Supplementation of neonatal calves with fatty acids: nutritional modulation of the immune response

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The Australian Dairy Industry

- Pasture based, seasonal calving
- Average herd size: 220 head (70% Friesian Holstein)
- Cows calve outside
- Calves reared in groups in outdoor sheds
Neonatal Calf Mortality

• Most susceptible to disease from birth to weaning
  – Neonatal mortality 2-10% in Australian herds

• Most common cause of death and disease in Australian herds diarrhoea
  – Cryptosporidium parvuum, E. coli, Salmonella sp., Corona virus and Rotavirus
Peyer’s Patches (PPs) and Serum IgG

PPs: dynamic innate immune structures in small intestine
- Provide first line of defence
- Produce B cells for acquired immunity

Serum IgG indicates effectiveness of passive transfer and development of acquired immunity
Nutritional Modulation

- Evidence suggests PP morphology can be altered by nutritional supplementation
- Nutritional support may assist in development of immunity
  - Stimulating mucosal growth/increasing innate response
  - Boosting/supporting immune response
Fatty Acid Supplementation

24 Friesian Holstein bull calves

*Treatments:*

– CO: CMR only (10% LW)
– SU: CMR + 5% sunflower oil
– PF: CMR + 5% palm shortening
– Twice daily hand-feeding from 3-5 to 13-14 days of age
Sample Collection

- Blood samples taken at 3-5, 10 and 12 – 13 days of age
  - Serum removed; analysed by conjugate ELISA

- Calves euthanised at 13-14 days of age
Morphology: Jejunal PP

- Villi
- Interfollicular area
- Follicle
Morphology: Ileal PP

- Villi
- Interfollicular Area
- Follicle
# Morphology of JPPs

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>IFA ($\times 10^3 \mu m^2$)</th>
<th>VA ($\times 10^3 \mu m^2$)</th>
<th>VH (µm)</th>
<th>VC (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (N = 8)</td>
<td>57.3</td>
<td>153.2</td>
<td>737.1</td>
<td>2096.1</td>
</tr>
<tr>
<td>SU (N = 7)</td>
<td>45.0</td>
<td>158.5</td>
<td>772.0</td>
<td>2145.0</td>
</tr>
<tr>
<td>PF (N = 7)</td>
<td>47.5</td>
<td>155.6</td>
<td>770.0</td>
<td>2097.1</td>
</tr>
</tbody>
</table>
### Morphology of JPPs

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>FA ($ \times 10^3 , \mu m^2$)</th>
<th>FH (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (N = 8)</td>
<td>99.0$^{ac}$</td>
<td>278.5$^{ac}$</td>
</tr>
<tr>
<td>SU (N = 7)</td>
<td>116.2$^{ab}$</td>
<td>320.9$^{ab}$</td>
</tr>
<tr>
<td>PF (N = 7)</td>
<td>76.8$^{c}$</td>
<td>240.9$^{c}$</td>
</tr>
</tbody>
</table>

Different letters indicate significant differences; $p < 0.05$
## Morphology of IPPs

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>VA ($x 10^3 \mu m^2$)</th>
<th>VH (µm)</th>
<th>VC (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (N = 8)</td>
<td>128.7</td>
<td>601.1</td>
<td>1925.5</td>
</tr>
<tr>
<td>SU (N = 8)</td>
<td>132.0</td>
<td>600.6</td>
<td>1917.3</td>
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<tr>
<td>PF (N = 8)</td>
<td>137.9</td>
<td>606.0</td>
<td>1914.9</td>
</tr>
</tbody>
</table>
# Morphology of IPPs

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>FA ($x 10^3 \mu m^2$)</th>
<th>FH ($\mu m$)</th>
<th>IFA ($x 10^3 \mu m^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (N = 8)</td>
<td>256.8</td>
<td>626.2</td>
<td>28.7</td>
</tr>
<tr>
<td>SU (N = 8)</td>
<td>249.7</td>
<td>671.9</td>
<td>37.4</td>
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<tr>
<td>PF (N = 8)</td>
<td>219.2</td>
<td>574.9</td>
<td>38.5</td>
</tr>
</tbody>
</table>
Serum IgG Concentration

Serum IgG Concentration (mg/ml)

Age (Days)

- CO
- SU
- PF
CONCLUSIONS

Supplementation with 5% SU or 5% PF:

• Influences follicular morphology of JPPs (unsaturated vs saturated)
• Does not influence IPP morphology
• Does not influence serum IgG concentration
• Does not influence morbidity outcomes
FINALLY...

• What is the relationship between follicle size, immune cell proliferation, PP gross morphology and long term health outcomes?

• Understanding vital to:
  – Improving feed formulation
  – Decreasing calf mortality and morbidity
  – Increasing economic return
Acknowledgements

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