Turbocharge your fresh cow diets

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Fresh cow nutrition

- The vast majority of controlled research during the past 25 years on transition cow nutrition has focused on the ***dry*** cow
- Most lactating cow nutrition studies did not start until three to four weeks after calving
- Several studies published over the past 10 years focused specifically on feeding the fresh cow

Fresh cow diets – common themes

- Frequently based upon high cow diet
- Some common “tweaks”
  - Lower starch
  - Higher physically effective fiber
    - Usually less than 0.5 kg/d of chopped straw/hay
  - Additional RUP/AA
  - Additional fat
  - Strategic addition of other nutrients (e.g., RP-choline)
- Success usually gauged by farm-level outcomes

Fresh diets – a few key questions

- How fermentable should fresh cow diets be?
  - do we need to feed lower starch diets to fresh cows?
  - what about starch fermentability?

- How important is physically effective NDF in fresh cow diets?

- MP supply to the postcalving cow

Several experiments conducted by groups at University of Alberta, Miner Institute, Cornell, and Michigan State University

- Starch level in fresh diet
  - Dann and Nelson, 2011 Cornell Nutrition Conference
  - Sun and Oba. 2014. J. Dairy Sci. 97:1594-1602.
  - McCarthy et al., 2015. J. Dairy Sci. 98:3335-3350.
  - Williams et al., 2015 ADSA-ASAS Joint Annual Meeting
  - Haisan et al., 2021. J. Dairy Sci. 104:4362-4374.

- Starch source in fresh diet
  - Rockwell and Allen. 2016. J. Dairy Sci. 99:4453-4463.

- Starch source and level in fresh diet
  - Dyck et al., 2011. J. Dairy Sci. 94:4636-4646.
  - Albornoz and Allen. 2018. J. Dairy Sci. 101:8902-8915.

Studies that had favorable responses to higher starch levels or increased starch fermentability generally had higher forage or forage NDF levels

- Favorable responses
  - McCarthy et al., 2015 (28.2% of DM as F-NDF)
  - Rockwell and Allen, 2016 (27.4% of DM as F-NDF)

- Neutral or negative responses
  - Albornoz and Allen., 2018 (~22.5% of DM as F-NDF)
  - Sun and Oba, 2014 (Diet was 39.9% forage)
  - Dann and Nelson, 2011 (Diet was ~ 50% forage)
  - Haisan et al., 2021 (~18% of DM as F-NDF)

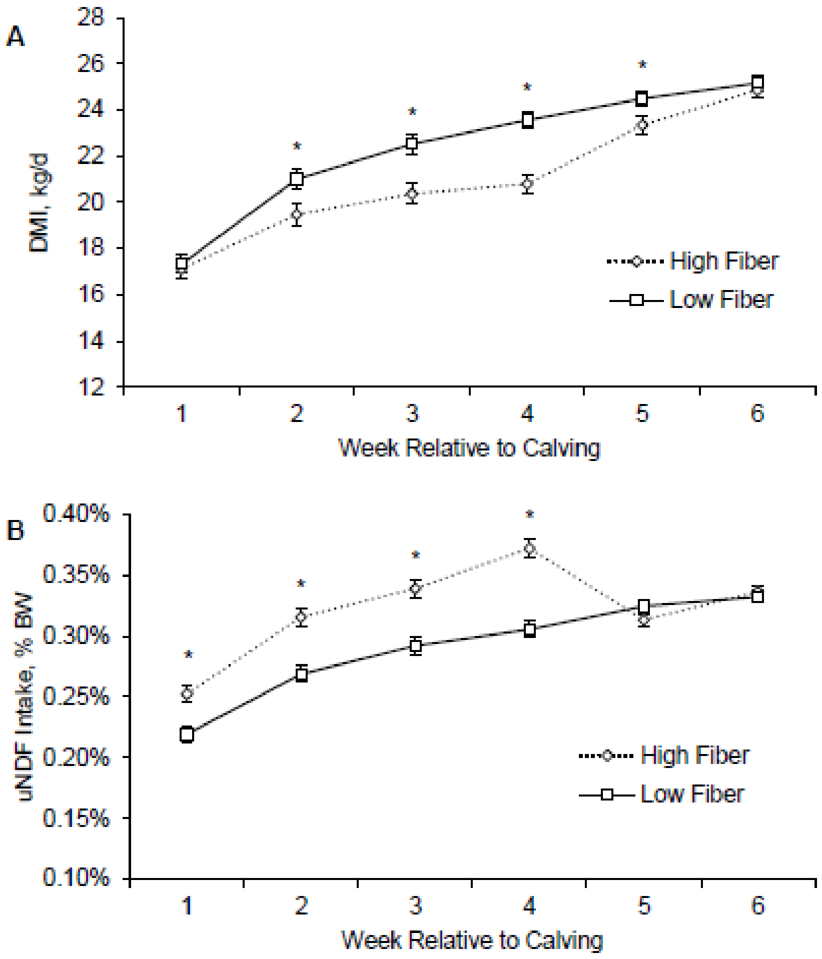
Can you go too far with higher $peNDF/uNDF_{240}/peuNDF_{240}$ in fresh cow rations?

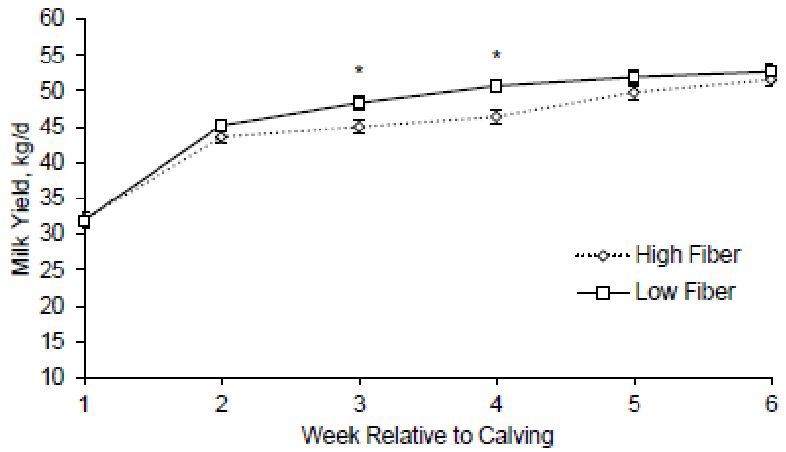
Ingredient and nutrient composition of experimental diets (LaCount et al., 2017)

	Diet		
Item	Prepartum	Low Fiber (LF)	High Fiber (HF)
Ingredients, % of ration DM			
Conventional corn silage	45.21	42.31	38.46
Alfalfa hay	-	10.58	10.58
Straw	20.84	1.15	8.65
Corn meal	2.43	17.64	20.15
Soybean meal	-	6.03	4.73
Wheat middlings	-	4.82	1.58
Amino Plus	5.9	4.34	5.31
Canola meal	3.47	1.61	3.88
Corn gluten feed	1.74	1.61	0.47
Blood meal	2.43	0.95	1.09
Soybean hulls	6.95	2.41	-
Citrus pulp	4.52	-	0.79
Energy Booster	-	1.29	1.58
Rumensin, mg/d[1]	439	365	334
Other	6.4	2.3	2.3
Analyses, % of ration DM			
aNDFom	43.1 ± 0.3	32.8 ± 1.4	35.3 ± 2.3
ADF	29.0 ± 0.5	21.3 ± 1.1	22.9 ± 2.1
Starch	15.6 ± 0.3	24.8 ± 1.7	24.6 ± 2.3
Sugar	3.5 ± 0.4	5.0 ± 0.7	3.9 ± 0.1
Fat	2.3 ± 0.2	3.3 ± 0.2	3.2 ± 0.2
$uNDF_{240}$	12.8 ± 0.5	9.5 ± 0.4	12.2 ± 1.6
peNDF	33.3	21.6	23.2
MP, g/kg DM[1]	89.0	112.1	108.0

Dry matter intake, milk yield, and milk composition for cows fed low fiber (LF) or high fiber (HF) diets from d 1 to 28 postcalving. LaCount et al., 2017

				P-Value	
Item	LF	HF	SEM	Trt	Trt×Time
Prepartum DMI, kg/d	15.5			-	-
Postpartum DMI, kg/d	21.1	19.4	0.4	<0.01	<0.01
uNDF intake, %BW	0.27	0.32	0.01	<0.01	0.06
Milk yield, kg/d	46.2	44.7	1.0	0.26	0.001
Fat, %	3.89	4.06	1.1	0.55	0.10
Protein, %	3.27	3.20	0.06	0.31	0.41
Lactose, %	4.73	4.69	0.04	0.49	0.39
Total solids, %	12.9	13.0	0.2	0.50	0.57
ECM, kg/d	47.2	46.0	1.1	0.55	0.10
Rumination, min/d	544	543	8	0.56	0.14





DMI, uNDF240 intake, and milk yield for cows fed High Fiber or Low Fiber diets from d 1 to 28 postpartum. From LaCount et al., 2017.

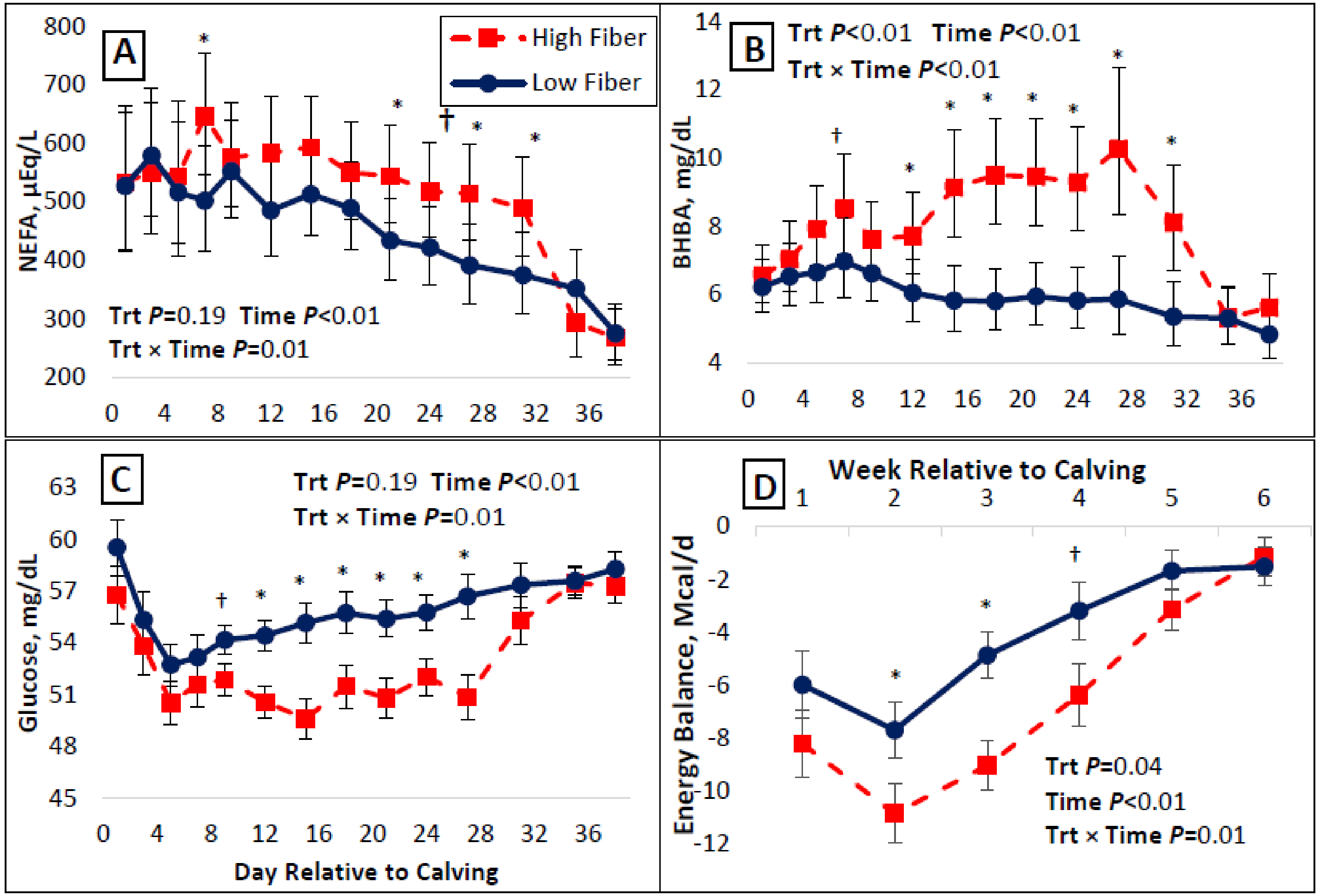
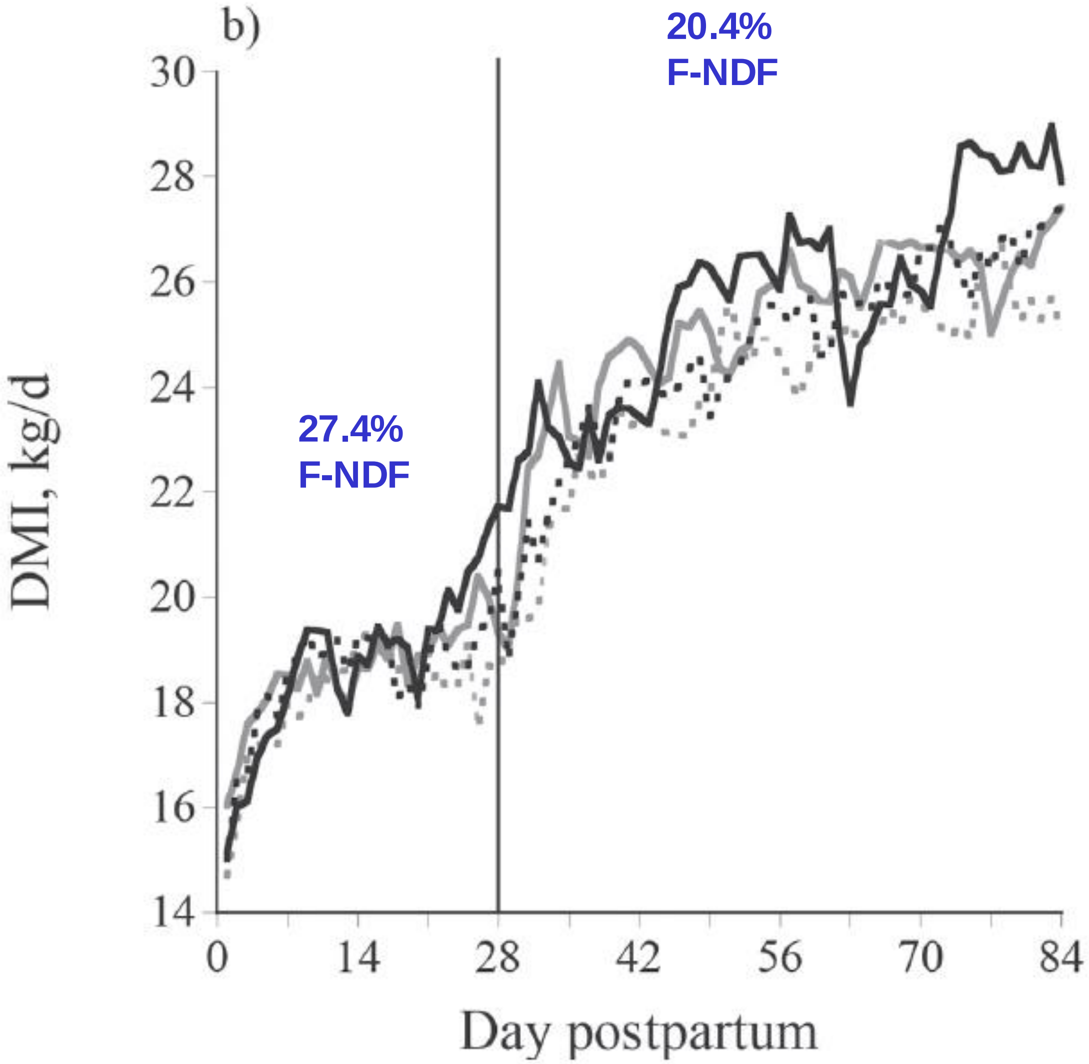


Figure 1. Plasma NEFA (A), BHBA (B), glucose (C), and energy balance (D) by time relative to calving, NEFA and BHBA reported as geometric means with back transformed 95% confidence intervals. Significant differences indicted with an asterisk (*), trends with a cross (†). Energy balance was calculated according to NRC (2001).

LaCount et al., 2017



Effects of chromium propionate (CrPr) and corn grain source on DMI (kg/d) over time during the treatment (1 to 28 d postpartum) and carryover (29 to 84 d postpartum) periods.

From Rockwell and Allen, 2016

MP and AA in the transition cow

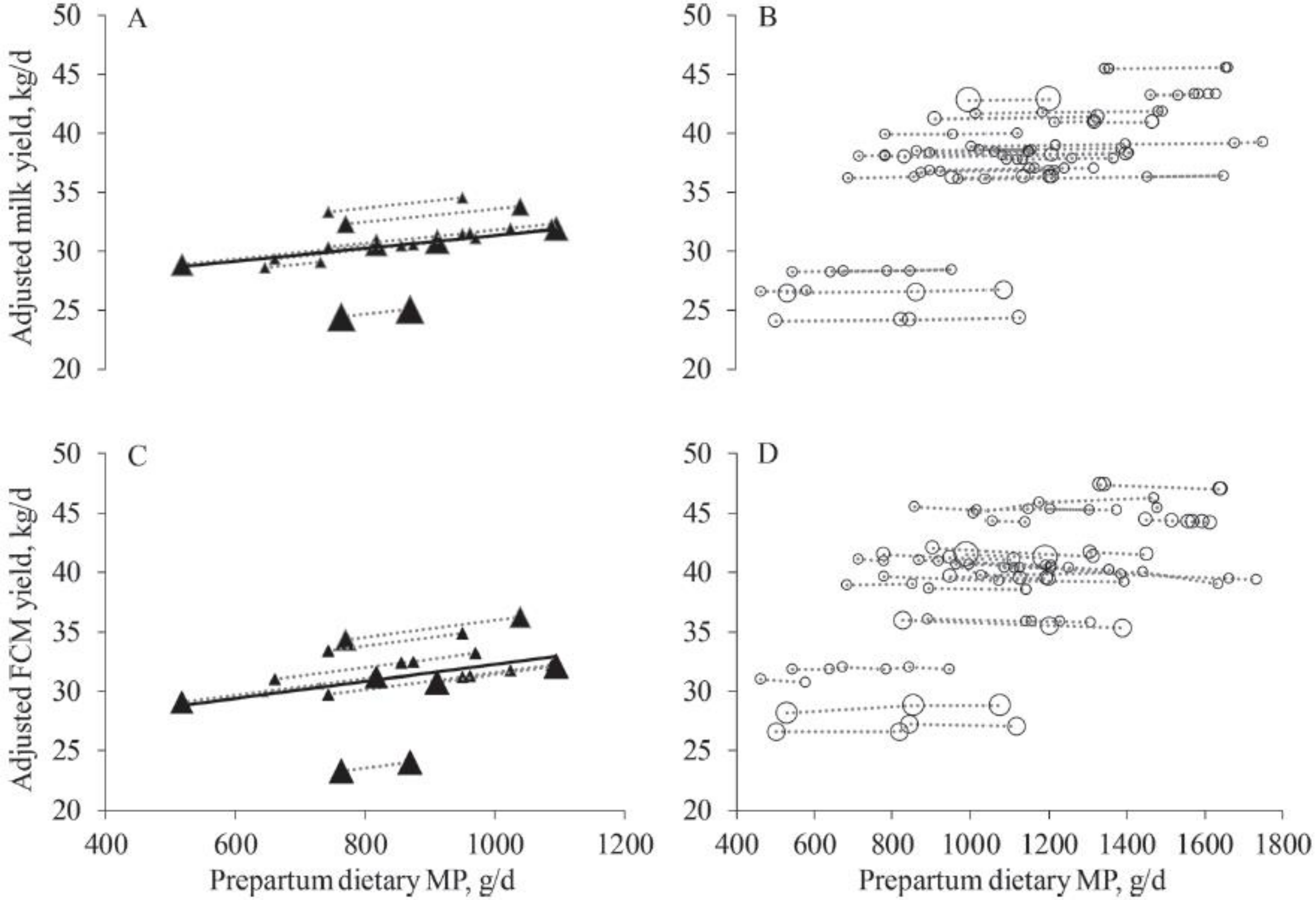


Figure 4. Postpartum performance in nulliparous (▲) and parous (○) cows according to the predicted supply of MP prepartum. Dotted lines

Increasing prepartum MP supply increases postpartum milk yield in nulliparous cows.

From Husnain and Santos, 2019

MP and AA recommendations prefresh

- Target 1200 to 1400 g/d MP (CNCPS 6.5 biology)
- Lysine ≥ 6.8 to 7.2 % of MP (CNCPS 6.5 biology)
- Methionine ≥ 2.6 – 2.8 % of MP (CNCPS 6.5 biology)
- Dr. Patrick French systematic review of literature and regression analysis (2012):
  - Suggests 1,300 g/d MP, 30 g/d Met, and 90 g/d Lys prepartum

- Focus protein supplementation pre-fresh on RUP sources with additional AA supplemented
  - Meet MP requirements more efficiently (feed less supplemental protein)
  - Cow metabolically does not handle excess N well at time of calving
  - Keep diet CP under 15%

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**

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…

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 RP-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

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

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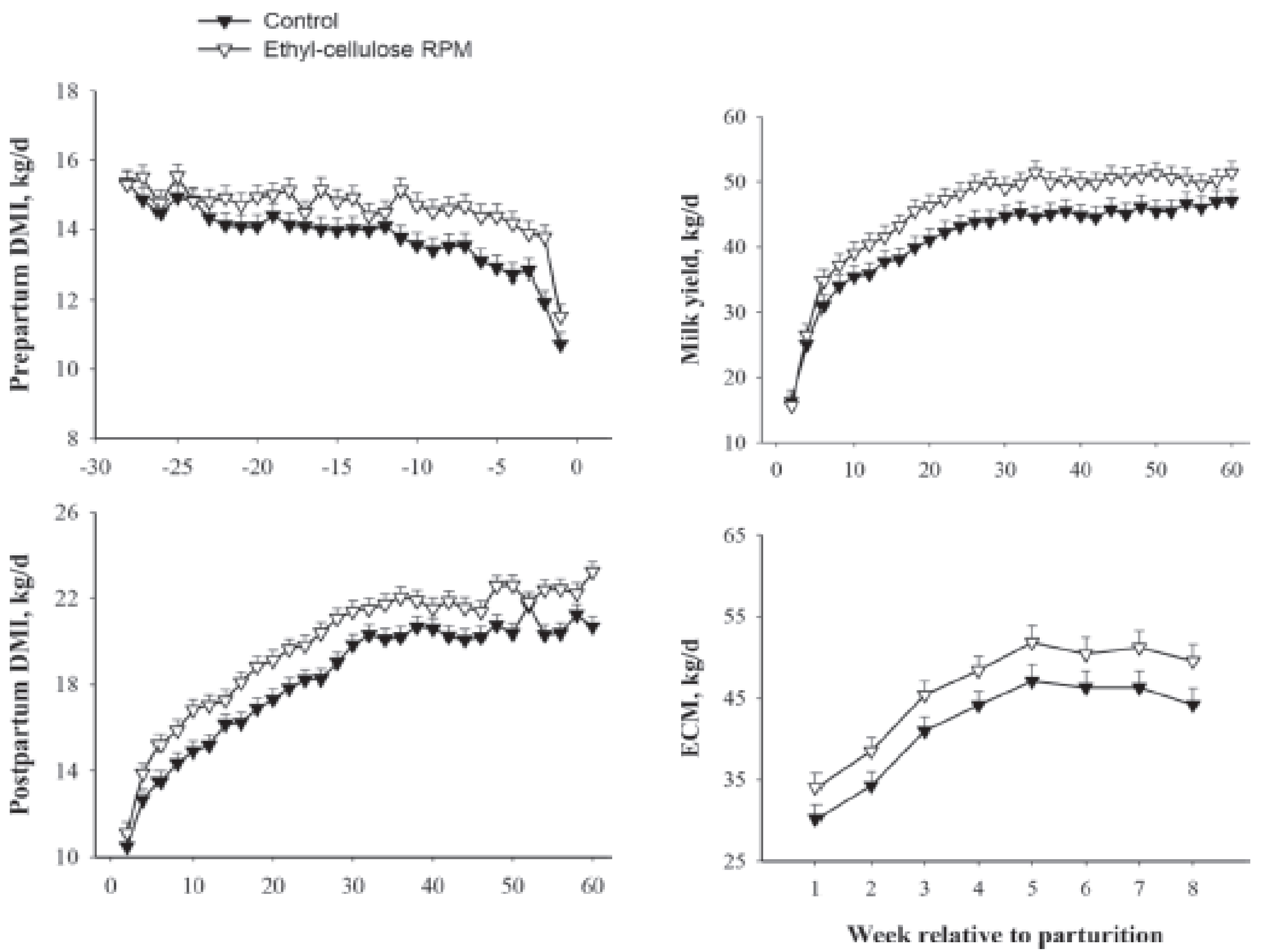
- 60 multiparous Holstein cows
- Treatments (- 28 d pre to 60 days post)
  - Control (Met ~ 1.7% of MP – NRC 2001)
  - Met (Met ~ 2.2 to 2.3% MP – NRC 2001)
- Lys ~ 6.5% MP prepartum; ~ 6.3 to 6.4% MP postpartum (NRC 2001)
- Ratio Lys:Met ~ 2.8 in RP-Met supplemented



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

What about rumen-protected lysine in transition cows?

J. Dairy Sci. 103:11386–11400
https://doi.org/10.3168/jds.2020-18542

Feeding rumen-protected lysine prepartum increases energy-corrected milk and milk component yields in Holstein cows during early lactation

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- 75 Holstein cows entering second or greater lactation
- 28 d prepartum through 28 d postpartum
- Four dietary treatments (AA predictions from CNCPS)
  - Pre-control (Lys 6.86% of MP), Post-control (Lys 6.27% of MP)
  - Pre- RP-Lys (Lys 8.24% of MP), Post control (Lys 6.27% of MP)
  - Pre- control (Lys 6.86% of MP), Post RP-Lys (Lys 7.15% of MP)
  - Pre- RP-Lys (Lys 8.24% of MP), Post RP-Lys (Lys 7.15% of MP)
- RP-Met also fed to all treatments (~2.96% of MP prepartum and ~ 2.55% of MP postpartum

Performance for cows fed RP-Lys during the prepartum and/or postpartum periods (Fehlberg et al., 2020)

Variable	Pre-Lys Post-Lys	Pre-Lys Post-control	Pre-control Post-Lys	Pre-control Post-Lys	SEM	P value, pre	P value, post
Pre-DMI, kg/d	12.1		11.8		0.21	0.31	
Post-DMI, kg/d	18.4	17.8	17.4	16.3	0.74	0.08	0.22
Milk, kg/d	40.8	41.1	40.1	37.1	1.65	0.15	0.40
Fat, %	4.44	4.56	4.59	4.31	0.16	0.73	0.59
Protein, %	3.31	3.24	3.32	3.32	0.05	0.44	0.50
ECM, kg/d	49.0	48.8	46.7	41.7	1.91	0.02	0.15
BW change, wk 1 to 4, kg	-28.8	-34.3	-33.0	-26.1	7.18	0.71	0.65
Efficiency, ECM/DMI	2.66	2.74	2.68	2.56			

MP and AA in the fresh cow

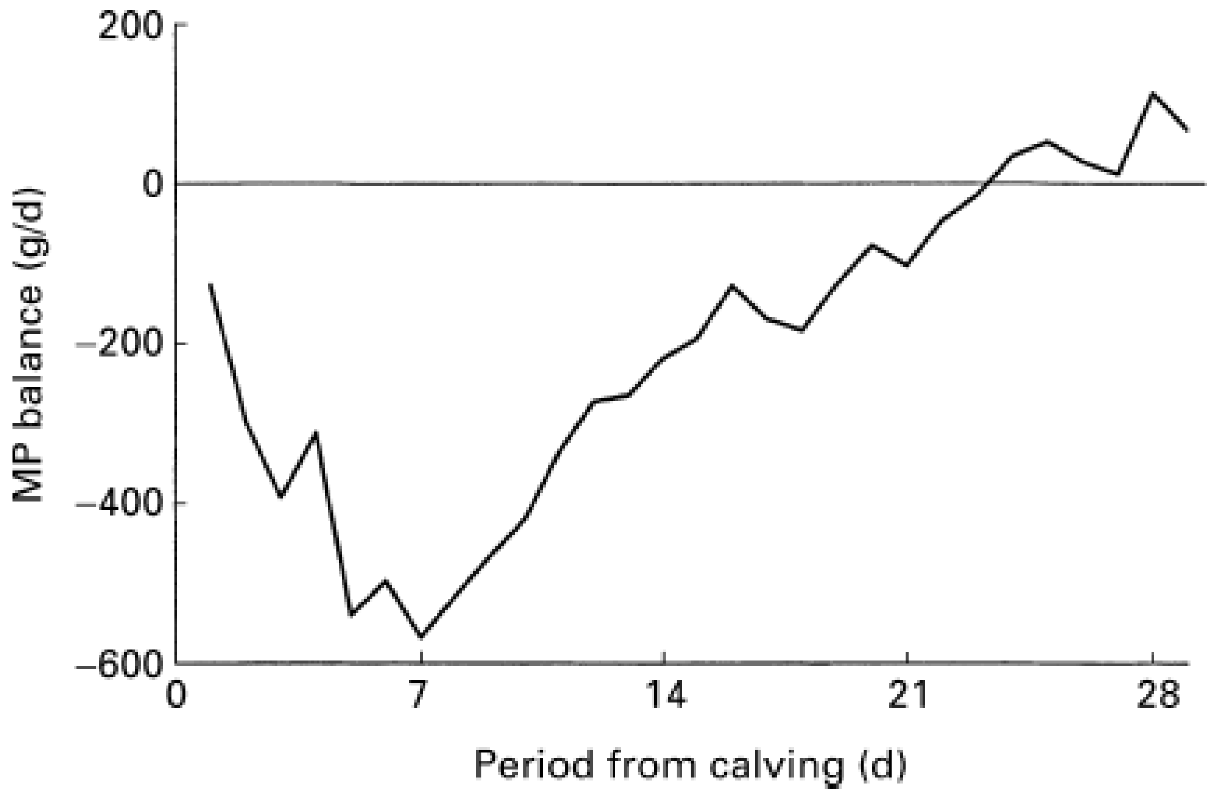


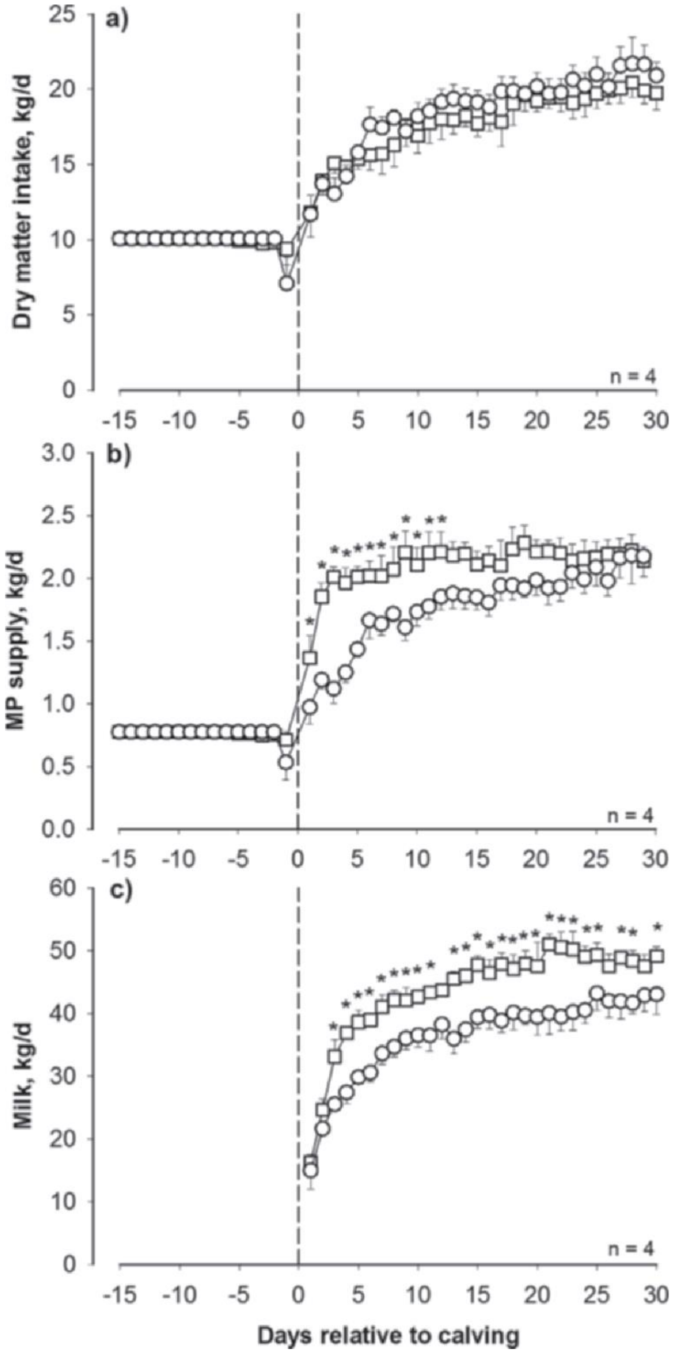
Fig. 1. Calculated metabolizable protein (MP) balance in post-parturient cows (*n* 80) fed on a ration containing (/kg DM) 178 g crude protein (nitrogen × 6·25) and 7·0 MJ net energy for lactation. Individual values were calculated from daily individual measurements of crude protein intake and milk yield, and weekly measurements of milk composition.

Bell et al., 2000

Increasing MP supply postpartum?

- 8 Holstein cows entering second lactation
- Received either water (control) or casein infused into the abomasum to meet approximate calculated deficit in MP
- Casein was supplied at 360 g/d at 1 DIM, 720 g/d at 2 DIM, followed by daily reductions of 19.5 g/d ending at 194 g/d at 29 DIM.

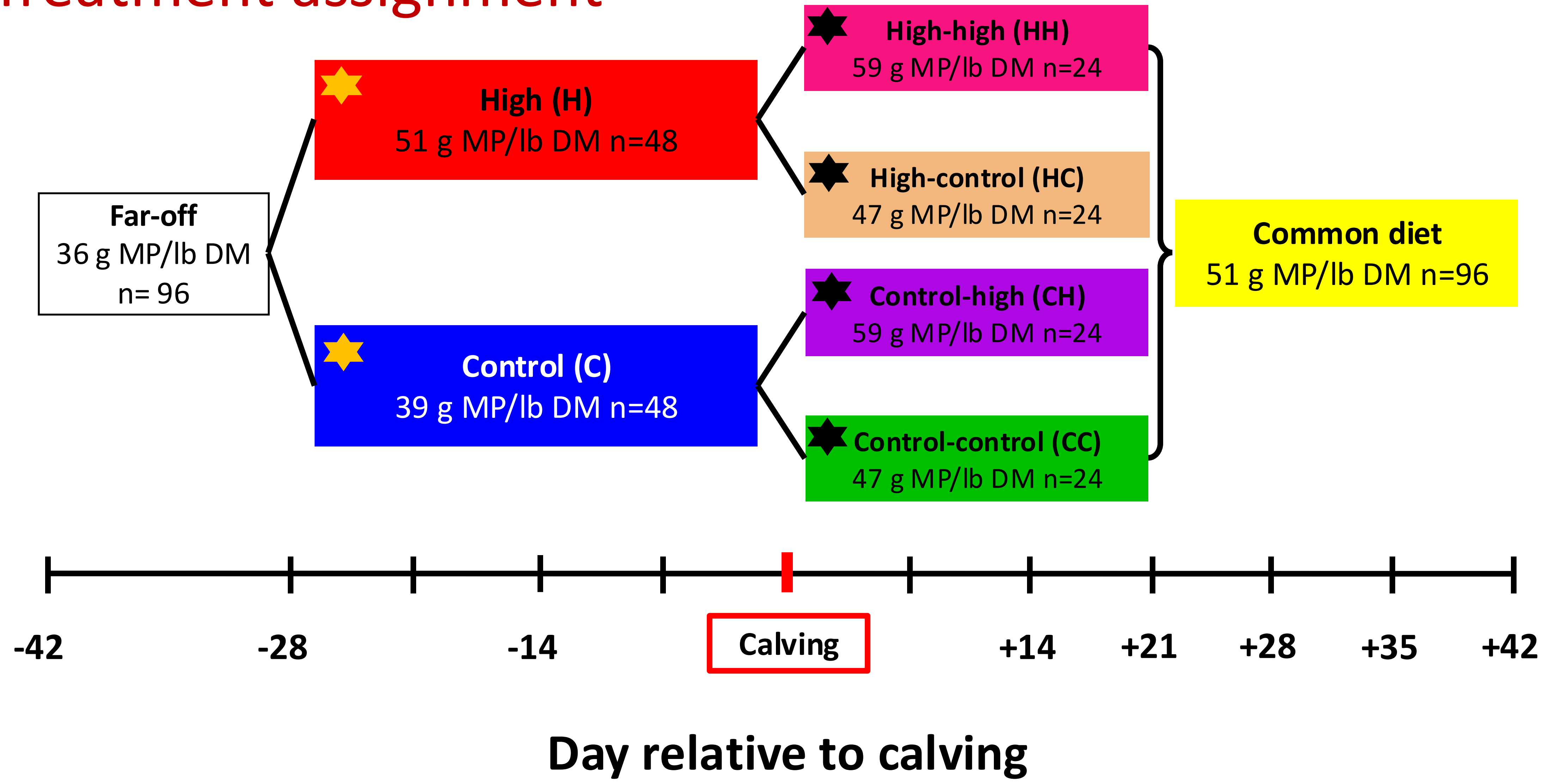
Larsen et al., 2014. J. Dairy Sci. 97:5608–5622



Milk yield was increased (~ 7.2 kg/d) in cows receiving additional MP by casein infusion postpartum

From Larsen et al., 2014. J. Dairy Sci. 97:5608–5622

Treatment assignment



- (yellow star) Methionine and lysine formulated at 1.24 and 3.86 g/Mcal metabolizable energy
- (black star) Methionine and lysine formulated at 1.15 and 3.20 g/Mcal metabolizable energy

Milk components (0 to 21 DIM)

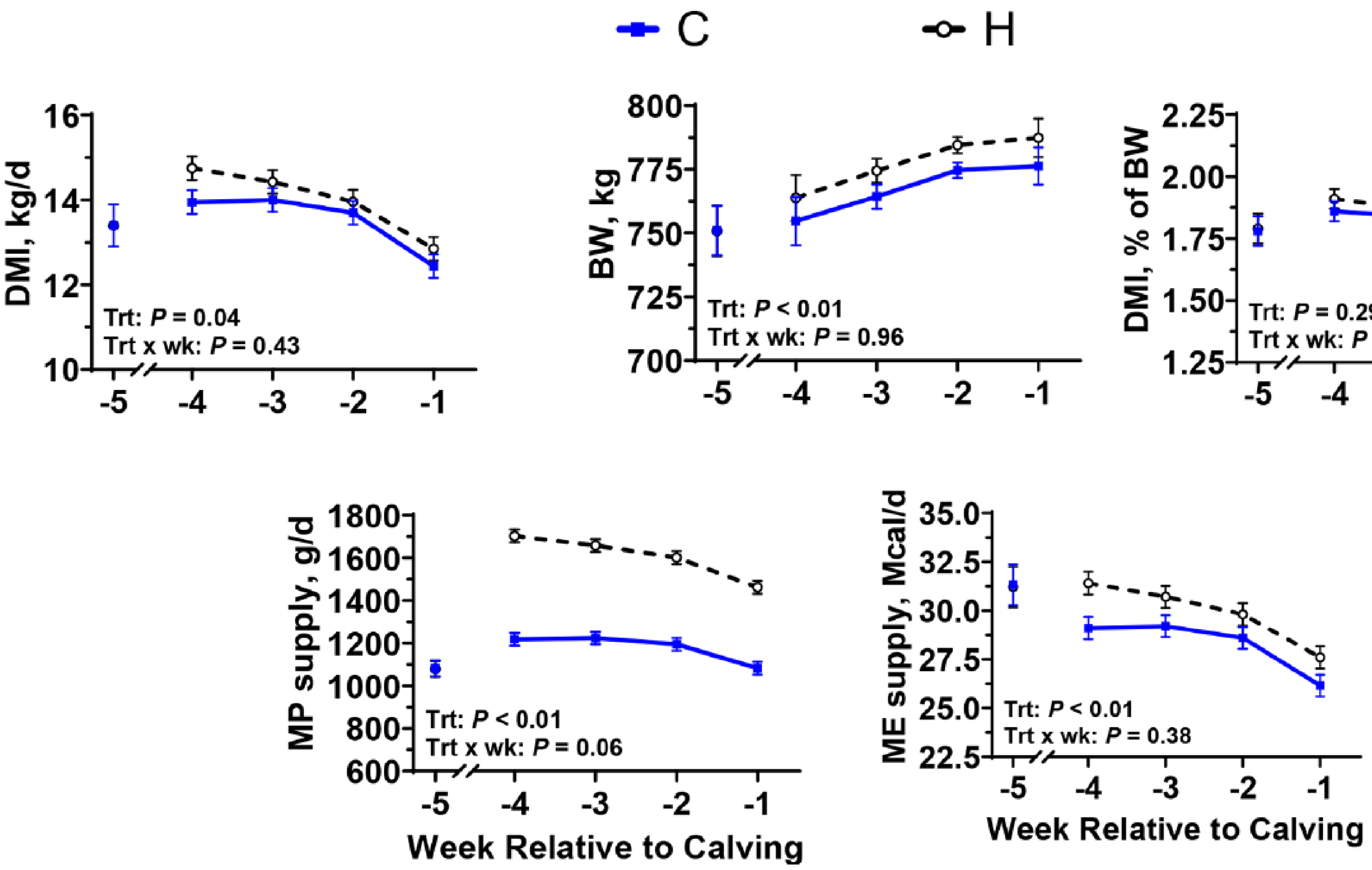
Variable	Treatment				*P*-value		
	CC	CH	HC	HH	Trt	Wk	Trt x Wk
Milk yield, lbs/d	86.4 ± 2.2[bc]	93.4 ± 2.0[ab]	83.8 ± 2.2[c]	98.5 ± 2.2[a]	< 0.01	< 0.01	< 0.01
Lactose, %	4.76 ± 0.02[b]	4.81 ± 0.02[a]	4.81 ± 0.02[ab]	4.79 ± 0.02[ab]	0.04	< 0.01	0.88

LSM ± SEM with different superscripts differ (P < 0.05; Tukey's test)

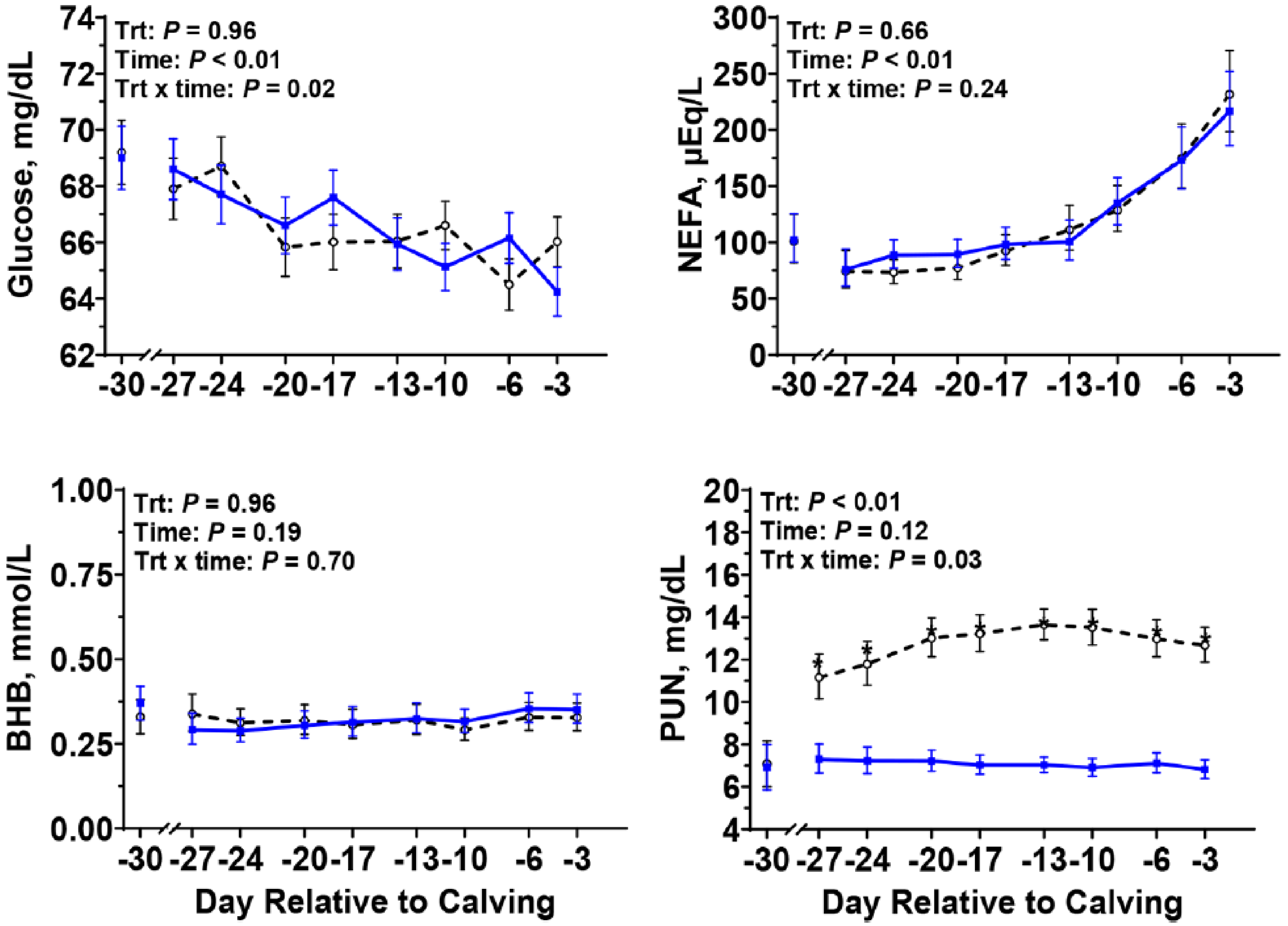
Milk components (22 to 42 DIM)

	Treatment				*P*-value		
Variable	CC	CH	HC	HH	Trt	Wk	Trt x Wk
Milk yield, lbs/d	109.3 ± 2.2[b]	117.5 ± 2.0[a]	108.7 ± 2.0[b]	119.2 ± 2.0[a]	< 0.01	< 0.01	0.21
Lactose, %	4.85 ± 0.01	4.86 ± 0.01	4.88 ± 0.01	4.85 ± 0.01	0.42	< 0.01	0.69
Fat, %	4.09 ± 0.09	4.28 ± 0.09	4.10 ± 0.10	4.11 ± 0.09	0.38	< 0.01	0.62
Protein, %	2.83 ± 0.03	2.82 ± 0.03	2.91 ± 0.03	2.79 ± 0.03	0.10	0.02	0.08
Total Solids, %	12.69 ± 0.11	12.89 ± 0.11	12.84 ± 0.11	12.70 ± 0.11	0.45	< 0.01	0.41

LSM ± SEM with different superscripts differ (P < 0.05; Tukey's test)



Westhoff et al., 2024. J. Dairy Sci. doi: 10.3168/jds.2024-25026



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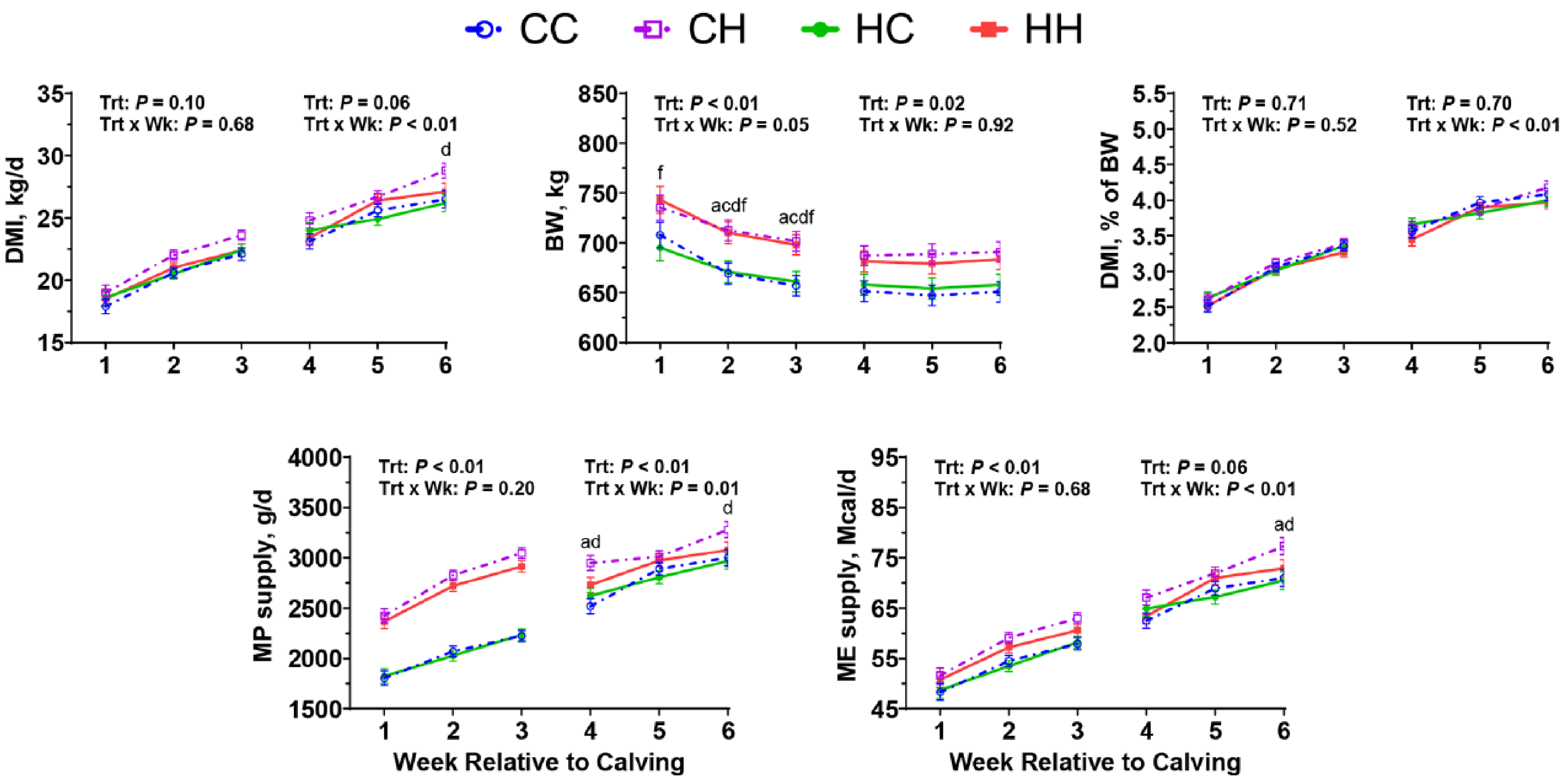

Westhoff et al., 2024. J. Dairy Sci. doi: 10.3168/jds.2024-25026

Table 7. Effect of increasing MP supply in the prepartum, postpartum, or both diets on postpartum plasma metabolic indicators

Variable[3]	Treatment[1]				*P*-value[2]			
	CC (n = 23)	CH (n = 24)	HC (n = 22)	HH (n = 23)	Trt	Time	Parity	Trt x time
1 to 21 DIM								
Glucose, mg/dL	55.1 ± 1.1[ab]	56.9 ± 1.1[ab]	57.2 ± 1.2[a]	53.1 ± 1.1[b]	0.03	<0.01	0.75	0.70
NEFA, μEq/L	591 (516–676)	521 (457–595)	572 (498–657)	600 (524–687)	0.41	<0.01	0.40	0.36
BHB, mmol/L	0.76 (0.65–0.88)[ab]	0.83 (0.72–0.96)[a]	0.60 (0.51–0.69)[b]	0.90 (0.78–1.05)[a]	<0.01	<0.01	0.22	0.50
PUN, mg/dL	4.3 (4.0–4.6)[c]	6.8 (6.3–7.3)[a]	4.8 (4.5–5.2)[b]	7.5 (7.0–8.1)[a]	<0.01	0.02	0.21	0.02
Hyperketonemia event[4]	9/69 (13.0%)	7/72 (9.7%)	2/66 (3.0%)	10/69 (14.5%)	0.13			
22 to 42 DIM								
Glucose, mg/dL	59.5 ± 1.1	59.2 ± 1.1	61.7 ± 1.1	59.0 ± 1.1	0.30	<0.01	0.75	0.05
NEFA, μEq/L	445 (371–534)[ab]	375 (314–448)[ab]	356 (296–428)[b]	495 (413–594)[a]	0.02	<0.01	0.85	0.52
BHB, mmol/L	0.74 (0.62–0.88)[ab]	0.82 (0.69–0.97)[a]	0.58 (0.49–0.70)[b]	0.87 (0.73–1.04)[a]	<0.01	<0.01	0.21	0.60
PUN, mg/dL	6.9 (6.3–7.4)	7.5 (6.9–8.1)	6.9 (6.3–7.4)	7.8 (7.2–8.5)	0.04	<0.01	0.97	<0.01

Westhoff et al., 2024. J. Dairy Sci. doi: 10.3168/jds.2024-25026

Other areas of opportunity in feeding the fresh cow

- Strategic use of nutrients and feed additives to modulate metabolism, health, and performance
  - RP-choline, RP-Met and RP-Lys, Cr, biotin, improved trace mineral sources
  - Monensin, yeast culture/yeast products, rumen buffers, mycotoxin mitigators
- Sugars in fresh cow diets
- Fatty acid nutrition
  - Essential FA and anti-inflammatory FA
- Macromineral nutrition
  - Ca and Mg

Thanks!!

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