Fatty Acid Supplementation to Early Lactation Cows?

- When Should Fat Feeding Begin?
  - Ideally, fat probably should be left out of the diet immediately postpartum
  - Numerous trials have indicated that there was little benefit from feeding fat during the first 5 to 7 wk postpartum
  - The lack of early lactation response seems to be related to depression in feed intake which offsets any advantage that may be gained by increasing energy density of the diet

Grummer. 1993. Large Dairy Herd Management. 2nd Edition
Recent Focus on Palmitic, Stearic, and Oleic Acids

- Due to BH C18:0, under typical feeding situations, it is the predominant FA available for absorption by the dairy cow.
- Represent the majority of FA in milk fat and adipose tissue.
- Predominant FA in the 3 main categories of dietary FA supplements:
  - Palmitate (C16:0)
  - Stearate (C18:0)
  - Oleate (C18:1)

Effect of Altering the FA Profile of Supplemental Fats on Apparent Total Tract NDF Digestibility

- Supplement blends fed at 1.5% DM
- Blends of 3 commercially available FA supplements:
  - C16:0-enriched free FA supplement
  - C16:0 and C18:0 free FA supplement
  - Ca-salt palm FA
- Blended in different ratios to alter content of C16:0, C18:0, and C18:1
- 24 cows in a 4 x 4 Latin square with 21 d periods

Effect of C16:0 Intake on NDF Digestibility

- Linear relationship between C16:0 intake and NDF digestibility
- Equations:
  - Baseline NDF digestibility: y = 43.4 + 0.001x
  - NDF digestibility increase: y = 38.4 + 0.010x

Effect of Fat Supplementation on NDF Digestibility

- Regression model: y = 0.010x + 38.4
- Least squares means model: y = 0.010x + 38.4

P values:
- FR = 0.49, Peak < 0.01
- FR x Peak = 0.37

Week Postpartum

- Control
- PA
- CON - CON
- CON - PA
- PA - CON
- PA - PA

NDF Digestibility (%)

- Control: 41
- PA: 44
- CON - CON: 43
- CON - PA: 42
- PA - CON: 44
- PA - PA: 45
Effect of Altering the FA Profile of Supplemental Fats on Apparent Total Tract FA Digestibility

Effect of Altering the FA Profile of Supplemental Fats on Apparent Total Tract FA Digestibility
Effect of C16:0 Intake on Fat and Energy-Corrected Milk Yields

- ECM increased to a greater extent in multiparous (2.1 vs. 5.7 kg)
- BW increased in primiparous but not multiparous

Treatment by Parity Interactions

- ECM increased to a greater extent in multiparous (2.1 vs. 5.7 kg)
- BW increased in primiparous but not multiparous

Effect of Altering the FA Profile of Supplemental Fats on ECM and BW

- Supplements fed at 1.5% DM
- 36 cows in an incomplete 4 x 4 Latin square with 35 d periods

Effect of Altering the Palmitic to Oleic Ratio of Supplemental Fats on DMI and BW
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### Treatment X Production Level Interactions

- **Bar Graph**
  - **X-axis**: Production Level (Low, Medium, High)
  - **Y-axis**: ECM kg
  - **Data Points**:
    - Low: 80:10, 73:17, 66:24, 60:30
    - Medium: 6.7 kg
    - High: 2.7 kg

- **Notes**:
  - Supplements fed at 1.5% DM
  - 36 cows in an incomplete 4 x 4 Latin square with 35 d periods

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### Fatty Acid Supplementation to Early Lactation Cows?

- **Diagram**
  - **Key Points**:
    - Should not feed supplemental FA to cows in negative energy balance
    - Already too much circulating FA

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

- **Effects**:
  - Prilled C16:0 and C18:0 supplement fed during first 6 wk of lactation (2.3% DM)
  - DMI lower in cows supplemented with fat during the first 4 wk of lactation
  - Energy intake and predicted energy balance similar between diets
  - Treatment X time interactions around ~ 4 wk

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

- **Graphs**
  - **Comparisons**:
    - Treatment vs. Control
    - Common Diet vs. Treatment Diet
  - **Results**:
    - 2% vs. 0% FA Supplement During PP:
      - Increased DMI and tended to decrease milk yield, increasing BCS
    - 2% vs. 0% FA Supplement During carryover:
      - Decreased milk yield and cumulative milk yield, but did not affect DMI, increasing BCS

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

- Inconsistent response to fat supplementation in early lactation may be associated with the time at which fat supplementation starts

**Effect of C16:0 Intake on DMI and Milk Yield**

- PA fed at 1.5% DM
- 52 multiparous Holstein cows
- Block design; assigned by parity, 305ME, and BCS

**C16:0 Supplementation to Early Lactation Cows?**

- C16:0 responses have only been evaluated in post peak cows
- Concern regarding:
  - Negative energy balance
  - Reduced DMI of cows in early lactation
  - Increased risk of metabolic disorders

- PA fed at 1.5% DM
- 52 multiparous Holstein cows
- Block design; assigned by parity, 305ME, and BCS

Effect of C16:0 Intake on Yield of Fat and ECM

- PA fed at 1.5% DM
- 52 multiparous Holstein cows
- Block design; assigned by parity, 305ME, and BCS

**Effect of DMI and Milk Yield**

- PA fed at 1.5% DM
- 52 multiparous Holstein cows
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**Effect of C16:0 Intake on Yield of Fat and ECM**

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**Effect of C16:0 Intake on Yield of Fat and ECM**

- PA fed at 1.5% DM
- 52 multiparous Holstein cows
- Block design; assigned by parity, 305ME, and BCS
**Effect of C16:0 Intake on Body Weight and Insulin**

- Control
- CON-CON
- CON-PA
- PA
- PA-CON
- PA-PA

**Palmitic and Oleic Effects on Energy Partitioning** (Post Peak Cows)

**Palmitic and Oleic Effects on Energy Partitioning** (Post Peak Cows)

**Relationship Between Oleic Acid Content of Adipose Tissue with BW Gain and Plasma Insulin**

- Linear effect: $P$-value = 0.01
- Quadratic effect: $P$-value = 0.05

**Abomasal Infusion of Oleic Acid Increases Plasma Insulin in Post Peak Cows**

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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

P values
CON vs. FAT = 0.19
Linear = 0.14
Quadratic = 0.94

P values
CON vs. FAT = 0.01
Linear = 0.41
Quadratic = 0.71

P values
CON vs. FAT = 0.71
Linear = 0.10
Quadratic = 0.69

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

Carry Over Period Common Diet
P values
CON vs. FAT = 0.02
Linear = 0.42
Quadratic = 0.61

Alteration of n-6 and n-3 Fatty Acids in Early Lactation

• Treatment diets fed from 14 DIM

P values

Caloric vs. Non-Caloric Effects of Fatty Acids?

• Effect of specific fatty acids:
  - Yield of milk and milk components
  - Maintenance of body condition
  - Nutrient digestion
  - Nutrient partitioning
  - Reproduction
  - Health

FA profile of a fat supplement most likely the first factor in determining the response to it
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Previous results are contradictory about the benefits of FA supplementation to early lactation dairy cows; we suggest this is due to differences in FA profile of supplements used, inclusion rates, and the time at which FA supplementation started

Use of supplemental FA in the fresh period should be considered; new research suggests that FA supplementation increases performance in fresh cows

Important to consider possible effects of FA in the rumen (BH/MFD/NDFd), in the small intestine (DMI/digestibility), in the mammary gland (increased incorporation/substitution), and energy partitioning between tissues

Profile of supplemental FA key in determining production responses and energy partitioning
1) C16:0 drives increases in milk fat yield and ECM partially due to a decrease in BW
2) C16:0 and C18:1 drives increases in milk yield and ECM without changing BW loss compared to non-supplemental diet
3) Feeding FA supplements in the fresh period has carryover effects on early lactation

Further Thoughts

• Studies in early lactation (negative energy balance) are limited, especially with single FA and specific combinations of FA
• Determining when to introduce and how long to feed a supplemental FA deserves future research
• How long the fresh period should be and when to introduce a supplemental FA deserves future research
• Profile of FA for different purposes?
  - What factors affect FA digestibility? Can we improve FA digestibility?
  - Different blends of FA for different purposes across lactation and/or for specific objectives?
  - Role of different ‘omega FA’ for production, health, reproduction?

➢ More research needed to clearly establish the effects of individual FA and FA supplements at different stages of lactation/levels of milk production, and their interaction with different diets
➢ Economics of the marginal return (in milk, milk components, health and reproduction) should drive the decision and be continually evaluated/considered

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Acknowledgements

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