Assessment of protection against ruminal biohydrogenation of different forms of flaxseed

Dr. Alfredo J. Escribano, Product Manager for Ruminants at Norel S.A. (Spain)

INTRODUCTION

Nowadays, consumers’ demands towards healthier food are increasing. In this sense, and in line with medical recommendations, many consumers tend to buy milk products with a healthier fatty acid profile. Especially, they prefer higher levels of Omega-3, due to the positive effects of these fatty acids in relation to cardiovascular diseases, different types of cancers and neurological health (Abuajah et al., 2014). Consequently, the presence of these fatty acids in milk is of great interest in terms of both human health and farmers’ income.

In fact, the dairy industry is currently rewarding farmers who produce milk with higher content of Omega-3. It is therefore interesting to provide farmers with elements (raw materials or feed additives) that allow them to take benefit from this situation. Among raw materials, flaxseed has been identified by several authors (Oeffner et al., 2013) as an option to increase the presence of Omega-3 in milk.

However, rumen physiology requires this type of fats to be administered in a way that this can be transferred into milk fat. For this, these fats must be protected from ruminal biohydrogenation, in order to make them available to the animal at the intestinal level (Petersen and Jensen, 2014).

OBJECTIVE

The aim of the study was to assess the effect of different forms of presentation of flaxseed on the degree of protection against rumen biohydrogenation of their polyunsaturated fatty acids (Omega-3 included).

MATERIALS AND METHODS

Treatments

Below, the crude fat content and the fatty acid profile are shown:

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Samples</th>
<th>T2: Flax oil</th>
<th>T3: Calcium soap of flax fatty acids</th>
<th>T4: Absorbed flax oil</th>
<th>T5: Extruded linseed</th>
<th>T6: Linseed-stearin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Fat (%)</td>
<td></td>
<td>100</td>
<td>78.4</td>
<td>65.4</td>
<td>25.1</td>
<td>95.2</td>
</tr>
<tr>
<td>Fatty acid profile %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C16:0</td>
<td>8.35</td>
<td>16.31</td>
<td>7.39</td>
<td>13.52</td>
<td>37.57</td>
<td></td>
</tr>
<tr>
<td>C18:0</td>
<td>3.9</td>
<td>5.98</td>
<td>3.77</td>
<td>4.25</td>
<td>35.54</td>
<td></td>
</tr>
<tr>
<td>C18:1</td>
<td>19.53</td>
<td>29.61</td>
<td>19.87</td>
<td>15.01</td>
<td>6.29</td>
<td></td>
</tr>
<tr>
<td>C18:2</td>
<td>16.00</td>
<td>15.75</td>
<td>15.67</td>
<td>18.72</td>
<td>4.51</td>
<td></td>
</tr>
<tr>
<td>C18:3</td>
<td>51.66</td>
<td>28.24</td>
<td>52.27</td>
<td>48.51</td>
<td>13.88</td>
<td></td>
</tr>
</tbody>
</table>
Control and experimental diets

Treatments were fermented in vitro separately along with the following control diet:

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>% DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn grain</td>
<td>31.55</td>
</tr>
<tr>
<td>Soybean 44%</td>
<td>11.41</td>
</tr>
<tr>
<td>Dehydrated alfalfa</td>
<td>34.60</td>
</tr>
<tr>
<td>Maize silage</td>
<td>21.62</td>
</tr>
<tr>
<td>Premix (Vit-Min)</td>
<td>0.51</td>
</tr>
<tr>
<td>CaCO₃</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Chemical composition of the diet

<table>
<thead>
<tr>
<th></th>
<th>%DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter (%)</td>
<td>89.80</td>
</tr>
<tr>
<td>Crude Protein (%)</td>
<td>16.82</td>
</tr>
</tbody>
</table>

Laboratory techniques

The Tilley-Terry in vitro digestibility methodology was used. In the following table, the culture media, the substrate and the different treatments are shown:

Ruminal liquid taken from a cannulated cow mixed with a buffer in the ratio 1:1 was used as incubation system. The laboratory tubes were prepared in triplicate for each treatment and two experimental periods were performed.

Each incubation tube contained 3 g. of experimental diet plus the corresponding treatment and the culture media (200 ml). To achieve an anaerobic environment, CO₂ was infused during the preparation of the media to the incubation tubes containing experimental diets. Incubation was performed in a thermostatic bath at 39 °C. Experimental diets were incubated during 16 hours with continued stirring. The residual content of each tube was weighed to determine the dry matter. Later, they were lyophilized for subsequent determination of the fatty acid profile by gas chromatography.

The fermentation process and the determination of the fatty acid profile have been schematized in the following figure.
Technical bulletin no. 31

Assessment of the level of protection against ruminal biohydrogenation

Due to the differences among the fatty acid profile of the treatments, the degree of protection (or bypass) of each of them was estimated by means of the following formula:

\[ \% \text{ fatty acid protection} = \left( \frac{\text{fatty acid after fermentation (g)}}{\text{fatty acid before fermentation (g)}} \right) \times 100 \]

RESULTS

Finally, we obtained the levels of protection of each fatty acid, which are represented in the following table as the percentage of fatty acid protected from its initial content in each treatment:

<table>
<thead>
<tr>
<th>Fatty Acid</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
</tr>
</thead>
<tbody>
<tr>
<td>C18:1t11</td>
<td>6.75c</td>
<td>1.71a</td>
<td>11.61d</td>
<td>11.03d</td>
<td>2.29a</td>
</tr>
<tr>
<td>C18:1t9</td>
<td>9.25e</td>
<td>11.61f</td>
<td>9.40e</td>
<td>8.06d</td>
<td>4.03b</td>
</tr>
<tr>
<td>C18:1c9,12</td>
<td>9.20cd</td>
<td>9.9d</td>
<td>7.68b</td>
<td>9.01c</td>
<td>5.34a</td>
</tr>
<tr>
<td>C18:2c10,12</td>
<td>5.04c</td>
<td>3.69b</td>
<td>6.92d</td>
<td>7.63d</td>
<td>1.6a</td>
</tr>
<tr>
<td>C18:3c6,9,12</td>
<td>0.21a</td>
<td>1.59b</td>
<td>No detectable</td>
<td>0.6a</td>
<td>0.02a</td>
</tr>
<tr>
<td>C18:3%</td>
<td>19.88d</td>
<td>10.33b</td>
<td>15.37c</td>
<td>16.82c</td>
<td>8.22b</td>
</tr>
<tr>
<td>C18:1 + C18:2</td>
<td>19.9</td>
<td>18.7</td>
<td>15.2</td>
<td>17.9</td>
<td>30.5</td>
</tr>
</tbody>
</table>

As it can be observed, differences (p <0.0001) among treatments for the analyzed fatty acids were found. The product with the highest degree of protection against biohydrogenation with respect to C18:3 was linseed-stearin.

Finally, and taking into account NOREL’s infrastructure and expertise, flax fatty acids were protected with hydrogenated fat.

CONCLUSION

The use of linseed-stearin is recommended to feed dairy cows in order to produce milk with a higher content of OMEGA-3.

PRODUCT DEVELOPMENT

REFERENCES
