolism

- DCAD is highly, and directly, correlated to blood-buffering capacity
  - Any other parameters affected are via this mechanism
- Buffers are necessary for:
  - Healthy, normal rumen function
  - Replenishing blood bicarbonate
    - Na and K buffers
    - DCAD

Interests

- Negative K balance in early lactation animals
  - Increase K requirement
- Source of K
  - Potassium carbonate: DCAD+

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Minerals in Milk

Mineral	Mg/100 ml
Potassium	138*
Calcium	125
Chloride	103
Phosphorus	96
Sodium	58
Sulfur	30
Magnesium	12

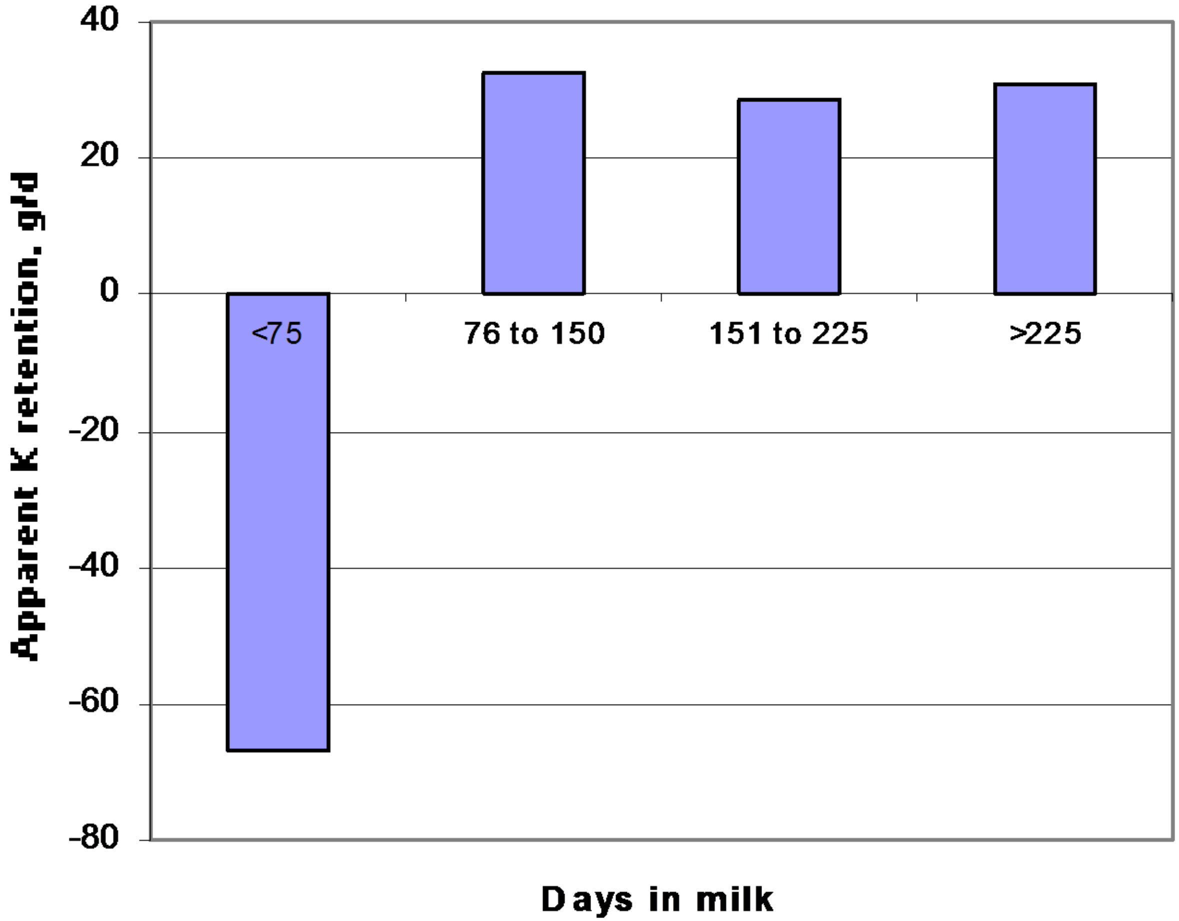
* Lactating Cow can Become Potassium Deficient

Potassium use by the Lactating Cow

A series of total collection digestion studies were conducted on cows in various stages of lactation.

One subset of cows were in early lactation and milk production ranged from 106 to 189 lb/day

Potassium use by the Lactating Cow



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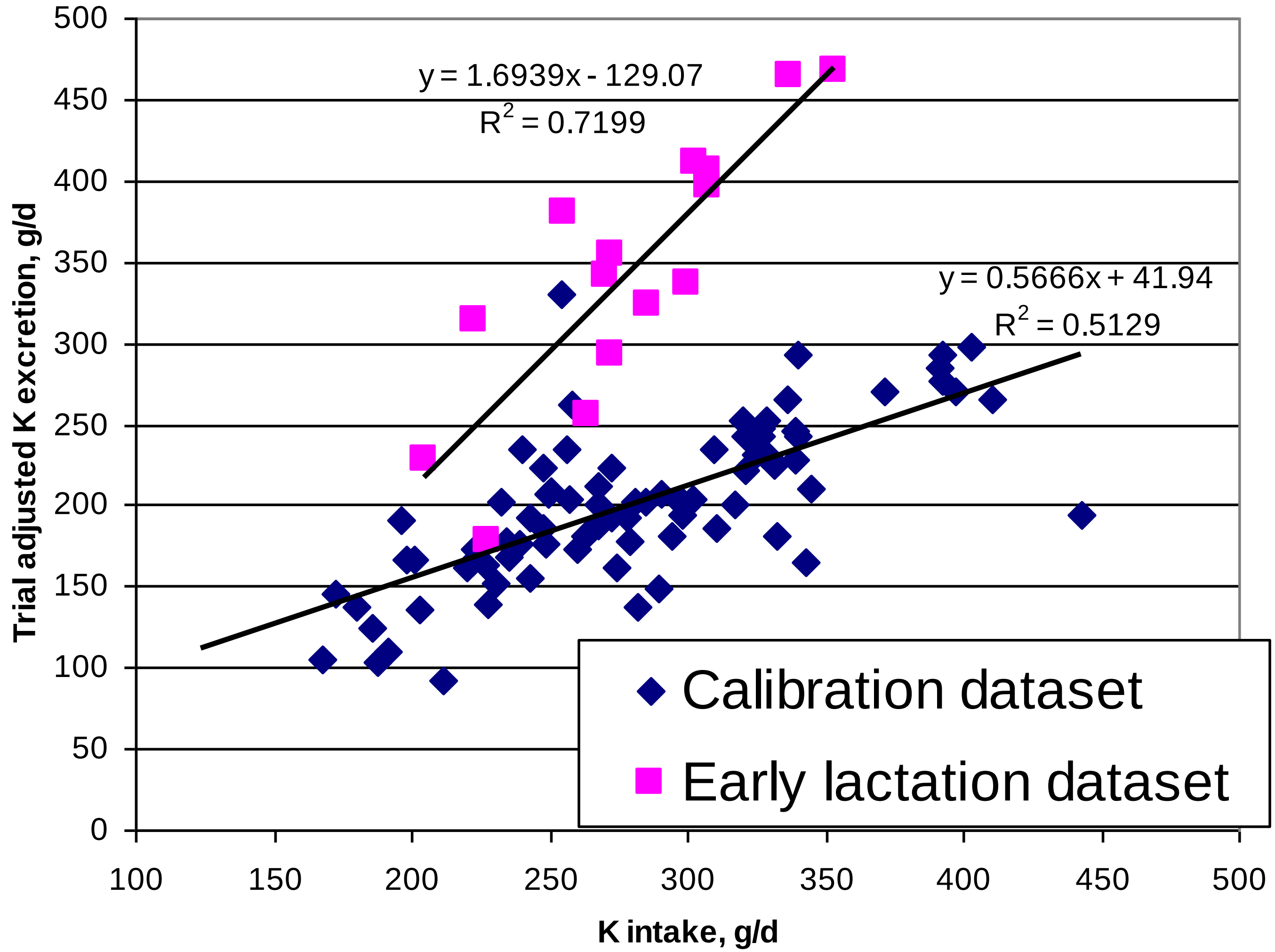
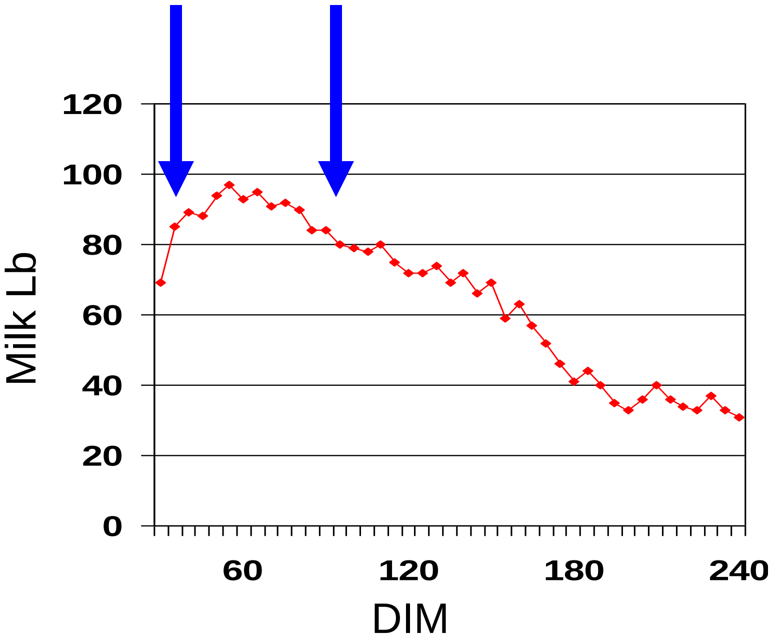
Potassium use by the Lactating Cow



Objectives – 2007 Lactation Study

- To evaluate the potassium requirement of the early lactation dairy cow and determine:
  - Efficiency of milk production
  - Potassium balance

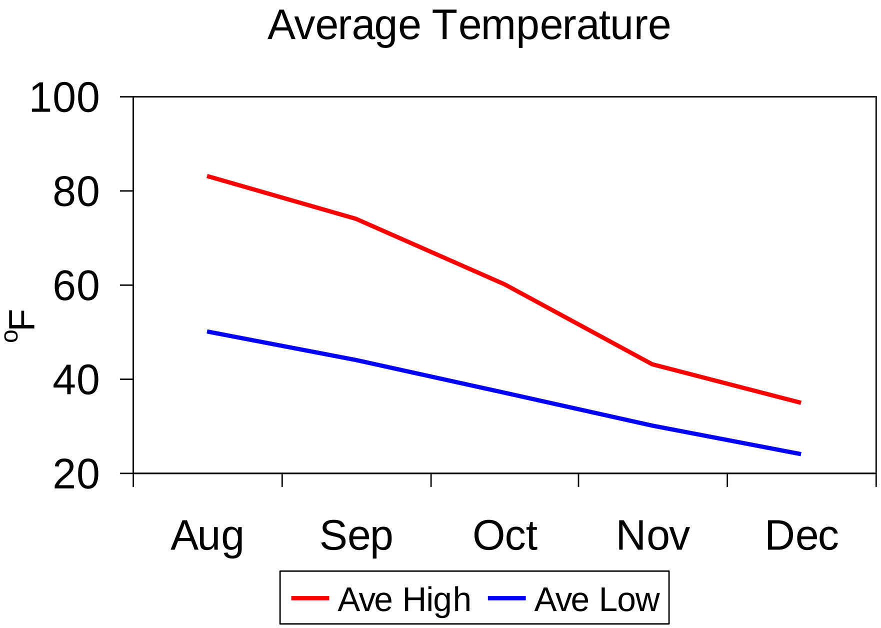
Animals



- Thirty Holstein cows (15 per treatment)
- Blocked by:
  - lactation number
  - expected calving date
  - predicted transmitting abilities (PTA)
- Fed ~15 DIM through ~85 DIM

Housing

- Conducted at Washington State University
- Free Stalls bedded with composted solids
- Trial carried out August through December



Diet ingredients

Component	% of DM
Alfalfa hay	13.4
Corn silage	12.1
Blue grass straw	8.6
DDGS	10.3
Whole cottonseed	6.2
Grain mix	49.4

% of DM	Control	DCAD+
DM	60.1	59.4
CP	16.1	16.1
ADF	19.8	19.3
NDF	35.0	34.7
Ca	0.69	0.66
P	0.37	0.36
Mg	0.43	0.45
K	1.28	2.07
Na	0.65	0.65
Cl	0.52	0.52
S	0.23	0.22
DCAD, mEq/100g	32	53

Fatty acid composition of total mixed rations.

Fatty Acid, % total	Control	DCAD+
c16:0	24.3	27.4
c16:1	0.38	0.42
c18:0	5.6	7.4
c18:1	23.3	25.1
c18:2	41.1	36.4
c20:0	0.70	0.78
c18:3	3.7	1.6
c24:0	0.76	0.89
c18:1 + c18:2 + c18:3	68.2	63.1

Sampling

Daily:
- Feed intake
- Milk weights

Weekly:
- Milk composition
- Diet composition
- BW

Weeks 2, 5, 9, 12 of lactation:
- Serum glucose, K
- Milk and Urine K
- Fecal composition

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Results

	Treatment		*P* <		
Item	Control	DCAD +	trt	wk	trt x wk
BW, kg	671	672	0.84	0.001	031
DMI, kg/d	26.0	26.7	0.35	<0.0001	0.04
Milk, kg/d	39.5	41.6	0.20	0.0001	0.60
ECM, kg/d	41.7	44.8	0.21	0.25	0.10
3.5% FCM, kg/d	42.8	46.7	0.14	0.14	0.12
Fat, kg/d	1.58	1.77	0.10	0.08	0.06
True protein, kg/d	1.16	1.15	0.94	0.001	0.16

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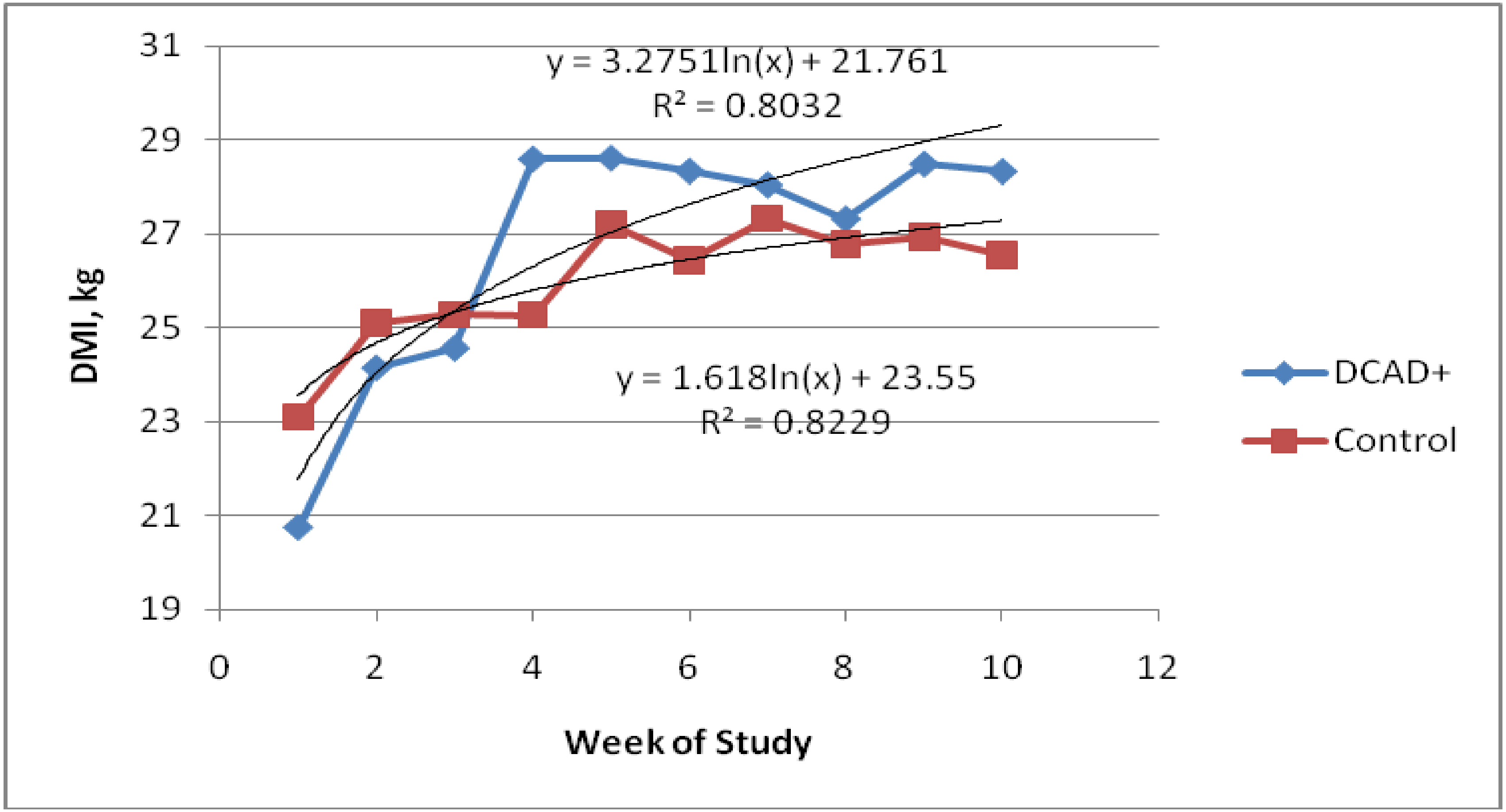
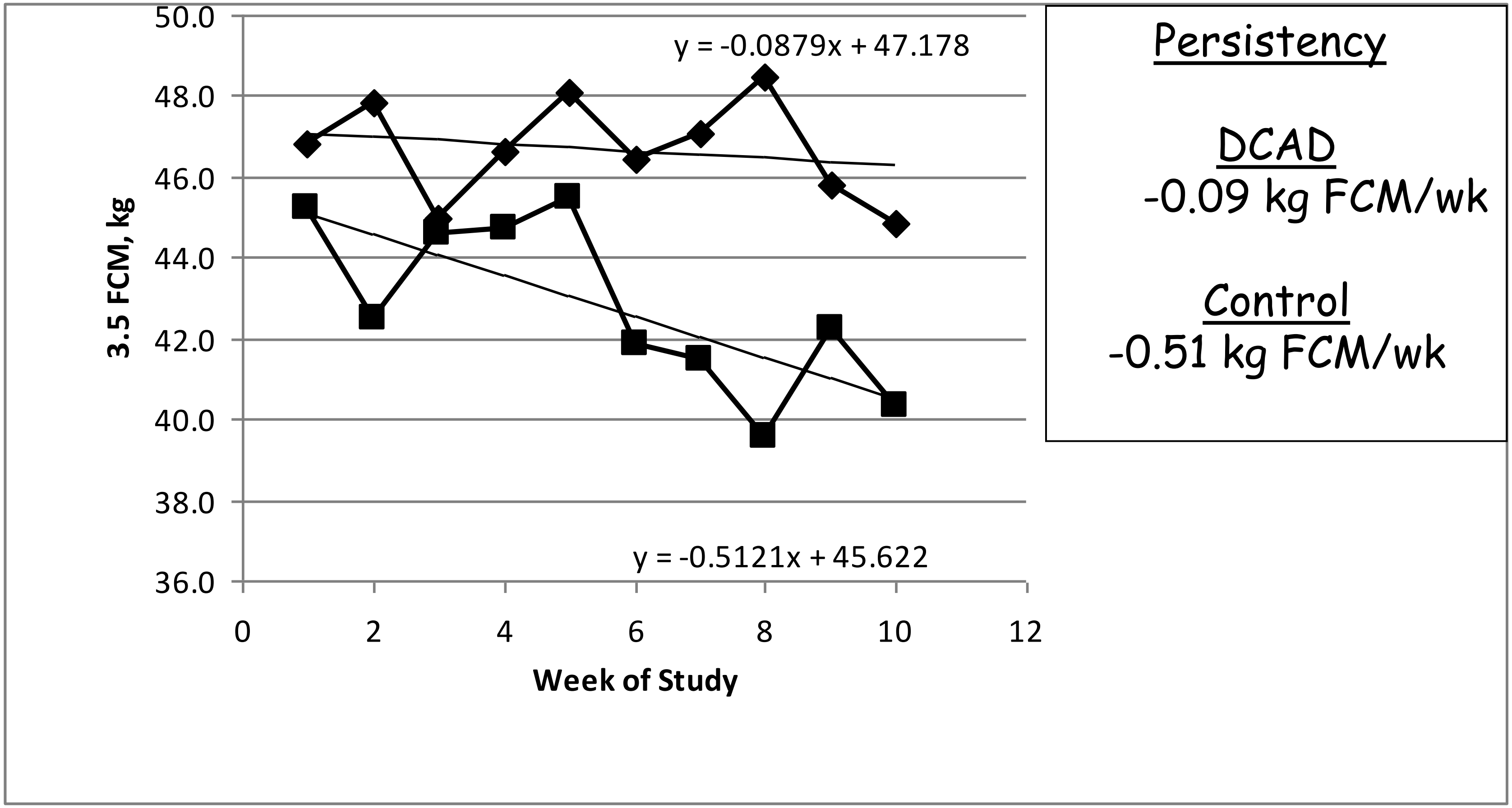
Dry Matter Intake



Linear effect – $p < .05$

Milk Yield



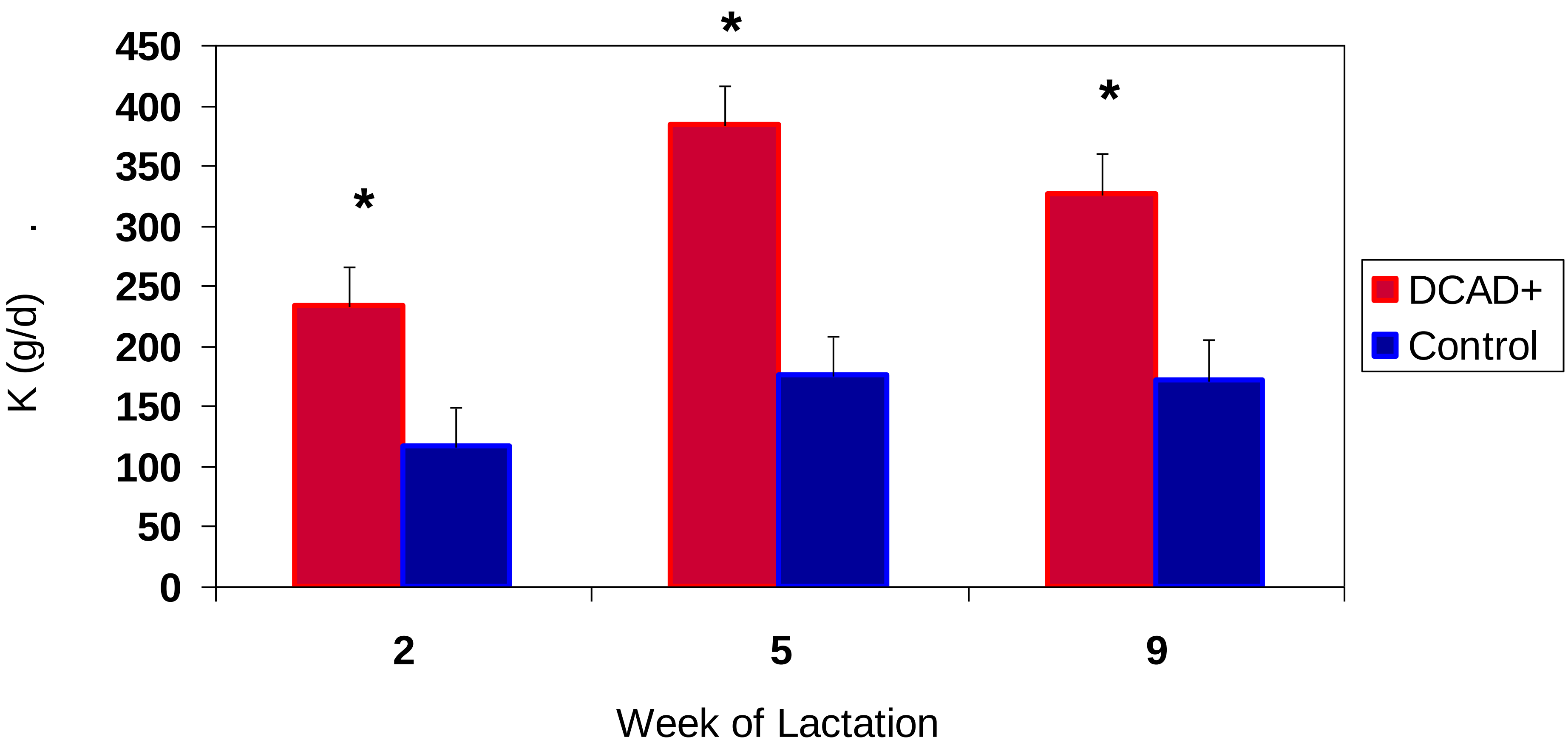
Trt x Week effect – P < .04

Results: Milk Composition

Item	Control		DCAD+		*P*< F	
	%	kg/d	%	kg/d	%	kg/d
Fat	4.01	1.58	4.38	1.77	<0.01	<.07*
Feed Efficiency, Kg FCM/kg DM	1.68		1.79		0.03	
Feed Efficiency, kg ECM/kg DMI	1.63		1.71		0.08	

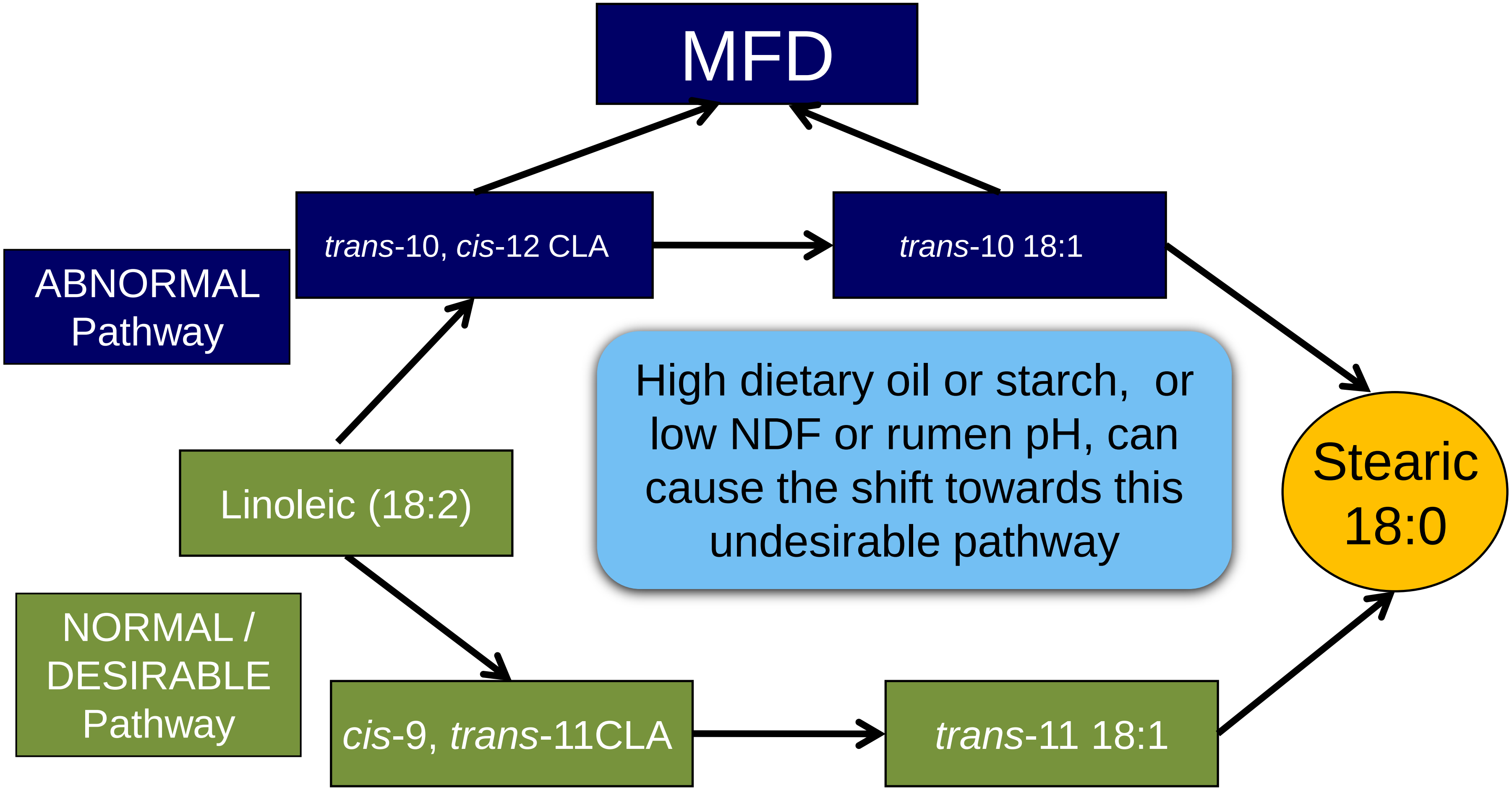
*Effect – Trt*Week-linear

Potassium Retention



Treatment = *P*<0.001*;* Wee = *P*<0.001*;* *Effect of Slices *P*< 0.05;

Biohydrogenation Pathways in the Rumen related to Milk Fat Depression (MFD)



Research Indicates K Impacts Ruminal Biohydrogenation

Item	DCAD 32 1.2% K	DCAD 53 2.1% K	SE	P > F
c16:1	1.47	1.32	0.05	0.03
c18:0	12.6	**14.2**	0.48	0.02
t6,t8 c18:1	**0.36**	0.31	0.02	0.03
t9 c18:1	**0.29**	0.26	0.01	0.07
t10 c18:1	**0.68**	0.4	0.09	0.03
t11 c18:1	**1.43**	1.05	0.17	0.11
t12 c18:1	**0.61**	0.55	0.03	0.09
c9,t11 CLA	**0.44**	0.34	0.03	0.03

- More complete biohydrogenation of fatty acids
- More stearic acid (C18:0)
- Fewer fatty acid intermediates

Harrison, Kincaid, Block, and Jenkins. 2010. J. Dairy Sci. v93, Suppl.1, Abstr. 883

Study Conclusions

- Increasing DCAD levels among high-producing cows is effective in improving performance
- Improved FCM production by 8.32 lbs.

Profit Potential per cow per day	
Milk Response	**8.32 lbs.**
FCM Yield Benefit ($22 cwt)	**$1.83**
Additional feed (**DCAD Plus**, DMI)	($0.48)
Additional Profit:	**+ $1.35**

Additional Profit of $1.35 per cow per day!

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Conclusions

- Potassium carbonate can be used to effectively increase DCAD in early lactation cows

The added dietary potassium carbonate decreased unsaturated and trans fatty acids, and increased C18:0 in milk.

Conclusions

The results indicate that added dietary potassium carbonate affects milk fat % and milk fatty acid profile in early lactation cows, and suggests a role of potassium at the rumen level in the process of bio-hydrogenation

Feed, milk, feces and urine samples were obtained from Taylor et al. (2009) in which 18 Holstein cows (10 primiparous and 8 multiparous) were uti

Virginia Tech Study - Knowlton

Feed, milk, feces and urine samples were obtained from Taylor et al. (2009) in which 18 Holstein cows (10 primiparous and 8 multiparous) were utilized In a 20 week experiment investigating calcium metabolism. Three dietary treatments; low, medium and high Ca supplying 0.45, 0.75 and 1.1% Ca, respectively.

The animals were fed their respective diets from date of calving to day 140 of lactation. On days 14, 35, 56, 77 and 140 of lactation, four day balance trials with total collection were conducted.

Diets contained 1.35 % to 1.40 % K on DM basis.

Effect of Week of lactation on K Utilization
Jarrett et al, 2010 unpublished

Week of lactation

	2	5	8	11	20
Intake K, g/d	230.6	300.6	353.5	375.1	364.7
Urine K, g/d	216.5	206.7	238.1	238.0	259.7
Fecal K, g/d	44.6	61.7	73.4	80.6	79.1
Milk K, g/d	56.3	59.9	64.8	61.7	57.9
Milk K, %	0.145	0.137	0.146	0.143	0.150
Milk yield, kg/d	37.7	42.8	43.5	42.5	38.6
K balance, g/d	-77.5	-27.7	-22.8	-5.2	-14.7

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Effect of Week of lactation on K Utilization
Jarrett et al, 2010 unpublished

	Parity			
	First	Multiple	SE	P-value
Intake K, g/d	278.5	362.4	12.7	0.0008
Urine K, g/d	223.6	240.0	9.5	0.2252
Fecal K, g/d	61.0	74.8	4.6	0.0458
Milk K, g/d	47.6	72.8	4.8	0.0020
Milk yield, kg/d	34.9	47.1	1.8	0.0003
K balance, g/d	-40.9	-18.2	11.7	0.1761

Effect of Week of lactation on K Utilization Jarrett et al, 2010 unpublished

	Treatment				
	Low Ca	Med Ca	High Ca	SE	P-value
Intake K, g/d	335.8	320.8	318.1	15.2	0.6606
Urine K, g/d	235.7	245.1	215.2	11.5	0.2050
Fecal K, g/d	85.1	62.5	56.1	5.5	0.0056
Milk K, g/d	57.0	59.1	64.3	5.7	0.6441
Milk yield, kg/d	39.8	41.2	42.0	2.1	0.7596
K balance, g/d	-41.4	-29.9	-17.5	14.0	0.4849

Take Home Messages

- Increased potassium content in early lactation diets with potassium carbonate can improve milk production and milk fat production
- Potassium level in the early lactation diet affects milk fatty acid composition
- The effect of potassium on milk fatty acids appears to be related to bio-hydrogenation in the rumen

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Forage levels of K

Grasses – as high as 6 % of DM

Corn Silage – 1.5 – 2.0 % DM

Alfalfa - ~ 3 % DM

High Potassium and Lactation Performance

K, % DM	DMI, lb	3.5 % FCM, lb	Water Intake, L	Urine Output, lb
1.6	50.6	70.6	86	35.6
3.13	52.4	71.8	113	82.1
4.57	49.1	68.7	120	91.3