Effects of Prepartum Acidogenic Salts on Calcium and Energy Metabolism in Transition Cows


Florida Dairy Production Conference
Gainesville, April 20, 2017

Consequences of Hypocalcemia

Risk of metritis increases with decreased post-partum calcium

Feeding Acidogenic Salts Prepartum Increases Postpartum Calcium

Santos, J.E.P., 2016, Proceedings Florida Ruminant Nutrition Symposium

Feeding Acidogenic Salts to Reduces Prepartum Intake

Charbonneau et al. (2006) J. Dairy Sci. 89:537-548
**Hypothesis**

Reducing the negative DCAD from -70 to -180 mEq/kg and extending the duration of feeding from 21 to 42 days will not affect performance and metabolism in dairy cows.

**Objective**

Evaluate the effects of two levels of negative DCAD, -70 vs. -180 mEq/kg, and two durations of feeding, 21 vs. 42 days, on performance and metabolism in parous Holstein cows.

**Cows and Treatments**

- 114 parous Holstein cows at 233 d of gestation were enrolled in the experiment.
- Randomized complete block design with a 2 x 2 factorial arrangement of treatments:
  - 2 durations of feeding (21 vs. 42 d)
  - 2 levels of negative DCAD (-70 vs. -180 mEq/kg)
Dietary Treatment Arrangement

Measurements

- Acid-base status and urine pH
- Concentrations of minerals and metabolites in blood
- Colostrum yield and composition
- Prepartum DM intake and lactation performance
- Daily body weight and weekly body condition
Data Analyses

- Continuous data were analyzed by ANOVA with mixed models using SAS
- First 21 d of the dry period: positive DCAD vs. -70 vs. -180
  - Fixed effects: treatment, day, and treatment x day
  - Random effect: block, cow (treatment)
  - Orthogonal comparisons: Positive vs. Negative DCAD and -70 vs. -180 mEq/kg
- Day -21 to +42: 2 levels of DCAD (-70 vs. -180) and the two durations of feeding (21 vs. 42)
  - Fixed effects: DCAD, duration, DCAD x duration, day, DCAD x day, duration x day, DCAD x duration x day
  - Random effects: block, cow (DCAD x Duration)

Diet Composition

<table>
<thead>
<tr>
<th>Ingredient (% DM)</th>
<th>Positive DCAD</th>
<th>-70 mEq/kg</th>
<th>-180 mEq/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn silage</td>
<td>34.2</td>
<td>34.2</td>
<td>34.2</td>
</tr>
<tr>
<td>Triticale silage</td>
<td>20.4</td>
<td>20.4</td>
<td>20.4</td>
</tr>
<tr>
<td>Bermuda hay</td>
<td>6.7</td>
<td>6.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Straw</td>
<td>13.8</td>
<td>13.8</td>
<td>13.8</td>
</tr>
<tr>
<td>Citrus pulp</td>
<td>7.7</td>
<td>7.1</td>
<td>6.7</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>13.1</td>
<td>8.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Prepartum mineral</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Bio-Chlor*</td>
<td>0</td>
<td>5.2</td>
<td>8.3</td>
</tr>
</tbody>
</table>

* Contains: condensed corn fermentation solubles, processed grain by-products, condensed extracted glutamic acid fermentation product and magnesium chloride hexahydrate
### Diet Composition

<table>
<thead>
<tr>
<th>Item, DM basis</th>
<th>Positive DCAD</th>
<th>-70 mEq/kg</th>
<th>-180 mEq/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP, %</td>
<td>14.9 ± 0.8</td>
<td>14.7 ± 0.4</td>
<td>14.6 ± 0.6</td>
</tr>
<tr>
<td>ADF, %</td>
<td>29.4 ± 1.4</td>
<td>28.9 ± 1.2</td>
<td>29.1 ± 1.1</td>
</tr>
<tr>
<td>NDF, %</td>
<td>43.1 ± 1.7</td>
<td>43.7 ± 1.5</td>
<td>43.8 ± 1.5</td>
</tr>
<tr>
<td>Forage NDF, %</td>
<td>39.3 ± 1.7</td>
<td>39.3 ± 1.7</td>
<td>39.3 ± 1.7</td>
</tr>
<tr>
<td>Nonfiber CHO, %</td>
<td>31.7 ± 1.3</td>
<td>31.1 ± 1.6</td>
<td>31.1 ± 1.9</td>
</tr>
<tr>
<td>Starch, %</td>
<td>12.3 ± 0.4</td>
<td>12.6 ± 0.5</td>
<td>12.9 ± 0.6</td>
</tr>
<tr>
<td>Fat, %</td>
<td>2.8 ± 0.2</td>
<td>2.8 ± 0.1</td>
<td>2.8 ± 0.1</td>
</tr>
<tr>
<td>Ca, %</td>
<td>0.67 ± 0.07</td>
<td>0.64 ± 0.05</td>
<td>0.62 ± 0.05</td>
</tr>
<tr>
<td>P, %</td>
<td>0.33 ± 0.01</td>
<td>0.33 ± 0.02</td>
<td>0.33 ± 0.03</td>
</tr>
<tr>
<td>Mg, %</td>
<td>0.44 ± 0.06</td>
<td>0.47 ± 0.06</td>
<td>0.48 ± 0.03</td>
</tr>
<tr>
<td>K, %</td>
<td>1.54 ± 0.10</td>
<td>1.49 ± 0.09</td>
<td>1.46 ± 0.09</td>
</tr>
<tr>
<td>S, %</td>
<td>0.29 ± 0.03</td>
<td>0.40 ± 0.03</td>
<td>0.47 ± 0.03</td>
</tr>
<tr>
<td>Na, %</td>
<td>0.08 ± 0.03</td>
<td>0.11 ± 0.03</td>
<td>0.13 ± 0.04</td>
</tr>
<tr>
<td>Cl, %</td>
<td>0.50 ± 0.07</td>
<td>0.86 ± 0.07</td>
<td>1.11 ± 0.03</td>
</tr>
<tr>
<td>DCAD, mEq/kg</td>
<td>+109 ± 35</td>
<td>-66 ± 17</td>
<td>-176 ± 20</td>
</tr>
</tbody>
</table>

### Urine pH

- Short -70
- Long -70
- Short -180
- Long -180

**Before diet change**
- DCAD: $P < 0.01$
- Duration: $P < 0.01$
- Interaction: $P < 0.01$

**After diet change**
- DCAD: $P < 0.01$
- Duration: $P = 0.40$
- Interaction: $P = 0.35$

Day relative to calving
Serum Calcium

- Short -70
- Long -70
- Short -180
- Long -180

Day Relative to Calving

Calcium, mM

Prepartum
DCAD: \( P = 0.36 \)
Duration: \( P = 0.16 \)
Interaction: \( P = 0.76 \)

Postpartum
DCAD: \( P = 0.61 \)
Duration: \( P = 0.53 \)
Interaction: \( P = 0.56 \)

Serum Phosphorous

- Short -70
- Long -70
- Short -180
- Long -180

Day Relative to Calving

Phosphorus, mM

Prepartum
DCAD: \( P = 0.99 \)
Duration: \( P = 0.84 \)
Interaction: \( P = 0.03 \)

Postpartum
DCAD: \( P = 0.53 \)
Duration: \( P = 0.73 \)
Interaction: \( P = 0.81 \)
Serum Magnesium

- Short -70
- Long -70
- Short -180
- Long -180

Day Relative to Calving

Prepartum
DCAD: $P = 0.84$
Duration: $P = 0.99$
Interaction: $P = 0.03$

Postpartum
DCAD: $P = 0.73$
Duration: $P = 0.53$
Interaction: $P = 0.81$

Serum β-Hydroxybutyric Acid (BHBA)

- Short-70
- Long-70
- Short-180
- Long-180

Day Relative to Calving

Prepartum
DCAD: $P = 0.87$
Duration: $P = 0.12$
Interaction: $P = 0.29$

Postpartum
DCAD: $P = 0.85$
Duration: $P = 0.82$
Interaction: $P = 0.11$
Serum Non-Esterified Fatty Acids (NEFA)

- Short-70
- Long-70
- Short-180
- Long-180

PREPARTUM DCAD: $P = 0.64$
Duration: $P = 0.29$
Interaction: $P = 0.06$

POSTPARTUM DCAD: $P = 0.65$
Duration: $P = 0.30$
Interaction: $P = 0.97$

Ionized Calcium and Measures of Acid-Base Status

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short -70</td>
<td>Short -180</td>
</tr>
<tr>
<td>Blood pH</td>
<td>7.419</td>
<td>7.382</td>
</tr>
<tr>
<td>Blood PCO$_2$, mm Hg</td>
<td>40.4</td>
<td>38.1</td>
</tr>
<tr>
<td>Blood HCO$_3^-$, mM</td>
<td>26.2</td>
<td>22.6</td>
</tr>
<tr>
<td>Base excess, mM</td>
<td>1.62</td>
<td>-2.40</td>
</tr>
<tr>
<td>Blood iCa, mM</td>
<td>1.26</td>
<td>1.29</td>
</tr>
</tbody>
</table>
### Postpartum Performance: Colostrum Yield and Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Short</th>
<th>Long</th>
<th>SEM</th>
<th>Dur</th>
<th>DCAD</th>
<th>Inter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colostrum, kg/d</td>
<td>-70</td>
<td>-180</td>
<td>-70</td>
<td>-180</td>
<td>0.42</td>
<td>0.45</td>
</tr>
<tr>
<td>Fat yield, %</td>
<td>4.56</td>
<td>3.49</td>
<td>4.43</td>
<td>4.26</td>
<td>0.40</td>
<td>0.85</td>
</tr>
<tr>
<td>Protein yield, %</td>
<td>11.77</td>
<td>12.61</td>
<td>12.57</td>
<td>12.57</td>
<td>0.44</td>
<td>0.38</td>
</tr>
<tr>
<td>Lactose yield, %</td>
<td>3.62</td>
<td>3.50</td>
<td>3.55</td>
<td>3.51</td>
<td>0.08</td>
<td>0.68</td>
</tr>
<tr>
<td>SNF yield, %</td>
<td>16.66</td>
<td>17.37</td>
<td>17.45</td>
<td>17.37</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>SCC yield, %</td>
<td>6.05</td>
<td>6.65</td>
<td>6.74</td>
<td>6.51</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td>Colostrum NE, Mcal/kg</td>
<td>1.21</td>
<td>1.31</td>
<td>1.26</td>
<td>1.28</td>
<td>0.04</td>
<td>0.77</td>
</tr>
</tbody>
</table>

### Postpartum Performance: Milk Yield and Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Short</th>
<th>Long</th>
<th>SEM</th>
<th>Dur</th>
<th>DCAD</th>
<th>Inter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, kg/d</td>
<td>43.1</td>
<td>41.7</td>
<td>39.1</td>
<td>41.1</td>
<td>1.1</td>
<td>0.04</td>
</tr>
<tr>
<td>3.5 FCM, kg/d</td>
<td>46.7</td>
<td>46.0</td>
<td>43.9</td>
<td>45.8</td>
<td>1.3</td>
<td>0.23</td>
</tr>
<tr>
<td>ECM, kg/d</td>
<td>45.2</td>
<td>44.5</td>
<td>42.4</td>
<td>44.3</td>
<td>1.2</td>
<td>0.21</td>
</tr>
<tr>
<td>Fat yield, kg/d</td>
<td>1.73</td>
<td>1.73</td>
<td>1.66</td>
<td>1.73</td>
<td>0.06</td>
<td>0.52</td>
</tr>
<tr>
<td>Protein yield, kg/d</td>
<td>1.27</td>
<td>1.25</td>
<td>1.18</td>
<td>1.24</td>
<td>0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>Lactose yield, kg/d</td>
<td>2.00</td>
<td>1.94</td>
<td>1.82</td>
<td>1.91</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>SNF yield, Kg/d</td>
<td>3.64</td>
<td>3.55</td>
<td>3.34</td>
<td>3.50</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>Milk NE, Mcal/kg</td>
<td>0.731</td>
<td>0.748</td>
<td>0.757</td>
<td>0.753</td>
<td>0.009</td>
<td>0.10</td>
</tr>
</tbody>
</table>
**Body Weight**

- Prepartum DCAD: $P = 0.78$
- Postpartum DCAD: $P = 0.61$
- Duration: $P = 0.50$
- Interaction: $P = 0.01$

**Dry Matter Intake**

- Before diet change: DCAD: $P = 0.02$
- After diet change: DCAD: $P < 0.01$
- Duration: $P = 0.02$
- Interaction: $P = 0.36$
Conclusions

- Feeding a negative DCAD reduced DMI by 1 kg/d in the first 21 d of the dry period
- Reducing the level of negative DCAD from -70 to -180 mEq/kg in the last 21 d of gestation:
  - Reduced DMI by 1.8 kg/d
  - Induced a more exacerbated metabolic acidosis prepartum
  - Increased the concentration of iCa in blood prepartum

- Extending the duration of negative DCAD had minor impacts on blood iCa and measures of acid-base status postpartum.
- Extending the duration of negative DCAD feeding decreased the milk yield 2.4kg/d, and lactose yield when fed for a longer time.
- Concentrations of minerals or metabolites were not significantly affected by level or duration of DCAD.
- Data suggest that extended feeding of negative DCAD is not detrimental to performance when fed at -180 mEq/kg
Thank You!

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Bolivar Faria
Maria Lucia Gambarini

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