Feeding and managing for maximum milk protein production

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2019	COMPONENT PRICES PER POUND BUTTER FAT	PROTEIN	OTHER SOLIDS	BOSTON PPD/cwt.	BOSTON BLEND PRICE @3.5 bf
JAN	$2.498	$1.193	$0.290	$2.46	$16.42
FEB	$2.535	$1.178	$0.263	$2.76	$16.65
MAR	$2.546	$1.630	$0.220	$2.13	$17.17
APR	$2.538	$1.989	$0.199	$1.38	$17.34
MAY	$2.572	$2.116	$0.185	$1.42	$17.80
JUN	$2.658	$2.005	$0.170	$2.01	$18.28
JUL	$2.686	$2.403	$0.169	$1.28	$18.83
AUG	$2.657	$2.445	$0.173	$1.37	$18.97
SEP	$2.498	$2.863	$0.176	$0.47	$18.78
OCT	$2.403	$3.170	$0.145	$0.00	$18.72
NOV	$2.319	$3.912	$0.111	-$1.25	$19.20
DEC	$2.195	$3.652	$0.134	-$0.09	$19.28
AVG	$2.509	$2.380	$0.186	$1.16	$18.12

2020	COMPONENT PRICES PER POUND BUTTER FAT	PROTEIN	OTHER SOLIDS	BOSTON PPD/cwt.	BOSTON BLEND PRICE @3.5 bf
JAN	$2.112	$2.961	$0.142	$1.73	$18.78
FEB	$1.981	$3.031	$0.175	$1.12	$18.12
MAR	$1.918	$2.842	$0.181	$1.49	$17.74
APR	$1.322	$2.482	$0.179	$1.85	$14.92
MAY	$1.334	$2.111	$0.184	$1.15	$13.21
JUN	$1.760	$3.213	$0.173	-$0.86	$15.93
JUL	$1.864	$3.105	$0.181	-$0.19	$16.68
AUG	$1.910	$2.958	$0.185	$0.30	$16.91
SEP	$1.937	$2.835	$0.185	$0.74	$17.08
OCT	$1.915	$2.865	$0.189	$0.78	$17.15
NOV	$1.941	$2.754	$0.184	$1.01	$17.11
DEC	$1.975	$2.603	$0.183	$1.30	$17.06
AVG	$1.831	$2.813	$0.178	$0.87	$16.72
Q2-Q4 AVG	$1.773	$2.770	$0.183	$0.68	$16.23

Northeast Milk Price Forecasts 2019-2020

Accessed 5/20/20 at

https://www.agrimark.coop/PDFs/AM_Weekly_Updates.pdf

"Feeding strategies during challenging times"

- Know and track Income Over Feed Cost (IOFC) Over Purchased Feed Cost (IOPurFC)
- Make sure optimizing use of (homegrown) forages and feeds
- Fine tune feeding management
- Strategically review rations
- Carefully review cow and heifer inventories and needs

Available at prodairy.cals.cornell.edu

3

4 herds with IOFC > $12.99 per cow per day					
	1	2	3	4	Average
High ECM	95.5	95.3	99.5	91.6	**95.48**
High Fat and Protein per cow per day	6.29	6.37	6.68	6.06	**6.35**
Higher Feed Efficiency (ECM/DMI)	1.75	1.69	1.75	1.68	**1.72**
Higher cost/cow per day	7.81	7.24	8.2	7.16	**7.60**
Lower stocking density, % of stalls	101	108	79	105	**98**
Higher Forage NDF intake, % of BW	0.91	0.96	1.04	0.95	**0.97**
Similar milk fat %	3.59	3.96	3.94	3.7	**3.80**
Similar milk protein %	2.91	3.05	3.09	2.99	**3.01**
Slightly higher cost per lb DM	0.143	0.128	0.144	0.131	**0.137**

3 herds with IOFC < $11.00 per cow per day					
	1	2	3		Average
Lower ECM	77.8	80.5	76		**78.10**
Lower Fat and Protein per cow per day	5.18	5.43	5.09		**5.23**
Lower Feed Efficiency (ECM/DMI)	1.57	1.6	1.6		**1.59**
Lower cost/cow per day	6.49	6.8	6.2		**6.50**
Higher stocking density, % of stalls	132	115	94		**114**
Lower Forage NDF intake, % of BW	0.87	0.81	0.6		**0.76**
Similar milk fat %	4.08	3.84	3.76		**3.89**
Similar milk protein %	2.94	3.14	3.11		**3.06**
Slightly lower cost per lb DM	0.131	0.135	0.13		**0.132**

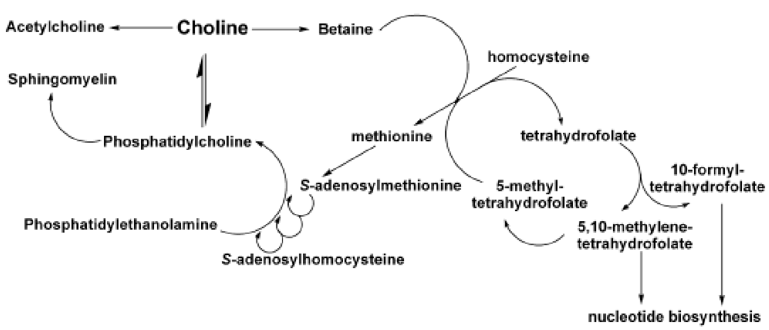
4

Strategic review of rations

- Optimize forage and (homegrown) feed use
- Adjust for fiber digestibility
- Evaluate protein sources for digestibility/undigestibility
- Prioritize maintaining ration ingredients (feeds, nutrient sources, and additives) that:
  - directly affect daily cash flow
  - are fed during very targeted periods of the lactation cycle (e.g., transition cows)

Amino acids are much more than building blocks for protein

- Roles in:
  - One-carbon metabolism
  - Regulation of metabolic pathways
  - Innate immunity
  - Oxidative metabolism
  - Epigenetic effects
  - and more…

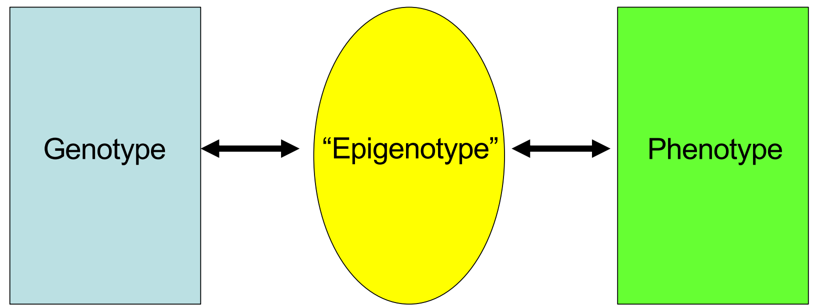


Methyl metabolism.

From Zeisel, 2009. Am J Clin Nutr 89(suppl):673S–7S.

7

Epigenetics



8

Epigenetic mechanisms

- Epigenetic "marks"
  - DNA methylation
  - Histone tail modifications
  - Chromatin remodeling
  - MicroRNAs and long non-coding RNAs
- Highly dynamic throughout life and impacted by
  - Nutrients
  - Pathogens
  - Environmental stimuli
  - Maternal environment

Incomplete list of nutrients/nutritional conditions that can modify epigenetic marks

- Energy/protein restrictions and status
- Nutrients involved in methyl metabolism
  - Choline, B12, folate, betaine, methionine
- Dietary fatty acids
  - Unsaturated FA that modulate PPAR-alpha

Ibeagha-Awemu EM and Zhao X (2015) Front. Genet. 6:302. doi: 10.3389/fgene.2015.00302

Summary of production responses to transition period AA

Study	Treatment	Response
Overton et al., 1996	RPMet	**↑ 2.7 kg/d FCM**
Socha et al., 2005	Met, Met+Lys	**↑ 2.9 kg/d ECM for Met + Lys**
Piepenbrink et al., 2004	HMTBa (13 g pre; 28 g post) HMTBa (27 g pre; 44 g post)	**↑ 3.0 kg/d milk** **NS**
Preynat et al., 2009; 2010	RPMet w/wo folic acid + B12	**NS – milk yield** **↑ milk CP (2.94 vs. 3.04%)**
Ordway et al., 2009	HMBi RPMet	**No effect on milk yield** **Both trts ↑ milk protein %**
Osorio et al., 2013	HMBi RPMet	**↑ 3.8 kg/d ECM** **↑ 4.0 kg/d ECM**
Batistel et al., 2017	RPMet	**↑ 4.3 kg/d ECM**

Osorio et al., 2013. J. Dairy Sci. 96:6248-6263.
Osorio et al., 2015. J. Dairy Sci. 97:7437-7450.
Osorio et al., 2014. J. Dairy Sci. 97:7451-7464.
Osorio et al., 2016. J. Dairy Sci. 99:234-244.

- ~38 multiparous Holstein cows
- Treatments (- 21 d pre to 30 days post)
  - Control (Met ~ 1.8% of MP – NRC 2001)
  - HMBi at 0.19% of DM; 2.35% MP pre; 2.15% MP post – NRC 2001)
  - RP-Met at 0.07% DM; 2.38% MP pre; 2.15% MP post – NRC 2001)(Met ~ 2.2 to 2.3% MP – NRC 2001)
- Lys ~ 6.6 to 6.7% MP prepartum; ~ 6.1 to 6.2% MP postpartum (NRC 2001)

Osorio et al., 2013. J. Dairy Sci. 96:6248-6263.
Osorio et al., 2015. J. Dairy Sci. 97:7437-7450.
Osorio et al., 2014. J. Dairy Sci. 97:7451-7464.
Osorio et al., 2016. J. Dairy Sci. 99:234-244.

- Cows fed Met pre- and postpartum
  - Tended to have greater neutrophil phagocytosis at 21 d postpartum
  - Lower plasma ceruloplasmin and serum amyloid A
  - Greater plasma oxygen radical absorbance capacity
  - Greater liver concentrations of glutathione and carnitine
  - Altered gene networks in liver consistent with altered oxidative metabolism and inflammatory responses above
  - Greater methylation of PPAR-alpha promoter and upregulation of associated pathways of lipid metabolism in liver

J. Dairy Sci. 100:7455–7467
https://doi.org/10.3168/jds.2017-12689

Ethyl-cellulose rumen-protected methionine enhances performance during the periparturient period and early lactation in Holstein dairy cows

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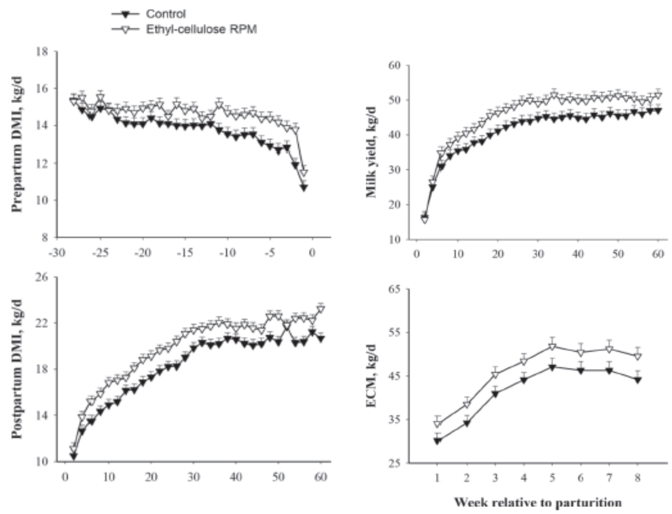
- 60 multiparous Holstein cows
- Treatments (- 28 d pre to 60 days post)
  - Control (Met ~ 1.7% of MP – NRC 2001)
  - Met (Met ~ 2.2 to 2.3% MP – NRC 2001)
- Lys ~ 6.5% MP prepartum; ~ 6.3 to 6.4% MP postpartum (NRC 2001)
- Ratio Lys:Met ~ 2.8 in RP-Met supplemented



Effect of RP-Met supplementation during the periparturient period and early lactation on DMI and milk yield (Batistel et al., 2017. J. Dairy Sci. 100:7455-7487)

The Journal of Nutrition
Biochemical, Molecular, and Genetic Mechanisms
J Nutr 2017;147:1640–7.

Placentome Nutrient Transporters and Mammalian Target of Rapamycin Signaling Proteins Are Altered by the Methionine Supply during Late Gestation in Dairy Cows and Are Associated with Newborn Birth Weight

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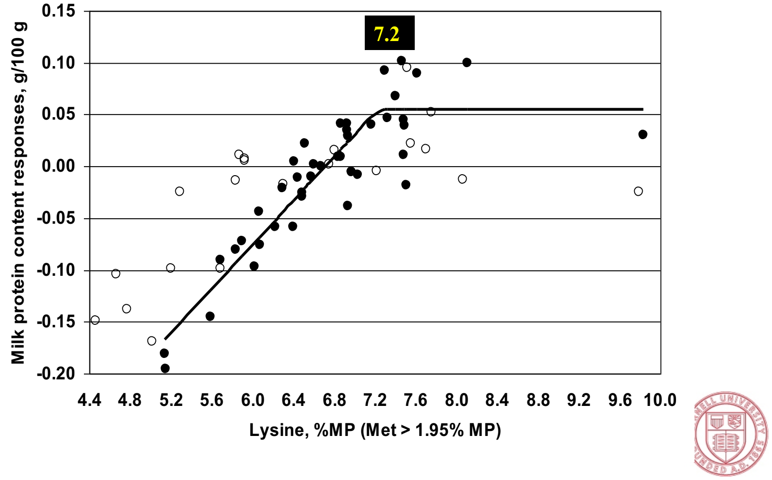
- Prepartum RP-Met increased calf birth weight (44.1 vs. 41.8 kg/d)
- Prepartum RP-Met upregulated AA transport and modulated mTOR signaling pathway in placentome

Jacometo et al., 2016. J. Dairy Sci. 99:6753-6763.
Jacometo et al., 2017. J. Dairy Sci. 100:3209-3219.

- Cows fed from 21 d prepartum to calving:
  - control (Met ~1.9% of MP – NRC 2001)
  - RP-Met (0.08% of DM; Met ~2.4% of MP – NRC 2001)
- Calves from cows fed RP-Met had:
  - Similar birth weight and ADG to 7 wk
  - Lower reactive oxygen metabolites at 14 d and trend for lower ceruloplasmin
  - Altered insulin signaling and glucose metabolism
  - Altered liver Met, choline, and homocysteine metabolism

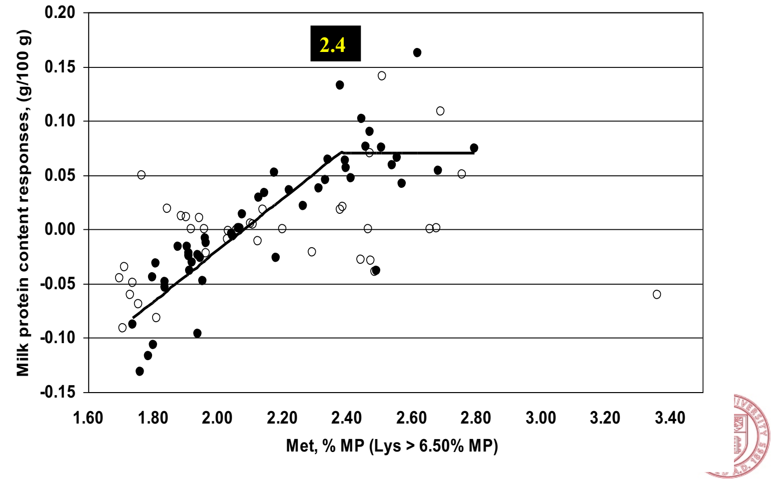
What about milk components and using AA to improve efficiency of N use?

Lysine Plot (NRC, 2001)



20

Methionine Plot (NRC, 2001)



21

Rumen Protected Methionine (RPM): Meta-Analysis

Patton et al., 2010. J. Dairy Sci. 93 :2105–2118

- Studies
  - 17 for Mepron
  - 17 for Smartamine
  - 1 Study for both
- 75 diet comparisons
  - 1040 individual cows
- Average of 20 g RP-Met/d
  - 12 g metabolizable Met

Courtesy Dr. Sarah Boucher

Patton, 2010. J. Dairy Sci. 93 :2105–2118

Item	Mean	Min.	Max.
DMI, kg	-0.04	-2.10	1.50
Milk, kg	0.02	-4.20	4.40
Milk true protein, %	0.07	-0.09	0.35
Milk true protein, kg	0.03	-0.07	0.19
Milk fat, %	-0.01	-0.30	0.41
Milk fat, kg	0.01	-0.19	0.19

Courtesy Dr. Sarah Boucher

Weighted average responses of cows to additional Met provided by experimental infusion or feeding protected forms or a Met analog

Item	DL-Met	HMTBa (Alimet)	Mepron	Smartamine	P
DMI, kg/d	+0.12[ab]	+0.15[a]	-0.25[b]	+0.31[a]	0.012
Milk, kg/d	-0.34	+0.28	+0.31	-0.13	0.055
Milk protein, g/d	+19[ab]	+13[b]	+35[a]	+19[ab]	<0.001
Milk protein, %	+0.08[a]	0.00[b]	+0.07[a]	+0.07[a]	<0.001
Milk fat, g/d	+12[ab]	+45[a]	+35[ab]	+6[b]	<0.001
Milk fat, %	+0.08[ab]	+0.13[a]	+0.05[b]	+0.04[b]	<0.001
(Protein+fat)/DMI	+0.78[b]	+1.70[ab]	+3.88[a]	-.0.42[b]	<0.001

Zanton et al., 2014. J. Dairy Sci. 97:7085-7101

Optimum AA concentrations in MP in CNCPS 6.55 biology

	Lysine	**Methionine**	**Optimal Lys/Met**
	AMTS/NDS (CNPS 6.5 biology) milk protein yield		
2015	7.00	2.60	**2.7**
	AMTS/NDS (CNCPS 6.5 biology) milk protein %		
2015	6.77	2.85	**2.4**

Van Amburgh (2015)

Using RP-Met and RP-Lys in conjunction with lower MP supply

J. Dairy Sci. 95:6042–6056
http://dx.doi.org/10.3168/jds.2012-5581

Rumen-protected lysine, methionine, and histidine increase milk protein yield in dairy cows fed a metabolizable protein-deficient diet

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- 48 Holstein cows in 2 phases (both starting 50 to 110 DIM)
- 2 wk covariate, 2 wk adaptation, 8 wk data collection
- Treatments:
  - ADMP -- MP-adequate diet – NRC 2001
  - DMP -- MP-deficient diet, -317 g/d; 87% of req. NRC 2001
  - DMPLM -- DMP plus RP-Met (30 g/d Mepron) and RP-Lys (100 g/d AminoShure-L)
  - DMPLMH -- DMPLM plus RP-His (50 g/d)
- Note – cows fed DMP outproduced NRC 2001 predicted MP allowable milk by ~ 10 kg/d

Lee et al., 2012. J. Dairy Sci. 95:6042-6056.

Item	P1–ADMP	P1-DMP		P2-ADMP	P2-DMP
Ingredient, % of DM					
Corn silage	40.7	40.7		39.7	39.7
Alf haylage	16.7	16.6		16.7	16.6
Grass hay	5.8	5.8		5.8	5.8
CS hulls	1.1	1.1		1.1	1.1
Corn meal	5.7	11.7		5.7	11.7
Bakery	7.4	7.4		7.4	7.4
WRSB	5.5	6.6		5.5	6.6
Canola, mech	5.0	3.0		5.0	3.0
Expeller SBM	5.0	0.0		6.0	1.0
Molasses	4.2	4.2		4.2	4.2
Min-vit	2.9	2.8		2.9	2.9

28

Lee et al., 2012. J. Dairy Sci. 95:6042-6056.

Item	P1–ADMP	P1-DMP		P2-ADMP	P2-DMP
Composition, % of DM					
CP	15.7	13.6		15.7	13.5
RDP	9.8	9.1		9.8	9.0
RUP	5.9	4.4		5.9	4.5
NDF	29.5	30.0		29.3	29.0
EE	4.8	4.7		4.1	4.5
NEL balance, Mcal	2	3		2	2
NFC	44.6	45.8		46.0	48.4

29

Lee et al., 2012. J. Dairy Sci. 95:6042-6056.

Item	ADMP	DMP	DMPLM	DMPLMH	SEM	P
DMI, kg/d	24.5	23.0	23.7	24.3	0.4	0.06
Milk, kg/d	38.8 a	35.2 b	36.9 ab	38.5 a	0.7	<0.01
Fat, %	3.50	3.51	3.32	3.30	0.12	0.44
Fat, kg/d	1.34	1.20	1.21	1.23	0.04	0.10
TP, %	2.98	2.94	2.99	3.03	0.03	0.23
TP, kg/d	1.13 a	1.01 b	1.10 a	1.14 a	0.02	<0.01
MUN, mg/dL	13.0 a	10.3 bc	10.1 c	11.1 b	0.37	<0.01
BW, kg	599	591	602	597	5	0.43
BW change, kg	2.8	-4.8	9.1	1.5	6.2	0.46

J. Dairy Sci. 99:4437–4452
http://dx.doi.org/10.3168/jds.2015-10822

Effects of rumen-protected methionine, lysine, and histidine on lactation performance of dairy cows

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#Ajinomoto Co., Inc., Tokyo, Japan 104

- 72 Holstein cows in 2 phases (Starting 132 and 98 DIM)
- 2 wk covariate, 2 wk adaptation, 5 wk data collection
- Treatments:
  - MPA -- MP-adequate diet NRC 2001
  - MPD -- MP-deficient diet, -50 to 80 g/d; 90 to 95% of req. NRC 2001
  - MPDM – MPD plus RP-Met (30 g/d Mepron)
  - MPDL – MPD plus RP-Lys (100 g/d AjiPro-L)
  - MPDH – MPD plus RP-His (120 g/d RP-His)
  - MPDMLH – MPD plus MLH

Giallongo et al., 2016. J. Dairy Sci. 99:4437-4452.

Item	P1-MPA	P1-MDP		P2-MPA	P2-MPD
Ingredient, % of DM					
Corn silage	42.0	42.0		42.0	42.0
Alf haylage	21.0	21.0		21.0	21.0
CS hulls	4.0	4.0		4.0	4.0
Corn meal	1.5	6.5		6.3	11.5
Candy meal	5.5	5.5		3.5	3.5
WRSB	4.5	4.5		4.0	4.0
Canola, mech	8.5	8.5		6.5	6.5
Expeller SBM	6.0	1.0		5.7	0.5
Molasses	4.0	4.0		4.0	4.0
Min-vit	3.0	3.0		3.0	3.0

Giallongo et al., 2016. J. Dairy Sci. 99:4437-4452.

Item	P1–MPA	P1-MPD		P2-MPA	P2-MPD
Composition, % of DM					
CP	16.8	14.8		16.1	14.1
RDP	10.2	9.6		9.6	9.1
RUP	6.7	5.2		6.5	4.9
NDF	32.4	31.8		34.0	33.4
EE	4.6	4.5		4.5	4.3
NEL balance, Mcal	3	4		3	6
NFC	40.5	43.2		39.6	42.4
Starch	19.0	22.0		20.1	23.2

Giallongo et al., 2016. J. Dairy Sci. 99:4437-4452.

Item	MPA	MPD	MPDM	MPDL	MPDH	MPDLMH	Effects (P < 0.10)
DMI, kg/d	29.0	27.7	28.2	28.1	28.4	28.5	MP, H, MLH
Milk, kg/d	42.5	38.2	38.5	37.9	38.4	39.6	MP
Fat, %	3.94	3.72	3.80	3.84	3.96	4.01	MLH
Fat, kg/d	1.65	1.40	1.42	1.45	1.51	1.56	MP, MLH
TP, %	3.02	3.00	3.04	3.13	3.11	3.14	L, H, MLH
TP, kg/d	1.27	1.13	1.15	1.17	1.18	1.23	MP, MLH
MUN, mg/dL	10.9	7.96	7.78	8.88	8.31	8.72	MP, L

Other considerations for AA balancing

- How digestible are your RUP sources?
- What about interactions with energy status?

Variation in RUP and digestibility (Ross Unavailable N assay)

RUP % CP			
Product	Average	Min	Max
Blood Meal	93.4	86.4	97.9
Bypass Soy	68.2	62.6	88.9
SBM	47.8	31.6	73.8
Distillers Grains	76.6	62.3	94.2
Canola Meal (all types)	41.5	27	52.3

Undigested CP % CP			
Product	Average	Min	Max
Blood Meal	16.8	0.0	59.2
Bypass Soy	5.6	3.3	10.4
SBM	3.7	1.4	6.9
Distillers Grains	20.9	7.8	56.2
Canola Meal (all types)	9.6	8.3	13.6

Source: Dairyland Labs

Role of energy nutrition in milk protein synthesis

- Sporndly (1989) reported much stronger relationship of milk protein percentage with dietary energy intake than dietary protein intake
  - Often attributed to ruminal fermentation and microbial protein synthesis
  - Sugars, starches, and digestible fiber sources will drive microbial protein yield

Effects of insulin on milk protein

- Hyperinsulinemic-Euglycemic clamps
  - Clamp alone
    - 15% increase in milk protein yield (Mackle et al., 1999)
  - Clamp w/ abomasal infusion of casein
    - 28% increase in milk protein yield (Griinari et al., 1997)
  - Clamp w/ abomasal infusion of BCAA & casein
    - 25% increase in milk protein yield (Mackle et al., 1999)
  - Clamp w/ IV infusion of AA (casein profile)
    - Insulin and insulin plus AA increased milk by 13 to 18% and protein by 10 to 21% in goats
      - (Bequette et al, 2001)

Long-acting insulins and milk protein

- 30 multiparous Holstein cows
  - 52 to 130 DIM, avg. 88 +/- 25
- 3 treatments given at 12-h intervals for 10 d
  - Control
  - 0.2 IU/kg of BW Humulin-N (Eli Lilly and Co.), 2X/d
  - 0.2 IU/kg of BW Insulin glargine (Sanofi-Aventis), 2X/d
- Blood samples
  - Twice daily from coccygeal vein
  - Before morning injections, 6 hours later
- Milk samples every other day, 2x/d

Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

Basal Diet, DM basis; CNCPS 6.1

Ingredient, %	Content
Corn silage	46.65
Ground corn	15.54
Wheat straw	6.89
Corn germ meal	5.22
Corn distillers	5.18
Canola meal	5.14
Amino Plus [1]	4.68
Minerals and vitamins[2]	2.97
Soybean meal	1.71
Blood meal	1.64
Citrus pulp, dry	1.60
Energy Booster [3]	1.10
Molasses	0.69
AminoShure-L[4]	0.50
Urea	0.34
Alimet[5]	0.08
Smartamine-M[6]	0.08

Energy and nutrients[7]	
NEL, Mcal/kg	1.67
NDF, %	34.8
NFC, %	42.3
Starch, %	30.5
Crude fat, %	3.8
ME allowable milk,[8] kg/d	47.7
MP allowable milk,[8] kg/d	49.3
MP supply,[8]g/d	3,255
Lys,[8] % of MP	7.33
Met,[8] % of MP	2.54
CP, %	15.2

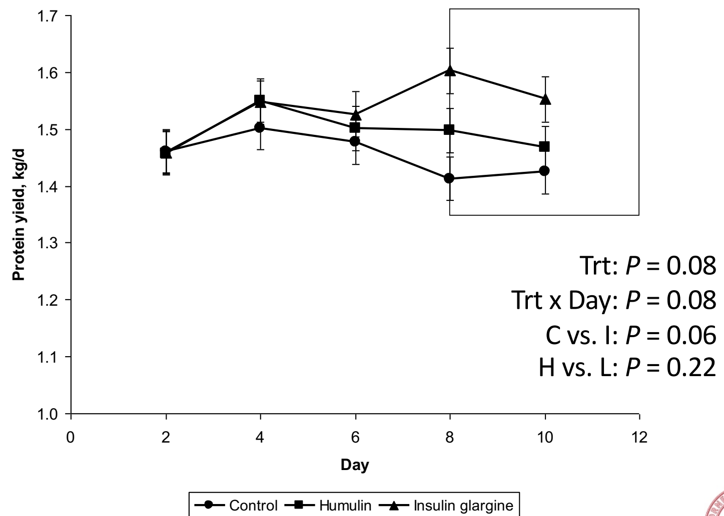
Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

DMI, milk yield, and milk composition for cows administered two forms of long-acting insulin

	Treatment					P-value				
Variable	C	H	L	SE		Trt	Day	Trt x Day	C vs. I	H vs. L
DMI, kg/d	26.4	26.2	26.8	0.4		0.58	<0.001	0.57	0.82	0.31
Milk yield, kg/d	48.3	47.3	47.1	0.9		0.46	0.12	0.29	0.27	0.86
Fat, %	3.17	3.32	3.50	0.11		0.12	0.08	0.28	0.09	0.24
Fat yield, kg/d	1.50	1.55	1.65	0.05		0.13	0.21	0.83	0.11	0.22
Protein, %	3.00	3.20	3.29	0.04		0.001	<0.001	0.42	<0.001	0.20
Protein yield, kg/d	1.46	1.49	1.54	0.03		0.08	0.001	0.08	0.06	0.22
Lactose, %	4.84	4.76	4.70	0.02		0.001	0.13	0.25	<0.001	0.10
Lactose yield, kg/d	2.34	2.26	2.21	0.04		0.07	0.04	0.06	0.03	0.39
Total solids, %	11.95	12.09	12.42	0.14		0.06	0.02	0.28	0.08	0.10
Total solids yield, kg/d	5.77	5.68	5.82	0.13		0.63	0.13	0.61	0.88	0.34
ECM, kg/d	46.8	46.5	48.3	1.1		0.50	0.08	0.62	0.68	0.27
SCC (x 1,000)[7]	62	44	113	24		0.12	0.18	0.26	0.57	0.05
MUN[8], mg/dL	13.5	12.5	12.3	0.5		0.01	<0.001	0.08	0.004	0.61

Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

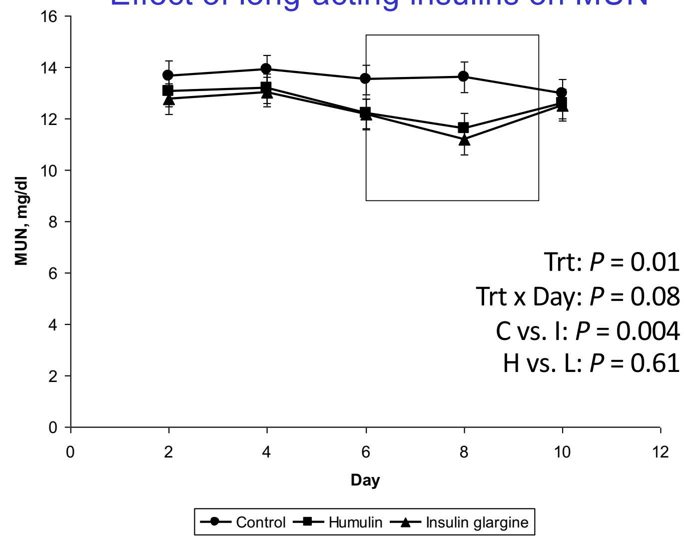
Effect of long-acting insulins on milk protein yield



Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

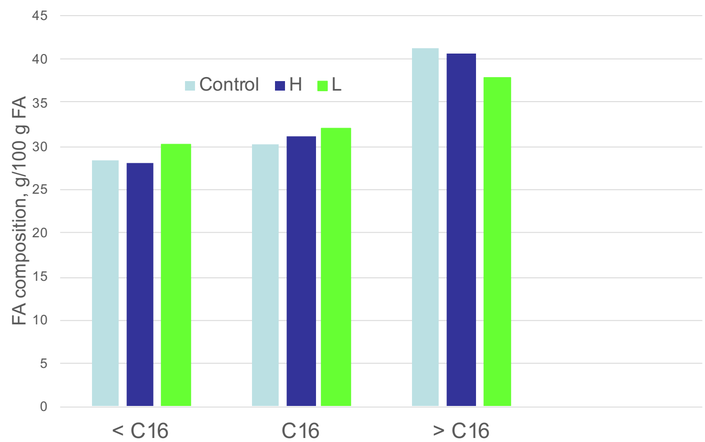
42

Effect of long-acting insulins on MUN



Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

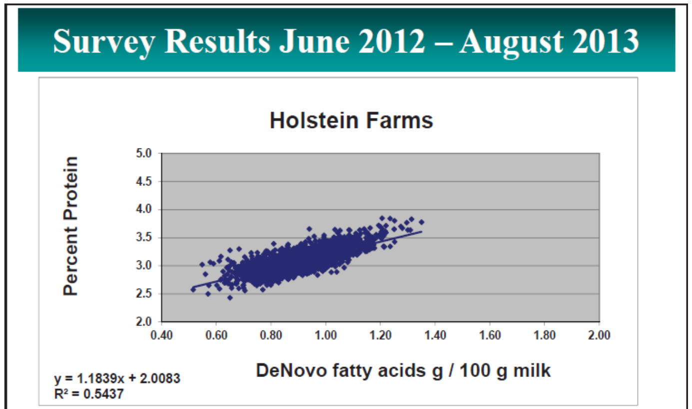
43



Milk FA composition for cows administered control (C) or two forms (H or L) of long-acting insulin. $P < 0.05$ for effects of treatment on < C16 and > C16. SEM = 0.9, 0.8, and 1.5 for < C16, C16, and > C16, respectively

Winkelman and Overton, 2013. J. Dairy Sci. 96:7565-7577.

De novo FA content of milk is positively correlated with milk protein content on commercial dairy farms. From Barbano et al., 2014.



Mean	1.09	3.36
Min	0.65	2.70
Max	1.78	4.54

Jersey

Mean	0.89	3.06
Min	0.52	2.43
Max	1.35	3.85

Holstein

Field implication – more glucogenic/propiogenic rations may support greater responses to AA supplementation?

46

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Effect of Casein and Propionate Supply on Mammary Protein Metabolism in Lactating Dairy Cows

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Four treatments:
Control
CN -- Duodenal infusion of casein (743 g/d)
C3 -- Ruminal infusion of propionate (1,041 g/d)
CN plus C3

47

Table 1. Effect of CN and propionate (C3) supply on milk yield and composition of the right-half udder in dairy cows[1]

Item	Treatment				SEM	*P*		
	Control	CN	C3	CN + C3		CN	C3	CN × C3
Milk, kg/12 h	6.38	7.39	6.55	7.38	0.19	<0.001	0.68	0.60
True protein, g/kg	29.3	30.2	30.6	32.8	0.8	0.04	0.03	0.35
True protein, g/12 h	186	222	197	240	7	<0.01	0.06	0.59
CN, % of true protein	82.4	83.5	82.0	82.3	0.4	0.07	0.05	0.31
NPN, % of CP	2.13	2.39	2.05	2.24	0.09	0.02	<0.01	0.17
Fat, g/kg	44.8	42.3	46.1	39.0	2.7	0.07	0.71	0.36
Fat, g/12 h	282	304	299	286	24	0.82	0.97	0.40

[1]Least squares means presented with pooled SEM, given for n = 3; from the half udder in the evening (12 h) of the Leu kinetic day (17 observations: control = 5, CN = 3, C3 = 5, CN + C3 = 4). *P* = probability corresponding to the null hypothesis with CN, C3, and CN × C3 contrasts.

Raggio et al., 2006

48

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Regulation of protein synthesis in mammary glands of lactating dairy cows by starch and amino acids

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Four treatments:
Control
Casein -- Abomasal infusion of casein (860 g/d)
Starch – Abomasal infusion of starch (2 kg/d)
Casein plus starch

49

Milk yield and composition for cows fed at 70% of ad libitum intake and infused abomasally with casein and/or starch

Item	Water	Casein	Starch	C + S	SEM	Starch	Casein	C x S
DMI + inf, kg/d	13.0	14.7	17.9	16.9	0.8	0.01	0.4	0.01
Milk, kg/h	0.98	0.83	1.09	1.20	0.10	0.02	0.8	0.2
Protein, g/h	31.4	25.0	30.2	37.5	4.2	0.05	0.8	0.02
Fat, g/h	48.0	34.9	42.6	50.0	4.7	0.3	0.4	0.03
Protein, %	3.05	3.29	3.15	3.18	0.11	0.9	0.03	0.04
Fat, %	4.68	4.40	4.25	3.73	0.30	0.05	0.1	0.6
MUN, mg/dL	12.0	14.7	9.2	13.1	0.5	0.01	0.01	0.2

Rius et al., 2010. J. Dairy Sci. 93 :3114–3127

Optimum Supply Of Each EAA Relative To Metabolizable Energy (Van Amburgh et al., 2015)

AA	R^2	Efficiency from our evaluation	Lapierre et al. (2007)	g AA/ Mcal ME	% EAA
Arg	0.81	0.61	0.58	2.04	10.2%
His	0.84	0.77	0.76	0.91	4.5%
Ile	0.74	0.67	0.67	2.16	10.8%
Leu	0.81	0.73	0.61	3.42	17.0%
Lys	0.75	0.67	0.69	3.03	15.1%
Met	0.79	0.57	0.66	1.14	5.7%
Phe	0.75	0.58	0.57	2.15	10.7%
Thr	0.75	0.59	0.66	2.14	10.7%
Trp	0.71	0.65	N/A	0.59	2.9%
Val	0.79	0.68	0.66	2.48	12.4%

Lys and Met requirements 14.9%, 5.1% - Schwab (1996)
Lys and Met requirements 14.7%, 5.3% - Rulquin et al. (1993)

Summary and conclusions

- Need to strive to make decisions and employ nutritional strategies that result in higher IOFC and strategically invest for gains over the longer term
- Amino acids are much more than simply building blocks for protein synthesis
  - Metabolic regulation, immunity, oxidative balance, epigenetics
- RPAA can be used strategically to improve transition cow outcomes and to decrease overall MP feeding levels
- Keep in mind potential effects of protein source quality and consistency as well as potential interactions with carbohydrate nutrition

Thanks!!

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