**Feeding the fresh cow: Fiber Considerations**

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**Body Reserve Mobilization**

- A necessary process
  - FA oxidation and ketogenesis supplies fuels for liver and peripheral tissues
- Excessive FA mobilization detrimental
  - Prepartum (>0.3 mEq/L) and postpartum (>0.7 mEq/L) NEFA linked to:
    - Increased disease incidence
    - Decreased reproductive parameters, milk production
    - Fatty liver disease
      - Decreased DMI, milk production, impaired health status and reproductive performance
      - Increased ROS and systemic inflammation

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**High Starch Fresh Rations**

- ↑Fermentable Starch → ↑Propionate production
- Mixed evidence of efficacy
  - Positives:
    - Increase DMI, milk yield, blood glucose
    - Decreased body reserve mobilization - NEFA, BHBA
  - Negatives:
    - Decreased DMI, milk yield
    - Low rumen pH
    - Increased inflammatory markers
- Success may be attributed to different dietary and management factors
  - Higher starch diets can lead to rumen acidosis

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Bell, 1995

- Ospina et al. 2010; Bobe et al. 2004; Sordillo et al. 2009

- McCarthy et al. 2015; Rabelo et al. 2003; Dann and Nelson 2011; Williams et al. 2015
Subacute Ruminal Acidosis

- Large changes in dietary composition and intake during the transition period increase the susceptibility of cows to subacute ruminal acidosis (SARA)
- SARA
  - Negatively affects ability of rumen epithelium to absorb volatile fatty acids
  - Low rumen pH shifts bacterial population
  - Decreases fiber digestion
  - Increase ruminal concentration of endotoxin
  - Increase inflammatory markers

Nocek 1997; Zebeli and Metzler-Zebeli 2012, Williams et al. 2015

Cows fed Higher Starch (27% vs 21% in diet)
- Lower rumen pH
- Higher ruminal LPS
- Higher haptoglobin
- Higher SAA

Williams et al. 2015

High Starch in fresh cow rations: A balancing act

- More energy available
- Less mobilization of body tissues
- Increased milk production
- Increased intake
- Higher risk of acidosis with consequences of:
  - Decreased intake
  - Decreased milk production
  - Higher disease incidence

Can we feed high starch and still keep the rumen healthy?

Of 9 cows:
- 2 RP, 1 DA, 4 CK

Of 5 cows:
- 1 RP, 2 DA, 4 CK

NDF and uNDF

<table>
<thead>
<tr>
<th>Description</th>
<th>NDF</th>
<th>uNDF 240</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS Pre Change</td>
<td>32.5</td>
<td>8.9</td>
</tr>
<tr>
<td>LS Post Change</td>
<td>33.5</td>
<td>10.9</td>
</tr>
<tr>
<td>HS Pre Change</td>
<td>26.4</td>
<td>7.7</td>
</tr>
<tr>
<td>HS Post Change</td>
<td>32.8</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Of 9 cows, 2 RP, 1 DA, 4 CK
Of 5 cows, 1 RP, 2 DA, 4 CK

Stone, 2004; Cotanch et al. 2014; McCarthy et al. 2014
Study 1: The effect of fiber level in fresh cow rations on performance, energy, and liver metabolism

CURC Experiment #757

Materials & Methods
- 56 multiparous cows
- Enrolled 28 days prepartum
- Receive one of two treatment diets at calving through 28 DIM
  - Once high fiber cows > 28 DIM switched to the low fiber diet until 43 DIM
- Formulated for high starch and different levels of uNDF and pNDF
  - High fiber: Target adequate levels of uNDF and pNDF
  - Higher fiber achieved through addition of chopped straw
- Low Fiber: Target marginal levels of uNDF and pNDF
- Hypothesis: Additional fiber in fresh rations would help buffer the rumen and attenuate any possible negative effects due to SARA without impacting DMI and milk yield.

Data Collection
- Sampling
  - Daily: Feed intake, milk production
  - Weekly: Milk Components, BW, BCS
  - Rumination: Continuously recorded in 2h intervals
  - Blood 2x/wk prepartum, daily from 0-7 DIM, 3x/wk through day 28, 2x/wk thereafter
  - Subset of 40 cows: Liver biopsies 7d and 14d postpartum
- Statistical analysis
  - Data were analyzed by repeated measures ANOVA
  - Fixed effects: cow within treatment

Results - Analyzed Diet Composition

<table>
<thead>
<tr>
<th>Item</th>
<th>Prepartum</th>
<th>Postpartum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Fiber</td>
<td>Higher Fiber</td>
</tr>
<tr>
<td>DM, %</td>
<td>45.9 ± 1.2</td>
<td>44.4 ± 2.3</td>
</tr>
<tr>
<td>MP, g/kg DM</td>
<td>89.2</td>
<td>111.5</td>
</tr>
<tr>
<td>ADF, %</td>
<td>28.9 ± 0.5</td>
<td>21.3 ± 1.1</td>
</tr>
<tr>
<td>uNDFom, %</td>
<td>43.1 ± 0.3</td>
<td>32.8 ± 1.4</td>
</tr>
<tr>
<td>uNDF240, %DM</td>
<td>12.82 ± 0.5</td>
<td>9.49 ± 0.4</td>
</tr>
<tr>
<td>peNDF, %DM</td>
<td>33.3</td>
<td>21.4</td>
</tr>
<tr>
<td>Sugar, %</td>
<td>3.5 ± 0.4</td>
<td>4.7 ± 0.7</td>
</tr>
<tr>
<td>Starch, %</td>
<td>15.7 ± 0.3</td>
<td>24.9 ± 1.7</td>
</tr>
<tr>
<td>Fat, %</td>
<td>2.3 ± 0.2</td>
<td>3.3 ± 0.2</td>
</tr>
</tbody>
</table>

- Treatments actually ended up being adequate uNDF and high uNDF, data now investigating upper limit of uNDF for fresh cows
Results - DMI and Milk Production

![Graph showing intake and milk yield with markers for significance]

- Intake, % of BW
- Milk Yield, kg

Results - uNDF₂₄₀ Intake & Rumination

![Graph showing uNDF₂₄₀ intake and rumination with markers for significance]

- uNDF₂₄₀ Intake, %BW
- Rumination (min/day)

Results - Energy Metabolites

![Graph showing BHBA and NEFA with markers for significance]

- BHBA, mg/dL
- NEFA, μEq/L

Results - Energy Balance and Glucose

![Graph showing energy balance and glucose with markers for significance]

- Energy Balance, Mcal/d
- Glucose, mg/dL
**Results & Conclusions**

- Feeding increased uNDF\textsubscript{240} and peNDF in the immediate postpartum period resulted in:
  - Decreased DMI & milk production
  - Decreased blood glucose, increased BHBA and NEFA
  - More severe negative energy balance
- The detrimental effects of feeding higher uNDF\textsubscript{240} and peNDF did not carry over once the cows were switched to a lower uNDF\textsubscript{240} and peNDF diet
- uNDF\textsubscript{240} levels likely play an important role in regulating feed intake in the early fresh period, although this area warrants further investigation
  - The maximum uNDF\textsubscript{240} level for cows in the post partum period is likely around 0.35\% of BW.
  - Potential optimal uNDF\textsubscript{240} range in the fresh period ~0.29-0.35\% of BW or 9.5-11\% of DM.

**Next Step**

- Still looking for strategies to lower body tissue mobilization and increase dietary energy.
- Now that we know more about the upper limit of undigestible fiber for fresh cows, can we learn more about the lower limit?

**High Starch in fresh cow rations: A balancing act**

- Fiber
  - peNDF: Physical characteristic, impacts passage rate and ruminal fermentation
  - uNDF: Chemical characteristic, undigested fiber measured at a defined time point
    - Focus on digestibility-
      - Milk production and intake
    - Focus on undigestibility (i.e. uNDF\textsubscript{240})
      - Milk components, rumen and animal health

**Digestible Fiber**

- Brown Midrib Corn Silage- BM3
  - Higher in-vitro digestibility (30h) and lower uNDF compared to conventional
  - Reduction in rumen fill
  - Higher passage rate
  - Increased
    - DMI
    - Milk yield
    - Milk components
    - Postpartum BW gain
  - Increases overall energy availability

Stone, 2004; Cotanch et al. 2015; McCarthy et al. 2014

Another tool—Monensin

- Increased:
  - DMI
  - Blood glucose
  - Capacity to convert propionate to glucose
  - Milk production
- Decreased body reserve mobilization
  - BHBA and NEFA
- Through alterations in rumen environment, monensin optimizes energy availability

Study 2:
Strategies for optimizing dietary energy availability in fresh dairy cows—Impacts on production and metabolism

CURC Experiment #768

Materials & Methods

- 85 multiparous cows enrolled 28d prior to expected calving, on study until 43 DIM
- Covariate diet from day -28 through -21
  - Conventional silage, no Rumensin
- Assigned randomly to one of four treatment schemes consisting of corn silage type with or without Rumensin supplementation (350 mg/d prepartum, 450 mg/d postpartum)
  - Conventional corn silage, Rumensin
  - Conventional corn silage, Rumensin
  - BMR corn silage, no Rumensin
  - BMR corn silage, Rumensin
- Cows received a fresh diet at calving formulated to meet the initial treatment scheme
- Diets were identical in ingredient composition except for corn silage type and small inclusion mix which delivered Rumensin

Data Collection

- Sampling
  - Feed intake and milk yield—Daily
  - BW, BCS—Weekly
  - Milk Composition—2x/week for first 2 weeks, then weekly thereafter
  - Fecal Samples—Collected for fecal uNDF analysis
  - Blood Sampling
    - 1x/wk prepartum
    - 2x/wk through 14 DIM
    - 1x/wk through 42 DIM
## Ration Composition

<table>
<thead>
<tr>
<th>Item</th>
<th>Prepartum</th>
<th>Postpartum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO RUM</td>
<td>NO RUM</td>
</tr>
<tr>
<td>Corn silage</td>
<td>51.67 51.67</td>
<td>51.46 51.46</td>
</tr>
<tr>
<td>Hay Crop Silage</td>
<td>10.65 10.65</td>
<td>10.65 10.65</td>
</tr>
<tr>
<td>Straw</td>
<td>2.66 2.66</td>
<td>2.66 2.66</td>
</tr>
<tr>
<td>Corn meal</td>
<td>4.57 4.57</td>
<td>4.45 4.45</td>
</tr>
<tr>
<td>Amino Plus</td>
<td>4.0 4.0</td>
<td>3.52 3.52</td>
</tr>
<tr>
<td>Blood meal</td>
<td>4.0 4.0</td>
<td>1.77 1.77</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>1.93 1.92</td>
<td>1.40 1.40</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>0.67 0.67</td>
<td>0.48 0.48</td>
</tr>
<tr>
<td>Citrus pulp</td>
<td>3.67 3.67</td>
<td></td>
</tr>
<tr>
<td>Rumensin, mg/d¹</td>
<td>0 336.9</td>
<td>0 449.7</td>
</tr>
<tr>
<td>Other</td>
<td>8.96 8.96</td>
<td>5.19 5.19</td>
</tr>
</tbody>
</table>

## Ration Analysis - Preliminary analyzed via NIR

<table>
<thead>
<tr>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CON BMR</td>
<td>CON BMR</td>
</tr>
<tr>
<td>aNDFom</td>
<td>44.0 ± 3.2 41.6 ± 1.5</td>
<td>33.2 ± 2.0 32.4 ± 1.7</td>
</tr>
<tr>
<td>ADF</td>
<td>29.5 ± 1.8 27.2 ± 1.2</td>
<td>21.9 ± 1.7 20.7 ± 1.4</td>
</tr>
<tr>
<td>Starch</td>
<td>20.3 ± 2.1 21.1 ± 1.0</td>
<td>27.0 ± 1.1 26.7 ± 1.8</td>
</tr>
<tr>
<td>Sugar</td>
<td>4.7 ± 0.6 5.4 ± 0.4</td>
<td>4.0 ± 0.9 4.2 ± 1.0</td>
</tr>
<tr>
<td>Fat</td>
<td>2.7 ± 0.2 2.8 ± 0.2</td>
<td>4.3 ± 0.4 4.4 ± 0.3</td>
</tr>
<tr>
<td>uNDF240</td>
<td>17.1 ± 1.9 14.6 ± 1.2</td>
<td>11.2 ± 1.1 10.1 ± 1.1</td>
</tr>
<tr>
<td>peNDF¹</td>
<td>35.1 35.3</td>
<td>22.8 23.4</td>
</tr>
<tr>
<td>MP, g/kg DM¹</td>
<td>94.5 96.5</td>
<td>115.5 117.2</td>
</tr>
</tbody>
</table>

## Results - Intake

Cows fed BMR had:
- Increased prepartum intake
- Decreased postpartum intake

Cows fed RUM had:
- Decreased prepartum intake

## Results - Milk Yield

Cows fed BMR had:
- Increased prepartum intake
- Decreased postpartum intake

Cows fed RUM had:
- Decreased prepartum intake

Cows × Rumensin:
- Increased prepartum intake
- Decreased postpartum intake

Cows × Time:
- Increased postpartum intake
- Decreased postpartum intake

Cows × Rumensin × Time:
- Increased postpartum intake
- Decreased postpartum intake

ECM, kg/day:
- 53.2 54.8 54.1 53.8 1.04 0.27 0.84 0.17 0.56 0.01 0.13
Results and Conclusions

**Corn Silage**
- Feeding BMR resulted in:
  - Higher intakes
  - Higher fluid milk yield
  - Lower NEFA & BHBA
- Increasing digestible fiber positively impacts performance and metabolism
  - An interaction of corn silage type and Rumensin supplementation with time on fluid milk yield would suggest there is a **synergistic effect** of increasing dietary energy through increased dietary fiber and altering rumen fermentation with an ionophore.
  - Overall, increasing dietary energy positively impacted performance and metabolism

**Rumensin Supplementation**
- Feeding RUM resulted in:
  - Lower intake prepartum
  - Lower NEFA & BHBA
- Feeding Rumensin increased energy availability from the diet, improving metabolism in the fresh period

**Overall Conclusions**
- Fiber fractions, both digestible and indigestible, have a role in transition cow rations
  - Indigestible fiber may improve rumen health, but can also limit intake
  - Potentially digestible fiber increases energy availability
- Increasing dietary energy increases energy status postpartum
- Total fermentable carbohydrates should be considered in ration formulation
- Important to realize management can add additional stressors which can impact rumen dynamics
- **Bottom line: The answer is always “it depends”**
Acknowledgements

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- Dr. Ron Butler
- Dr. Jessica McArt
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Questions?