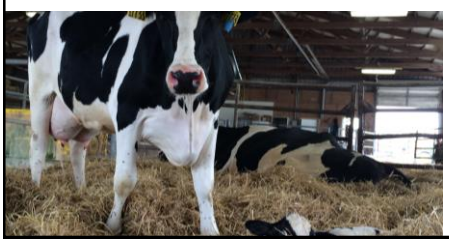


Impact of Supplementing Fatty Acids on Performance and Digestibility in Dairy Cows

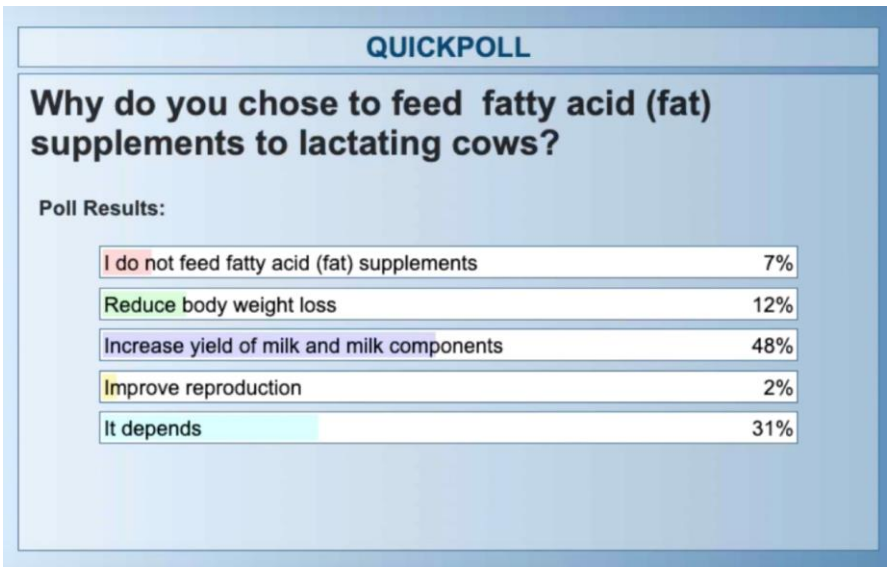
Jonas de Souza, PhD

Director of Tech Services and R&D

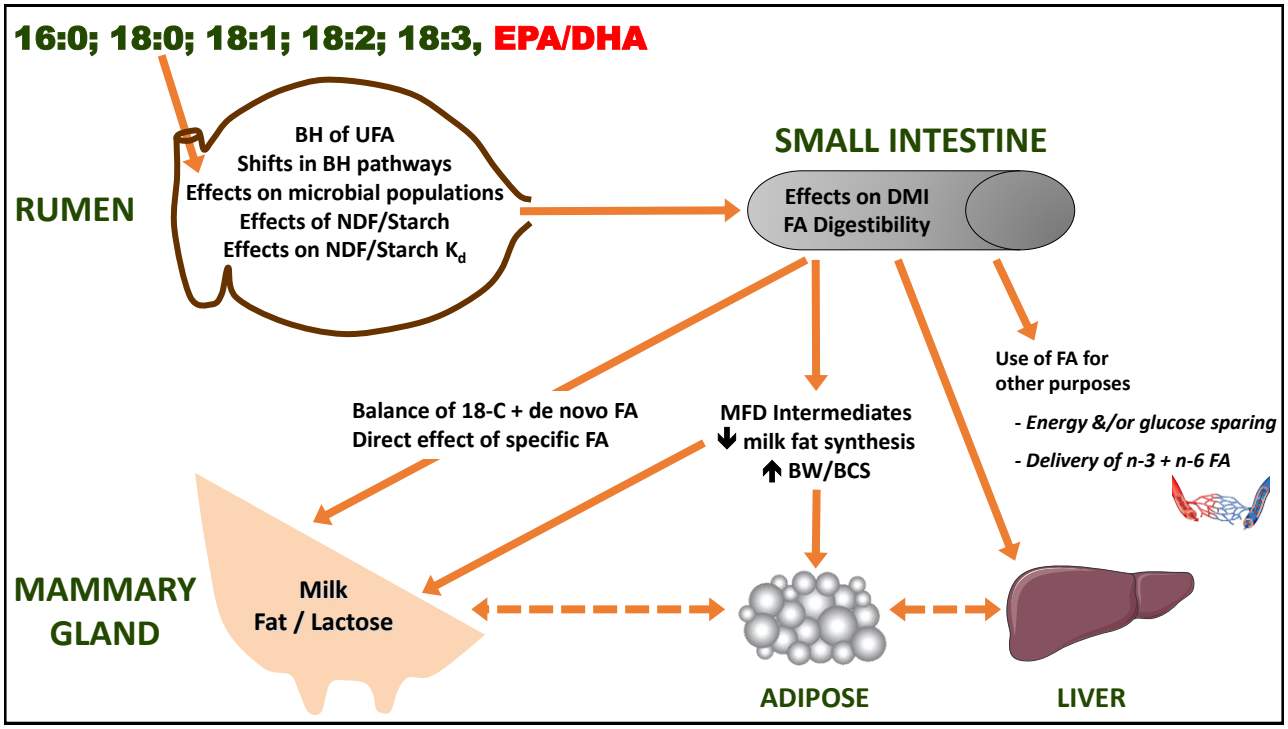
Perdue Animal Nutrition

1

Why do We Feed Fatty Acids to Dairy Cows?

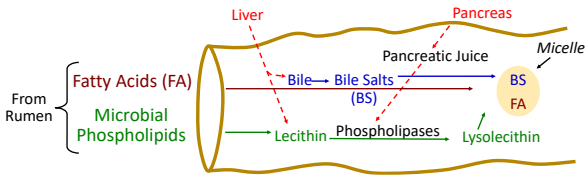


2

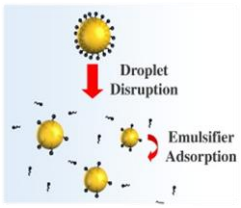


3

What Limits/Impacts FA Digestibility?



- Profile of FA reaching the duodenum
- Emulsification capacity
- Total FA flow to the duodenum
- Degree of esterification/physical form

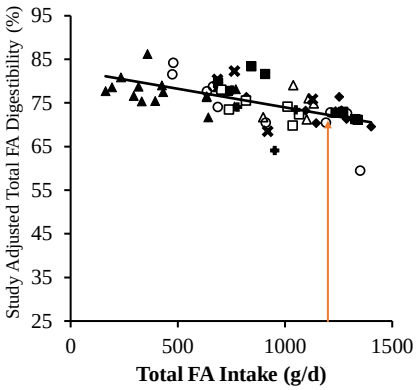


➢ The ability of ruminants to absorb SFA is much higher than that of non-ruminants
- In most feeding situations, C18:0 is the predominant FA available for absorption
- **The greatest opportunity will be to improve C18:0 absorption and/or limit its effects on the absorption of other FA**

4

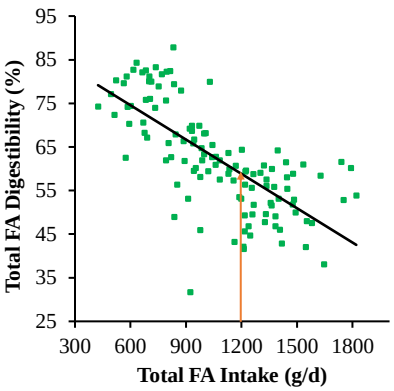
Apparent Intestinal Digestibility of Fatty Acids

Intestinal Digestibility
Meta Analysis



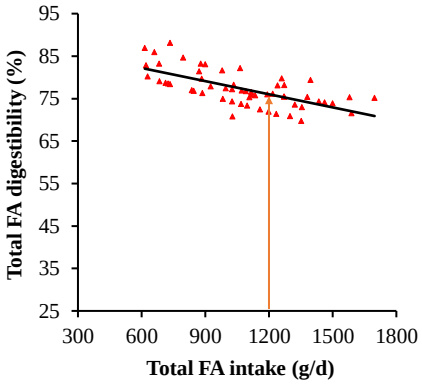
Boerman et al. 2015.
J. Dairy Sci. 98:8889–8903

Dose Response C18:0
Supplementation Study



Boerman et al. 2017.
J. Dairy Sci. 100:1-10

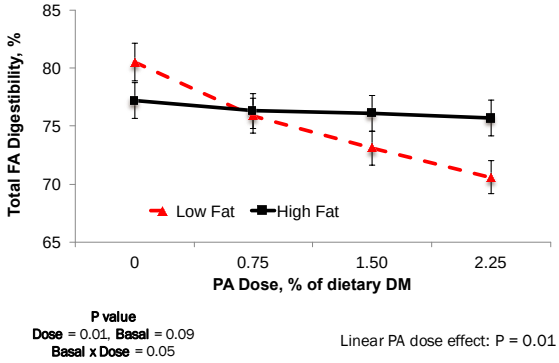
Dose Response C16:0
Supplementation Study



Rico et al. 2017.
J. Animal Sci. 95:436-446

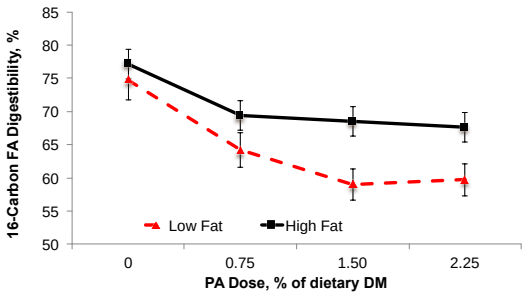
5

Effect of C16:0 Intake and Basal diet on FA Digestibility



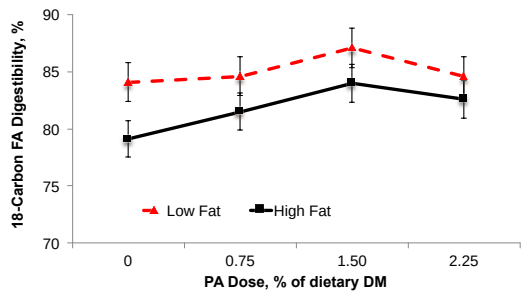
P value
Dose = 0.01, **Basal** = 0.09
Basal x Dose = 0.05

Linear PA dose effect: P = 0.01



P value
Dose < 0.01, **Basal** = 0.01
Basal x Dose = 0.038

Quadratic PA dose effect: P= 0.01



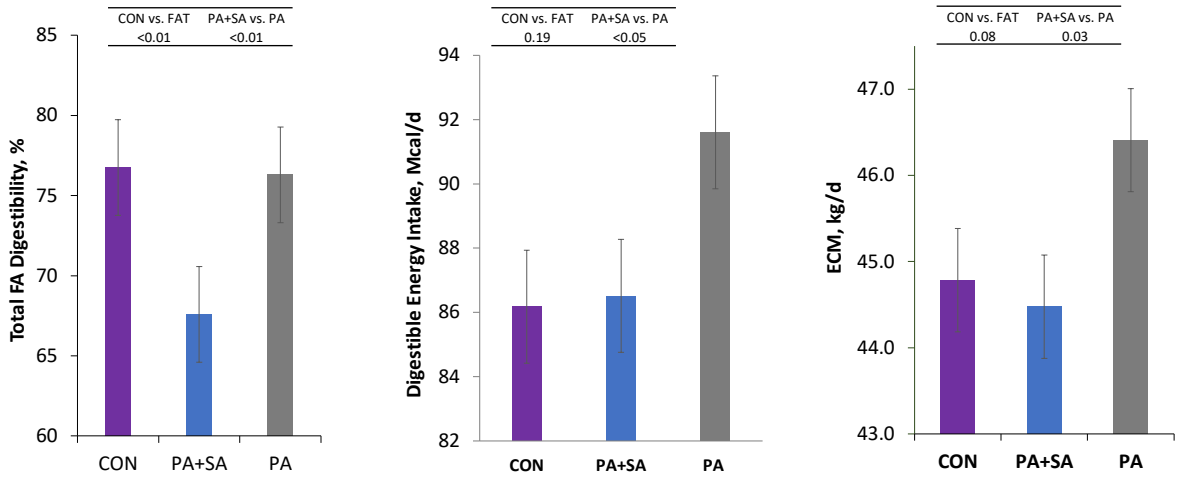
P value
Dose = 0.05, **Basal** = 0.07
Basal x Dose = 0.35

Quadratic PA dose effect: P = 0.01

Rico et al. 2017. J. Animal Sci. 95:436-446

6

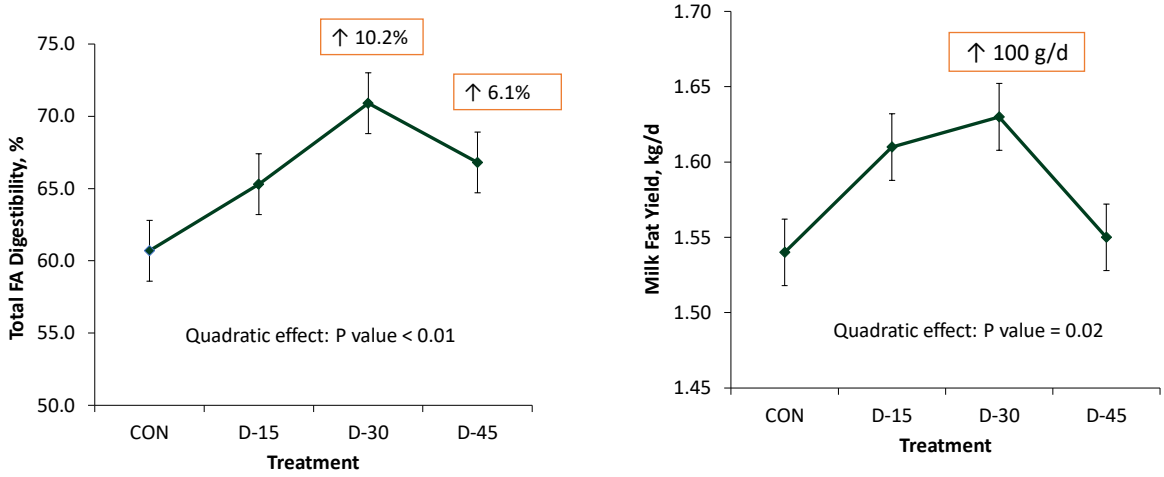
Effect of Altering the FA Profile of the Supplement on FA Digestibility and Performance



Western et al. 2020. J. Dairy Sci. 103: 5131–5142

7

Abomasal Infusion of an Exogenous Emulsifier



de Souza et al. 2020 J. Dairy Sci. 103:6167–6177

8

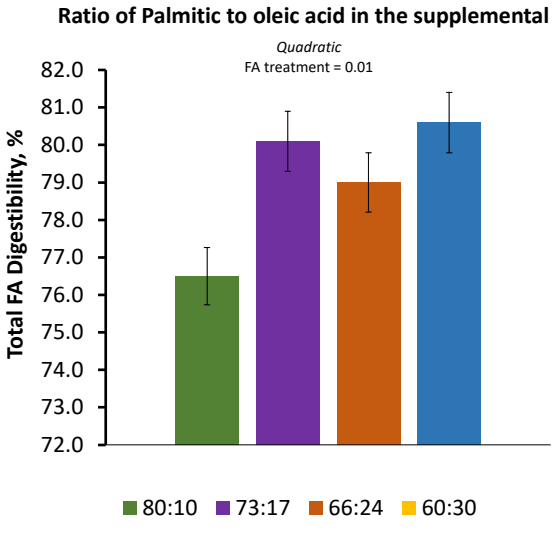
Association of Feeding Lysophospholipids and FA Supplements

	PA	PA+SA	No	LPL	SEM	FA	LPL	Int
DMI, kg/d	27.3	27.5	27.6	27.5	0.81	0.84	0.84	0.21
Milk yield, kg/d	40.4	38.7	39.8	39.3	2.65	0.21	0.70	0.42
ECM, kg/d	39.7	36.8	38.1	38.4	1.03	0.02	0.81	0.34
ECM/DMI, kg/kg	1.44	1.35	1.38	1.40	0.027	<0.01	0.54	0.75
Fat, kg/d	1.60	1.42	1.50	1.52	0.05	<0.01	0.82	0.32
Protein, kg/d	1.30	1.26	1.28	1.28	0.058	0.38	0.91	0.54
Lactose, kg/d	1.96	1.91	1.96	1.92	0.147	0.48	0.60	0.47
Fat, %	4.00	3.74	3.83	3.91	0.277	0.12	0.64	0.68
Protein, %	3.24	3.30	3.24	3.30	0.08	0.42	0.39	0.84
Lactose, %	4.84	4.93	4.90	4.87	0.042	0.03	0.49	0.79
BW initial, kg	691	686	696	681	22.2	0.72	0.35	0.63
BW final, kg	703	701	709	694	18.8	0.91	0.33	0.99

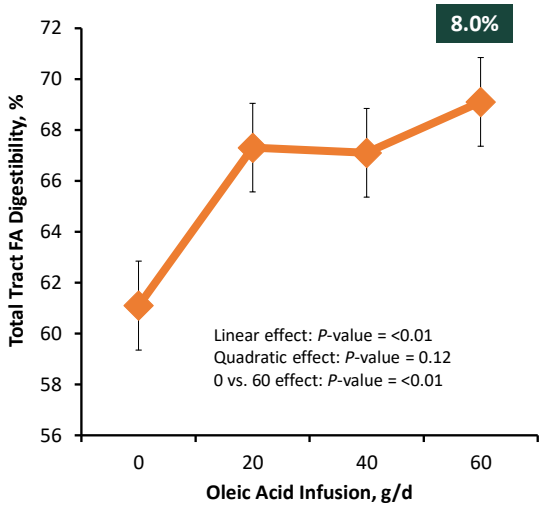
Porter et al. 2024 J. Dairy Sci. In Press

9

Oleic Acid Improves Total Tract FA Digestibility



de Souza et al. 2019. J. Dairy Sci. 102:9842–9856

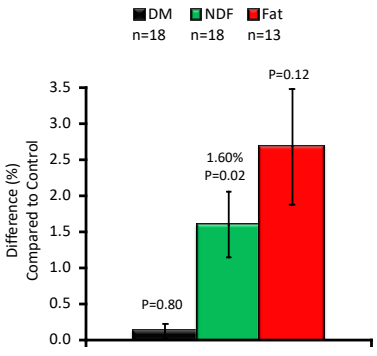


Prom et al. 2021. J. Dairy Sci. 104:12616-12627

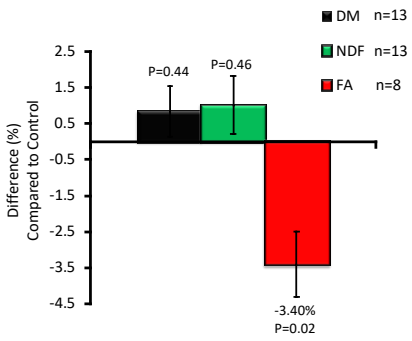
10

Effect of FA Supplements on Nutrient Digestibility

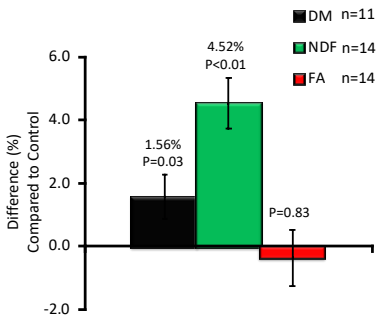
Ca-Salts PFAD



Mixed SFA Prills



C16:0-Enriched Prills

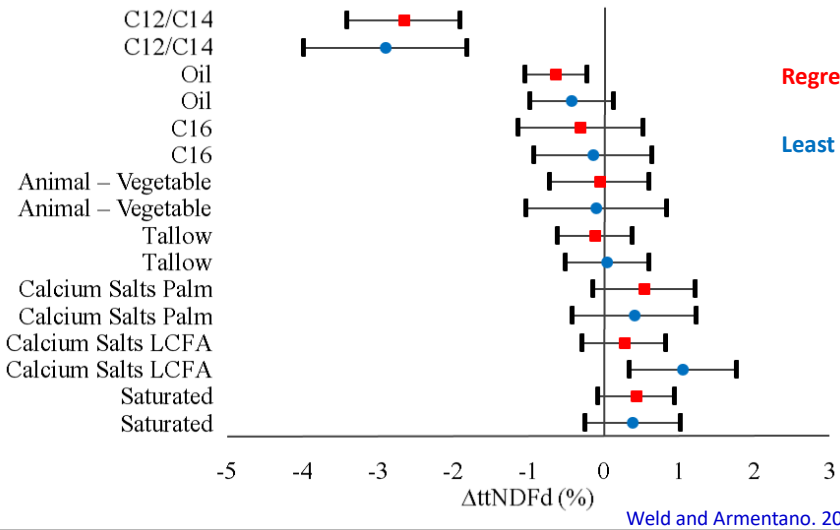


Neto et al. 2021. J. Dairy Sci. 104:9752-9768
Neto et al. 2021. J. Dairy Sci. 104:12628-12646

11

Effect of Fat Supplementation on Fiber Digestibility

Slide courtesy of Lou Armentano, University of Wisconsin



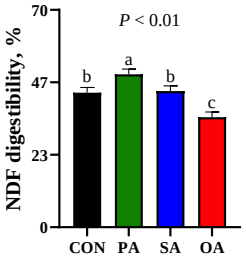
Regression model

Least squares means model

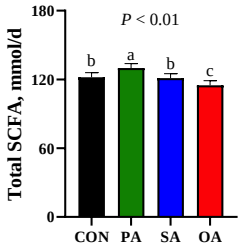
Weld and Armentano. 2017 J. Dairy Sci. 100:1766–1779

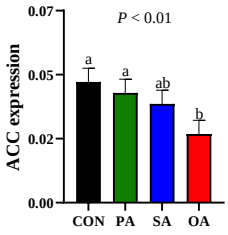
12

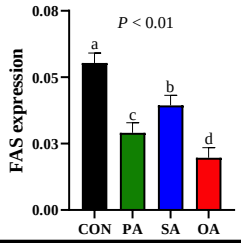
Effect of Individual FA on Fiber Digestibility



	CON	PA	SA	OA	P
Prevotella	18.3^{B}	22.7^{A}	17.4^{B}	18.0^{B}	<0.01
Megasphaera	1.76^{B}	2.06^{B}	2.22^{B}	3.10^{A}	0.05
Fibrobacter	0.71^{AB}	1.07^{A}	0.70^{AB}	0.28^{B}	0.01
Acidaminococcus	0.30^{AB}	0.36^{AB}	0.57^{A}	0.17^{B}	0.02
Pseudobutyrivibrio	0.33^{B}	0.44^{B}	0.35^{B}	0.62^{A}	0.02
Anaerovibrio	0.07^{B}	0.07^{B}	0.07^{B}	0.17^{A}	0.02
Ruminococcus	1.29	1.16	1.42	1.36	0.53
Butyrivibrio	1.09	0.96	0.77	0.90	0.34

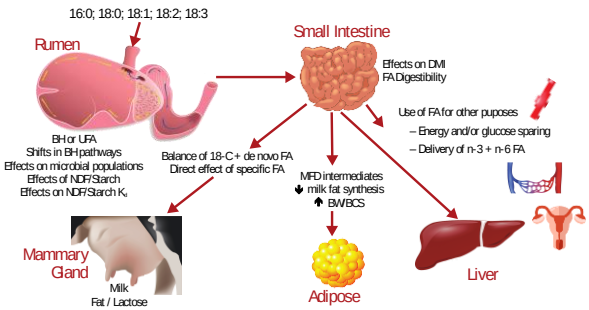


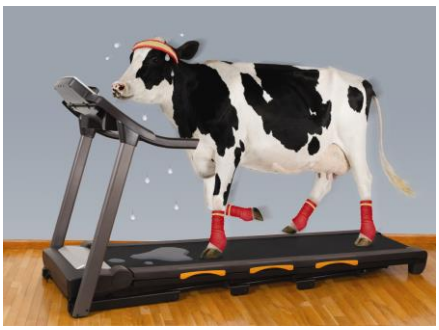




Sears et al., 2024. JDS. 107:902-916

13



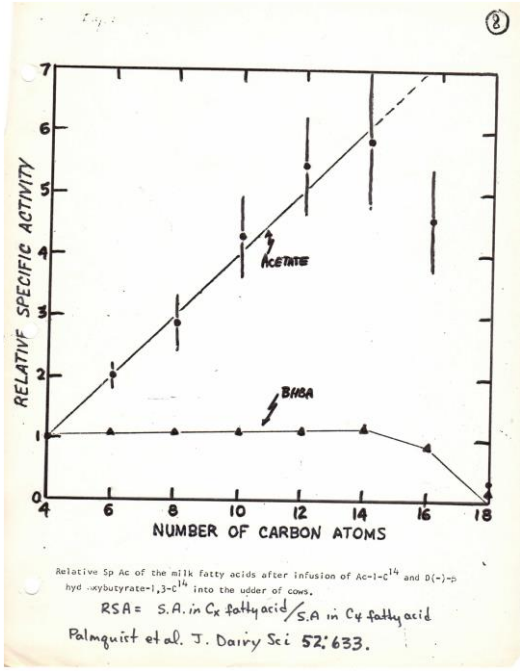


Effect of Dietary FA on Performance

14

Source of Milk Fatty Acids

- **De novo synthesis**
  - **C4 to C14**
  - **Part of C16**
    - Acetate
    - B-hydroxybutyrate
- **Uptake of preformed fatty acids**
  - **Part of C16**
  - **All long chain**
    - Absorbed from digestive tract
    - Mobilized from body fat



15

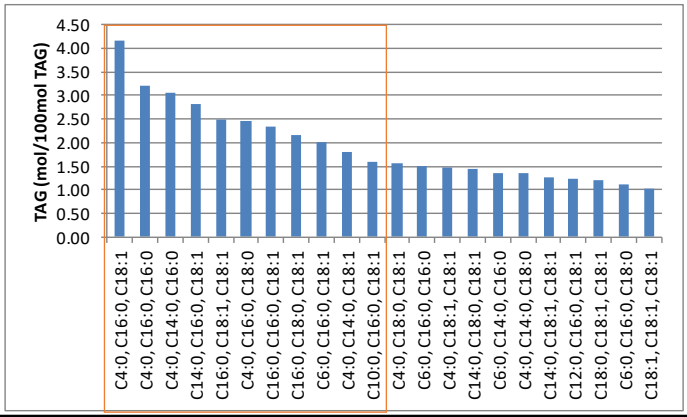
Milk Triglycerides

mol/100mol fatty acid[1]

	C4:0	C6:0	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C18:1
sn-1	1.6	3.1	10.3	15.2	23.7	27.3	44.1	54.0	37.3
sn-2	0.3	3.9	55.2	56.6	62.9	65.6	45.4	16.2	21.2
sn-3	98.1	93.0	34.5	28.2	13.4	7.1	10.5	29.8	41.5

Major TAG in bovine milk fat[2]
Only TAG > 1% are shown
Position of individual FA on glycerol backbone may vary

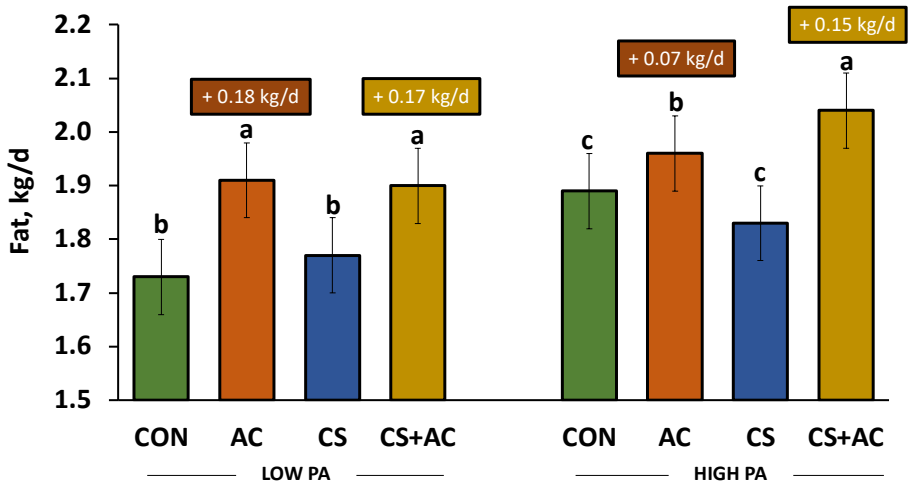
Lipid synthesis is highly coordinated in order to produce a fluid milk fat



1. Calculated by Jensen (2002) J. Dairy Sci. 85: 295-350 from Australian butter reported by Parodi (1979) J. Dairy Res. 46:75-81
2. Gresti et al. (1993) J. Dairy Sci. 76: 1850-1869. Normandy summer milk

16

Altering the Dietary Supply of De Novo and Preformed Fatty Acids

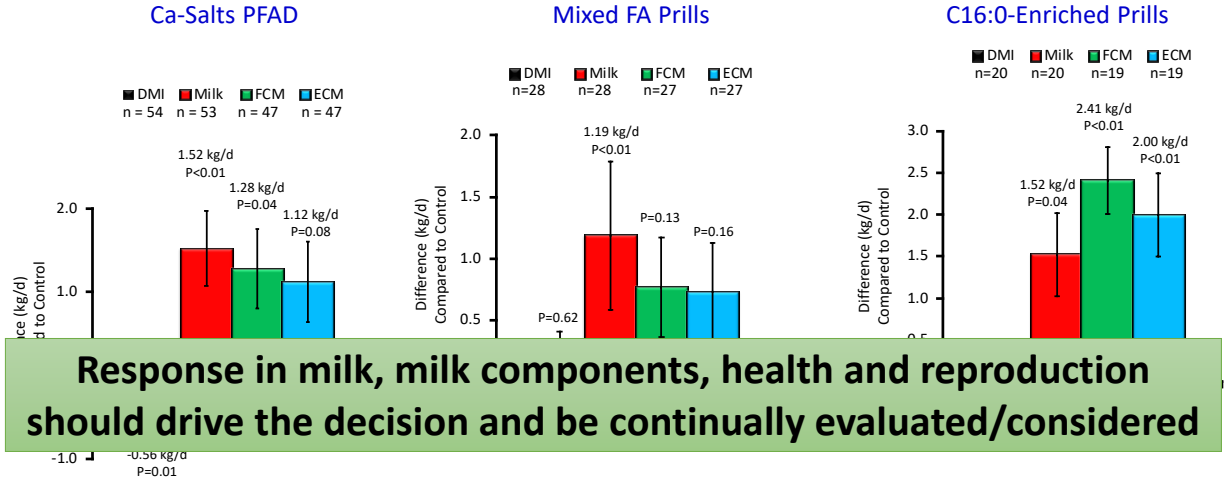


Base *P* = 0.27
CS *P* = 0.42 | AC *P* < 0.01
CS*AC *P* = 0.19
Base*CS*AC *P* < 0.01

Benoit et al. (ADSA Abstract 2023)

17

Effect of FA Supplements on DMI and Milk Yields

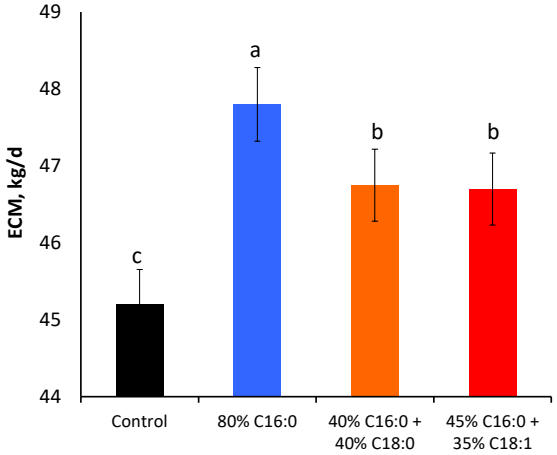


Response in milk, milk components, health and reproduction should drive the decision and be continually evaluated/considered

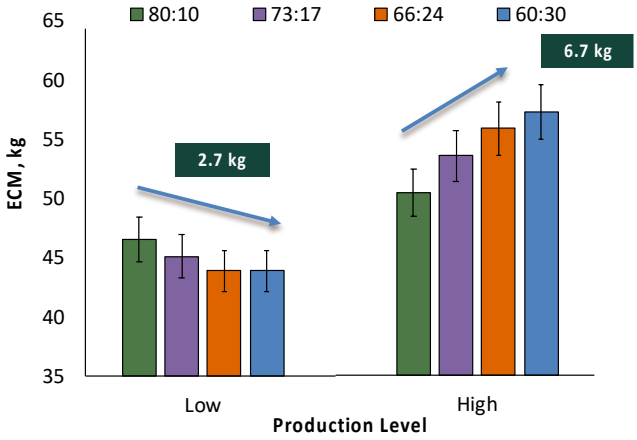
Neto et al. 2021. J. Dairy Sci. 104:9752-9768
Neto et al. 2021. J. Dairy Sci. 104:12628-12646

18

Effect of Palmitic, Stearic, and Oleic Acids in Post-Peak Cows



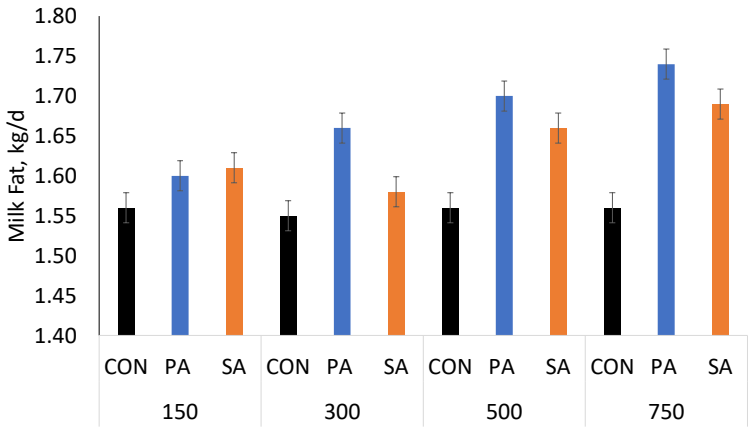
de Souza et al. 2018. J. Dairy Sci. 101:172–185



de Souza et al. 2019. J. Dairy Sci. 102:9842–9856

19

Milk Fat Responses to Level and Profile

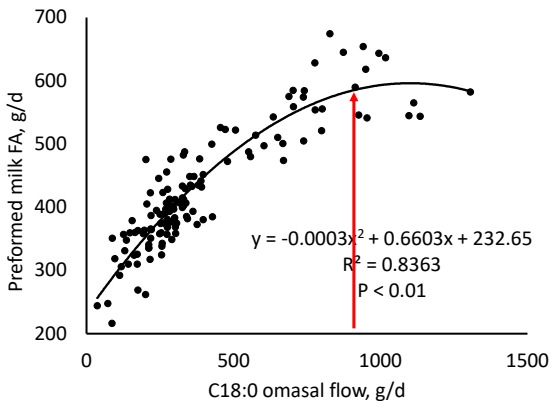


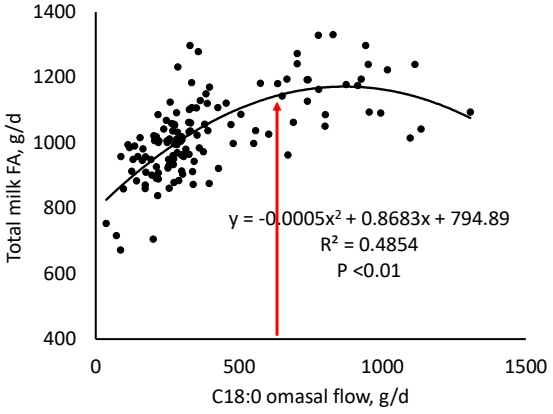
	Transfer, %	
	PA	SA
150	0.27	0.33
300	0.39	0.10
500	0.28	0.20
750	0.24	0.17

Staffin et al., 2023 (ADSA Abstract)

20

Relationship Between C18:0 Omasal Flow on Preformed and Total milk FA



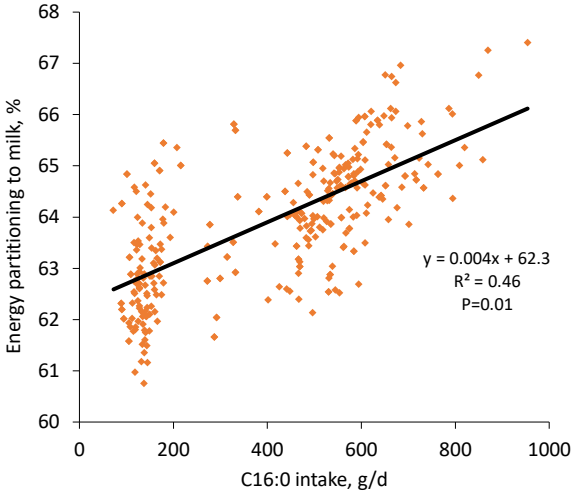


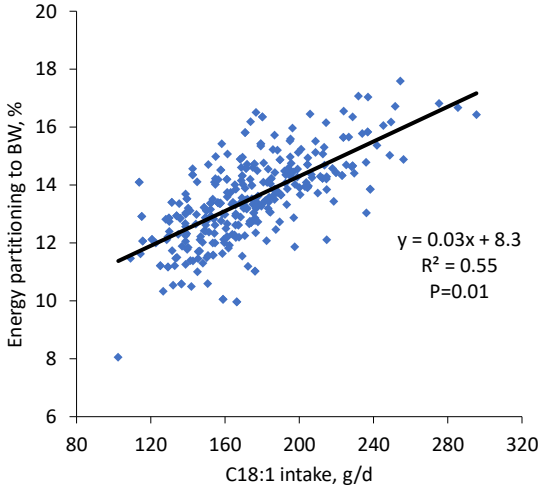
De Souza et al., 2018 (ADSA Abstract)

21

Palmitic and Oleic Effects on Energy Partitioning

(Post Peak Cows)

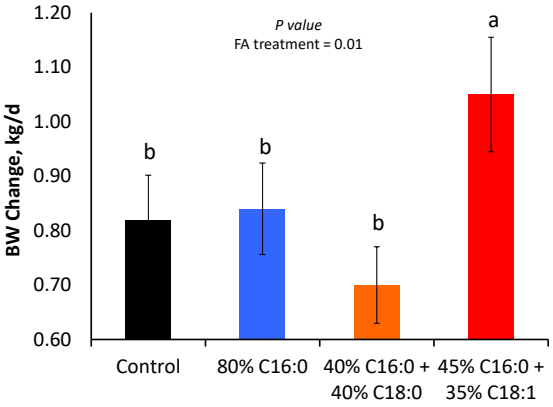




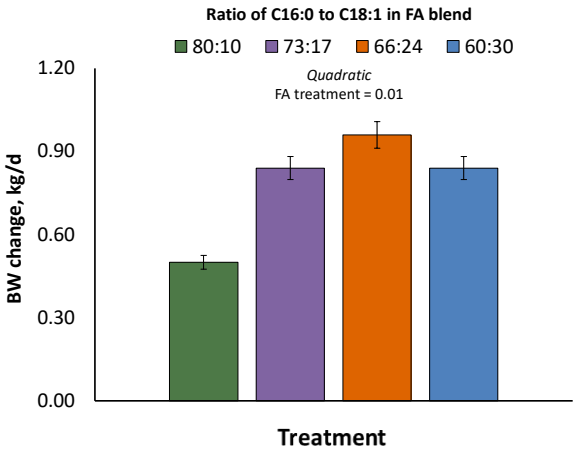
de Souza & Lock (Unpublished)

22

Effect of Palmitic, Stearic, and Oleic Acids in Post-Peak Cows



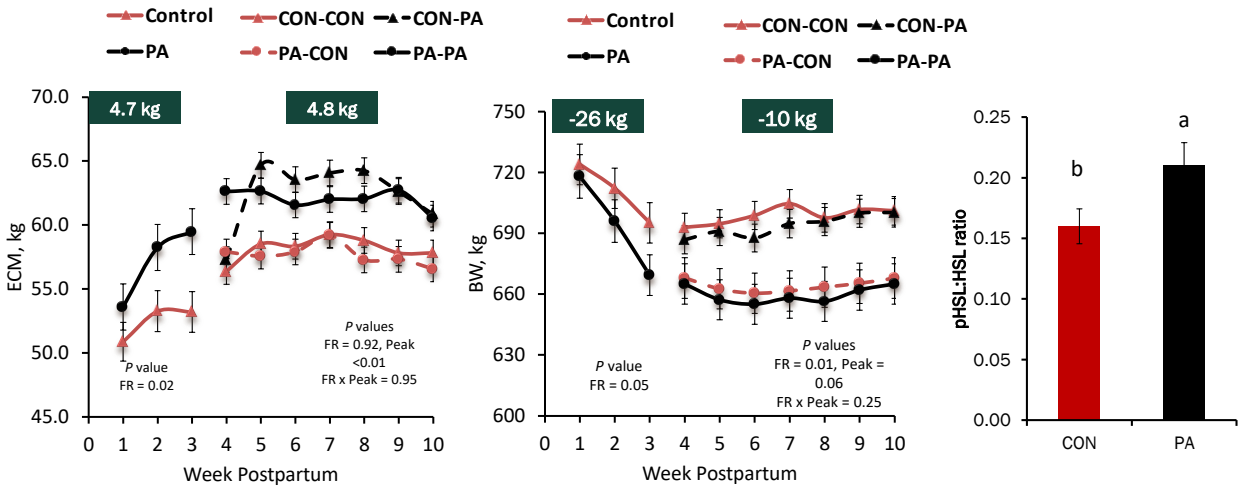
de Souza et al. 2018. J. Dairy Sci. 101:172–185



de Souza et al. 2019. J. Dairy Sci. 102:9842–9856

23

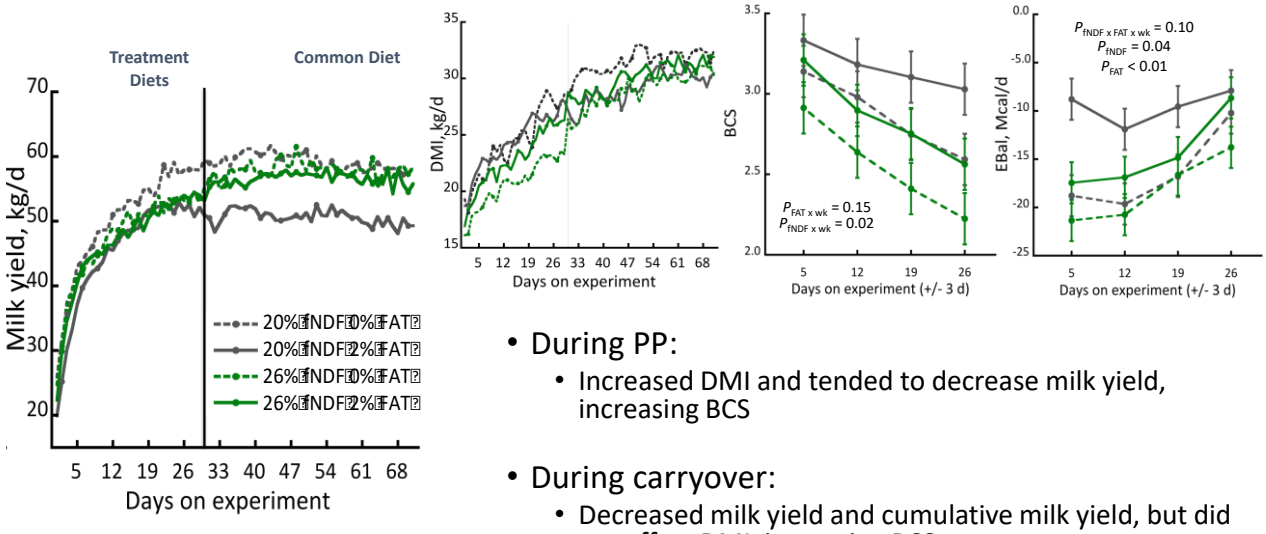
Effect of Palmitic Supplementation – Early Lactation



de Souza & Lock. 2019. J. Dairy Sci. 102:260-273
de Souza et al. 2019. J. Dairy Sci. 102:274-287

24

Effect of a C16:0 + C18:0 FA Supplement in Early Lactation

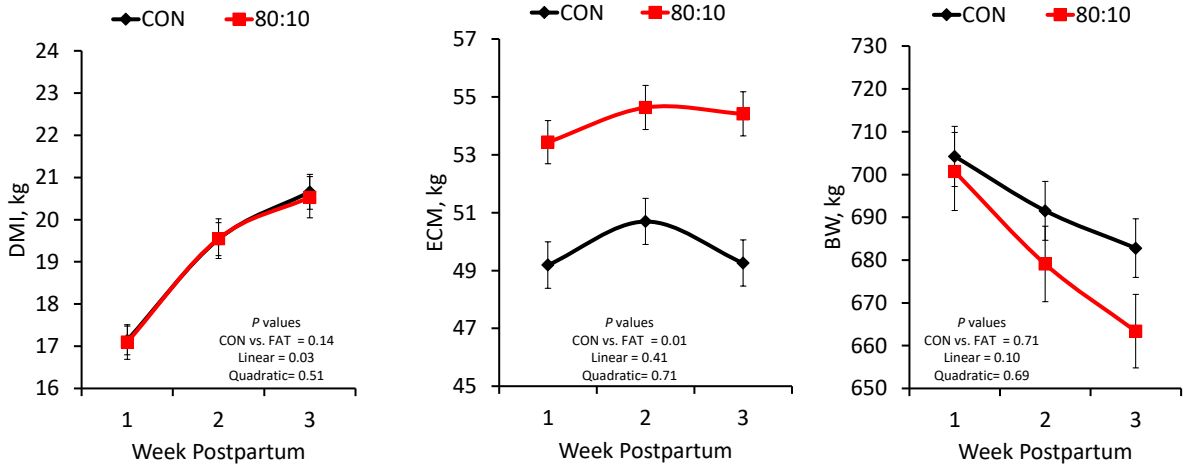


- During PP:
  - Increased DMI and tended to decrease milk yield, increasing BCS
- During carryover:
  - Decreased milk yield and cumulative milk yield, but did not affect DMI, increasing BCS

Piantoni et al. 2015. J Dairy Sci. 98:3309–3322; Piantoni et al. 2015. J Dairy Sci. 98:3323–3334

25

Effect of Altering the Palmitic to Oleic Ratio of Supplemental Fats to Fresh Cows



- CON: Control diet (no supplemental fat)
- FA supplement blends fed at 1.5% DM
- Supplemental fat blends fed from calving for first 3 wk of lactation

de Souza et al., 2021. JDS 104:2896

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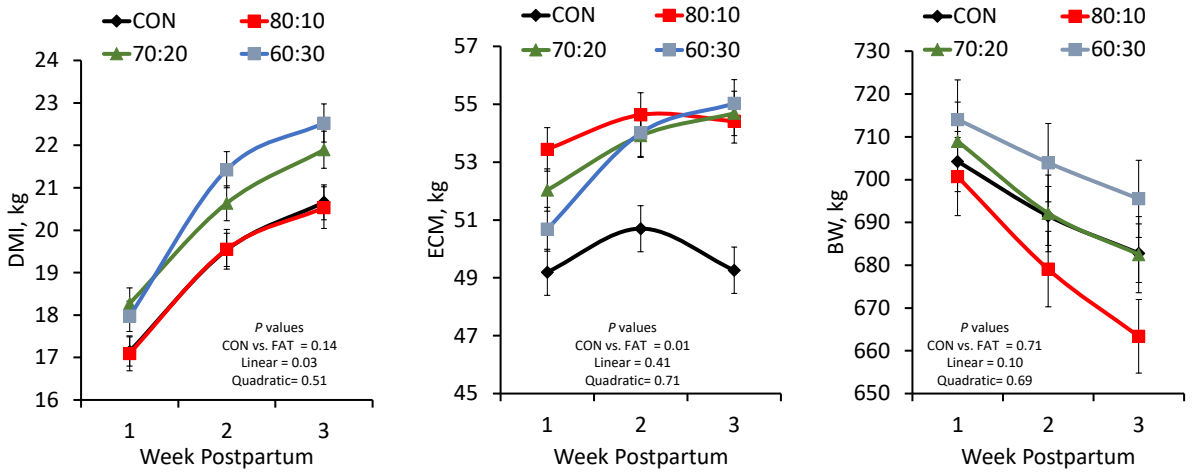
Effect of Altering the Palmitic to Oleic Ratio of Supplemental Fats to Fresh Cows



- CON: Control diet (no supplemental fat)
- FA supplement blends fed at 1.5% DM
- Supplemental fat blends fed from calving for first 3 wk of lactation

de Souza et al., 2021. JDS 104:2896

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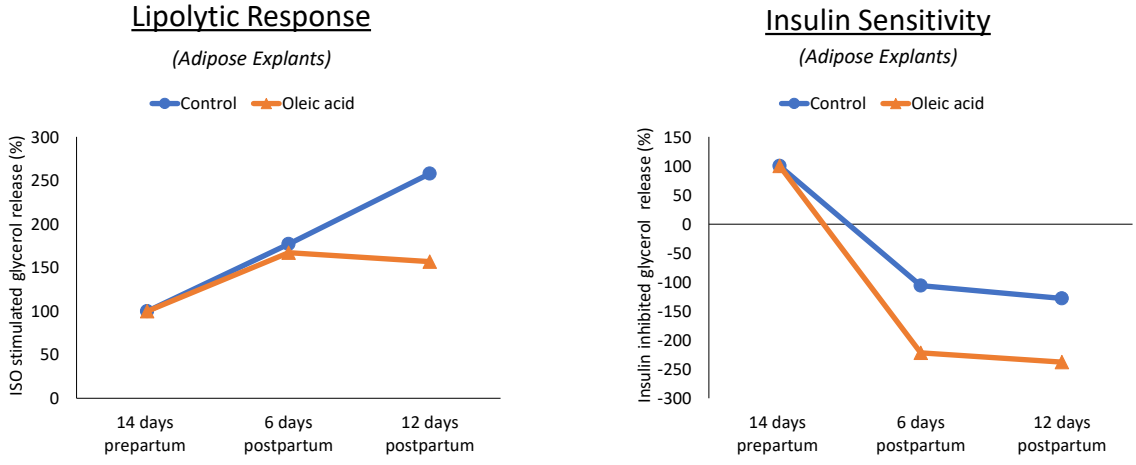
Abomasal Infusion of Oleic Acid in Fresh Cows



- Results suggest that oleic acid supplementation immediately postpartum may reduce lipolytic responses and improves insulin sensitivity of AT in early lactation dairy cows

Abou-Rjeileh et al. 2023. J. Dairy Sci 106:4306–4323

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Fatty Acids and Repro

SYMPOSIUM: OPTIMIZING ENERGY NUTRITION FOR REPRODUCING DAIRY COWS

Influence of Supplemental Fats on Reproductive Tissues and Performance of Lactating Cows[1]

C. R. STAPLES,[2] J. M. BURKE, and W. W. THATCHER
Department of Dairy and Poultry Sciences, University of Florida, Gainesville 32611

Item	RR or SMD (95% CI)	I^2	*P*-value
Proportion pregnant to service[2]			
Overall	1.20 (1.04 to 1.38) 1.27 (1.09 to1.45) (Knapp-Hartung)	19.9	0.19
Oilseed	1.14 (0.91 to 1.43)	0.0	0.51
CSFA	1.05 (0.78 to 1.42)	31.8	0.16
Tallow	1.09 (0.53 to 2.24)	63.3	0.07
CLA	1.29 (0.89 to 1.88)	0.0	0.84

Rodney et al. 2015. J. Dairy Sci 98:5601–5620

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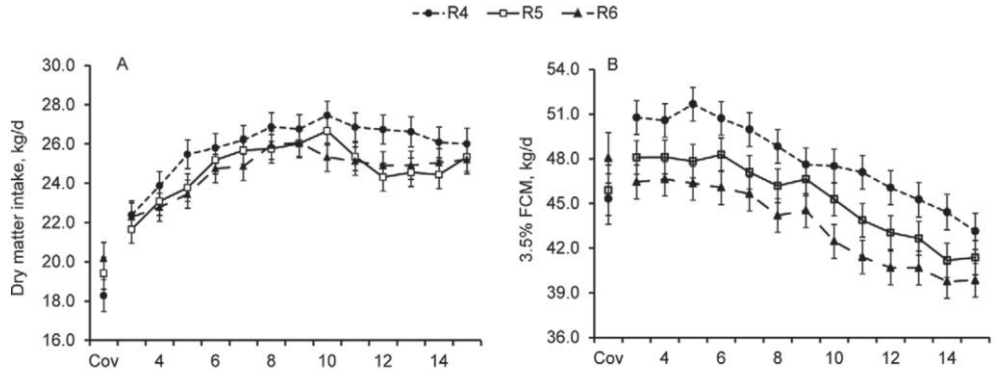
Altering n-6 to n-3 Fatty Acids in Early Lactation

	Treatment[1]				*P*-value[2]	
Item	R4	R5	R6	SEM	Trt	Trt × Wk
DMI, kg/d	26.1[a]	24.6[b]	24.7[b]	0.5	0.07	0.46
FA intake,[3] g/d	931.5	952.9	975.0	24.1	0.45	0.46
Linoleic	298.1[c]	329.5[b]	369.4[a]	8.6	<0.001	0.50
EPA + DHA	21.3[b]	14.9[c]	10.0[c]	0.3	<0.001	0.44
Total n-6	300.6[c]	332.0[b]	371.9[a]	8.6	<0.001	0.50
Total n-3	77.3[a]	67.3[b,x]	62.8[b,y]	1.7	<0.001	0.38
Milk, kg/d	46.8[a,x]	44.8[y]	43.2[b]	0.7	<0.01	0.66

- Treatment diets fed from 14 DIM



Greco et al. 2015. J Dairy Sci. 98:602–617.

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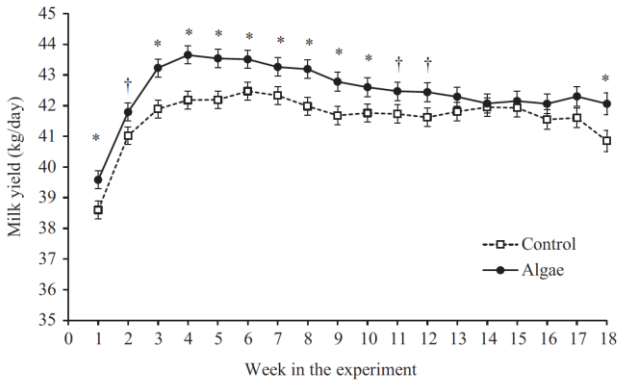
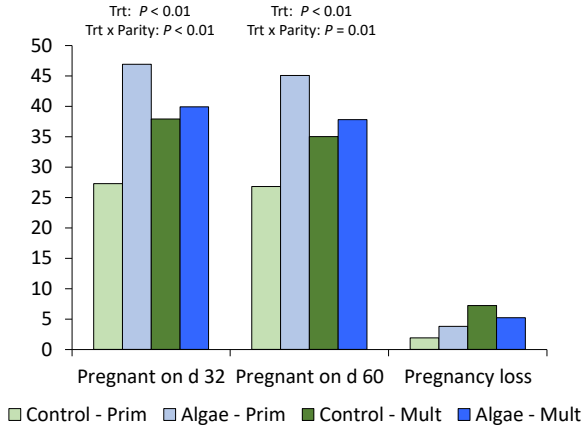
Feeding Algae Rich in DHA (C22:6 n-3)

Milk Yield



Pregnancy per AI



- Treatments started 27 ± 5 d postpartum and lasted 120 d
- Treatments supplied 10 g of DHA per cow per d

Sinedino et al. 2017. Reproduction. 153:707–723.

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What Ingredients Should I use to Provide FA?

	First Source	Second Source
C16:0	Supplements	Oilseeds (Cottonseed)
C18:0	Basal diet (rumen BH)	Supplements
C18:1	Supplements	Oilseeds (HO soybeans)
C18:2	Basal diet	Oilseeds (Cottonseed)
C18:3	Basal diet	Supplements, oilseeds
Omega 3	Supplements	Oilseeds

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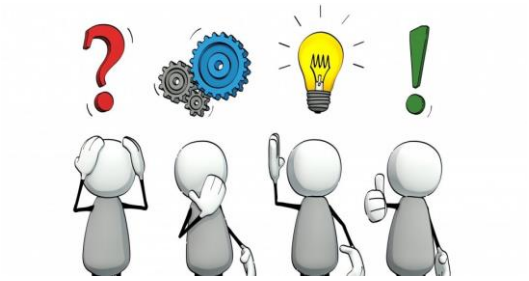
Considerations for Supplemental Fat

- Fresh / Peak lactation
  - ECM milk response
  - Managing BCS and repro
  - ***Positive ROI***
- Post-peak lactation
  - Primarily milk fat response
  - Depending on production level of the herd
  - ***Likely positive***
- Late lactation cows
  - Consider energy content of diet
  - ***Likely negative ROI***



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Thanks!

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https://www.perdueanimalnutrition.com/

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