Visible inflammation of the rumen wall correlates with caecal lipopolysaccharide concentrations

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Sub-acute ruminal acidosis

- pH = 6.5: Rapid ingestion of starch
  - pH down
  - VFA formed

- pH = 5.5: Streptococcus bovis takes over
  - pH down
  - Lactic acid formed

- pH = 4.5: Only Lactobacillus can grow
  - pH down
  - More lactic acid formed
  - Death
Lipopolysaccharide (LPS) / endotoxin

Component of **Gram negative** bacteria

Released when cells **lyse** – especially at **low pH**

Potential role of the hindgut in SARA?

- “Translocated LPS during SARA may aggravate ruminal acidosis” (Jing et al., 2014)

- “The hindgut is less capable (than the rumen) of maintaining digesta pH during times of increased VFA production” (Gressley et al., 2011)

Aims and Objectives

- Determine LPS concentrations
  - In the **rumen** AND **hindgut**
  - In ruminants from **commercial farms** (Low/high risk)

- Record **visible signs of damage**
Animal Study

- In total **98** continental crossbred steers and heifers from **5 farms**
- **Rumen damage scores** used to assess condition of rumen wall
  - Both pre- and post-cooking
- **Ruminal fluid** and **caecum content** collected
- Lab analyses: *Limulus*-amebocyte lysate (LAL) assay used to quantify LPS (EU/mL), VFAs quantified by GC
Rumen Scoring

Post-cooking appearance

0 = No blackened areas, 1 = very small blackened areas, 2 = small blackened areas, 3 = moderate blackened areas, 4 = large blackened areas

Papillae integrity

0 = No damage, 1 = small areas bare, 2 = larger areas bare, 3 = moderate areas of damage, 4 = large areas of damage.
Rumen Scoring

**Papillae pinkness**

0 = Black/brown, 1 = grey/brown, 2 = grey/brown small areas with pink tips, 3 = grey/brown large areas with pink tips, 4 = pink.

**Papillae shape**

0 = Long & thin, 1 = Long + oval, 2 = Short & thin, 3 = short & oval, 4 = short & brittle.
Results – LPS concentration

<table>
<thead>
<tr>
<th></th>
<th>Farm</th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LPS (10^6 EU/mL)</td>
<td>BH1</td>
<td>BH6</td>
<td>BH7</td>
<td>BL2</td>
<td>BL6</td>
<td>s.e.d.</td>
<td>Sig.</td>
</tr>
<tr>
<td>Rumen</td>
<td>0.068</td>
<td>0.136</td>
<td>0.056</td>
<td>0.116</td>
<td>0.072</td>
<td>0.024</td>
<td>0.003</td>
</tr>
<tr>
<td>Caecum</td>
<td>0.624</td>
<td>0.125</td>
<td>0.879</td>
<td>0.537</td>
<td>1.976</td>
<td>0.208</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

- **10-fold** higher concentration of LPS in caecal compared to ruminal digesta
- Significant **differences between farms**
- **High variation**
Results – Volatile Fatty Acids

- Significant **difference between farms**
- **Lactate levels low** – not acute acidosis
- **High variation**
## Results – Rumen damage scores

<table>
<thead>
<tr>
<th>LPS (10^6 EU/mL)</th>
<th>Papillae integrity</th>
<th></th>
<th></th>
<th></th>
<th>s.e.d.</th>
<th>Sig.</th>
<th>lin</th>
<th>dev</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 (n = 85)</td>
<td>1 (n = 8)</td>
<td>2 (n = 3)</td>
<td>3 (n = 1)</td>
<td>4 (n = 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumen</td>
<td>0.089</td>
<td>0.080</td>
<td>0.038</td>
<td>0.026</td>
<td>0.438</td>
<td>0.099</td>
<td>&lt;0.001</td>
<td>0.909</td>
</tr>
<tr>
<td>Caecum</td>
<td>0.823</td>
<td>1.260</td>
<td>0.668</td>
<td>0.576</td>
<td>0.042</td>
<td>0.127</td>
<td>0.599</td>
<td>0.364</td>
</tr>
</tbody>
</table>

0 = No damage, 1 = small areas bare, 2 = large areas bare, 3 = small areas of damage, 4 = large areas of damage.

- **Papillae integrity** appears to be related to ruminal LPS – but results are **not conclusive**

- **No significant results** for:
  - Papillae shape
  - Post-cooking appearance
Results – Rumen damage scores

Significant linear relationship between caecal LPS and papillae pinkness

Example of Score 0

Example of Score 4

0 = Black/brown, 1 = grey/brown, 2 = grey/brown small areas with pink tips, 3 = grey/brown large areas with pink tips, 4 = pink.
Results – Rumen damage scores

0 = Black/brown, 1 = grey/brown, 2 = grey/brown small areas with pink tips, 3 = grey/brown large areas with pink tips, 4 = pink.
LPS and rumen pre-cooking colour

Pinkness (inflammation?) of rumen wall

Inflammation cascade

LPS from caecum translocates into bloodstream

Results highlight the need to consider the role of the hindgut in the pathology associated with SARA
Conclusions

- Caecal LPS much **higher** than rumen LPS

- Caecal LPS and not ruminal LPS **correlated with visible inflammation of the rumen wall**

- Thus, some **inflammation associated with SARA** may actually **originate in the lower gut**
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