

## Short Communication

# An evaluation of fababean (*Vicia faba*) and lupin (*Lupinus albus*) stubble and seed for sheep<sup>1</sup>

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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 ( $P \leq 0.01$ ) 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 ( $P \leq 0.07$ ) 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 vitro* 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, and at an outflow rate of 0.05/h, lupin seed had an undegradable protein (UDP) content of 3.1% and fababeans a UDP content of 1.6%. The DM of lupin stalks were degraded to a larger extent in the rumen than fababean stalks (55.8% vs. 46.1%).

Die eksperiment is uitgevoer om fababoon- en soetlupien-oesreste as somerweiding vir jong Merinohamels te vergelyk. Die droë materiaal (DM)- en ruproteïen (RP)-degradeerbaarheid sowel as die chemiese samestelling van fababoon- en lupiensaad en stoppel is bepaal. Skape op beide stoppellande het toegeneem in liggaamsmassa ( $P \leq 0.01$ ) oor die eerste 35 dae van beweiding, waarna skape op beide weidings se gemiddelde liggaamsmassa afgeneem

het. Die gemiddelde liggaamsmassa van die hamels het nie betekenisvol tussen behandelings verskil nie, hoewel die gemiddelde liggaamsmassa van hamels wat fababoonoestereste bewei het, geneig het ( $P \leq 0.07$ ) om hoër te wees gedurende die vierde week van beweiding. Hierdie verskil in liggaamsmassa kan moontlik toegeskryf word aan die hoeveelheid saad wat ná oes op die land agtergebly het (384 teenoor 204 kg/ha). Die RP-inhoud (22.2%), *in vitro*-verteerbaarheid van organiese materiaal (89.1%) en ruveselinhoud (8.8%) van fababoonsaad was laer as die onderskeie waardes vir soetlupiene (35.5, 91.1 en 10.1%). Die fababoonsaad sowel as lupiensaad is hoog degradeerbaar in die rumen. Lupiensaad het 'n nie-degradeerbare proteïen (NDP)-inhoud van 3.1% en fababoon 'n NDP-inhoud van 1.6% by 'n uitvloeiempo van 0.05/h. Die DM van lupienstoppel (55.8%) word tot 'n groter mate as DM van fababoonstoppel (46.1%) in die rumen gedegraddeer.

**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. Fababeans (*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 (Crocker *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 (Ørskov & 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 & Ørskov, 1984) as well as potential DM intake (Ørskov *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 ( $\pm SD$ ) of  $31.8 \pm 4.5$  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 fababeen 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.

Fababeen 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 fababeen and lupin seed and the DM degradability of fababeen and lupin stalks were determined by the *in situ* technique described by Ørskov & McDonald (1979) and Ørskov *et al.* (1980), using polyester bags (14 × 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 forceddraught oven at 65°C for 48 h. Contents of the bags were removed and residual DM (AOAC, 1984) and nitrogen (Auto Analyser, samples digested in an aluminium block by Industrial Method No. 369 - 75 A/13, 1977; Technicon Industrial Systems, Tarrytown, New York) contents were determined. The percentage of material degraded was determined according to the model of Ørskov & McDonald (1979):

$$p = a + b(1 - e^{-ct}), \quad \text{where}$$

$p$  = 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 ( $P \leq 0.01$ ) higher for fababeans

(384 ± 19 kg/ha) than for lupins (204 ± 15 kg/ha). This was possibly due to the higher seed production of fababeans (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 fababeen plant and were therefore not harvested. The seed losses on the land were respectively 18% for fababeans 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 fababeans and lupins respectively.

The weekly average live masses of sheep which grazed lupin or fababeen crop residues are presented in Figure 1.

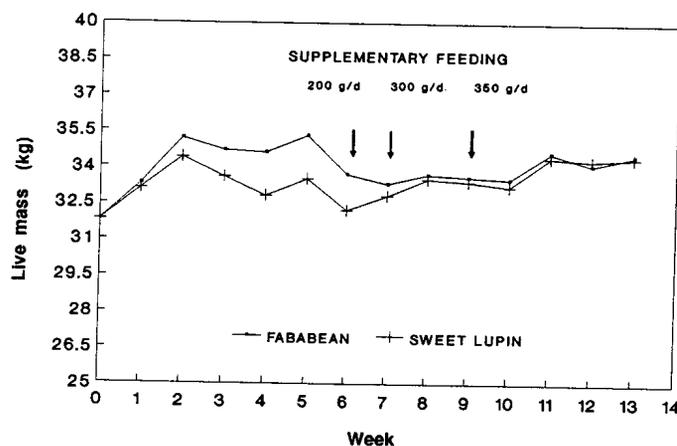


Figure 1 Live mass responses of young Merino wethers grazing fababeen and sweet lupin crop residues.

Sheep which utilized either crop residue gained in live mass ( $P \leq 0.01$ ) over the experimental period. The average live mass gains were similar for sheep on lupin and fababeans (2.6 vs. 2.7 kg respectively;  $P \geq 0.05$ ). Sheep which grazed fababeen crop residues reached a peak average live mass (35.3 kg) after five weeks, whereas sheep which grazed lupin crop residues reached a peak average live mass (34.4 kg) after two weeks. It was clear that the greatest response in live mass-gain occurred at the beginning of the experiment, and continued up to the fifth week, after which average live mass started to decline in sheep on both crop residues. Supplementary feeding commenced after six weeks, resulting in a stabilization of average live mass. No significant differences in the average live masses of sheep between treatments were observed, although sheep which grazed fababeen crop residues tended ( $P \leq 0.07$ ) to have higher live masses than sheep on lupin crop residues at week 4 after the beginning of the trial. This finding is probably related to the greater amount of residual fababeen seed compared to lupin seed that remained on the land after harvesting. In this study both lupin and fababeen stubble, stocked at a rate of 38 young Merino wethers per hectare, supported live mass for approximately six weeks without supplementary feed. Supplementation at the described levels similarly supported live mass for another seven weeks. Arnold *et al.* (1976) have similarly shown that adult wether sheep maintained live mass

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 A14-10) 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 crop residues 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 &

Allden (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 ( $P \leq 0.05$ ) higher for lupin seed at the low outflow rate, but significantly ( $P \leq 0.05$ ) lower for lupin seed at the high outflow rate. Several other researchers (Cronjé, 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)

Test component	Chemical composition (%)						
	Moisture	Ash	<i>In vitro</i> DOM	CP	CF	Ca	P
Sweet lupin seed	4.36	5.52	91.1	35.50	10.08	0.30	0.45
Fababean seed	4.16	4.48	89.1	22.20	8.81	0.15	0.28
Sweet lupin stalks	6.34	5.23	47.7	5.25	33.07	0.68	0.13
Fababean stalks	5.04	5.27	32.4	4.63	53.35	0.37	0.08

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

Test component	Non-linear parameters*				Effective degradation**			
					Fractional outflow rate			SE
	<i>a</i>	<i>b</i>	<i>c</i>	<i>r</i> <sup>2</sup>	0.02/h	0.05/h	0.08/h	
<b>DM degradability</b>								
Sweet lupin seed	45.0 <sup>a</sup>	54.6 <sup>a</sup>	0.093 <sup>a</sup>	0.99	89.9 <sup>a</sup>	80.4	74.3 <sup>a</sup>	1.8
Fababean seed	58.5	33.0	0.126	0.96	86.9	82.1	78.6	1.0
Sweet lupin stalks	16.0	39.8 <sup>1</sup>	0.062	0.96	46.1 <sup>1</sup>	38.0 <sup>1</sup>	33.3	1.6
Fababean stalks	21.2	24.9	0.054	0.85	39.3	34.1	31.2	1.0
<b>CP degradability</b>								
Sweet lupin seed	64.2	35.2	0.166	0.99	95.6	91.3	88.0	1.9
Fababean seed	66.7	32.0	0.228	0.96	96.1	92.9	90.4	1.2
Sweet lupin stalks	57.4 <sup>2</sup>	21.0	0.05	0.96	72.0	67.5 <sup>2</sup>	65.2 <sup>2</sup>	1.8
Fababean stalks	46.9	27.5	0.05	0.97	66.2	60.3	57.2	1.2

\* Calculated by the iterative least-squares procedures fitting the model  $p = a + b(1 - e^{-ct})$ .

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

<sup>a</sup> Denote significant differences ( $P \leq 0.05$ ) in DM degradability between fababean and sweet lupin seed.

<sup>1,2</sup> Denote significant differences ( $P \leq 0.05$ ) 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  $^{35}\text{S}$ -incorporation technique), while McMeniman & Armstrong (1979) found the undegradable protein fraction of fababeans to be 20%. Although fababeans and lupins were degraded to the same extent, a trend was observed whereby the CP in fababeans was degraded more rapidly (rate constant of 0.228) than the CP in lupins (rate constant of 0.166). The DM in fababeans, however, degraded significantly ( $P \leq 0.05$ ) 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 fababeans (21.1%). The effective DM degradabilities ( $P$ ) for lupin and fababean stalks ( $k = 0.05/\text{h}$ ) were respectively 38.0% and 34.1% and differed significantly ( $P \leq 0.05$ ). The CP solubility of lupin stalks was, however, significantly ( $P \leq 0.05$ ) higher than for fababeans, while the effective CP degradability ( $P$  at  $0.05/\text{h}$ ) of lupin stalks was also higher (significant at  $P \leq 0.05$ ) 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%,  $k = 0.025/\text{h}$ ) and grass hay (22.4%,  $k = 0.025/\text{h}$ ) (Negi *et al.*, 1988), but corresponded well with the degradability of urea-ammoniated wheat (38.4%), oat (38.9%) and barley straw (40.7%) ( $k = 0.05/\text{h}$ ) (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 wethers 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 rapid degradation of fababean seed might possibly lead to acidosis if ingested in large amounts by sheep. This problem does not occur with lupins (Rowe, 1986), which include only a small starch fraction (0.3—0.5%) compared to fababeans (30—40%) (Cerning-Beroad & Filiatre, 1976). The stalks of both fababeans and lupins have a relatively high DM degradability compared to the literature values found for other roughages.

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