Increasing amounts of sunflower seeds increase CLA and vaccenic acid content in milk fat from dairy cows

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What is CLA?

* cis-9, cis-12, C18:2 (Linoleic acid) *

* cis-9, trans-11, CLA 75-90% of total CLA in milk fat *

* trans-10, cis-12, CLA *

Adapted from Bessa et al. (2000)
Why is CLA interesting?

- Anti-carcinogenic
- Anti-atherosclerotic
- Anti-diabetogenic
- Anti-adipogenic
- Bone formation
- Immune function

Isomer specific effect of CLA
Origin of milk fat CLA

Rumen

Linolenic acid
\(cis-9, \, cis-12, \, cis-15\)
\(\text{C18:3}\)

\(\downarrow\)

\(cis-9, \, trans-11, \, cis-15, \, \text{C18:3}\)

\(\downarrow\)

\(trans-11, \, cis-15\)
\(\text{C18:2}\)

\(\downarrow\)

\(\text{CLA}\)
\(cis-9, \, trans-11\)

\(\downarrow\)

Vaccenic acid
\(trans-11, \, \text{C18:1}\)

\(\downarrow\)

\(\text{C18:0}\)

Stearic acid

Mammary gland

CLA
\(cis-9, \, trans-11\)

\(\uparrow\)

\(\Delta^9\)-desaturase

Vaccenic acid
\(trans-11, \, \text{C18:1}\)

Adapted from Bauman (2003)
Alternative biohydrogenation pathway of linoleic acid under certain dietary conditions

Rumen

Linoleic acid

CLA

\(_{cis-9, trans-11}\)

Vaccenic acid

\(_{trans-11, C18:1}\)

C18:0

Stearic acid

CLA

\(_{trans-10, cis-12}\)

\(_{trans-10, C18:1}\)

C18:0

Stearic acid

Adapted from Griinari & Bauman (1999)
Objective

Determine the effect of increasing amounts of sunflower seeds in the diet on CLA and vaccenic acid concentrations in milk

Experiment: 24 cows - 5 week study period

<table>
<thead>
<tr>
<th></th>
<th>Dietary treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I (control)</td>
</tr>
<tr>
<td>% of dry matter</td>
<td></td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>0</td>
</tr>
<tr>
<td>Grass silage</td>
<td>55</td>
</tr>
<tr>
<td>FA, g/kg dry matter</td>
<td>12</td>
</tr>
</tbody>
</table>
# Fatty acid composition of different fat sources

<table>
<thead>
<tr>
<th></th>
<th>C16:0</th>
<th>C18:0</th>
<th>C18:1</th>
<th>C18:2</th>
<th>C18:3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans(^1)</td>
<td>12</td>
<td>4</td>
<td>23</td>
<td>53</td>
<td>6</td>
</tr>
<tr>
<td>Rapeseed cake(^1)</td>
<td>6</td>
<td>2</td>
<td>59</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td><strong>Sunflower seeds</strong>(^1)</td>
<td><strong>6</strong></td>
<td><strong>4</strong></td>
<td><strong>26</strong></td>
<td><strong>63</strong></td>
<td><strong>0.3</strong></td>
</tr>
<tr>
<td>Peanut oil(^2)</td>
<td>12</td>
<td>3</td>
<td>51</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Linseed(^2)</td>
<td>7</td>
<td>4</td>
<td>23</td>
<td>15</td>
<td>51</td>
</tr>
</tbody>
</table>

1 Nielsen et al. (unpublished)
2 Kelly et al. (1998)
## Daily feed intake and milk production

<table>
<thead>
<tr>
<th></th>
<th>Treatment group</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>P-value</td>
</tr>
<tr>
<td>Feed intake, kg DM</td>
<td>16.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>**</td>
</tr>
<tr>
<td>Milk, kg</td>
<td>27.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>**</td>
</tr>
<tr>
<td>ECM, kg</td>
<td>26.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>***</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.00&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.05</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.29</td>
<td>3.27</td>
<td>3.10</td>
<td>3.17</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Level of dietary fat and milk fat and protein percentage

Fat
\[ y = 0.012x + 3.5 \]
\[ R^2 = 0.81 \]
\[ P < 0.001 \]

Protein
\[ y = -0.00003x + 3.2 \]
\[ R^2 = 0.0002 \]
\[ P = 0.98 \]
Temporal pattern of milk fat CLA

Cis-9, trans-11 CLA, g/100 g FA

- 0% Sunflower seeds
- 5% Sunflower seeds
- 10% Sunflower seeds
- 16% Sunflower seeds

Experimental week
Vaccenic acid, g/100 g FA

\[ y = 0.34x + 0.11 \]
\[ R^2 = 0.8 \]

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<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>g/100 g FA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cis-9, trans-11 CLA</td>
<td>0.49\textsuperscript{a}</td>
<td>0.84\textsuperscript{ab}</td>
<td>1.20\textsuperscript{b}</td>
<td>1.81\textsuperscript{c}</td>
<td>***</td>
</tr>
<tr>
<td>Vaccenic acid</td>
<td>1.07\textsuperscript{a}</td>
<td>2.13\textsuperscript{b}</td>
<td>3.47\textsuperscript{c}</td>
<td>4.79\textsuperscript{d}</td>
<td>***</td>
</tr>
</tbody>
</table>
Individual variation among cows

cis-9, trans-11 CLA, g/100 g FA

Treatment group
Conclusions

• The effect of sunflower seeds on milk fat CLA and vaccenic acid was dose dependent

• CLA and vaccenic acid concentration in milk can be enhanced more than 3 times by adding high levels of sunflower seeds to the diet

• High levels of sunflower seeds in the diet was not associated with milk fat depression – grass silage effective forage source in maintaining normal rumen function and biohydrogenation of PUFA

• Feed intake, milk production and milk protein may be compromised by high levels of sunflower seeds
Thank you for your attention !!