Association of individual cow milk fatty acid proportion and variance with milk production

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United States Milk Testing

- 3.9M of cows (41.9%) on DHI testing
- > 90% of cows sampled at one milking, once monthly
United States Milk Testing

FTIR Instruments

Fat
Protein
Lactose
SCC
MUN
Fatty Acids
Casein
Other traits/components

National Cooperator Database
Milk Fatty Acid Origins

De novo Fatty Acids
≤ C14
(made within the mammary gland)

- Higher production herds
- Optimal rumen fermentation
- High effective fiber

Preformed Fatty Acids
≥ C18
(from the diet or body fat reserves)

- Body weight loss
- Low energy diets
- High fat diets

* At the herd (bulk tank) level

Woolpert et al., 2016; Barbano et al., 2018; Santschi, 2019
Lactation Factors Project

- Re-evaluate projection factors and update yield trait predictions

Partial Yield (single milking) → Daily Yield → Lactation Yield
Lactation Factors Project

- **0 DIM**
  - **EARLY LACTATION**
  - Weekly sampling all milkings within a day

- **120 DIM**
  - **MID/LATE LACTATION**
  - Monthly sampling one milk sample

- **BREED**
  - Holstein
  - Jersey

- **MILKING FREQUENCY**
  - 2X, 3X, 4X
Dataset

- 2,400 cow 3x Holstein herd
  - 40.8 kg/d

- 82,071 milk samples
  - 4,825 cow-lactations
  - 3,518 unique cows
Objective

1. Identify associations of morning milking de novo and preformed fatty acids with:
   - Test day yield
   - 305 day cumulative yield
   - Test day energy corrected milk

2. Identify if the variance of morning milking de novo and preformed fatty acids are associated with lactation yield
Methods

- 3 lactation stages
  - First milk test (30 ± 3 DIM)
  - Peak milk test (68 ± 30 DIM)
  - Mid-lactation milk test (100 ± 3 DIM)
Methods

- Mixed linear model (lmer; R 4.3.1)
  - **Fixed effects**: fatty acid proportion, parity (binary), their interaction, day in milk
  - **Random effect**: month of sample
Fatty Acid Units

\[ R^2 = 0.83 \]

[Graph showing correlation between milk fat and de novo fatty acid production, with a high \( R^2 \) value indicating a strong relationship]

\[ R^2 = 0.03 \]

[Graph showing correlation between milk fat and denovo fatty acid production, with a low \( R^2 \) value indicating a weak relationship]
De novo: Test Day Milk
De novo: 305 Day Cumulative Milk Yield

First Milk Test

Peak Milk Test

Mid-Lactation Milk Test

Partly x De novo

$P < 0.01$

$P < 0.01$

$P = 0.20$
De novo: Energy Corrected Milk

First Milk Test

Peak Milk Test

Mid-Lactation Milk Test

Energy Corrected Milk yield, kg

Lactation
- 1
- 2+

Parity x De novo
$P = 0.05$

De novo Fatty Acid, % of Fat

De novo Fatty Acid, % of Fat

De novo Fatty Acid, % of Fat

$P > 0.10$

$P < 0.01$
Preformed: Test Day Yield

First Milk Test

Peak Milk Test

Mid-Lactation Milk Test

$P < 0.01$

$P < 0.01$

$P = 0.02$
Preformed: 305 Day Cumulative Milk Yield

First Milk Test

Peak Milk Test

Mid-Lactation Milk Test

*Parity x De novo*

\[ P = 0.02 \]

\[ P < 0.01 \]

\[ P < 0.01 \]
Preformed: Energy Corrected Milk Yield

First Milk Test

Peak Milk Test

Mid-Lactation Milk Test

\[ P < 0.01 \]

\[ P = 0.01 \]

\[ P = 0.02 \]
## Fatty Acids Summary

<table>
<thead>
<tr>
<th>Variable</th>
<th>De novo Fatty Acid</th>
<th>Preformed Fatty Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Day Yield</td>
<td>![Down Arrow]</td>
<td>![Up Arrow]</td>
</tr>
<tr>
<td>305 Day Cumulative Milk Yield</td>
<td>![Down Arrow] Early &amp; Peak</td>
<td>![Up Arrow] Early &amp; Peak</td>
</tr>
<tr>
<td>Energy Corrected Milk Yield</td>
<td>![Down Arrow] Early Lactation</td>
<td>![Up Arrow] Early Peak Mid- Lactation</td>
</tr>
</tbody>
</table>
Objective

1. Identify associations of morning milking de novo and preformed fatty acids with:
   - Test day yield
   - 305 day cumulative yield
   - Test day energy corrected milk

2. Identify if the variance of morning milking de novo and preformed fatty acids are associated with lactation yield
Variation in Fatty Acids Across Lactation
Methods

• For de novo and preformed:
  
  • Fit individual cow Wilmink lactation curve
    
    • Deviance = observed – predicted value
    
    • Variance = log[Variance(Deviance)]
Variation in De novo Fatty Acids

Low Variance

High Variance

[CDCB logo]
Methods

• Mixed linear model (lmer; R 4.3.1)
  • **Fixed effects**: fatty acid variance, parity (binary), their interaction
  • **Random effect**: month-year of calving
## Fatty Acid Variance and Lactation Yield

<table>
<thead>
<tr>
<th>Variable, kg</th>
<th>Estimate</th>
<th>SEM</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>De novo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Day Cumulative Yield</td>
<td>97.88</td>
<td>52.40</td>
<td>0.06</td>
</tr>
<tr>
<td>305 Day Cumulative Yield</td>
<td>1848.04</td>
<td>596.83</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Summary

1. Identify associations of morning milking de novo and preformed fatty acids with performance
   • Strong associations depending on parity and lactation stage
2. Identify if the variance of morning milking de novo and preformed fatty acids are associated with lactation yield
   • Higher variation of de novo associated with greater lactation yield
     • Further work into association with health, diet, etc. is ongoing
THANK YOU FOR YOUR ATTENTION

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