Overview on methane proxies (COST Action ‘METHAGENE’)

Richard Dewhurst

Leading the way in Agriculture and Rural Research, Education and Consulting
Short-term measurements not covered
Potential targets for proxies

- Extent of rumen fermentation (FOM)
- Type of rumen fermentation (VFA profile)
- Conditions for methanogenic archaea
- Methanogens and methane production
- Digestibility & rumination
- Rumen volume & passage rates (X-ray CT)
- Thermal imaging?
- Milk fatty acids & MIR analysis
- Faecal ether lipids
- Methanogens in digesta (abattoir)
- H isotope fractionation
Low-methane yield sheep have smaller rumens and shorter rumen retention time

John P. Goopy\textsuperscript{1}, Alastair Donaldson\textsuperscript{1}, Roger Hegarty\textsuperscript{2}, Philip E. Vercoe\textsuperscript{3,4}, Fay Haynes\textsuperscript{2}, Mark Barnett\textsuperscript{2} and V. Hutton Oddy\textsuperscript{1}

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Do we want smaller rumen and shorter rumen retention time?
Recent meta-analysis (8 studies)

Meta-analysis of relationships between enteric methane yield and milk fatty acid profile in dairy cattle

H. J. van Lingen,*† L. A. Crompton,‡ W. H. Hendriks,¶ C. K. Reynolds,§ and J. Dijkstra†

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\[
\text{CH}_4 \text{ (g/kg of DMI)} = 23.39 \pm 1.21 + 9.74 \pm 3.23 \\
\times \text{C16:0-iso} - 1.06 \pm 0.17 \times \text{trans-10+11 C18:1} \\
- 1.75 \pm 0.49 \times \text{cis-9,12 C18:2},
\]

\[ [3] \]
Potential use of milk mid-infrared spectra to predict individual methane emission of dairy cows

F. Dehareng¹, C. Delfosse¹, E. Froidmont², H. Soyeurt³,⁴, C. Martin⁵, N. Gengler³,⁴, A. Vanlierde¹ and P. Dardenne¹

¹Valoration of Agricultural Products Department, Wallon Agricultural Research Centre, B-5030 Gembloux, Belgium; ²Department of Production and Soil Agroecology, Wallon Agricultural Research Centre, B-5030 Gembloux, Belgium; ³Animal Science Unit, Gembloux Agro-Bio-Tech, University of Liège, B-5030 Gembloux, Belgium; ⁴Fonds Publics for Scientific Research, B-1000 Brussels, Belgium; ⁵ULiège Herbesvives, BIOAGRI-Clermont-Ferrand Research Centre, F-63122 Saint Genis, Champagnole, France.

Figure 3 Infrared methane prediction on the basis of milk spectra of the day 1.5 for the different diets: corn silage (●), fresh pasture (○) and grass silage (+). PCA = principal component analysis.
Methanogen lipid markers

- GDGT - tetraether
- Archaeol - diether

Types of structures:
- Monolayer with tetraethers
- Bilayer with diethers
Treatment means – across studies
# Faecal tetraethers

<table>
<thead>
<tr>
<th>Dietary treatment</th>
<th>Concentrates</th>
<th>Grass silage</th>
<th>s.e.d.</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaeol (mg/kg DM)</td>
<td>9.4</td>
<td>71.1</td>
<td>6.57</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GDGT-0 (mg/kg DM)</td>
<td>87</td>
<td>147</td>
<td>36.9</td>
<td>0.138</td>
</tr>
<tr>
<td>Ratio (g/g)</td>
<td>10.4</td>
<td>2.09</td>
<td>1.95</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Tetraethers reduce membrane permeability and so are advantageous at low rumen pH

McCartney et al., 2014
Methanogen abundance

Archael abundance in *post-mortem* ruminal digesta may help predict methane emissions from beef cattle

R. John Wallace¹, John A. Rooke², Carol-Anne Duthie³, Jimmy J. Hyslop³, David W. Ross³, Nest McKain¹, Shirley Motta de Souza¹, Timothy J. Snelling¹, Anthony Waterhouse² & Rainer Roehe²

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FACCE JPI Multi-partner call on Agricultural Greenhouse Gas Research

Understanding the development and control of stability in the rumen microbiome as a basis for new strategies to reduce methanogenesis

ACRONYM: RumenStability
Project partners

- Richard Dewhurst (SRUC; co-ordinator)
- Teagasc (Ireland): Sinead Waters
- UCD (Ireland): Evelyn Doyle
- CSIC (Spain): David Yanez-Ruiz
- Ghent University (Belgium): Veerle Fievez
- INRA (France): Diego Morgavi
- ILVO (Belgium): Sam De Campeneere
- FBN (Germany): Björn Kuhla
- AgResearch (New Zealand): Stefan Muetzel
- Aberystwyth University (UK): Jamie Newbold
Objective

- Investigate long-term effects of short-duration dietary treatments on rumen microbiome and methanogenesis:
  1. weaning;
  2. diet transitions in adult ruminants (e.g. to grazing or high-concentrate feeding)

- Hypothesis: initial microbial colonisation influences the microbial ecosystem in later life…. and that the development of host immune response to the microbiome is involved
Application

• Identify short-term treatments that can give long-term reductions in methane production (reduced cost; easier to implement, particularly in grazing situations)

• Understand adaptation of the rumen – reasons for failure of treatments designed to reduce methanogenesis

• Understanding of the basis for between-animal variation in methane production (that will feed into genetic/genomic studies)
Components of the work

• New animal studies
  – Platform Experiments – biobanking and sharing samples for different experiments; and future funding bids

• Additional analysis on existing/planned studies (methane measurements; rumen microbiome analysis)

• Workshops, visits, training, standardisation

• Economic evaluation of strategies

• Dissemination
New animal studies

- Weaning age x animal type (dairy vs. beef) (Teagasc)
- Use of PUFA and medium-chain oils in diets of ewes/lambs (Ghent)
- Conventional vs. ‘step-down’ weaning strategy for calves (FBN)
- Methanogen inhibitors from birth to weaning (AgResearch)
- Dietary treatments for calves (ILVO)
- Diet treatments for ewes and lambs (INRA)
- Diet treatments for bull calves (INRA)