Short communication

Fat digestion and faecal bile acid excretion in veal calves fed milk replacers containing either coconut fat or tallow

Chao Xu, Theo Wensing, Anton C. Beynen*

Department of Large Animal Medicine and Nutrition, Faculty of Veterinary Medicine, Utrecht University, 3508 TD Utrecht, The Netherlands

Received 24 March 1998; received in revised form 1 April 1999; accepted 12 April 1999

Abstract

Thirty eight veal calves aged 7 weeks were fed milk replacers containing either coconut fat or tallow for a period of 15 weeks. Body weight gain was 114.2 ± 10.3 and 115.7 ± 22.5 kg (mean ± SD, n = 19, P > 0.05) for the calves fed the diets with either coconut fat or tallow, respectively. Faeces were collected during the last week of the trial. Apparent digestibility of crude fat was 93.3 ± 4.9 and 91.4 ± 3.4% (P = 0.17) for the calves fed on either coconut fat or tallow, respectively. Group mean of bile acid excretion was higher in the calves fed coconut fat instead of tallow, but the difference was not statistically significant. For individual calves a significant (P = 0.001), negative correlation coefficient (r = −0.54) was computed for the relation between faecal bile acid excretion and apparent fat digestibility. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Veal calves; Growth performance; Fat digestion; Bile acids

1. Introduction

In our previous feeding experiments with veal calves a low fat digestibility was associated with a high faecal excretion of bile acids (Xu et al., 1997, 1998). The observed relations can be explained as bile acids promote dietary fat absorption from the small...
intestine (McDonald et al., 1995). Medium and short-chain fatty acids do not require bile acids for absorption as they are relatively soluble in the digesta (McDonald et al., 1995). Coconut fat is rich in saturated medium-chain fatty acids and tallow is rich in saturated long-chain fatty acids. In calves, dietary coconut fat is more efficiently absorbed than tallow (Jenkins et al., 1985). The question may then be raised whether the negative relation between fat digestion and faecal bile acid excretion holds for fats with different digestibility. To address this question, veal calves were fed milk replacers containing dairy protein and either coconut fat or tallow as a sole source of fat. Apparent digestibility of fat and faecal bile acid excretion were measured.

2. Materials and methods

The experiment was approved by the animal experiments committee of the Utrecht Faculty of Veterinary Medicine.

2.1. Animals and diets

Thirty eight male Dutch Friesian–Holstein calves, about 1 week of age, were purchased at a local market. Their body weight was 44.8 ± 4.6 kg (mean ± SD, n = 38). The calves were housed individually in wooden stalls (70 cm × 170 cm) with slatted floors. The stalls were placed in a ventilated room. The calves were fed twice a day, at 06:00 and 15:30 h, with a reconstituted milk replacer presented in plastic buckets.

On arrival (week 0), the calves were given a starter diet (Tentego B.V., Mijdrecht, The Netherlands). After 6 weeks, the calves were divided into two groups of 19 animals each so that body weight distributions of the two groups were similar. Then the experimental diets were fed for another 15 weeks. The experimental diets contained dairy protein and either coconut fat or tallow as fat source. Table 1 shows the ingredient and analysed nutrient composition of the diets. The milk replacers were reconstituted in hot water (65°C) and fed at a temperature of about 41°C. On arrival, the animals received 1.0 l containing 125 g air-dry milk replacer per meal, the volume being gradually increased to 6.0 l after 6 weeks. The starter milk replacer was then gradually replaced by the experimental diets (115 g air-dry milk replacer/l) over a period of four days. After the replacement was complete, the concentration of the experimental milk replacers was gradually increased to 150 g/l within 15 weeks and the volume from 6.0 to 8.5 l within 4 weeks. The volume was then kept constant until week 21, i.e. the end of the trial.

2.2. Collection of samples

Faeces were collected quantitatively for a period of 5 days during week 21 of the experiment. Faeces collection was performed by the use of plastic trays that were placed under the slatted floors of the pens. Body size of the male calves and position of the trays excluded contamination of faeces with urine. On each collection day, faeces were removed from the trays, weighed and homogenised with tap water in 1 : 1 weight ratio.
Five percent fractions of each day’s homogenate were pooled per calf and stored at $-20^\circ$C.
Reconstituted milk was sampled during the faeces collection period and the samples were pooled per diet and stored at $-20^\circ$C.

2.3. Chemical analyses

Milk and faeces samples were freeze-dried. After acidification of the samples with 8 M HCl, total lipids in the samples were extracted with diethyl ether and petroleum ether (b.p. 40–60°C) and measured gravimetrically (Horwitz, 1975). Bile acids in faeces samples were extracted using a mixture of t-butanol and water (1:1, v/v) and then measured on a COBAS-BIO autoanalyser (Hoffmann-La Roche B.V., Mijdrecht, The Netherlands) with an enzymatic, spectrofluorimetric reagent, prepared according to the formula of the kit Sterognost-3a Flu (Nyegaard, Oslo, Norway) and a bile acid calibrator set as standards (SIGMA, St. Louis, MO, USA). A bile acid control set from SIGMA and an appropriate reference faeces were used as control samples. Both feed and faeces samples were dried at 105°C for 16 h for moisture determination.

2.4. Calculations and statistical analyses

The apparent fat digestibility was expressed as percentage of intake and computed as $(\text{intake} – \text{output with faeces}) \times \text{intake}^{-1} \times 100$. 

---

Table 1
Composition of the experimental milk replacers

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Coconut fat (g/100 g of air-dry matter)</th>
<th>Tallow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut fat</td>
<td>20.25</td>
<td>–</td>
</tr>
<tr>
<td>Tallow</td>
<td>–</td>
<td>20.25</td>
</tr>
<tr>
<td>Lecithin</td>
<td>1.65</td>
<td>1.65</td>
</tr>
<tr>
<td>Whey powder</td>
<td>22.65</td>
<td>23.05</td>
</tr>
<tr>
<td>Whey protein</td>
<td>2.50</td>
<td>–</td>
</tr>
<tr>
<td>Delactosed whey powder</td>
<td>21.00</td>
<td>23.00</td>
</tr>
<tr>
<td>Skim-milk powder</td>
<td>25.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Calcium formiate</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Heat-treated starch</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Premixa</td>
<td>0.50</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Chemical analysis

<table>
<thead>
<tr>
<th></th>
<th>Coconut fat</th>
<th>Tallow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>94.5</td>
<td>94.5</td>
</tr>
<tr>
<td>Crude fat</td>
<td>21.2</td>
<td>22.4</td>
</tr>
</tbody>
</table>

*aTentego B.V., Mijdrecht, The Netherlands.*
The data were statistically analysed by subjecting them to the Student’s $t$ test using a computer program (SPSS for windows 6.1, SPSS, Chicago, IL, 1996). The level of significance was pre-set at $P < 0.05$.

3. Results

3.1. Growth performance

The feeding of either coconut fat or tallow had no differential effect on growth performance in the veal calves. For the period of 7 to 21 weeks, body-weight gain in the calves fed coconut fat was $114.2 \pm 10.3$ kg (mean $\pm$ SD, $n = 19$) and for the calves given tallow it was $115.7 \pm 22.5$ kg. In that period, the calves fed coconut fat consumed on average 212.1 kg of air-dry feed and those fed tallow ate 210.3 kg.

3.2. Fat digestibility and faecal bile acid excretion

Fat digestibility was $91.4 \pm 1.3$% of intake (mean $\pm$ SD, $n = 19$) in the calves fed the diet containing tallow and $93.3 \pm 4.9$ in those fed coconut fat. The difference was not statistically significant ($P = 0.17$). Group mean of faecal bile acid excretion was 61% higher in the calves fed the diet with coconut fat ($339 \pm 465 \mu$mol/day) instead of tallow ($211 \pm 290 \mu$mol/day). Because of the large individual variation the difference was not significant ($P = 0.313$). Fig. 1 shows that for individual calves there was a significant ($P = 0.001$), negative correlation ($r = -0.54$, $n = 38$) between faecal bile acid excretion and apparent fat digestibility. The figure also indicates that the correlation is strongly influenced by the clustering of 35 calves in the left part of the graph and of 3 calves on the right side. For the calves fed tallow the correlation was not significant ($r = -0.37$,

Fig. 1. Relationship between faecal bile acid excretion and apparent fat digestibility in individual veal calves fed milk replacers containing either coconut fat (triangles) or tallow (circles). The regression line is $y = -1.18x + 93.96$ ($r = -0.54$, $P = 0.001$, $n = 38$).
$P = 0.119, \ n = 19$, but for the calves fed coconut fat it was ($r = -0.70, \ P = 0.001, \ n = 19$).

4. Discussion

Unlike Jenkins et al. (1985), we did not find that fat digestibility in the group fed coconut fat was higher than in the group fed tallow. Jenkins et al. (1985) reported that lipid digestion was 96.4 and 92.8% by calves fed diets containing either coconut fat or tallow, respectively. The calves used in this experiment were 21 weeks of age, whereas those used by Jenkins et al. (1985) were 2 weeks of age. Guilloteau et al. (1983) reported that the activity of pancreatic lipase increased markedly from 1.5 days after birth to 21 weeks in veal calves. In addition, increasing age is associated with an increase in fat digestibility in calves fed a diet with skim-milk powder (Lallès et al., 1995). Possibly, the differential effect of fat type on fat digestion was masked by the relatively high age of the calves used in the present study.

As far as we know, the effects of coconut fat and tallow as sole source of dietary fat on faecal bile acid excretion in veal calves has not been reported earlier. The amounts of bile acids excreted by the calves are in the range of values that we found earlier (Beynen et al., 1983; Xu et al., 1997). The feeding of coconut fat instead of tallow raised group mean bile acid excretion, but the increase was not statistically significant. It is not known whether dietary coconut fat caused an increase in biliary bile acid secretion or led to interruption of the entero-hepatic cycle of bile acids. In individual calves apparent fat digestibility was negatively, and significantly, correlated with bile acid excretion. This observation extends and supports our earlier studies with calves fed milk replacers containing either different proteins (Xu et al., 1997) or different amounts of calcium (Xu et al., 1998). Taken together all the data collected so far, it appears that diet changes that lead to a decrease in faecal bile acid excretion enhance fat digestibility. The underlying mechanism warrants further investigation.

Acknowledgements

This study was supported by The Netherlands Foundation for Nutrition and Health Research, Loders Croklaan B.V., Wormerveer, and Tentego B.V., Mijdrecht, The Netherlands.

Thanks are due to Xandra Fielmich-Bouman and Inez Lemmens for analytical assistance, Jan Van Dasselaar and Dick Van De Pol for assistance with faeces collection and Bert Van Beek for taking care of the calves.

References


