Exploiting Protein from Alternative Crops for UK Livestock Production

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Commercial feeds for ruminant animals account for a high proportion of farm overheads in the UK. There are now restrictions on the use of animal-based protein supplements in these concentrates, and fish stocks for fish meal production are dwindling. In addition, increasing demand is raising the price of soya protein concentrates. What are the alternatives? Can we in the UK produce high-protein feeds from alternative forages to supplement grazed and ensiled grass. At IGER we are applying our extensive experience of grazing and grass silage technology to investigate and develop alternative forage protein systems for ruminants. Taking a holistic approach we are able to integrate studies on the agronomy of the crops, their grazing/harvesting and the use of suitable ensiling technology. We can monitor the microbiology and biochemistry of the ensiling process and link it with nutritional studies on rumen function and dairy and beef cattle production responses.

Inoculants in grass silage making

Typically about 90% of herbage nitrogen in grasses and legumes is in the form of protein. However, up to 70% of this is degraded during ensilage. The IGER Microbiology and Conservation Group research teams have studied and made considerable advances in ensiling technology and in particular the biological control of grass silage fermentations. Inoculants containing lactic acid bacteria have been developed which deter the growth of spoilage microorganisms and improve fermentation characteristics in low dry matter grass silages. They also preserve a greater proportion of herbage proteins in an intact form (Table 7.1a), or conversely reduce free amino acid content in mature silages (Table 7.1b).

This ability of inoculants to reduce protein breakdown during ensilage of grasses has been indirectly linked to increased production response in beef cattle (Table 7.2). Although the underlying mechanisms are unclear, it is known that the correct balance of different protein degradation products is important to stimulate fibre digestion, maximise rumen microbial protein synthesis and thus improve protein supply to the ruminant.

Ensiling alternative crops

Our experience in ensiling technology of grasses at IGER is now being applied to conservation of a
number of alternative protein-rich forage crops including kale, red clover, sainfoin, lucerne, lotus, field beans and peas, either grown as mono-crops (Figure 7.1) or bi-cropped with cereals (Figure 7.2).

Kale, for example, has potential as a high protein, high digestibility alternative forage source. In the past it has usually been strip-grazed during autumn by dairy cows and finishing lambs, often in very muddy conditions, thus welfare and fleece quality have been adversely affected. Kale and other alternative crops are well suited to baling and ensiling technology. Application of these methods to kale will extend its use from a crop solely used for autumn grazing, and produce a highly nutritious winter feed supplement to grass silage. A trial carried out in 1996 indicated that kale can be baled successfully, but that harvesting date is vitally important. As with grass there is an inverse relationship between water soluble carbohydrate and protein content in the fresh crop (Table 7.3).

Thus, silage fermentation characteristics appear to improve with increases in soluble carbohydrate as the crop matures but at the expense of protein content, although there are marginal benefits in terms of reduced dry matter losses (Table 7.4).

More work is needed to determine the optimum conditions for harvesting and to investigate the effect of silage inoculants, which could decrease the absolute amount of soluble carbohydrate required for

<table>
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<th>Harvest Stage</th>
<th>15 week</th>
<th>18 week</th>
<th>week 20</th>
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</thead>
<tbody>
<tr>
<td>Dry matter (DM, g per kg)</td>
<td>156</td>
<td>163</td>
<td>168</td>
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<tr>
<td>Crude protein (g per kg DM)</td>
<td>158</td>
<td>125</td>
<td>114</td>
</tr>
<tr>
<td>Water soluble carbohydrate (g per kg DM)</td>
<td>105</td>
<td>156</td>
<td>185</td>
</tr>
</tbody>
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Figure 7.1 Forage kale grown as a mono-crop.
a good fermentation, making earlier harvesting at higher protein content an option. Very low numbers of lactic acid bacteria were detected on freshly harvested kale (Figure 7.3) and, during ensilage, counts increased more slowly than would be anticipated with a grass fermentation. Thus, there is good reason to suppose that inoculants, containing selected lactic acid bacteria, will also benefit kale silage fermentation characteristics and have a similar protein-sparing effect as has been shown with grass silages.

**Ongoing and future innovations**

We are also examining the conservation of novel
Research at IGER into alternative forages will point the UK dairy and beef sectors in the direction of less dependence on imported protein concentrates by using alternative home-grown protein-rich forages to supplement the grass, grass silage and forage-maize/whole crop cereal diets typically fed to dairy cows. This is desirable not only because of legislation and supply and demand problems, but also to restore consumer confidence in animal products in the post-BSE era.

IGER research into alternative protein-rich forage sources is being funded jointly by the MAFF and the Milk Development Council. Commercial sponsorship is supporting other aspects of our conservation and microbiology programmes.

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