Webinars

enhance

Resources for DAIRYWOMEN without leaving the farm

DairyGirlNetwork.com
Use of Milk Fatty Acids to Make Nutrition and Management Decisions

Heather Dann, Rick Grant, & Dave Barbano
Dairy Girl Network Webinar, September 21, 2018
Used world-wide to measure fat, protein, and lactose for payment and dairy herd improvement programs
Develop new tools in milk analysis for bulk tank using mid infrared technology to provide information to support decision making for feeding and general management of the herd.
Key Findings from Monitoring 430 Farms over a 15-Month Period with Milk Fatty Acid Metrics

- Milk fat and protein increased when de novo fatty acids in milk increased

- Occurred for both Holstein and Jersey herds

Barbano, 2016
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What are Milk Fatty Acid Metrics? Are They Useful?

- De Novo Fatty Acids
- Mixed Fatty Acids
- Preformed Fatty Acids
- Unsaturation Index
- Double Bonds per Fatty Acid
- Relative %
- g/100 g milk
Milk Fat Composition
Most Variable Component of Milk

• 98% triglycerides

More than 400 unique fatty acids (FA) in milk (GC analysis)
• About 20 FA make up the majority
  – Broadly grouped into 3 subcategories

Jensen et al., 2002; Palmquist, 2006; Moate et al., 2007
Milk Fatty Acid (FA) Groups

- **De novo FA - < C16**
  - Made in the mammary gland
  - Influenced by rumen fermentation/function
  - 18-30 relative % (21-26)

- **Preformed FA - > C16**
  - From fat the diet
  - From body fat mobilization
  - 32-42 relative % (35-42)

- **Mixed origin FA - C16**
  - From fat the diet (preformed)
  - Made in the mammary gland (de novo)
  - 30-40 relative % (35-42)

![Venn diagram illustrating the distribution of fatty acids by origin](image)
Fat and Fatty Acid Groups – Relationship in Bulk Tank Milk

- De Novo FA: 0.94 g/100 g milk
- Mixed FA: 1.62 g/100 g milk
- Preformed FA: 1.31 g/100 g milk

~94.5% of fat test

Fat, %

4.10
Milk Fatty Acid Profiles Provide Insight: Performance and Health of Cow/Herd

• Profile of de novo, mixed, and preformed fatty acids reflect:
  – Diet and dietary changes
    • CHO fermentability, RUFAL, forages...
  – Management environment
    • Behavior, rumen pH
    • Physiological state of cow
    • Risk of milk fat depression
    • Energy balance
    • Stage of lactation
Focus on De Novo Fatty Acids...

- De novo fatty acids reflect rumen function – especially fiber fermentation
- Acetate and butyrate are building blocks
Focus on De Novo Fatty Acids...

• Rumen conditions that enhance microbial fermentation stimulate microbial protein production and increase milk protein content

• De novo fatty acids in milk fat tells us how well the cow is being fed and managed for optimal rumen fermentation conditions
How Should We Use Milk Fatty Acid Metrics?

- Herd “snapshot” and troubleshooting
- Evaluating changes over time
Troubleshooting Herds

Milk Samples over Multiple Days, Herd Average Plotted

- **De Novo**
- **Holstein**
- **Jersey**
Troubleshooting Herds
Milk Samples over Multiple Days, Herd Average Plotted

De Novo

Mixed

Holstein

Jersey

Fat, %

FA, g/100 g milk
Troubleshooting Herds
Milk Samples over Multiple Days, Herd Average Plotted
# Prediction of Fat % (Y) From Milk Fatty Acid Metrics (X)

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<th>De Novo FA, g/100 g milk</th>
<th>Mixed Origin FA, g/100 g milk</th>
<th>Preformed FA, g/100 g milk</th>
<th>Unsaturation, DB/FA</th>
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<td><strong>40 Holstein Herds</strong></td>
<td>Y = 2.297X + 1.844</td>
<td>Y = 1.540X + 1.586</td>
<td>Y = 0.793X + 2.774</td>
<td>Y = -8.583X + 6.421</td>
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<td>(St. Albans 2015)</td>
<td>R² = 0.80</td>
<td>R² = 0.88</td>
<td>R² = 0.07</td>
<td>R² = 0.69</td>
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<td><strong>167 Holstein Herds</strong></td>
<td>Y = 2.233X + 1.800</td>
<td>Y = 1.892X + 1.179</td>
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<td>Y = -7.449X + 5.971</td>
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<td>(US 2016-2017)</td>
<td>R² = 0.61</td>
<td>R² = 0.79</td>
<td>R² = 0.35</td>
<td>R² = 0.31</td>
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Barbano et al., 2017; Barbano et al., unpublished
Expected vs Actual Results – A Holstein Example with a Goal of 3.8% Fat

- Too much fat (RUFAL) or starch?
- Too little peNDF?
- Management affecting feeding behavior?
- Problems with rumen function?
- Overstocked?

- Keep up the good work!
- Good rumen function

- May consider feeding rumen inert fat?
- Thin cows?

St. Albans herds 2015

Courtesy of M. Woolpert
Research Conducted on St. Albans Coop Herds
Better Understand Management and Nutrition Differences between Herds with High and Low De Novo Fatty Acids

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<th>Year</th>
<th>Breed</th>
<th>Fat, %</th>
<th>True protein, %</th>
<th>De novo FA, g/100 g milk</th>
<th>Mixed FA, g/100 g milk</th>
<th>Preformed FA, g/100 g milk</th>
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<td>2015 – Holstein</td>
<td>High</td>
<td>3.96</td>
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<td>0.92</td>
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<td>1.27</td>
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<td>Low</td>
<td>3.75</td>
<td>3.10</td>
<td>0.81</td>
<td>1.41</td>
<td>1.30</td>
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Woolpert et al., 2016; Woolpert et al., 2017
High de novo herds feed...
Less ether extract (≤3.5%)
More physically effective fiber (≥21%)

Woolpert et al., 2016; Woolpert et al., 2017
High de novo herds tend to be...

5x more likely to delivery feed 2x/d in freestall

11x more likely to delivery feed 5x/d in tiestalls

Woolpert et al., 2016; Woolpert et al., 2017
High de novo herds tend to be...

10x more likely to provide ≥18 in bunk space/cow

5x more likely to stock stalls at ≤110%

Woolpert et al., 2017
Need to Get the Diet and the “Dining Experience” Right

Must focus on diet formulation & management environment
Factors Associated with Increased Risk of Milk Fat Depression

Diet Factors
- Fermentable carbohydrates
  - Starch
  - Forage fiber
  - peNDF
- Fats (RUFAL)
  - C18:1 + C18:2 + C18:3
  - < 3.5% of diet DM
- Feed additives (+/-)
- Yeasts/molds

Cow/Environment/Management Factors
- Genetics
- Parity
- Days in milk
- Season
- Time budget (behavior)
  - Stocking density
- Feeding strategy
  - TMR vs. PMR vs. component
  - Frequency of feed delivery/push up

Jenkins, 2013; Bauman, 2017 AMTS webinar
Soybeans, RUFAL, and Low Milk Fat

- **Snapshot: ~3.4 to 3.5% fat**
  - 0.77 g de novo FA/100 g milk
  - 1.09 g mixed FA/100 g milk
  - 1.30 g preformed FA/100 g milk
  - 0.35 double bonds/FA

- **Problem: Diet too high in RUFAL**
  - Use of home grown roasted soybean
  - Ground extremely fine with hammer mill

- **Solution: ↑ grind size**

- **Outcome: ≥ 3.7% fat**
  - 0.94 g de novo FA/100 g milk
  - 1.18 g mixed FA/100 g milk
  - 1.56 g preformed FA/100 g milk
  - 0.31 double bonds/FA

Example courtesy of M. Carabeau
Herd Level Risk Factors for Milk Fat Depression

- 79 herds feeding monensin in the NE and MW US

- Several *trans*-C18:1 fatty acids (products of alternate pathways of ruminal biohydrogenation) were negatively related to herd milk fat

- Milk fat content of fatty acids synthesized de novo in the mammary gland were positively related to bulk tank milk fat

McCarthy et al., 2018
Herd Level Risk Factors for Milk Fat Depression: Relationship with TMR Composition

- No single diet component accounted for more than 11% of the variation in herd level milk fat percentage

- 4 factors together (starch content, monensin, PUFA, and MUFA) only accounted for 32% of the variation in herd milk fat percentage

- Indicates many variables contribute to low milk fat and herds experiencing low milk fat will need to examine many potential risk factors when working to troubleshoot milk fat depression

McCarthy et al., 2018
Milk Fat Depression Timeline When Feeding “High Risk” Diets

**Induction**
- When did the problem start?
- After a diet change – 7 to 10 day lag
- Consider diet PUFA, CHO fermentability, rumen modifiers, feeding management

**Recovery of Milk Fat**
- When should it improve?
- After a diet change – 10 to 14 days

Rico and Harvatine, 2013; Harvatine, 2015
How Should We Use Milk Fatty Acid Metrics?

- Herd “snapshot” and troubleshooting
- Evaluating changes over time
## Monitor Fatty Acid Metrics in Bulk Tank Milk for Changes Over Time

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<th>Fatty Acid Metric</th>
<th>Increases</th>
<th>Decreases</th>
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| De novo FA               | • Positive impact on milk fat and/or protein  
                            • Response to improved rumen function and/or feed quality | • Evaluate management and nutrition  
                            • Did an unexpected change occur?                                                     |
| Mixed origin FA          | • Response to increased dietary fat  
                            • Possible response to de novo synthesis | • Evaluate management and nutrition  
                            • Did an unexpected change occur?                                                     |
| Preformed FA             | • Response to more body fat mobilization or increased dietary fat | • Milk fat may decrease  
                            • Energy partitioning change                                                            |
| Unsaturation Index       | • Greater risk for milk fat depression                                                     |                                                                            |
Variation in November... Diet Changed
(More BMR CS and Different Feeder)
Forage Quality Changed Unexpectedly

[Graph showing changes in forage quality metrics over time]
Factors Affecting Variation Within & Between Herds

- Management related to feeding, housing, and milking of cows
- Diet and feed quality
- Consistency in day to day routine
  - Affects time budget of cow
- Days off and vacations
- Weather and season changes
- Herd demographics (parity, DIM)
- Filling sequence of multiple tanks
Monthly Averages for Tank 1 and 2

Tank 1: 4:30 am, 8:30 pm
Tank 2: 12:30 pm

Fat (D), %

True Protein, %
Monthly Averages for Tank 1 and 2

Tank 1: 4:30 am, 8:30 pm
Tank 2: 12:30 pm
Milk Solids

Dec-17
86 lb milk, 3.85% fat, 2.90% protein

Jan-18
90 lb milk, 4.00% fat, 3.00% protein
What Else is Needed to Interpret Milk Fatty Acid Metrics?

Need to understand changes in milk profiles with season and stage of lactation

Herd distribution
Seasonal Changes in Milk Composition

40 St. Albans Coop herds
Seasonal Changes in Milk Composition

Fat, %

De Novo FA, g/100 g milk

40 St. Albans Coop herds
Seasonal Changes in Milk Composition

40 St. Albans Coop herds
Stage of Lactation Affects Milk Components

Holstein herd, ~90-95 lb milk/d, TMR feeding system
Stage of Lactation Affects Milk Fatty Acid Metrics

Holstein herd, ~90-95 lb milk/d, TMR feeding system
Holstein Herd Distribution
Going Beyond Bulk Tank Sampling...

Bulk Tank/Tanker

Group/Pen/String

Cow

http://qualitru.com
Bulk Tank vs. In-line Group Sampling
(More Sensitivity)
Bulk Tank De Novo FA Changed when Fat % Did Not
Holstein Herd – Group Example

Fatty Acids (FA), g/100 g milk

- Fresh Heifers: 1.44
  - Preformed FA: 1.05
  - Mixed FA: 0.68

- Fresh Cows: 2.02
  - Preformed FA: 1.40
  - Mixed FA: 0.85

- High Group: 1.38
  - Preformed FA: 1.51
  - Mixed FA: 0.99

Legend:
- Green: Preformed FA
- Red: Mixed FA
- Blue: De Novo FA
Weekly Variation in Pens - Fat

High  1st  Fresh  Low,  Sick  Late

Fat, %

Pen
Weekly Variation in Pens – De Novo FA

De Novo FA, g/100 g milk

Pen

01 02 03 04 05 14 19 31

High 1st Fresh Low, Late Sick

8 9 10 11 12 13 14
Weekly Variation in Pens – Preformed FA

![Bar chart showing weekly variation in pens for preformed FA. The x-axis represents pens (01 to 31) and the y-axis represents preformed FA in g/100 g milk. The chart color codes each pen: 8, 9, 10, 11, 12, 13, 14. Categories on the top of the chart are: High, 1st, Fresh, Low, Sick, Late.]
Commercial Herds – Group Samples
Commercial Herds – Group Samples

- Preformed FA, g/100 g milk

- Preformed FA, g/100 g FA

Fat, %

- Fresh
- High
- Low
Blood NEFA can be Predicted from Milk During the Fresh Period

- Provides information about the severity and duration of the negative energy balance (fat mobilization)
- Early warning of problems ahead

Barbano et al., 2015 ADSA
Milk Predicted Blood NEFA is Higher for Cows with Ketosis or Displaced Abomasum

Clinical Ketosis

Displaced Abomasum
Fatty Acid Metrics for Cows with Ketosis
Fatty Acid Metrics for Cows with Displaced Abomasum
Milk Fatty Acid Metrics – Another Tool for Your Toolbox
How Best to Use the Milk Fatty Acid Metrics Information

• In conjunction with
  – Diet information
  – Management information, other systems
  – On-farm assessment
  – *Don’t use the FA information “in a vacuum”*

• Can give you clues as to what is happening
  – More specific than milk fat or protein %
  – Low milk fat can be caused by different factors – MIR FA information may allow you to identify what is wrong
  – May allow more rapid decision making
Questions

Thank you for attending Dairy Girl Network’s Enhance Webinar