A COMPARISON OF TRITICALE AND BANDICOOT OATS AND THE INFLUENCE OF CRACKING BARLEY GRAIN ON DIGESTIBILITY IN CATTLE AND SHEEP

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SUMMARY

The in vivo dry matter digestibility (DMD) of whole and cracked barley grain in cattle and sheep was compared to validate laboratory estimates of grain DMD. Mean (±SD) DMD of cracked barley fed to sheep and cattle was not significantly different, (81.8 ± 1.7% v 82.2 ± 2.3%), but DMD of whole grain fed to cattle (52.9 ± 3.4%) was lower than when fed cracked to cattle (82.2 ± 2.3%) and whole or cracked to sheep (83.1 ± 2.5% & 81.8 ± 2.1%). The DMD of Bandicoot oats, a high fat content grain, and triticale, a low fat content grain was determined in vivo in cattle and sheep and estimated by laboratory analysis. Mean DMD of Bandicoot oats was found to be 81.5 ± 5.0% in sheep, 79.9 ± 3.9% in cattle and 87.2% by near infrared (NIR) spectroscopy using standard grain calibrations obtained by FEEDTEST from pepsin cellulase and in vivo investigations. The mean DMD of triticale was found to be 84.6 ± 4.5% in sheep, 78.4 ± 3.0% in cattle and 88.9% by NIR. Bandicoot oats and triticale were also compared as the main component (67%) of a feedlot ration for steers. Growth rates, carcass weights and fat cover were similar; however the intake of steers fed triticale was restricted to the appetite of steers fed Bandicoot oats.

Keywords: dry matter digestibility, cattle, sheep, grain, fat content

INTRODUCTION

The demand for objective assessment of feed quality has led to the development of FEEDTEST, which utilises the technique of near infrared (NIR) spectroscopy for many feeds to provide a low cost rapid service. NIR spectra of a large and representative sample population are correlated with known values of feed constituents obtained from reference methods to derive calibration equations, which are then used to analyse similar unknown samples. Dry matter digestibility (DMD) is one of the most important indicators of feed quality and has been successfully determined using NIR on a variety of feeds. A limited number of feed samples with known in vivo DMD are included with every batch of unknown samples analysed for pepsin-cellulase dry matter disappearance (Clarke et al., 1982). DMD is then predicted for each sample using a linear regression based on the in vivo “standards”. These predicted DMD values are then used in the NIR calibration procedure. The majority of the in vivo standards have been obtained using sheep, with only a few having values obtained from cattle. Processing of grain has been found to increase grain digestibility when fed to cattle (Toland 1976).

The Bandicoot oat is a naked variety where the lack of husk results in low fibre, but high protein, fat and energy compared with traditional varieties. Bandicoot oats typically have a 10% fat content (P.C. Flinn, personal communication) and triticale a low fat content of 2% (CSIRO 1982) similar to many other cereal grains. The metabolisable energy (ME) prediction equation currently used by FEEDTEST for most feeds (SCA 1990) does not account for fat content, which can result in underestimates of ME for feeds containing appreciable levels of fat. This can be overcome by estimating fat and incorporating it in the alternative prediction equation $\text{ME} = 0.164 (\text{DMD}\% + \text{Fat}\%) - 1.6$ as suggested by M. Freer (personal communication)

The experiments described in this paper have been carried out to obtain in vivo data for on-going validation and updating of the FEEDTEST service. A cattle production trial comparing triticale and Bandicoot oats was undertaken in conjunction with digestibility studies. These studies also investigated the influence of cracking on the digestibility of whole barley grain in sheep and cattle. All feed values given in the text are expressed in terms of dry matter (DM).

MATERIALS AND METHODS

Animals and management

Adult Merino wethers Hereford cross steers were used in digestibility studies, and Hereford steers in a prediction study. In the digestibility studies the animals were kept indoors in individual pens or digestibility crates to which they were accustomed. In the prediction study the animals were kept in open feedlots. The animals had continuous access to water and were randomly allocated to the various treatments.

The dietary ingredients used were pasture hay and barley grain grown locally and Bandicoot oats and 286
triticale purchased from commercial sources. The grains were fed whole or cracked by dry rolling. Animals were fed and feed residues collected once daily at a fixed time each morning. In the production study a premix (vitamins, minerals, ionophores) was included in the diet (Beef Gro Rumensin, Rhône-Poulenc). In the digestibility studies feeding was at a level calculated to meet the maintenance energy requirement and hay was fed with the grain at levels considered to be sufficient to prevent digestive upsets (Heazlewood and Hay 1990).

The animals were fitted with harnesses to permit faeces collection at a fixed time each morning. The DM content of the faeces was determined daily using the entire output with sheep and 5% of thoroughly mixed output with cattle.

Chemical and statistical analysis

The DM content of feeds, feed residues and faeces was determined by drying samples for 24 hours at 100°C in a forced-draught oven. Fat in the Bandicoot oat grain was determined by ether extraction using a Soxhlet method.

Unpaired t-tests were used to analyse the significance of differences between treatment means. The DM digestibility of the grains was estimated using data obtained in digestibility studies with (i) a mixture of grain and hay and (ii) hay alone, assuming that the hay digestibility was the same in the mixed diet as when fed alone.

ME was estimated using the FEEDTEST equation and corrected for fat in the case of Bandicoot oat grain.

Experiments

a) Comparative digestibility of whole and cracked barley in sheep and cattle

DM digestibility values for whole and cracked barley grain were obtained in a series of digestibility experiments with sheep and cattle involving faecal collection periods of 8 days. The studies were conducted with (i) 4 sheep fed pasture hay (684 g/day), (ii) 5 sheep fed whole grain and hay, (iii) 5 sheep fed cracked grain and hay, (iv) 5 steers fed pasture hay (3.7 kg/day), (v) 5 steers fed whole grain and hay and (vi) 6 steers fed cracked grain and hay (one steer from this group was subsequently excluded because it scoured during the collection period). In (ii) and (iii) above the daily ration was 378 g grain and 160 g hay per head; in (v) and (vi) the corresponding values were 2.3 kg and 970 g. The hay was fed long (unchopped) after the grain ration was offered. The grain content of the mixed diets was gradually increased to the required level over an introductory period of 13 days with sheep, and 17 days with steers. The steers were 12 months old at the start of the study.

b) Bandicoot oat grain and triticale grain comparisons

(i) Digestibility

Digestibility studies involving a faeces collection period of 8 days were conducted with (i) 6 sheep fed pasture hay (408 g/day), (ii) 10 sheep fed cracked Bandicoot oats (3 16 g/day) and hay (132 g/day), (iii) 14 sheep fed cracked Bandicoot oats (305 g/day) and hay (1.32 g/day), (iv) 6 steers fed hay (5.90 kg/day), (v) 6 steers fed cracked Bandicoot oats (3.15 kg/day) and hay (1.00 kg/day), (vi) 5 steers fed cracked triticale grain (3.15 kg/day) and hay (1.00 kg/day). The steers were aged 26 months at the start of the study. The hay was cut from a different paddock to that used in part (a) and was hammermilled and fed mixed with the grain. The grain content of the mixed diets increased during introductory periods of 11 days for cattle and 21 days for sheep.

(ii) Production

Two groups of 9 steers, each separated in 3 groups of 3 were offered diets based on either cracked Bandicoot oat grain or cracked triticale grain over a period of 94 days which followed an introductory period of 21 days. During the introductory period some of the steers on Bandicoot oats suffered mild acidosis for several days. They were treated with sodium bicarbonate and seemed to recover fully. One steer in the third Bandicoot oat pen was excluded from the analysis of growth and carcass data because it was affected by occasional bloat and was unthrifty, just maintaining weight over the whole trial. As a consequence the feed wastage from this group was higher. The original intention was to feed the diets at levels approaching 3% of liveweight but intake of the Bandicoot oat diet was appreciably below that of the triticale diet. Hence, both diets were fed at a fixed level (grain: 4.6 kg/day; hay: 2.2 kg/day). This was an intake level of about 2% liveweight but was close to the ad libitum intake for the Bandicoot oat diet. Liveweight was recorded every 3 weeks and at the end of the study the steers were slaughtered and carcass weight and fat depth measured. The steers were aged 14 months at the start of the study, with the triticale and Bandicoot oat treatments weighing 307 kg and 3 15 kg respectively.
RESULTS

a) Comparative digestibility of whole and cracked barley in cattle and sheep

Cracking barley grain increased the DMD in cattle by 29.3% but in sheep the increase was only 1.3% (Table 1). Sheep in vivo digestibility figures for barley were found to adequately indicate the digestibility of cracked barley grain in cattle, but were not representative of the whole barley grain fed to cattle. In vivo hay digestibility values for sheep and cattle were similar at 59.2 ± 0.8% and 59.1 ± 1.6% respectively.

Table 1. DMD (%) of whole and cracked barley in cattle compared to sheep (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Whole barley</th>
<th>Cracked barley</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td>83.1 ± 2.5</td>
<td>8 ± 1.7</td>
<td>NS</td>
</tr>
<tr>
<td>Cattle</td>
<td>12.9 ± 3.4</td>
<td>2.2 ± 2.3</td>
<td>9.3***</td>
</tr>
</tbody>
</table>

*** denotes significance at 0.1% level (P<0.001), NS denotes no significant difference

FEEDTEST (Table 2) provided DMD values for barley close to those obtained in vivo with sheep but with cattle this applied only when the grain was cracked. For hay, the laboratory estimates were similar to the in vivo data for both species.

Table 2. Feed quality measured by FEEDTEST for experiments (a) and (b)

<table>
<thead>
<tr>
<th></th>
<th>DM (%)</th>
<th>Crude Protein (%)</th>
<th>MD (%)</th>
<th>Fat (%)</th>
<th>Est ME (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Pasture hay</td>
<td>87.5</td>
<td>13.0</td>
<td>62.8</td>
<td>not measured</td>
<td>8.6</td>
</tr>
<tr>
<td>(a) Barley</td>
<td>88.5</td>
<td>10.7</td>
<td>82.0</td>
<td>not measured</td>
<td>11.9</td>
</tr>
<tr>
<td>(b) Pasture hay</td>
<td>87.7</td>
<td>13.6</td>
<td>62.8</td>
<td>not measured</td>
<td>8.8</td>
</tr>
<tr>
<td>(b) Triticale</td>
<td>87.2</td>
<td>12.9</td>
<td>88.9</td>
<td>not measured</td>
<td>13.1</td>
</tr>
<tr>
<td>(b) Bandicoot oats</td>
<td>90.2</td>
<td>12.8</td>
<td>87.2</td>
<td>12.0</td>
<td>14.7</td>
</tr>
</tbody>
</table>

b) Bandicoot oat grain and triticale grain comparisons

With sheep, the mean digestibility of Bandicoot oats was 81.5 ± 5.0% and the mean digestibility of triticale was 84.8 ± 4.5%, these did not differ between the two 4 day collection periods. For cattle the digestibility of both grains increased between the first and second periods of faecal collection (Table 3) with the value in the second collection period more closely matching the sheep data. This lower DMD in cattle may have resulted from the cattle not fully adjusting to the ration at the start of the trial. It was observed that both the sheep and the steers ate more slowly and showed a higher incidence of feed refusal with Bandicoot oats, especially in the second period however, there were no significant feed refusals from sheep or cattle fed triticale in either period. The in vivo digestibility of hay in cattle and sheep was 65.4 ± 1.5% and 64.3 ± 2.4% respectively. Apart from the first collection period with the grain rations in cattle, the FEEDTEST estimates were in reasonable agreement with the in-vivo estimates (Table 2).

Table 3. DMD (%) of cracked triticale and Bandicoot oats in cattle and sheep (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Bandicoot Oat</th>
<th>Triticale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period 1 (days 1-4)</td>
<td>Period 2 (days 5-8)</td>
</tr>
<tr>
<td>Sheep</td>
<td>80.9 ± 4.8</td>
<td>82.1 ± 5.2</td>
</tr>
<tr>
<td>Cattle</td>
<td>76.7 ± 2.4</td>
<td>83.2 ± 5.6</td>
</tr>
<tr>
<td>Difference</td>
<td>4.2 NS</td>
<td>11 NS</td>
</tr>
</tbody>
</table>

*** denotes significance at 0.1% level (P<0.001), NS denotes no significant difference.

Grain type did not significantly affect growth rate, carcass weight or fat depth in the production study, as shown in Table 4.
Table 4. Growth and slaughter performance of steers fed Bandicoot oats or triticale (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Daily gain (kg)</th>
<th>Carcass wt. (kg)</th>
<th>Fat depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandicoot oat</td>
<td>8</td>
<td>0.78 ± 0.17</td>
<td>215.8 ± 14.6</td>
<td>9.7 ± 2.9</td>
</tr>
<tr>
<td>Triticale</td>
<td>9</td>
<td>0.73 ± 0.10</td>
<td>216.3 ± 9.9</td>
<td>7.9 ± 2.0</td>
</tr>
</tbody>
</table>

NS denotes no significant difference

**DISCUSSION**

The higher DMD of whole barley fed to sheep compared to cattle may reflect more efficient mastication of grain by sheep. The 30% increase in DMD found by cracking barley for cattle is similar to the results reported by Toland (1976). The type of grain fed to cattle influences both the efficiency of mastication (Beauchemin et al. 1994) and the effect of cracking on digestibility (Toland 1976). These results confirm that DMD data on whole grain as obtained with sheep cannot be applied to cattle. Conversely, if grain is to be fed cracked to cattle, *in vivo* DMD derived from sheep can accurately indicate DMD for cattle. Furthermore, for accurate *in vivo* digestibility studies with grain, cattle may require more than 11 days introductory period to adjust to the ration. *In vivo* DMD for hay in sheep and cattle were very similar and hence DMD obtained in sheep was adequate to predict the DMD of the hay in cattle.

Including the fat content in the prediction of ME for feeds such as Bandicoot oats is important if a true indication of the energy value of the feed is to be obtained. Using the existing prediction equation (SCA 1990), triticale had an ME of 13.1 MJ/kg and Bandicoot oats an ME of 12.8 MJ/kg. After correction for fat content the Bandicoot oat ME increased to 14.7 MJ/kg. Based on GRAZFEED (CSIRO Division of Plant Industry 1995) this difference between the energy content of the 2 rations should have been sufficient to increase the growth rate of steers fed Bandicoot oats by about 30%. The actual difference was only 7% in favour of Bandicoot oat, with the Bandicoot oat groups having 2 mm greater carcass fat depth. The performance of steers fed triticale was similar to that predicted by GRAZFEED. However, if the triticale groups had been fed to appetite and not restricted to the level of intake in the Bandicoot treatment, steer performance on triticale would have improved considerably.

These grains are likely to differ in starch fermentation patterns which may have contributed to the results, however with Bandicoot oats at 67% of the ration the level of fat in the diet was 8%. This is above the recommended intake of fat and approaching a level likely to reduce the activity of rumen microbes, retard carbohydrate fermentation and reduce food intake (McDonald et al. 1988). Rations high in Bandicoot oats clearly caused inappetence in both sheep and cattle. Subsequent unpublished data showed that when Bandicoot oats were mixed with triticale and hay (37.5: 37.5: 25.0 respectively) the steers ate at the expected *ad libitum* levels. This grain may therefore make a useful contribution as a high energy supplement for ruminants in a mixed ration.

**REFERENCES**


