Possibility of feeding dairy cows without soybean extract meal  
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At the individual farm level, assessing the possibilities for feeding dairy cows in Germany GE-free ought to focus on the impacts on the performance and health of the animals and on the economies of the enterprises. At the level beyond individual enterprises, it should concern itself with the availability of the necessary substitutes.

This account is concerned solely with the impacts on single farm enterprises. The question of the availability of alternative feed is not dealt with as this should not be appraised in the light of current availability alone but must without doubt consider existing potentials for producing alternative sources of protein as a result of changes in demand.

With regard to the goal of "GE-free feeding", soybean extraction meal (below soy meal for short) plays the major role in feedstuffs for feeding dairy cows. In what follows, the examination of the problem has for this reason been confined to possible alternatives to soy meal. Maize gluten is of lesser significance because substantial quantities of maize-gluten products not containing genetic modifications are produced in Germany. As for mineral feeds, almost all mineral feed manufacturers now provide a range of mineral feedstuffs guaranteed GE-free not only to organic commercial enterprises but also in the conventional sphere, so that no problems are anticipated where such feedstuffs are concerned.

In feeding ruminants the protein quality (biological value / essential amino acids) of feedstuffs has nothing like the importance it has with monogastrics, but substituting for soy meal in dairy cows' ration is not only a quantitative problem but also, as the milk yield of the animals increases, a qualitative problem which has to do with the special features of ruminants' protein metabolism.

With ruminants 70-90% of the crude protein in feed, depending on the source of the protein, is broken down by micro-organisms in the rumen – by far the most of it to ammonia. Only 10-30% directly reaches the small intestine as undegradable dietary protein (UDP) and is there available to the animal as a source of protein. By far the largest part of the available protein in their intestines has to be newly synthesised from the decomposed feed protein (ammonia) by microbial protein synthesis in the rumen. This "roundabout route" of microbial decomposition and reconstitution of the protein has the advantage that ruminants depend hardly at all on the protein quality of the feed protein since the microbial protein as a rule provides the ruminant with all the amino acids it needs in sufficient quantities (with the exception of the most extreme high yields). But for there to be sufficient microbial protein synthesis it is absolutely essential that adequate energy is supplied to the rumen. As the animals' yield increases, drawbacks to this "roundabout route" take effect. That is, it becomes increasingly more difficult for the energy the ruminant needs to be supplied to the rumen and, as proportions of protein in the ration which are stable in the rumen increase, quality of the feed protein becomes increasingly important. Depending on the feed ration and the ability of the animal to take in the feed, and taking into account the suitability (of the composition) of the ration for the ruminant, with daily yields upwards of 30, 35 or 40 kg of milk it is no longer possible to make sufficient energy available in the rumen. Consequently not enough microbial protein can be synthesised and excess ammonia has to be detoxified into urea, and this can have adverse consequences for the animal's health. In addition, the protein content of the milk falls as a result of the inadequate supply of protein to the small intestine.

To ensure sufficient protein is supplied to the intestine when high yields are sought, more feedstuff with high UDP values, which also includes soy meal, is used (Table 1). Farms' own grain legumes notably have relatively low contents of UDP.
**Table 1**
Comparisons between feedstuffs rich in protein (DLG [German Agricultural Society], 1997)

<table>
<thead>
<tr>
<th>feedstuff</th>
<th>energy content [MJ NEL/kg DM]</th>
<th>crude protein [g/kg DM]</th>
<th>usable crude protein [g/kg DM]</th>
<th>UDP [%]</th>
<th>RNB [g/kg DM]</th>
</tr>
</thead>
<tbody>
<tr>
<td>soybean extraction meal</td>
<td>8.6</td>
<td>510</td>
<td>308</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>field beans</td>
<td>8.6</td>
<td>298</td>
<td>195</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>peas</td>
<td>8.5</td>
<td>251</td>
<td>187</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>yellow lupin</td>
<td>9.0</td>
<td>438</td>
<td>232</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>rape extraction meal</td>
<td>7.3</td>
<td>399</td>
<td>219</td>
<td>25</td>
<td>33</td>
</tr>
<tr>
<td>silaged brewer's grains</td>
<td>6.7</td>
<td>249</td>
<td>185</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>grass meal</td>
<td>6.4</td>
<td>197</td>
<td>177</td>
<td>40</td>
<td>3</td>
</tr>
</tbody>
</table>

SPIEKERS’ (1997)’s comparison of UDP percentages in feed rations cited as required by the GEH¹ in 1986 or GfE² in 1997 (figure 1) shows the growing importance of UDP content of feedstuffs with regard to the supply of protein needed by high-yielding dairy cows.

**Fig. 1** Percentages of undegradable feed protein (UDP) required to provide energy and crude protein according to norm [Milchmenge [kg/Tag] = amounts of milk (kg per day)] (SPIEKERS, 1997)

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¹ Society for the Conservation of Old and Endangered Species
² Society for Nutritional Physiology
As the UDP values in basic farm-produced feedstuffs (pasturage, grass silage, hay) are around 10-20%, compensatory, performance-inducing feed (feed concentrate) must have correspondingly high percentages of protein stable in the rumen in order for the above values to be attained in the overall ration.

Several strategies which can also be combined with one another can be pursued to attain the goal of feeding dairy cows without using soybeans:
- making changes in the basic feed ration so as to reduce the need for protein supplementation;
- improving basic feed yield to reduce need for feed concentrate; and/or
- direct substitution of soybean extract meal protein components.

The protein supplement requirement can be reduced through feed concentrate by limiting the proportion of maize in the ration, reducing the proportion of succulent feed rich in energy (pressed pulp) and by increasing the proportion of legumes (grass-clover, lucerne), although at very high yields the animals' physiological demands set limits to these options (see above).

Measures that can be taken to improve yields through basic feed include improving the quality of basic feed, increasing its proportion of legume, increasing the proportion of hay in the ration, reducing the feed concentrate given, improving the management of basic feed and breeding for good persistency. The management measures needed here are well enough known, and will not therefore be gone into in detail here.

Grain legumes can make a very substantial contribution to the direct substitution of soy meal protein components especially in the low and middle yield range. Despite sometimes having considerable crude protein content, they are however less suitable with high-yielding cows since their UDP value of 15-20% is too low (see above).

Brewer's grains and grass meal have favourable UDP values and can be used as a high-grade source of protein if they are available and economically priced, but their relatively low energy content has to be taken into consideration.

There are numerous studies on the suitability of rape extraction meal for feeding ruminants and their findings in the main concur with one another where rape meal of current quality is concerned. An extensive project undertaken by research groups at Kiel and Hohenheim universities, the Federal Agricultural Research Centre in Braunschweig and the Rheinland Chamber of Agriculture compared soy and rape meal. Extensive sampling was carried out at ten German oil mills.

In the project's initial investigations SPIEKERS ET AL. (1998) concluded that soy meal could be replaced by rape meal without loss of yield. They put this down to UDP values in rape meal being higher than stated in tables. Further studies by SPIEKERS ET AL. (2000) confirm this and noted that when soy meal was completely replaced by rape meal this had no influence on the quantity of milk nor its fat or protein content. With the lower energy content of rape meal taken into account, soy and rape meal can be regarded as being of equal value for feeding dairy cows since both feedstuffs have a UDP value deviating by 30% from that in the German Agricultural Society table (SUEDEKUM AND SPIEKERS, 2002).

In another experiment to compare soy and rape meal made by the Landesanstalt agricultural institute at Iden a slightly higher milk yield was found in the rape group in dairy cows with daily yields of 40 kg of milk and identical milk protein values. Although dietary fat was used to try and compensate for the lower energy content in the rape meal, the milk fat content of the rape group was somewhat higher (0.06 %) on account of greater mobilisation of body fat, as were the milk acetone values, although the latter were in the physiological sphere in both groups (ENGELHARD ET AL., 2002).

An investigation at the Schaumann research institute at Huelsenberg likewise found no differences when comparing rape and soy meal (RAAB, 2002).

The reason for the positive results in using rape meal is the markedly higher proportion of UDP in today's rape meal compared to that in the German Agricultural Society table. In having 30% UDP it is on a par with soy meal, the UDP value for which was clearly somewhat overestimated by the Society's table (SUEDEKUM AND SPIEKERS, 2002).
Negative effects on dairy cows’ absorption of feed or their health are not anticipated. In a 10-month trial on 110 animals with 30% rape meal in milk-yield feed no negative effects occurred with respect to health, fertility or milk yield (ZECH, 1993).

Summary
Rape meal can completely substitute for soybean extraction meal in feeding dairy cows. Depending on local circumstances, milk yield and price level, brewer's grains, grass meal and grain legumes can also make an important contribution in replacing soybeans. Protein supplement requirements can in addition be reduced through changes in feeding strategies. Providing rape extraction meal is sufficiently available, it is thus possible for dairy cows to be fed GE-free without this having any significant disadvantages for the milk industry.

References