Short Communication

An evaluation of fababean (Vicia faba) and lupin (Lupinus albus) stubble and seed for sheep¹

T.S. Brand* and F. Franck
Elsenburg Agricultural Development Institute, Private Bag, Elsenburg, 7607 Republic of South Africa

A. A. Brand
P.O. Box 101, Laaiplek, 7310 Republic of South Africa

A. Durand
Langgewens Experimental Farm, Private Bag X2, Moorreesburg, 7310 Republic of South Africa

J. Coetzee
University of Stellenbosch, Stellenbosch, 7600 Republic of South Africa

¹ Part of a Ph.D(Agric) thesis submitted by TSB to the Department of Sheep and Wool Science, University of Stellenbosch. Promotor Dr J. Coetzee.

* Author to whom correspondence should be addressed.

Received 19 December 1990; revised 25 July 1991; accepted 14 February 1992

The experiment was carried out to compare fababean with lupin crop residues for summer grazing by young Merino wethers. The crude protein (CP) and dry matter (DM) degradability as well as chemical composition of fababean and lupin seed and stalks were also determined. Sheep which utilized both crop residues gained in live mass (P < 0.01) over the first 35 days of grazing, after which average live mass of sheep on both crop residues started to decline. No significant differences in the average live masses of sheep between treatments were observed, although sheep which grazed fababean crop residues tended (P < 0.07) to have higher live masses than sheep which grazed lupin crop residues at the fourth week after the start of the trials. That observation can probably be attributed to a higher amount of seed remaining on the land after harvesting the crops (384 vs. 204 kg/ha). The CP (22.3%), in vivo digestibility of organic matter (89.1%) and crude fibre (8.8%) content of fababean seed were lower than the corresponding values found for sweet lupins (35.5, 91.1, and 10.1% respectively). Fababean as well as lupin seed was highly degradable in the rumen. Lupin seed has an undegradable protein (UDP) content of 3.1% and fababean an NDP-inhoud van 1.6% by 'n uitvloeitempo van 0.05/h. Die DM van lupienstoppel (55.8%) word tot 'n groter mate as DM van fababoonstoppel (46.1%) in die rumen gedegra-deer.

Keywords: Crop residues, degradability, fababean, in situ, lupin, sheep, summer grazing, supplementary feed.

Sweet lupin (Lupinus albus) has been introduced as a legume ley crop in the Winter Rainfall Region of South Africa over the last few years, especially where cereal monoculture is practised. Fababean (Vicia faba) has recently attracted attention as a promising grain legume suitable for cultivation in the region. Although the potential nutritive value of lupin seed as supplementary feed for ruminants (Ralph, 1986; Rowe, 1986; Rowe et al., 1989), and lupin crop residues as pasture (Croker et al., 1979a, 1979b; Allen & Cowling, 1986; Arnold et al., 1976) is well known, most of the available Australian literature concerning lupins deals with the narrow-leaf sweet lupin (Lupinus angustifolius). On the other hand, limited information is available on the utilization of fababean seed and crop residues. It is also important to evaluate protein feedstuffs for ruminant nutrition in terms of degradability (Orskov & McDonald, 1979), because degradability might play an important role in the potential value for production (Cronjé, 1990). It is also known that the rate of in situ dry matter (DM) degradation of low-quality roughages is an important indication of in vivo DM digestibility (Fahmy & Orskov, 1984) as well as potential DM intake (Orskov et al., 1980). This study compares the value of fababean crop residues and supplementary fababean seed with lupin crop residues and supplementary lupin seed for summering of young Merino wethers. The DM degradability of lupin and fababean stalks and crude protein (CP) degradability of lupin and fababean seed were also determined.

Fababean and sweet lupin legume grain crops were established on two adjoining test plots (1 ha each) at the Langgewens Experimental Farm in the Swartland area of the Winter Rainfall Region. The availability of stubble and location of the plots did not allow replication of treatments. It was concluded that the experimental procedure could not evaluate the crop residues conclusively, but as the plots were located on the same soil type (Glenrosa-Swartland), and were treated similarly prior to harvesting, there was no reason to suspect that treatments would be seriously biased by external influences. Seventy-six Merino wethers, approximately nine months of age and with a mean live mass (± SD) of 31.8 ± 4.5 kg, were thus randomly allocated to either fababean or lupin crop residues as experimental units.

The amount of seeds that remained on the ground after harvesting were estimated by weighing the residual seeds in 10
randomly sited 0.5-m squares. The feeding trial started on 17 December 1987 and ended on 17 March 1988. The sheep were weighed weekly. Supplementary feeding started after 42 days when a decline in live mass was observed in both groups. Lupin and fababean seed were introduced gradually at 200 (days 42—49), 300 (days 49—63), and 350 g/sheep/d (days 63—91), to sheep grazing the corresponding crop residues.

Fababean and lupin seed and stalk samples were pooled and analysed for DM, CP and crude fibre (CF) by standard methods (AOAC, 1984). In vitro digestibility of organic matter (IVDOM) was determined by methods described by Engels & Van der Merwe (1967). Concentrations of calcium and phosphorus were determined by atomic absorption spectrophotometry. The CP degradabilities of fababean and lupin seed and the DM degradability of fababean and lupin stalks were determined by the in situ technique described by Ørskov & McDonald (1979) and Ørskov et al. (1980), using polyester bags (14 x 9 cm) with a 53 μm mesh. Seed (5 g) and stalk (2 g) samples (on a DM basis) were milled through a Wiley mill (sieve size 1 mm), and placed into the bags. The bags were then placed in lukewarm water (35—40°C) for 1 min, whereafter they were inserted into the rumens of four rumen-fistulated sheep. Seeds were incubated for 2, 4, 12, 36 and 48 h, while stalks were incubated for an additional 72-h period. This procedure was replicated twice for each sample, giving a total of eight observations for each variable studied. The sheep received lucerne hay (milled through a 18-mm screen) ad libitum during the experimental period. At the end of each incubation period, the bags were removed from the rumen, rinsed under running tap water until no further colour washed out from the bags, and dried in a forced draught oven at 65°C for 48 h. Contents of the bags were removed and residual DM (AOAC, 1984) and nitrogen (Auto Analyser, Technicon Industrial Systems, Tarrytown, New York) contents were determined. The percentage of material degraded was determined according to the model of Ørskov & McDonald (1979):

\[ p = a + b(1 - e^{-kt}) \]

where

- \( p \) = actual degradation after time 't'
- \( a \) = intercept of the degradation curve at time zero
- \( b \) = potential degradability of the insoluble fraction
- \( c \) = rate constant for the degradation of the fraction described by 'b'.

The effective degradability \((P)\) was calculated from the equation:

\[ P = a + \frac{bc}{c + k} \]

where \( k \) = the outflow rate from the rumen, and fractional outflow rates of 0.02, 0.05 and 0.08/h were used in the calculations. Non-linear parameters were estimated by an iterative, least-square procedure (Statgraphics, 1986).

Live mass differences at each week between the groups of sheep grazing the respective crop residues were analysed according to a one-way analysis of variance. Effective degradability figures were also analysed by standard one-way analyses of variance procedures, using the F test to detect significance.

The amount of seed that remained on the paddock after harvesting was significantly \((P < 0.01)\) higher for fababean (384 ± 19 kg/ha) than for lupins (204 ± 15 kg/ha). This was possibly due to the higher seed production of fababean (2.08 t/ha) compared to lupins (1.01 t/ha), or can perhaps be ascribed to pods that shattered or pods that were low on the fababean plant and were therefore not harvested. The seed losses on the land were respectively 18% for fababean and 20% for lupins. Allen & Cowling (1986) reported that the amount of seed that remained on the land after harvesting was 524 ± 160 kg/ha (mean for five cultivars) for lupins, which was slightly higher than the amount found in this study (a mean yield of 0.9 ± 0.2 t/ha). Croker et al. (1979a; 1979b) reported residual seed quantities of 281 and 350 kg/ha for fababean and lupins respectively.

The weekly average live masses of sheep which grazed lupin or fababean crop residues are presented in Figure 1.
for approximately 50 days on *Lupinus angustifolius* (cv. Uniwhite) stubbles at stocking rates of 25 sheep/ha under Australian conditions. Croker *et al.* (1979a) found that sheep which had grazed up to 80 days showed increases in live mass at a stocking rate of 25 sheep/ha (residual lupin seeds amounted to 281 kg/ha), while Croker *et al.* (1979b) found increased live masses (25 sheep/ha) over 65 days with sheep which had grazed lupin crop residues (residual seed amounted to 350 kg/ha). Allen & Cowling (1986) found the grazing time by Merino wether weaners on fababean and lupin residues (stocking rate of 25/ha) to be 23 days (cv. Yandee) and 48 days (cv. 75 AI4-10) respectively with corresponding highest live mass changes of 1.2 and 6.3 kg and overall gains of -1.6 and 3.1 kg. The latter result corresponds to some extent with that of the present study, although the experiment had been conducted with *Lupinus angustifolius*. It seemed that the days of grazing and live mass-gains, found in their study, were also related to the amount of seed left after harvesting. This was confirmed by Carbon *et al.* (1972) who found that the seed fraction of lupin stubble is the most important fraction in determining the performance of animals grazing the stubble. Allden & Geytenbeek (1980) found that lambs grazing fababean and lupin crop residues induced greater live mass-gains than lambs on cereal stubble, which Hynd & Allen (1986) also attributed to the presence of unharvested seed in the stubble.

The chemical compositions of fababean and lupin seed and stalks are presented in Table 1. The CP, IVDOM and CF contents of fababean seed were lower than the corresponding values found for sweet lupin seed. Calcium (Ca) and phosphorus (P) content in fababean seed were also lower compared to that in lupins, although the ratio of Ca:P did not differ much (0.7:1 vs. 0.5:1). Stalks of both crops were low in IVDOM and CP.

The *in situ* results for CP and DM degradability of fababean and sweet lupin seed and stalks are summarized in Table 2. Fababean as well as lupin seed were highly degradable in the rumen, with the CP being almost totally degraded. At an outflow rate of 0.05/h, lupin seed had an undegradable protein (UDP) content, as percentage of DM, of 3.1% and fababeans a UDP content of 1.6%. No significant differences in CP degradability between fababean and lupin seed were observed, while DM degradability was significantly (*P* ≤ 0.05) higher for lupin seed at the low outflow rate, but significantly (*P* ≤ 0.05) lower for lupin seed at the high outflow rate. Several other researchers (Cronje, 1983; Freer & Dove, 1984; Erasmus *et al.*, 1988) have reported lupin seed to be highly degradable in the rumen. Hume (1974), however, found that only 65% of the

### Table 1 Chemical composition of fababean and lupin seed and stalks (DM basis)

<table>
<thead>
<tr>
<th>Test component</th>
<th>Moisture</th>
<th>Ash</th>
<th>In vitro DOM</th>
<th>CP</th>
<th>CF</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet lupin seed</td>
<td>4.36</td>
<td>5.52</td>
<td>91.1</td>
<td>35.50</td>
<td>10.08</td>
<td>0.30</td>
<td>0.45</td>
</tr>
<tr>
<td>Fababean seed</td>
<td>4.16</td>
<td>4.48</td>
<td>89.1</td>
<td>22.20</td>
<td>8.81</td>
<td>0.15</td>
<td>0.28</td>
</tr>
<tr>
<td>Sweet lupin stalks</td>
<td>6.34</td>
<td>5.23</td>
<td>47.7</td>
<td>5.25</td>
<td>33.07</td>
<td>0.68</td>
<td>0.13</td>
</tr>
<tr>
<td>Fababean stalks</td>
<td>5.04</td>
<td>5.27</td>
<td>32.4</td>
<td>4.63</td>
<td>53.35</td>
<td>0.37</td>
<td>0.08</td>
</tr>
</tbody>
</table>

### Table 2 *In situ* results for fababean and sweet lupin stalks and seed estimated by the model of Ørskov & McDonald (1979)

<table>
<thead>
<tr>
<th>Test component</th>
<th>Non-linear parameters*</th>
<th>Effective degradation**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>DM degradability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet lupin seed</td>
<td>45.0*</td>
<td>54.6*</td>
</tr>
<tr>
<td>Fababean seed</td>
<td>58.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Sweet lupin stalks</td>
<td>16.0</td>
<td>39.8</td>
</tr>
<tr>
<td>Fababean stalks</td>
<td>21.2</td>
<td>24.9</td>
</tr>
<tr>
<td>CP degradability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet lupin seed</td>
<td>64.2</td>
<td>35.2</td>
</tr>
<tr>
<td>Fababean seed</td>
<td>66.7</td>
<td>32.0</td>
</tr>
<tr>
<td>Sweet lupin stalks</td>
<td>57.4*</td>
<td>21.0</td>
</tr>
<tr>
<td>Fababean stalks</td>
<td>46.9</td>
<td>27.5</td>
</tr>
</tbody>
</table>

* Calculated by the iterative least-squares procedures fitting the model *P* = a + b (1 - e^-ct).

** Calculated by the equation *P* = a + b \(\frac{c}{c + k}\) for *k* = 0.02, *k* = 0.05, *k* = 0.08.

1 Denote significant differences (*P* ≤ 0.05) in DM degradability between fababean and sweet lupin seed.

2 Denote significant differences (*P* ≤ 0.05) in DM and CP degradability between fababean and sweet lupin stalks.
protein in lupin meal was degraded in the rumen (determined in vivo with the \(^{35}\)S-incorporation technique), while McMeniman & Armstrong (1979) found the undegradable protein fraction of fababean to be 20%. Although fababean and lupins were degraded to the same extent, a trend was observed whereby the CP in fababean was degraded more rapidly (rate constant of 0.228) than the CP in lupins (rate constant of 0.166). The DM in fababean, however, degraded significantly (P ≤ 0.05) faster than the DM in lupins.

The DM of lupin stalks was degraded to a larger extent in the rumen (55.8% as calculated by a+b) than the DM of fababean stalks (46.1%), although the solubility of lupin stalks at time zero (16.0%) was lower than that of fababean (21.1%). The effective DM degradabilities (P) for lupin and fababean stalks (k = 0.05/h) were respectively 38.0% and 34.1% and differed significantly (P ≤ 0.05). The CP solubility of lupin stalks was, however, significantly (P ≤ 0.05) higher than for fababean, while the effective CP degradability (P at 0.05/h) of lupin stalks was also higher (significant at P ≤ 0.05) than for fababean stalks. Although no degradability values for lupin and fababean stalks were found in the literature, the DM degradability seemed to be higher than values for other roughages like wheat straw (21.7%, k = 0.025/h) and grass hay (22.4%, k = 0.025/h) (Negi et al., 1988), but corresponded well with the degradability of urea-ammoniated wheat (38.4%), oat (38.9%) and barley straw (40.7%) (k = 0.05/h) (Brand, 1988).

In this study it was found that, when fababean and lupin crop residues were grazed by 38 Merino wethers/ha, mass losses occurred at approximately 42 days after the treatments were subjected to the residues. Both crop residues may thus play an important role in the summering of young sheep. The seeds of both legume crops contain low amounts of UDP. The stalks of both fababean and lupins have a relatively high DM degradability compared to the literature values found for other roughages.

The authors express their sincere thanks to Mr H. Agenbagh who supplied the data on the crop production aspects. Messrs P. Adams and S. Adams are thanked for their help with the degradation studies. The staff of the Elsenburg Animal Production Laboratory are thanked for chemical analyses.

References


