FATTY ACID FORUM .COM

Pre- and Postpartum Nutritional Management

TO OPTIMIZE ENERGY BALANCE AND FERTILITY IN DAIRY COWS

Phil Cardoso, DVM, MS, PhD
Assistant Professor
Department of Animal Sciences

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

The Fatty Acid Forum sponsored by VIRTUS NUTRITION™
SMART SOLUTIONS FOR INNOVATIVE DAIRIES

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

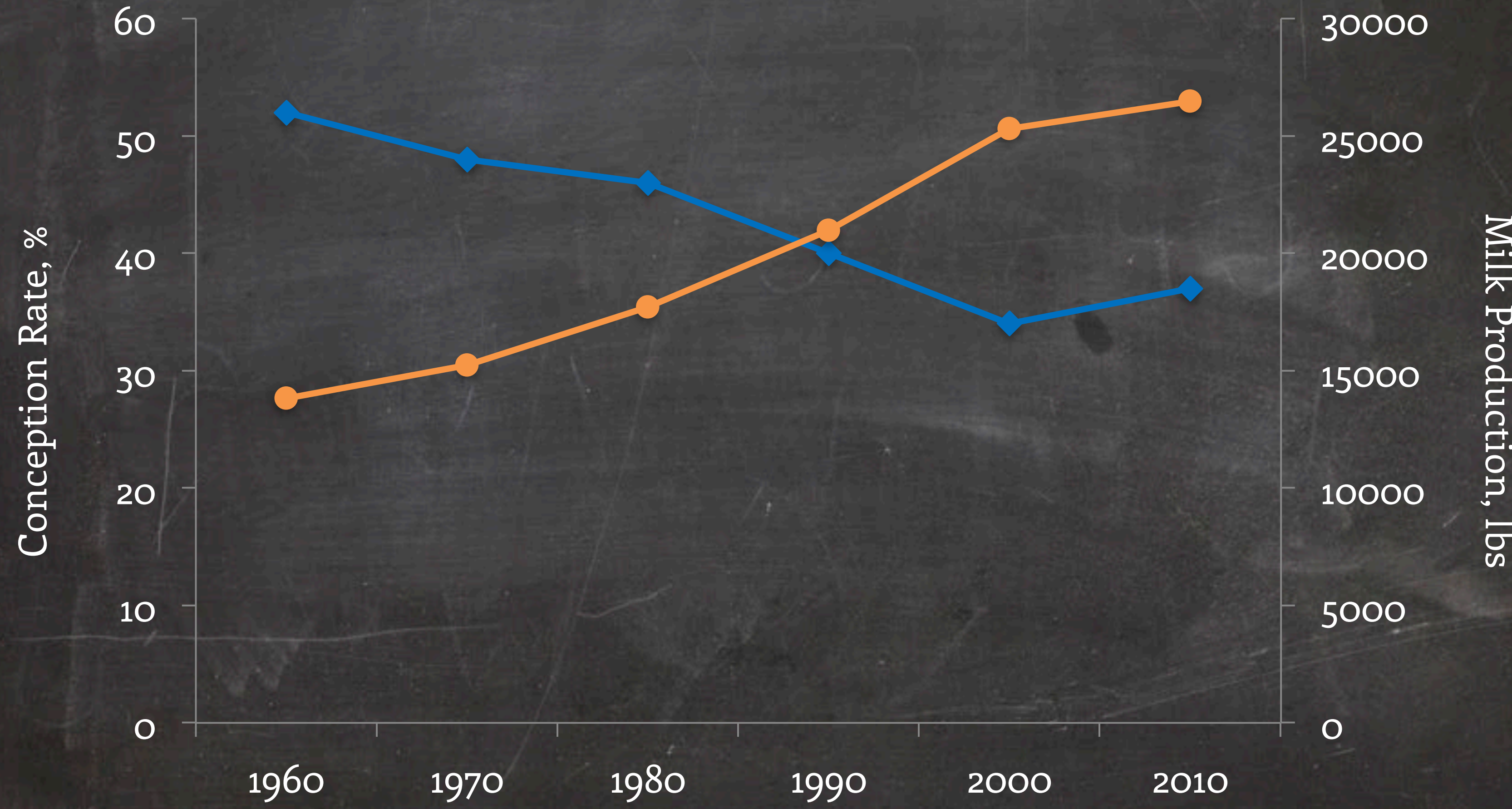
We should feed and manage dry and transition cows to:

- Minimize health disorders,
- Maximize production and reproduction

$$$

Pre- and Postpartum Nutritional Management

Evolution of Milk Production and Reproduction in the Last 50 years



Walsh,S.W. et al., 2011

Pre- and Postpartum Nutritional Management
Fertility and high milk production: Are they biologically compatible?

Quartile	Milk yield (kg/d)	Estrual cyclic. by d 65, %	Pregnant at d 30 post-AI, %	Pregnant at d 58 post-AI, %	Pregnancy loss d 30 to 58, %
1	32.1	72.7	37.2	30.3	12.7
2	39.1	77.6	38.9	29.8	11.6
3	43.6	77.6	39.3	33.7	12.8
4	50.0	75.3	37.6	35.3	15.6
P		0.002	0.74	0.008	0.57

6,396 cows on 4 TMR-fed farms in California

Santos et al., 2009

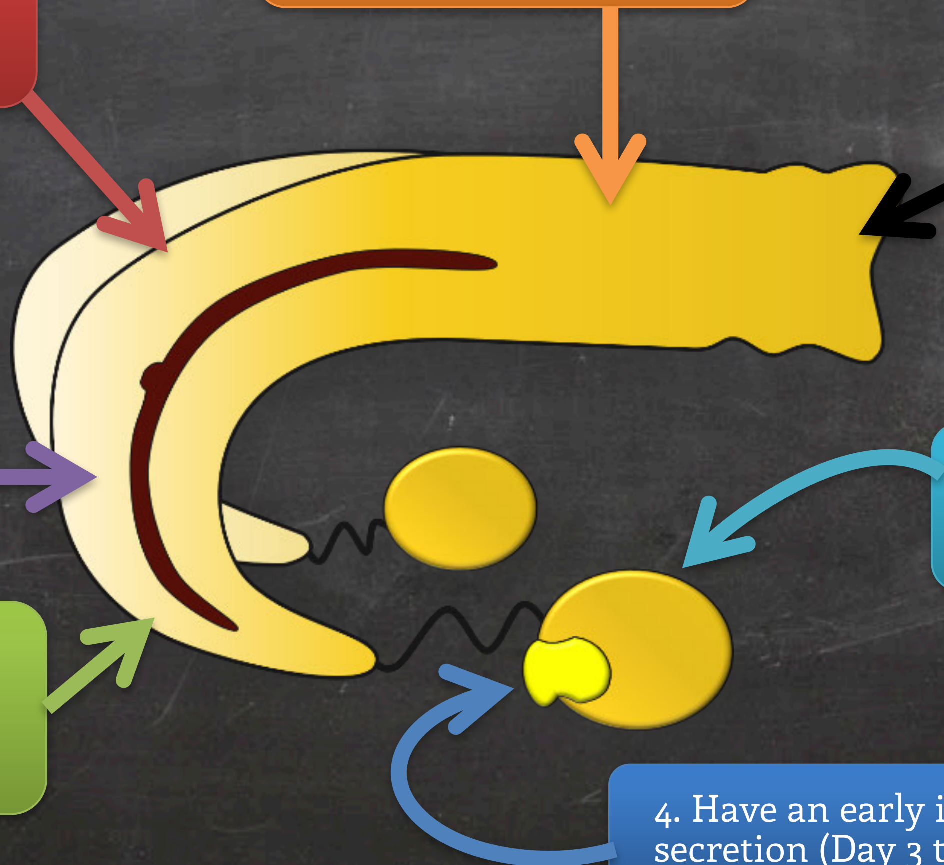
Pre- and Postpartum Nutritional Management
Reproduction: Early Embryonic Loss

Reference	Cows	Days 1st Check	Days last Check	Days	Loss %	Loss/ Day %
Chebel et al., 2002a	195	28	42	14	17.9	1.28
Moreira et al., 2000a	139	27	45	18	20.7	1.15
Chebel et al., 2002b	1,503	31	45	14	13.2	0.94
Stevenson et al., 2000	203	28	45	17	15.8	0.93
Santos et al., 2002b	360	31	45	14	11.1	0.79
Santos et al., 2002a	220	27	41	14	10	0.71
Cerri et al., 2002	176	31	45	14	9.7	0.70
Juchem et al., 2002	167	28	39	11	11.4	1.03

Daily embryonic loss in the first 50 days of pregnancy = 0.9%

Santos et al., 2009

Pre- and Postpartum Nutritional Management Factors Affecting Pregnancy in Dairy Cows



Walsh et al., 2011

Pre- and Postpartum Nutritional Management
Dietary Recommendations for Dry Cows

- NEL: Control energy intake at 14 to 16 Mcal daily [diet ~ 1.30 Mcal/kg (0.60 Mcal/lb) DM]
  for mature cows
- Crude protein: 12 – 14% of DM
- Metabolizable protein (MP): > 1,200 g/d
- Starch content: 12 to 16% of DM
- NDF from forage: 40 to 50% of total DM or 4.5 to 5 kg per head daily (~0.7 – 0.8% of BW). Target the high end of the range if more higher-energy fiber sources (like grass hay or low-quality alfalfa) are used, and the low end of the range if straw is used (2-5kg).
- Total ration DM content: <55% (add water if necessary)
- Minerals and vitamins: follow guidelines (For close-ups, target values are 0.40% magnesium (minimum), 0.35 – 0.40% sulfur, potassium as low as possible, a DCAD of near zero or negative, 0.27% phosphorus, and at least 1,500 IU of vitamin E)

Pre- and Postpartum Nutritional Management
Dietary Recommendations for Dry Cows

- NEL: Control energy intake at 14 to 16 Mcal daily [diet ~ 1.30 Mcal/kg (0.60 Mcal/lb) DM]
  for mature cows
- Crude protein: 12 – 14% of DM
- Metabolizable protein (MP): > 1,200 g/d

→ Methionine
Lysine

- Starch content: 12 to 16% of DM
- NDF from forage: 40 to 50% of total DM or 4.5 to 5 kg per head daily (~0.7 – 0.8% of BW). Target the high end of the range if more higher-energy fiber sources (like grass hay or low-quality alfalfa) are used, and the low end of the range if straw is used (2-5kg).
- Total ration DM content: <55% (add water if necessary)
- Minerals and vitamins: follow guidelines (For close-ups, target values are 0.40% magnesium (minimum), 0.35 – 0.40% sulfur, potassium as low as possible, a DCAD of near zero or negative, 0.27% phosphorus, and at least 1,500 IU of vitamin E)

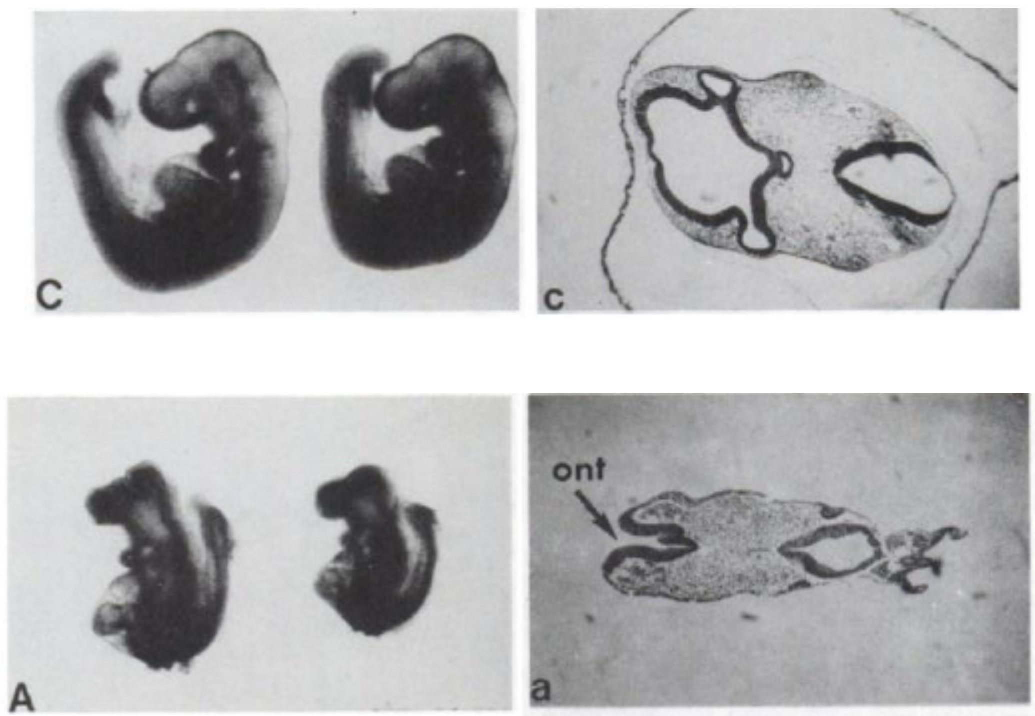
Pre- and Postpartum Nutritional Management
Can Methionine Prevent Embryonic Losses?

Pre- and Postpartum Nutritional Management
Can Methionine Prevent Embryonic Losses?

Whole Rat Embryos Require Methionine for Neural Tube Closure when Cultured on Cow Serum[1−4]

CAROLINE N. D. COELHO,*†‡[5] JAMES A. WEBER,*‡[6] NORMAN W. KLEIN,*†‡[7]
WILLARD G. DANIELS,§ AND THOMAS A HOAGLAND†

Center for Environmental Health, Department of Animal Science,† Department of Molecular and Cell Biology‡ and Department of Pathobiology,§ University of Connecticut, Storrs, CT 06269*



Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6^{a}	100%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6^{a}	100%
Amino acids + vitamins	130.0 ± 7.7^{b}	0%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 $\pm$ 8.6[a]	100%
Amino acids + vitamins	130.0 $\pm$ 7.7[b]	0%
Amino acids	117.1 $\pm$ 8.5[b]	0%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6[a]	100%
Amino acids + vitamins	130.0 ± 7.7[b]	0%
Amino acids	117.1 ± 8.5[b]	0%
Vitamins	56.6 ± 5.76[a]	100%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6[a]	100%
Amino acids + vitamins	130.0 ± 7.7[b]	0%
Amino acids	117.1 ± 8.5[b]	0%
Vitamins	56.6 ± 5.76[a]	100%
Amino acids w/o methionine	82.9 ± 8.7[a]	100%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6[a]	100%
Amino acids + vitamins	130.0 ± 7.7[b]	0%
Amino acids	117.1 ± 8.5[b]	0%
Vitamins	56.6 ± 5.76[a]	100%
Amino acids w/o methionine	82.9 ± 8.7[a]	100%
Methionine	133.7 ± 5.5[b]	0%

Coelho et al., 1989

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 ± 8.6[a]	100%
Amino acids + vitamins	130.0 ± 7.7[b]	0%
Amino acids	117.1 ± 8.5[b]	0%
Vitamins	56.6 ± 5.76[a]	100%
Amino acids w/o methionine	82.9 ± 8.7[a]	100%
Methionine	133.7 ± 5.5[b]	0%

Coelho et al., 1989

FATTY ACID FORUM .COM

Pre- and Postpartum Nutritional Management
Effects of Rumen-Protected Methionine/Choline Supplementation on the 1st Dominant Follicle

- 72 Holstein cows entering 2nd or greater lactation
- Experimental design was a randomized block design
- Housed in tie stalls with sand bedding
- Milked 3x per day
- Fed same basal TMR to meet but not exceed 100% of the energy requirements as outlined by NRC, 2001
  - From -34 d to calving: prepartum diet
  - From 0 to 30 DIM: fresh cow diet
  - From 31 to 72 DIM: high cow diet
- Treatments were given as top-dress

Acosta et al., 2016

Pre- and Postpartum Nutritional Management

Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

1. Rumen-protected methionine (MET; n = 20, received 0.08% of the DM of the diet/d as methionine, Smartamine M®, Adisseo, Alpharetta, GA, USA, to a Lys:Met = 2.9:1)
2. Rumen-protected choline (CHO; n = 17, received 60 g/d choline, Reassure, Balchem Corporation, New Hampton, NY)
3. Both rumen protected methionine and choline (MIX; n = 19, received 0.08% of the DM of the diet/d as methionine to a Lys:Met = 2.9:1 and 60 g/d choline)
4. No supplementation to serve as control (CON; n = 16, fed TMR with a Lys:Met = 3.5:1

Acosta et al., 2016

Pre- and Postpartum Nutritional Management
Diets

	Pre-Fresh -21 d to calving	Fresh Calving to 30 DIM	High 31 to 73 DIM
Ingredients		% DM	
Alfalfa silage	8.35	5.07	6.12
Alfalfa hay	4.29	2.98	6.94
Corn silage	36.40	33.41	35.09
Wheat straw	15.63	2.98	---
Cottonseed	---	3.58	3.26
Wet brewers grain	4.29	9.09	8.16
Soy hulls	4.29	4.18	4.74
Concentrate mix	26.75	38.71	35.69

Acosta et al., 2016

Pre- and Postpartum Nutritional Management Diets; Chemical Composition

Item	Pre-Fresh -21 d to calving	Fresh Calving to 30 DIM	High 31 to 73 DIM
		% DM	
DM, %	47.1	47.9	47.1
CP, % of DM	18.0	17.6	18.3
ADF, % of DM	22.7	24.4	23.2
NDF, % of DM	35.6	37.3	36.3
Lignin, % of DM	4.53	4.00	3.80
Starch, % of DM	22.3	21.4	23.6
Crude fat, % of DM	5.23	4.70	4.57

Acosta et al., 2016

Pre- and Postpartum Nutritional Management
Milk Yield and Components

	MET				*P*-value		
Parameter	With	Without	SEM	MET	Parity	Time	M × T
Milk composition (%)							
Fat	3.72	3.74	0.11	0.92	-	<0.01	0.58
Protein	3.32[a]	3.14[b]	0.05	<0.01	-	<0.01	0.67
SCC	1.86	1.81	0.07	0.55	-	<0.01	0.85
Lactose	4.70	4.69	0.03	0.79	<0.01	<0.01	0.90
Total solids	12.65	12.39	0.12	0.13	-	<0.01	0.24
Other solids	5.62	5.60	0.03	0.58	<0.01	<0.01	0.82
MUN	12.80	12.94	0.30	0.75	-	0.50	0.92
Milk production							
Milk yield	44.32[a]	40.32[b]	1.29	0.03	-	<0.01	0.60
Milk fat yield	1.67[a]	1.53[b]	0.05	0.04	-	<0.01	0.47
Milk protein yield	1.51[a]	1.33[b]	0.05	<0.01	-	<0.01	0.73
ECM	44.81[a]	40.25[b]	1.05	<0.01	-	<0.01	0.16

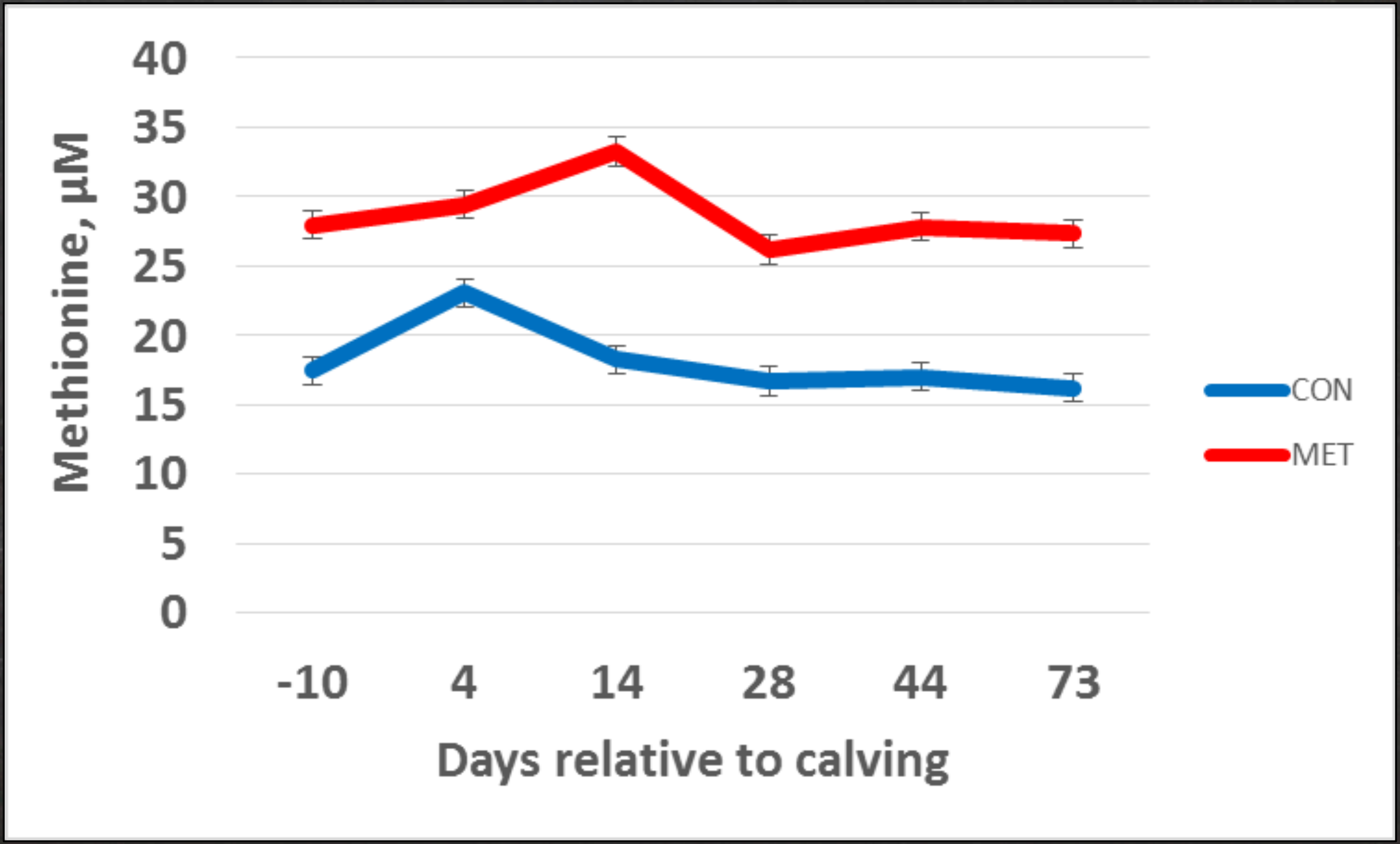
Zhou et al., 2016

Pre- and Postpartum Nutritional Management
Milk Yield and Components

	MET			*P*-value			
Parameter	With	Without	SEM	MET	Parity	Time	M × T
Milk composition (%)							
Fat	3.72	3.74	0.11	0.92	-	<0.01	0.58
Protein	3.32[a]	3.14[b]	0.05	<0.01	-	<0.01	0.67
SCC	1.86	1.81	0.07	0.55	-	<0.01	0.85
Lactose	4.70	4.69	0.03	0.79	<0.01	<0.01	0.90
Total solids	12.65	12.39	0.12	0.13	-	<0.01	0.24
Other solids	5.62	5.60	0.03	0.58	<0.01	<0.01	0.82
MUN	12.80	12.94	0.30	0.75	-	0.50	0.92
Milk production							
Milk yield	44.32[a]	40.32[b]	1.29	0.03	-	<0.01	0.60
Milk fat yield	1.67[a]	1.53[b]	0.05	0.04	-	<0.01	0.47
Milk protein yield	1.51[a]	1.33[b]	0.05	<0.01	-	<0.01	0.73
ECM	44.81[a]	40.25[b]	1.05	<0.01	-	<0.01	0.16

Zhou et al., 2016

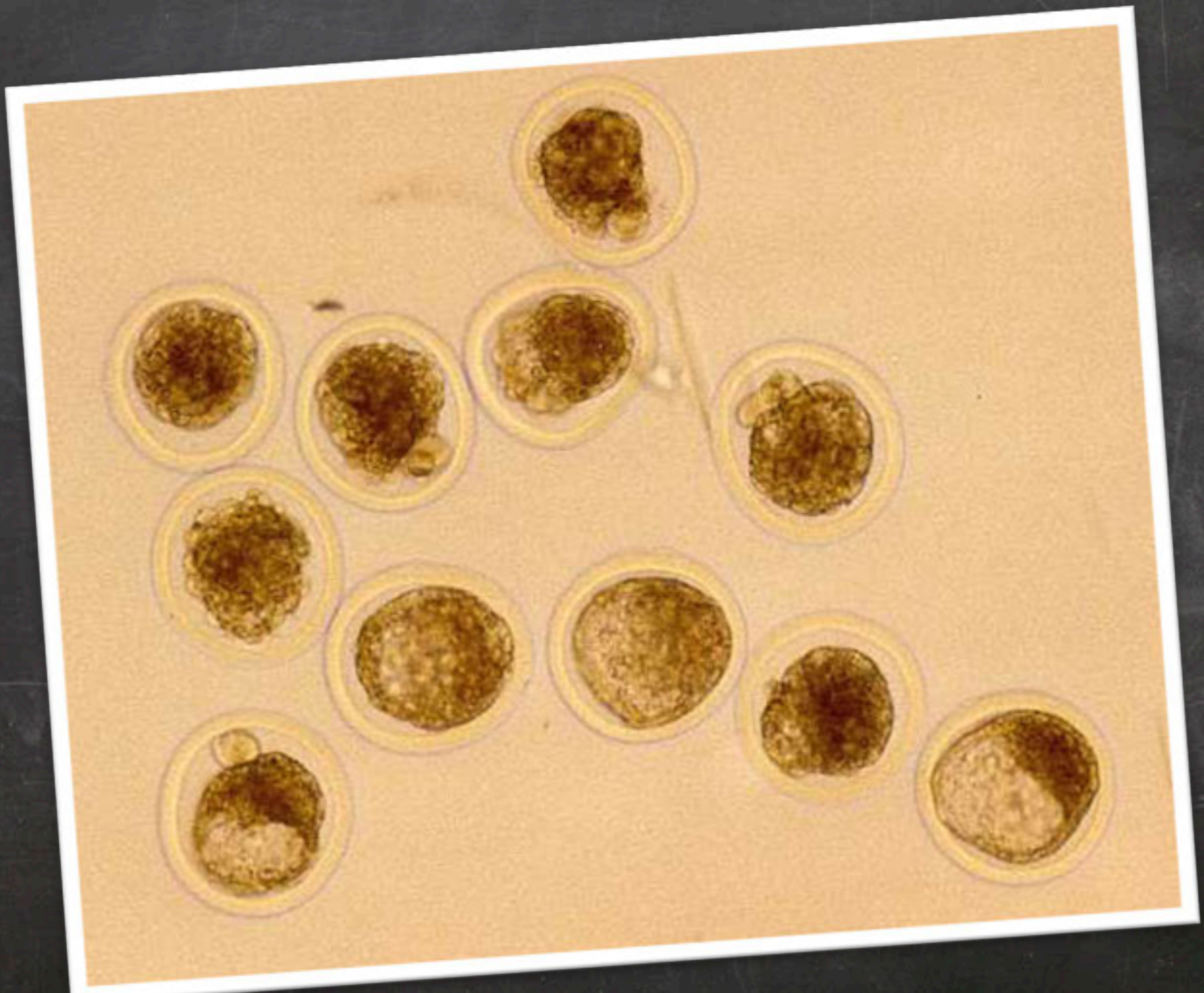
Pre- and Postpartum Nutritional Management
Serum Methionine Concentration from Cows Fed rumen-protected methionine (MET) or not (CON)



Stella et al., unpublished

Control: n = 7; Methionine: n = 10

Pre-and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows



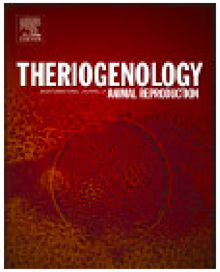
Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

Theriogenology 85 (2016) 1669–1679

Contents lists available at ScienceDirect

Theriogenology

journal homepage: www.theriojournal.com



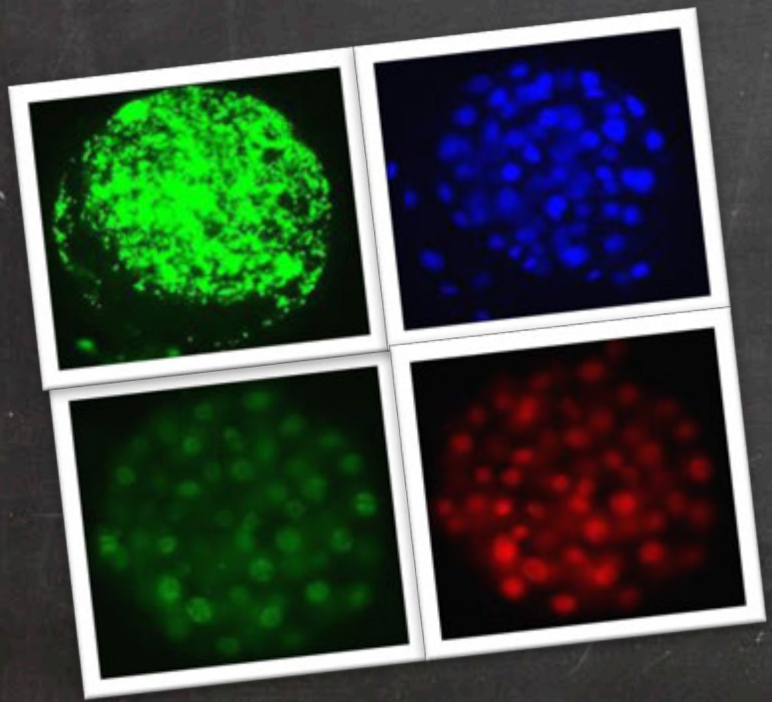
Effects of rumen-protected methionine and choline supplementation on the preimplantation embryo in Holstein cows

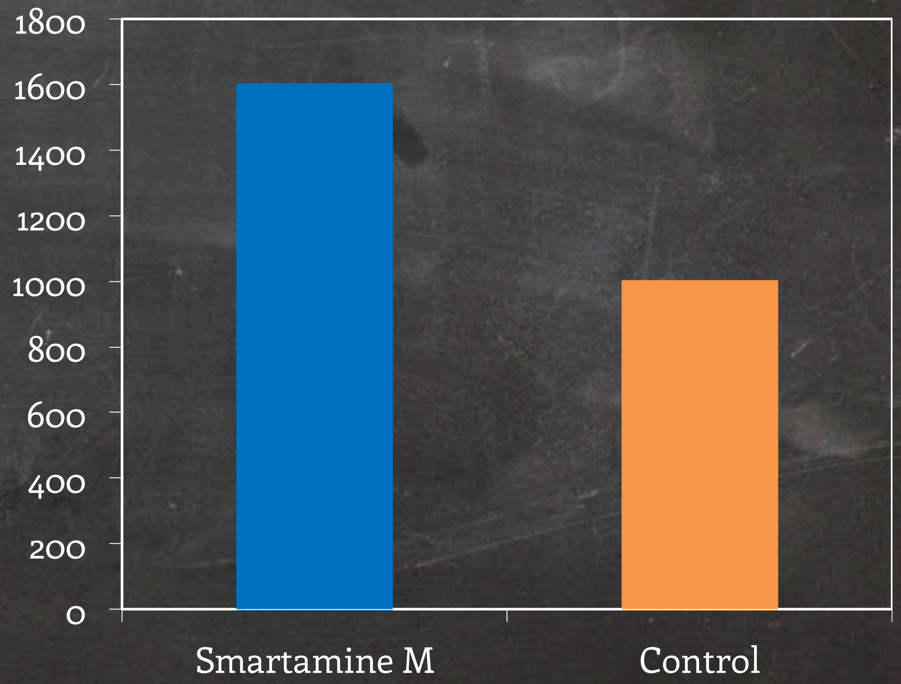
D.A.V. Acosta [a,b], A.C. Denicol [c,d], P. Tribulo [d], M.I. Rivelli [a], C. Skenandore [a], Z. Zhou [a], D. Luchini [e], M.N. Corrêa [b], P.J. Hansen [d], F.C. Cardoso [a,*]

[a] Department of Animal Sciences, University of Illinois, Urbana, Illinois, USA
[b] Faculty of Veterinary Medicine, Department of Clinics, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil
[c] Department of Biology, Northeastern University, Boston, Massachussets, USA
[d] Department of Animal Science, University of Florida, Gainesville, Florida, USA
[e] Adisseo NACA, Alpharetta, Georgia, USA

Pre- and Postpartum Nutritional Management
Effect of Methionine Supplementation from -21 DIM to 72 DIM on Lipid Accumulation of Preimplantation Embryos

Embryos (n= 37) harvested 7 d after timed AI at 63 DIM from cows fed a control diet or the control diet enriched with rumen-protected methionine.





Fluorescence intensity of Nike Red staining

Acosta et al., 2016

OPEN ACCESS Freely available online

PLOS ONE

Effect of Maternal Methionine Supplementation on the Transcriptome of Bovine Preimplantation Embryos

Francisco Peñagaricano[1], Alex H. Souza[2], Paulo D. Carvalho[2], Ashley M. Driver[1], Rocio Gambra[1], Jenna Kropp[1], Katherine S. Hackbart[2], Daniel Luchini[3], Randy D. Shaver[2], Milo C. Wiltbank[2]*, Hasan Khatib[1]*

1 Department of Animal Sciences, University of Wisconsin, Madison, Wisconsin, United States of America, **2** Department of Dairy Science, University of Wisconsin, Madison, Wisconsin, United States of America, **3** Adisseo USA Inc., Alpharetta, Georgia, United States of America

Penagaricano et al., 2013

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

OPEN ACCESS Freely availal | ONE

Effect of Ma... e Transcripton...

Francisco Peñagarican...
Jenna Kropp[1], Katheri...
Hasan Khatib[1]*

1 Department of Animal Sciences, Un... adison, Wisconsin, United States of America,

Table 3. Top 30 most significant genes that showed differential expression between control and methionine-rich treatment.

Gene	Name	log2 FC	FDR
LAPTM5	Lysosomal protein transmembrane 5	−14.9	4.7×10^{-9}
NKG7	Natural killer cell group 7 sequence	−13.6	4.4×10^{-8}
VIM	Vimentin	−13.8	1.8×10^{-7}
TYROBP	TYRO protein tyrosine kinase binding protein	−13.2	3.2×10^{-6}
IFI6	Interferon, alpha-inducible protein 6	−12.6	1.5×10^{-5}
CUFF.2147.1	*Novel transcript unit*	−8.2	1.5×10^{-5}
LOC505451	Olfactory receptor, family 1, subfamily J, member 2-like	−13.0	1.5×10^{-5}
SLAMF7	Signaling lymphocyte-activating molecule family 7 family member 7	−10.4	3.5×10^{-5}
LOC788199	Olfactory receptor 6C74-like	−10.4	7.6×10^{-5}
LCP1	Lymphocyte cytosolic protein 1 (L-plastin)	−9.9	1.1×10^{-4}
LOC100849660	*Uncharacterized*	11.9	2.2×10^{-4}
BLA-DQB	MHC class II antigen	−11.1	2.2×10^{-4}
SHC2	SHC (Src homology 2 domain containing) transforming protein 2	−11.5	3.4×10^{-4}
NT5C3	5′-nucleotidase, cytosolic III	−11.5	3.5×10^{-4}
LOC510193	Apolipoprotein L, 3-like	7.8	4.3×10^{-4}
LOC100848815	SLA class II histocompatibility antigen, DQ haplotype D alpha chain-like	−11.4	4.3×10^{-4}
CUFF.606.1	*Novel transcript unit*	−5.6	4.3×10^{-4}
LOC100850656	*Uncharacterized*	−11.2	4.8×10^{-4}
SLC11A1	Solute carrier family 11 (proton-coupled divalent metal ion transporters), member 1	−10.7	6.9×10^{-4}
LOC100852347	Beta-defensin 10-like	−11.2	7.3×10^{-4}
LOC100297676	C-type lectin domain family 2 member G-like	−6.8	9.2×10^{-4}
BCL2A1	BCL2-related protein A1	−7.1	1.2×10^{-3}
INSR	Insulin receptor	−5.1	1.3×10^{-3}
NOVA1	Neuro-oncological ventral antigen 1	−10.6	1.5×10^{-3}
TBX15	T-box 15	−11.2	2.2×10^{-3}
TMEM200C	Transmembrane protein 200C	−6.6	2.2×10^{-3}
GPNMB	Glycoprotein (transmembrane) nmb	−7.5	2.3×10^{-3}
ARHGAP9	Rho GTPase activating protein 9	−5.7	2.7×10^{-3}
EIF4E1B	Eukaryotic translation initiation factor 4E family member 1B	−11.3	3.1×10^{-3}
LOC100295170	Protein BEX2-like	−9.3	3.5×10^{-3}

A negative log2 Fold Change (FC) value means that the gene showed higher expression in control treatment while a positive value means that the gene showed higher expression in methionine-rich treatment.

doi:10.1371/journal.pone.0072302.t003

Penagaricano et al., 2013

Pre- and Postpartum Nutritional Management To Optimize Energy Balance and Fertility in Dairy Cows

OPEN ACCESS Freely availal

ONE

Effect of Ma… Transcripton…

Francisco Peñagarican…
Jenna Kropp[1], Katheri…
Hasan Khatib[1]*

Table 3. Top 30 most significant genes that showed differential expression between control and methionine-rich treatment.

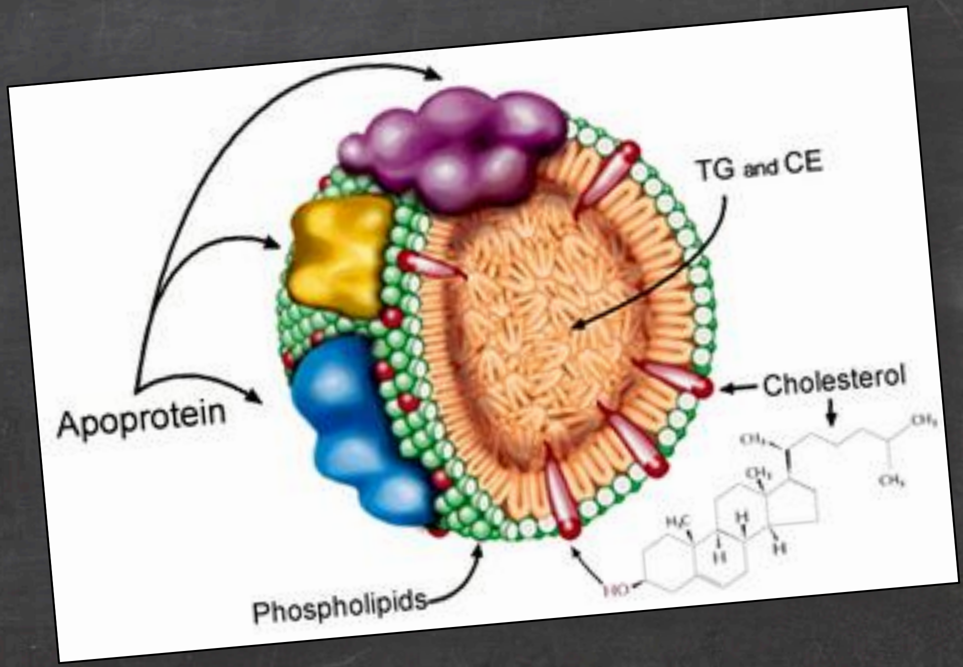
Gene	Name	log2 FC	FDR
LAPTM5	Lysosomal protein transmembrane 5	−14.9	4.7×10^{-9}
NKG7	Natural killer cell group 7 sequence	−13.6	4.4×10^{-8}
VIM	Vimentin	−13.8	1.8×10^{-7}
TYROBP	TYRO protein tyrosine kinase binding protein	−13.2	3.2×10^{-6}
IFI6	Interferon, alpha-inducible protein 6	−12.6	1.5×10^{-5}
CUFF.2147.1	*Novel transcript unit*	−8.2	1.5×10^{-5}
LOC505451	Olfactory receptor, family 1, subfamily J, member 2-like	−13.0	1.5×10^{-5}
SLAMF7	Signaling lymphocyte-activating molecule family 7 family member 7	−10.4	3.5×10^{-5}
LOC788199	Olfactory receptor 6C74-like	−10.4	7.6×10^{-5}
LCP1	Lymphocyte cytosolic protein 1 (L-plastin)	−9.9	1.1×10^{-4}
LOC100849660	*Uncharacterized*	11.9	2.2×10^{-4}
BLA-DQB	MHC class II antigen	−11.1	2.2×10^{-4}
LOC100849660	*Uncharacterized*	11.9	2.2×10^{-4}
LOC510193	Apolipoprotein L, 3-like	7.8	4.3×10^{-4}
CUFF.606.1	*Novel transcript unit*	−5.6	4.3×10^{-4}
LOC100850656	*Uncharacterized*	−11.2	4.8×10^{-4}
SLC11A1	Solute carrier family 11 (proton-coupled divalent metal ion transporters), member 1	−10.7	6.9×10^{-4}
LOC100852347	Beta-defensin 10-like	−11.2	7.3×10^{-4}
LOC100297676	C-type lectin domain family 2 member G-like	−6.8	9.2×10^{-4}
BCL2A1	BCL2-related protein A1	−7.1	1.2×10^{-3}
INSR	Insulin receptor	−5.1	1.3×10^{-3}
NOVA1	Neuro-oncological ventral antigen 1	−10.6	1.5×10^{-3}
TBX15	T-box 15	−11.2	2.2×10^{-3}
TMEM200C	Transmembrane protein 200C	−6.6	2.2×10^{-3}
GPNMB	Glycoprotein (transmembrane) nmb	−7.5	2.3×10^{-3}
ARHGAP9	Rho GTPase activating protein 9	−5.7	2.7×10^{-3}
EIF4E1B	Eukaryotic translation initiation factor 4E family member 1B	−11.3	3.1×10^{-3}
LOC100295170	Protein BEX2-like	−9.3	3.5×10^{-3}

A negative log2 Fold Change (FC) value means that the gene showed higher expression in control treatment while a positive value means that the gene showed higher expression in methionine-rich treatment.

doi:10.1371/journal.pone.0072302.t003

Penagaricano et al., 2013

Pre- and Postpartum Nutritional Management



Apolipoproteins are involved in the transport and metabolism of lipids, including cholesterol, and allow the binding of lipids to organelles

Methionine influences lipid metabolism in the preimplantation embryo

Penagaricano et al., 2013

Pre- and Postpartum Nutritional Management
Effect of Supplementation with Smartamine M on Reproduction of Lactating Dairy Cows

Cows were fed a basal TMR (6.9% Lys of MP and 1.87% Met of MP) from 30 ± 2 to 128 ± 2 DIM and assigned to two treatments:

RPM: Basal TMR top dressed daily with Smartamine M

CON: Basal diet top dressed daily with DDG

Toledo et al., unpublished

Pre- and Postpartum Nutritional Management
Effect of Supplementation with Smartamine M on Reproduction of Lactating Dairy Cows

RPM cows were top dressed with 50 g (29 g of DDG and 21 g of Smartamine M)

CON cows were top dressed with 50 g of DDG

RPM

CON

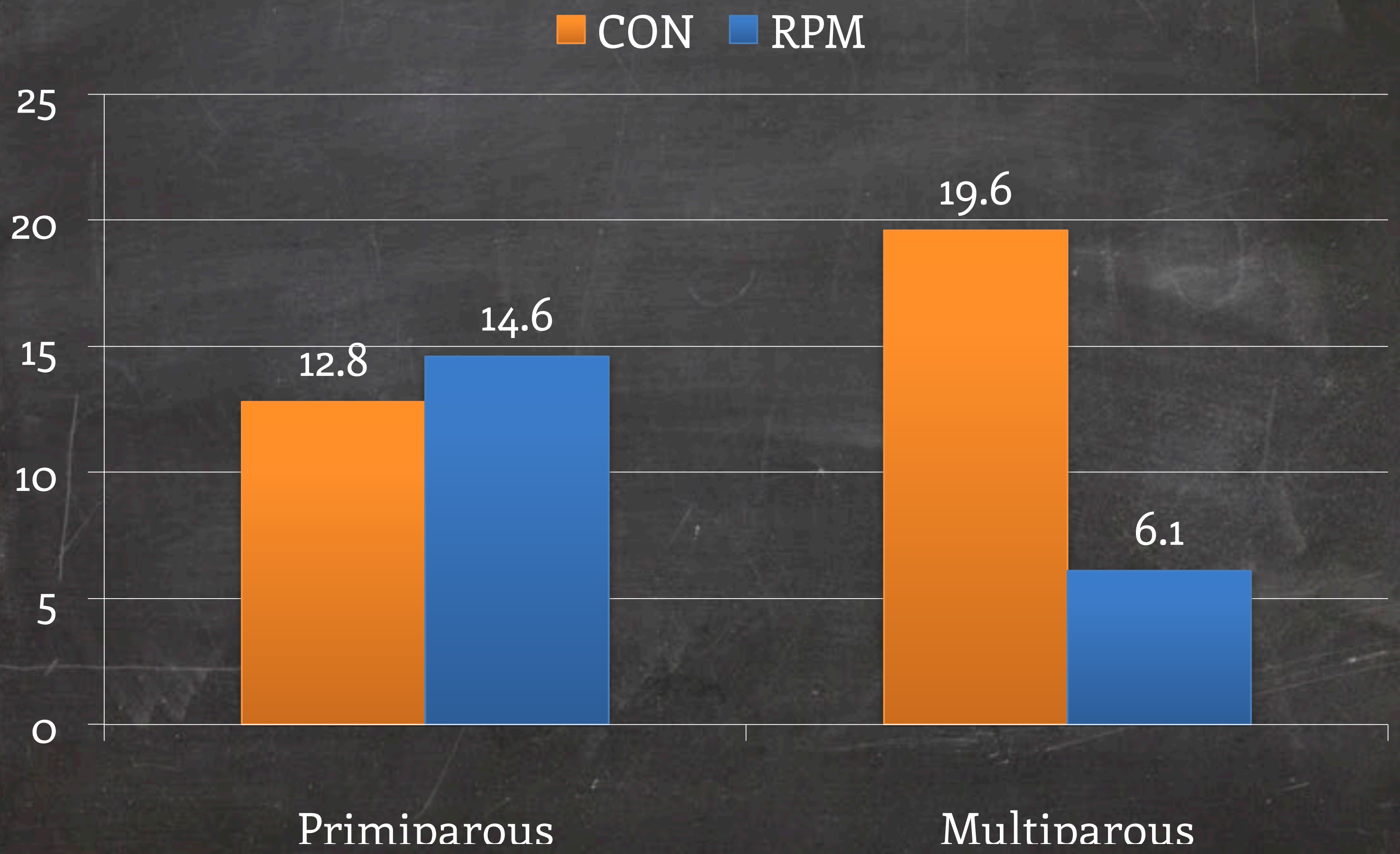
Toledo et al., unpublished

Pre- and Postpartum Nutritional Management
Animals

	CONTROL	RPM	TOTAL
Primiparous	68	70	138
Multiparous	85	86	171
TOTAL	153	156	309

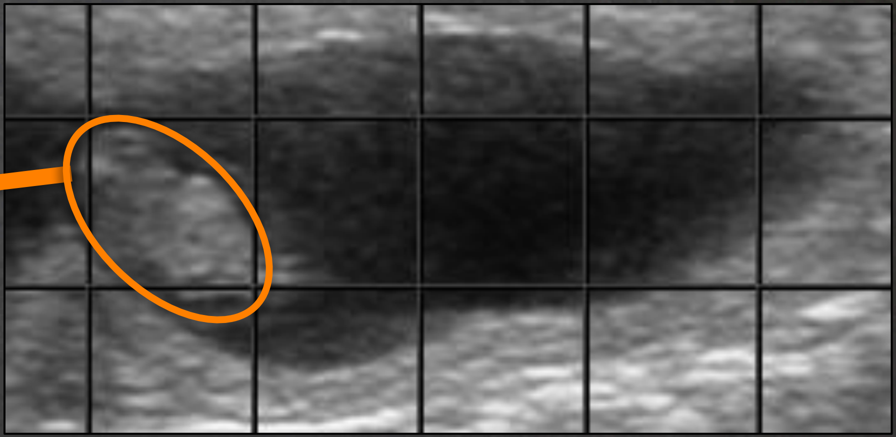
Toledo et al., unpublished

Pre- an Postpartum Nutritional Management
Pregnancy Losses (%) from 28 to 61 days after AI



Toledo et al., unpublished

Pre- and Postpartum Nutritional Management
Amniotic Vesicle Size



Day 33	n	Volume (mm^3) ± SEM
Primiparous		
Control	31	610.6 ± 38.6
RPM	36	596.0 ± 36.9
P-value		0.71
Multiparous		
Control	35	472.3 ± 28.6
RPM	45	592.1 ± 46.0
P-value		0.05

Toledo et al., unpublished

Is Embryo Lipid Composition (▲) Associated with Lower Embryonic Death in Dairy Cows?

Pre- and Postpartum Nutritional Management
Summary

- Rumen-protected methionine increased methionine concentration in serum and follicular fluid of dairy cows.
- The cow's pregnancy success starts during the transition phase.
- Amino acid balancing (methionine) from pre-fresh to confirmed pregnancy may not only improve milk production and composition, it may also improve embryo quality and reduce early embryo losses.

FATTY ACID FORUM .COM

The Fatty Acid Forum sponsored by VIRTUS NUTRITION™

SMART SOLUTIONS FOR INNOVATIVE DAIRIES