Association of nitrate and linseed oil effectively reduces methane emission in ruminants
Jessie Guyader, Maguy Eugène, Michel M. Doreau, Yvanne Rochette, Diego Morgavi, Cécile Martin

To cite this version:

HAL Id: hal-02744062
https://hal.inrae.fr/hal-02744062
Submitted on 3 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Association of Nitrate and Linseed Oil Effectively Reduces Methane Emission in Ruminants

J. Guyader\textsuperscript{AB}, M. Eugène\textsuperscript{AB}, M. Doreau\textsuperscript{AB}, Y. Rochette\textsuperscript{AB}, D.P. Morgavi\textsuperscript{AB} and C. Martin\textsuperscript{AB}

\textsuperscript{A}INRA, UMR1213 Herbivores, F-63122 Saint-Genès-Champanelle, France
\textsuperscript{B}Clermont Université, VetAgro Sup, UMR1213 Herbivores, BP 10448, F-63000, Clermont-Ferrand, France

Using linseed oil or nitrate in diets are long-term viable strategies for mitigating enteric methane (CH\textsubscript{4}) emission from ruminants (Hristov et al. 2013). These additives individually reduce methane emissions by affecting the rumen hydrogen (H\textsubscript{2}) pool: linseed oil reduces H\textsubscript{2} production through its toxic effect against rumen protozoa (Doreau and Ferlay 1995) and nitrate acts as a H\textsubscript{2} sink through its reduction into nitrite then ammonia (Van Zijderveld et al. 2010). As the mechanisms of action of these additives in the rumen are different, we hypothesized that their combination would lead to lower CH\textsubscript{4} emissions than when they are fed individually.

Four multiparous dry Holstein cows fitted with rumen cannulas were randomly assigned to 4 dietary treatments in a 4 x 4 Latin square design. Each experimental period lasted 5 weeks with measures performed in the last 2 weeks (wk1 and wk2). Diets were on a dry matter (DM) basis: 1) control diet (CON, 50% natural grassland hay and 50% concentrate), 2) control diet with 4% linseed oil (LIN), 3) control diet with 3% calcium nitrate (NIT), and 4) control diet with 4% linseed oil and 3% calcium nitrate (LIN+NIT). Diets were offered twice daily and formulated to have similar amounts of crude protein (12.2%), starch (25.5%) and neutral detergent fiber (NDF, 39.5%). Feed availability was restricted to 90% of voluntary intake (average 9.2 kg DM/day). Total tract digestibility of organic matter (OM) and NDF was determined from total feces collection for 6 days in wk1. Daily CH\textsubscript{4} emissions were determined in kinetics using open chambers for 4 days in wk2. Methane was expressed as a function of gross energy (GE) intake, DM intake and digested OM. Data were analyzed using the MIXED procedure of SAS (SAS, 2009) with a model including period and diet as fixed effects, and cow as random effect.

Table 1. Digestibility and CH\textsubscript{4} emission of dry cows fed linseed oil and/or nitrate

<table>
<thead>
<tr>
<th>Diet</th>
<th>CON</th>
<th>LIN</th>
<th>NIT</th>
<th>LIN+NIT</th>
<th>s.e.</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH\textsubscript{4} (% of GE intake)</td>
<td>7.2\textsuperscript{a}</td>
<td>5.6\textsuperscript{b}</td>
<td>5.8\textsuperscript{b}</td>
<td>4.8\textsuperscript{c}</td>
<td>0.20 &lt;0.001</td>
<td></td>
</tr>
<tr>
<td>CH\textsubscript{4} (g/kg DM intake)</td>
<td>25.0\textsuperscript{a}</td>
<td>20.7\textsuperscript{b}</td>
<td>19.4\textsuperscript{b}</td>
<td>17.0\textsuperscript{b}</td>
<td>0.70 &lt;0.001</td>
<td></td>
</tr>
<tr>
<td>CH\textsubscript{4} (g/kg digested OM)</td>
<td>46.2\textsuperscript{a}</td>
<td>37.6\textsuperscript{b}</td>
<td>35.1\textsuperscript{bc}</td>
<td>31.4\textsuperscript{b}</td>
<td>1.31 &lt;0.001</td>
<td></td>
</tr>
<tr>
<td>OM digestibility (%)</td>
<td>66.6</td>
<td>66.9</td>
<td>67.2</td>
<td>66.4</td>
<td>1.19 0.891</td>
<td></td>
</tr>
<tr>
<td>NDF digestibility (%)</td>
<td>42.6</td>
<td>42.2</td>
<td>43.2</td>
<td>38.1</td>
<td>2.67 0.109</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a,b} Within a row, means without a common superscript differ (P<0.05).

Linseed oil and nitrate fed individually decreased CH\textsubscript{4} emissions by 17 and 22%, respectively (Table 1). These results are in accordance with previous data (Van Zijderveld et al. 2010; Grainger and Beauchemin 2011). The association of these two additives induced the lowest CH\textsubscript{4} emissions (-32%), which can be explained by their different mechanisms of action throughout the day. Indeed, daily pattern of CH\textsubscript{4} emissions showed that LIN decreased emissions throughout the day, NIT strongly reduced production during the 3 hours postfeeding and LIN+NIT combined the two effects (data not shown). For the first time, we demonstrated the partial additivity of nitrate and linseed oil on methanogenesis in ruminants, without altering diet digestibility.

J. Guyader is the recipient of an INRA-Région Auvergne PhD scholarship.


Email: cecile.martin@clermont.inra.fr This work was funded by InVivo NSA.