OILSEED MEALS OR FORTIFIED CEREAL GRAIN SUPPLEMENTS FOR YOUNG SHEEP FED ROUGHAGE DIETS

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SUMMARY

In Experiment 1 46 young crossbred sheep (18-24 kg liveweight (LW)) were fed for 63 days chopped barley straw or oat straw (a) alone (NIL), or given supplements each third day of (b) barley grain + urea + Na_2SO_4 at 1.1% LW (BAR), (c) safflower meal at 1.8% LW (SAF) or (d) linseed meal at 1.1% LW (LIN). Straw DM intake was similar for the two straws (1145-1261 g/3 d), and was increased 17-33% (P<0.05) by each of the supplements. Rumen NH_3-N concentrations were on average 11 and 22 mg N/l for NIL treatments and were increased by all supplements. BAR supplement decreased rumen pH below 6.0 only briefly. Disappearance of straw from nylon bags increased due to BAR supplement, and was further increased by SAF and LIN supplements. Sheep given NIL supplements lost LW (-85 to -103 g/d), while each of the supplements resulted in approximate LW maintenance. In Experiment 2 46 young Merino sheep (26-32 kg LW) were fed for 42 days chopped pasture hay and the supplement treatments described in Experiment 1. Hay DM intake with NIL (2555 g/3 d) was decreased (P<0.05) by BAR supplement, but was not affected by SAF or LIN supplements. Sheep given NIL maintained LW (4 g/d); LW change tended to increase to 23 g/d with BAR, and increased (P<0.05) to 50-53 g/d with SAF and LIN supplements. Disappearance of supplement N from nylon bags indicated that both SAF and LIN supplements provided rurnen degradable N rather than undegraded dietary protein. These experiments indicated that when young sheep were fed cereal straws alone and were losing LW, supplements based on cereal grain + urea N + inorganic S could be as effective as oilseed meals high in true protein to maintain LW. However where the basal roughage was of sufficient quality for the sheep to maintain LW, the cereal grain + urea N + inorganic S supplement was much less efficient than oilseed meals to increase LW gain and wool growth.

INTRODUCTION

When animals are fed roughage diets of low nitrogen (It) content and low digestibility, supplements high in N and other essential nutrients often result in major increases in roughage intake and animal productivity. Despite numerous published experiments the responses of animals in various physiological states and consuming various types of low N roughage to provision of the supplementary N as rumen degradable N (RDN), or as undegraded dietary protein (UDP), or various proportions of RDN to UDP are not clear. For example Kellaway and Leibholz (1981) concluded that roughage intake and liveweight (LW) gain responses obtained with supplementary RDN were often equal to those obtained with supplements high in UDP. Conversely other research groups (Hennessy, 1981; Preston and Leng, 1987) have concluded that productivity responses to supplements of RDN were generally low compared with supplements containing substantial proportions of UDP cL "bypass protein". Egan (1984) and Hunter (1988) have discussed the balance between supply and demand for abscrbed amino acids for various dietary situations and for animals in various physiological states, and likely animal responses to additional absorbed amino acids.

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The following studies were undertaken to further investigate responses of young sheep fed several types of roughage to supplements high in N. Supplements examined were barley grain plus urea and inorganic sulpher, safflower seed meal known to contain a high proportion of fibre and with the protein readily fermented in the rumen, and linseed meal known to be low in fibre and with a protein less extensively fermented in the rumen. Roughages examined were low quality oat straw and barley straw, and a medium quality grass pasture hay. Supplements were given once each three days to simulate the infrequent feeding of supplements which is the usual management practice on commercial farms.

MATERIALS AND METHODS

Experiment 1

Forty-six Merino x Romney cross lambs initially approximately 12 months of age and 21-31 kg liveweight (LW) were used in the experiment. The sheep were maintained in either single pens or in metabolism crates. The sheep were divided into six blocks on the basis of surgical modification and liveweight; blocks 1-3 were rumen cannulated whereas blocks 4-6 were not cannulated. Eight dietary treatments were imposed for each of two periods of 63 days, and the sheep within each block were allocated at random to the eight diets. Blocks 1-3 were held in the metabolism crates for the first 42 days of each period, and Blocks 4-6 were held in the metabolism crates from days 43-63. The diets consisted of two roughages (chopped barley straw or chopped oat straw and minerals) given ad libitum (approximately 20% excess of previous intake) alone (NIL) or supplemented each third day with 1.1% LW barley grain plus urea plus sodium sulphate (BAR), with 1.8% LW safflower meal (SAF) or with 1.1% LW linseed meal (LIN). The supplements were intended to provide approximately equal amounts of N. The BAR supplement was made by preparing an aqueous solution of 344 g urea and 67 g sodium sulphate per i, and on the day of providing supplements to the sheep mixing 200 ml of this solution with each kg airdry barley grain. Due to the difficulties of satisfactorily measuring roughage intake of the sheep when held in single pens, only the intake of roughage when the sheep were held in metabolism crates was considered reliable. Thus reported measurements of intake were made from day 25 to day 42 for Blocks 1-3, and from day 46 to day 63 for Blocks 4-6. Total collection of faeces to determine digestibility was done from day 34 to day 42 for Blocks 1-3, and from day 55 to day 63 for Blocks 4-6.

Measurements of rumen digestion were made in the 24 cannulated sheep in Blocks 1-3. Nylon bags (45 x 110 mm, 44 µm pore size cloth) containing approximately 2 g straw DM were inserted into the rumen at the time of providing supplements, and duplicate bags removed after 24 h, 48 h and 72 h. Nylon bags containing straw were also inserted 24 h or 48 h after providing supplements and duplicate bags were removed after 24 h incubation and also in the former case 48 h incubation. During one 3 d feeding cycle samples of rumen fluid were obtained by gentle suction from nylon gauze covered probes in the rumen. pH was measured immediately using a glass electrode and 40 ml samples were acidified (0.5 ml, 10 N H_2SO_4) and stored for subsequent NH_3-N analysis. Sheep were weighed at 6 day or 9 day intervals on day 1 of the feeding cycle and before feeding, and LW change calculated by linear regression of LW and time. Wool growth was measured by clipping midside patches (100 x 100 mm) on approximately day 21 and day 49 of each period.

Following the above feeding period all sheep were fed oat straw and respective supplement treatments. Sheep were killed with an overdose of sodium pentabarbitone 6 h, 23.5 or 71.5 h after offering supplements, and the reticulo-rumen contents weighed and sampled.

Experiment 2

Forty-six Merino lambs initially approximately 15 months of age and 25-33 kg LW were used. The treatments imposed and measurements were similar to Experiment 1, the major difference being that the roughage consisted of grass pasture hay. The experimental design differed to the extent that measurements were made with the group of sheep not surgically modified during period 1, while the equivalent measurements with rumen cannulated sheep were made during period 2. Each period was 42 days. In addition to the measurements for Experiment 1 the rate of disappearance of supplement DM and N from nylon bags incubated in the rumen for 6, 24, 48 and 72 h was determined. Following these measurements the sheep were killed and reticulo-rumen contents measured.

RESULTS

Experiment 1

The leaf/stem ratio of the barley straw was 0.88, but the straw also contained appreciable proportions of head (81 g/kg) and weed (72 g/kg) (Table 1). Grinding energy of barley stem (333 J/g) and head (392 J/g) were much higher than for barley leaf (134 J/g) and the weed (54 J/g). The leaf/stem ratio of the oat straw was 0.55, and the straw contained only low proportions of head (36 g/kg) and of weed (8 g/kg). Grinding energy of oat stem (144 J/g) was higher than that of oat leaf (92 J/g), but both were much lower than the respective fractions of barley straw. Consequently the grinding energy of entire oat straw (113 J/g) was much lower than that of entire barley straw (193 J/g). Contents of N, NDF and ADF and IVOMD were similar for the two straws.

TABLE 1. Experiment 1. Proportions of morphological components, proximal analysis (g/kg) and grinding energy of entire straw and straw components

	Barley straw					Oat straw		
	Entire	Leaf	Stem	Head	Weed	Entire	Leaf	Stem
Proportion of components	1000	396	452	81	72	1000	346	612
Grinding energy (J/g DM)	193	134	333	392	54	113	92	144
Organic matter	954	933	966	955	958	966	961	964
Nitrogen	4.3	5.4	2.5	6.0	9.4	4.0	4.6	2.2
NDF	839	782	895	744	547	833	819	846
ADF	497	491	553	378	370	417	440	543
Lignin	52	34	70	48	74	61	41	81
Silica	10	29	8	16	1	1	3	1
IVOMD	467	650	303	562	364	446	608	253

Oat straw also contained 36 g/kg of head and 8 g/kg of weed.

The N contents of the oilseed meal supplements were 37.0 g/kg for safflower meal and 47.1 g/kg for linseed meal. Barley grain contained 18.4 g N/kg, and the fortified barley grain 52.0 g N/kg. The safflower meal was extracted from safflower seeds without prior removal of the hull, and had high contents of NDF (634 g/kg), ADF (445 g/kg) and lignin (155 g/kg).

The intakes of the two straws when fed alone were similar (1261 and 1145 g/3 d for barley and oat respectively) (Table 2). Intakes of both straws were increased by the supplements by 17-33%, and there were no differences among supplements in straw intake. Grinding energy of straw refusals (264-277 J/g for barley, 135-142 J/g for oat) were similar to the respective stem fractions, indicating that sheep selectively consumed the leaf fraction. DM digestibility of oat straw (432 g/kg) was greater ($P<0.05$) than for barley straw (396 g/kg). DM digestibility was increased ($P<0.05$) by the SAF supplement (to 458 and 467 g/kg) and further increased ($P<0.05$) by the BAR and LIN supplements to the range 503 to 524 g/kg. Digestible DM intakes were 495 and 499 g/3 d for the straws fed alone, and were increased to the range 856 to 949 g digestible DM/ 3 d for the supplemented diets. Sheep fed straw alone were losing LW at 85 to 103 g/d, while all supplements resulted in approximate LW maintenance. Clean wool growth was similarly increased from 33 mg per patch per day for the sheep fed straw alone to 47-58 mg per patch per day for the sheep receiving supplements.

TABLE 2. Experiment 1. Intake, digestion and growth of lambs given straw ad libitum alone or with supplements each third day of fortified barley grain, safflower meal or linseed meal (n = 11 or 12)

Measurement	Barley straw				Oat straw				SEM	Prob
	NIL	BAR	SAF	LIN	NIL	BAR	SAF	LIN		
DM intakes										
Straw, Day 1 (g)	414	439	452	446	382	347	378	399	25.4	NS
Straw, Day 2 (g)	417	521	582	546	362	495	535	559	29.5	**
Straw, Day 3 (g)	430	539	586	552	401	498	520	565	28.5	**
Straw, total (g/3 d)	1261	1499	1620	1544	1145	1340	1433	1524	78.6	**
Supplement (g/3 d)	0	289	453	282	0	293	440	284	-	-
Total (g/3 d)	1261	1788	2073	1826	1145	1633	1873	1808	82.7	**
DM dig. (g/kg)	396	510	458	503	432	524	467	508	9.4	**
Dig. DM intake (g/3 d)	499	912	949	918	495	856	875	918	42.0	**
LW change (g/d)	-103	4	10	11	-85	-10	-1	6	10.2	**
Clean wool (mg/patch/d)	33	47	58	57	33	49	47	54	5.4	**
(g/d)	2.6	3.8	4.5	5.1	2.4	3.9	3.8	4.0	0.6	**

The rumen NH_3-N concentration was low (11 and 22 mg N/l) in sheep fed straw alone (Table 3). When supplements were given NH_3-N concentration was increased on Day 1 of the feeding cycle, but by Day 3 had decreased almost to the concentrations in sheep given the straw alone. Rumen pH was greater than about pH 6.2 for most of the feeding cycle. Rumen pH was depressed to pH 6.0 or less on Day 1 of the feeding cycle when BAR supplement was given, but this depression was brief, being observed at only one sampling time. Rate of disappearance of straw from nylon bags over 24 h was increased markedly by all the supplements and particularly on Day 1 of the 3 day feeding cycle, and was increased more by the two oilseed meals than by the fortified barley grain.

TABLE 3. Experiment 1. Disappearance of DM from nylon bags incubated in the rumen, and rumen fluid pH and NH_3-N of lambs given straw alone or supplemented with fortified barley grain, safflower meal or linseed meal (n = 6)

Measurement	Barley straw				Oat straw				SEM	Prob.
	NIL	BAR	SAF	LIN	NIL	BAR	SAF	LIN		
Straw DM										
0 h	97	97	97	97	125	125	125	125		
24 h - Day 1	232	374	446	430	345	366	430	410	2	**
Day 2	241	361	459	446	344	384	418	413	2	**
Day 3	218	286	316	310	320	390	406	378	2	**
48 h - Day 1	363	530	595	590	504	525	537	537	2	**
Day 2	362	513	576	566	492	540	527	533	2	**
72 h - Day 1	455	609	646	633	561	570	589	585	2	**
Rumen pH - mean	6.8	6.5	6.4	6.5	6.6	6.6	6.6	6.5	0.06	*
- minimum	6.6	6.0	6.2	6.2	6.4	5.7	6.4	6.2	0.12	**
Rumen NH_3-N (mg N/l)										
Day 1	7	310	56	47	9	206	118	151	17	**
Day 2	10	35	49	45	12	58	78	74	9	**
Day 3	15	28	27	23	44	49	57	42	8	**

Experiment 2

The pasture hay offered contained 16.1 g N, 692 g NDF, 400 g ADF and 45 g lignin per kg DM, The supplements were similar in composition to those used in Experiment 1.

Intake of hay given alone was 2555 g DM/3 d, and intake was depressed ($P<0.05$) by the BAR supplement with a substitution rate of 1.0 (Table 4).

TABLE 4. Experiment 2. Intake, digestion and growth in young sheep given grass hay ad libitum alone or with supplements each third day of fortified barley, safflower meal or linseed meal (n = 10 or 12).

Measurement	Pasture hay				Prob.
	NIL	BAR	SAF	LIN	
DM intake (g)					
Hay, Day 1	823^{a}	561^{b}	572^{b}	620^{b}	**
Hay, Day 2	850^{ab}	775^{b}	855^{ab}	882^{a}	*
Hay, Day 3	882	848	888	926	NS
Hay (g/3 d)	2555^{b}	2184^{a}	2315^{ab}	2428^{ab}	*
Supplement (g/3 d)	0	382	568	355	-
Total (per 3 d)	2555^{a}	2566^{a}	2883^{b}	2783^{ab}	*
DM digestibility (g/kg)	551^{b}	582^{c}	530^{a}	562^{bc}	**
Dig. DM intake (g/3 d)	1408	1493	1528	1564	NS
LW change (g/d)	4^{a}	23^{ab}	50^{bc}	53^{c}	**
Clean wool growth (mg/patch/day)	83^{a}	80^{a}	89^{ab}	101^{b}	*

Hay intake was not significantly changed (P>0.05) by the oilseed meal supplements, and substitution rates for both supplements were 0.4. DM digestibility was little affected by the supplements, and digestible DM intakes tended to increase by 6% for the BAR supplement and 9-11% for the SAF and LIN supplements. Sheep given hay alone maintained LW (+ 4 g/d). BAR supplement tended to increase LW gain to 23 g/d, while the SAF and LIN supplements increased (P<0.05) LW gain to 50-53 g/d. Clean wool growth (83 mg/patch) was not affected by BAR supplement, tended to be increased by 7% by the SAF supplement and was increased (P<0.05) by 22% by the LIN supplement.

TABLE 5. Experiment 2. Disappearance of DM and N from nylon bags incubated in the rumen, rumen fluid pH and rumen fluid NH_3-N concentration in young sheep given pasture hay ad libitum alone or with supplements each third day of fortified barley grain, safflower meal or linseed meal (n = 6).

Measurement		Pasture hay				Prob.
		NIL	BAR	SAF	LIN	
Supplement DM,	0 h		329	200^{d}	307^{b}	-
	6 h	-	843^{c}	294^{d}	452^{b}	**
	24 h	-	897^{c}	466^{a}	700^{b}	**
	48 h		927^{c}	521^{a}	800^{b}	**
	72 h		937^{c}	544^{a}	819^{b}	**
Supplement N,	0 h	-	-	290	380	-
	6 h	-	-	631^{b}	436^{a}	**
	24 h	-	-	826^{b}	762^{a}	*
	48 h	-	-	908	909	NS
	72 h	-	-	921	932	NS
Hay DM,	0 h	108	108	108	108	-
	24 h - Day 1	514^{b}	491^{a}	541^{c}	544^{c}	***
	Day 2	505^{a}	508^{ab}	500^{a}	530^{b}	*
	Day 3	497	509	494	494	NS
	48 h - Day 1	674	677	690	682	NS
	Day 2	648	655	648	665	NS
	72 h - Day 1	732	732	738	734	NS
Rumen pH - mean		6.3	6.4	6.4	6.4	NS
- minimum		6.0	5.5	6.3	6.1	**
Rumen NH_3-N (mg N/l)						
	Day 1	75	302	227	216	**
	Day 2	81	87	107	96	NS
	Day 3	77	70	61	75	NS

The rate of disappearance of supplement N from nylon bags indicates that both oilseed meals provided the majority of their N as RDN rather than as UDP, although linseed meal was less readily fermented than safflower meal. Following 24 h incubation 826 g/kg of safflower meal N and 762 g/kg of-linseed meal N had apparently disappeared from the nylon bags (Table 5). Rumen pH was maintained when oilseed meal supplements were fed, but was depressed to pH 5.5 with BAR supplement. Rumen NH_3-N concentration was elevated by all supplements on Day 1 of the feeding cycle, but was not different (P>0.05) on Day 2 and Day 3. Hay

disappearance from nylon bags during 24 h on Day 1 of the feeding cycle was decreased ($P<0.05$) by the BAR supplement, and was increased ($P<0.05$) by **both** oilseed meal supplements. However by Day 2 of the feeding cycle only LIN supplement was associated with greater disappearance of hay DM from the nylon bags and by Day 3 there were no differences between dietary treatments.

Reticulo-rumen digesta at slaughter

The amounts of wet and dry digesta present in the rumen at slaughter were similar for all treatments 23.5 and 71.5 h after offering supplements (Table 6). At 6 h after offering supplements the amount of digesta DM was increased ($P<0.05$) for all of the supplement treatments. However the sheep accommodated the additional DM in the ingested supplement not by increasing the amount of wet digesta, but by increasing the DM content of that digesta; DM content increased from 11% for NIL sheep to 13-16% for the sheep consuming supplements.

TABLE 6. Weights (g/kg fleece-free LW) of wet digesta and of dry digesta in the reticulo-rumen of sheep measured by slaughter at various times after offering supplements to sheep (n = 4)

Treatments		Oat straw (Expt 1)		Pasture hay (Expt 2)	
		Wet	Dry	Wet	Dry
6 h	NIL	222	24.2[a]	194	21.2[a]
	BAR	219	31.8[c]	204	27.8[b]
	SAF	251	35.9[d]	196	30.8[b]
	LIN	223	29.4[b]	212	28.2[b]
	Prob.	NS	**	NS	*
23.5 h	NIL	190	18.2	170	19.4
	BAR	191	20.1	153	17.3
	SAF	192	21.0	180	21.7
	LIN	180	19.1	160	17.9
	Prob.	NS	NS	NS	NS
71.5 h	NIL	-	-	-	-
	BAR	168	18.4	165	16.0
	SAF	155	16.5	184	20.7
	LIN	205	20.2	165	16.8
	Prob.	NS	NS	NS	NS

DISCUSSION

The oat straw and the barley straws were selected to provide two straws of low and high grinding energy, but similar contents of N, NDF, ADF and IVOMD. Oat straw is generally considered to be associated with higher voluntary intakes and to be of superior nutritive value to barley straw (McDonald et al. 1969; Mulholland et al. 1974). The grinding energies of the two straws were similar to the highest and lowest values for a group of wheat straws within which voluntary intake by sheep of the straws increased from 303 g/d to 617 g/d as grinding energy decreased (Doyle et al. 1988). It would appear that if grinding energy is an important factor affecting voluntary intake of straws, separate relationships 'between grinding energy

and intake may occur for different species of straw. Parameters such as leaf/stem ratio (apart from its effect on grinding energy) and availability of nutrients in the straw to microbes may also be important. In the present experiment the higher stem content of oat straw (612 g/kg.) than of barley straw (452 g/kg) may have negated any beneficial effects associated with lower grinding energy of the oat straw.

In Experiment 1 the intakes of the straws fed alone were about 20 g DM/kg LW, and the sheep were losing LW rapidly (-85 to -103 g/d) and producing only 2.4-2.6 g clean wool per day. The pasture hay used in Experiment 2 was higher in N and lower in NDF and ADF than the straws, and was associated with higher voluntary intake of about 26 g DM/kg LW. Nevertheless these sheep were able only to maintain LW on this hay when fed alone.

The rate of disappearance of oilseed meal N from the nylon bags of 63% and 44% at 6 h incubation and 83% and 76% at 24 h incubation for safflower meal and linseed meai respectively (Table 5) indicated that for both of these oilseed meals the majority of the N was fermented in the rumen to provide RDN rather than providing UDP for absorption from the small intestines. This disappearance from nylon bags is similar to previous measurements with samples of those oilseed meals in our laboratories (Hosking et al. 1987). In Experiment 2 the 22% increase in wool production due to LIN supplement and the 9% increase due to SAF supplements also supported the concept that SAF provided little UDP and LIN a greater amount.

The BAR supplement increased rate of digestion of the straw in the rumen, but was not as effective as the oilseed meals in this respect. BAR increased 24 h disappearance of barley straw by 61%, while LIN and SAF increased this disappearance by 85% and 92% respectively. The increases were less with oat straw, perhaps because 24 h disappearance of oat straw with NIL supplement (345 g/kg) was much greater than the equivalent disappearance of barley straw (232 g/kg) even though potential digestibilities, as reflected by the 72 h nylon bags with oilseed supplements, were similar. The increased straw digestion associated with the BAR supplement was probably primarily due to the urea N and Na_2SO_4 in this supplement providing substrate for microbial activity. The rumen NH_3-N concentrations of 11 and 22 mg N/l when barley and oat straw respectively were fed alone indicate that was a deficiency of NH_3-N substrate for rumen microbial activity. The reasons for the greater straw fermentation with the oilseeds were not known, but may have been associated with an improved supply of peptides and amino acids as microbial substrates, changes in microbial populations present with the various supplements, or the short-term decrease in rumen pH associated with the BAR supplement. Rumen NH_3-N supply in the rumen did not differ markedly between supplements (Table 3), but may have been less than optimal by Day 3 of the feeding cycle. Clearly 24 h disappearance of straw when supplements were fed was lower on Day 3 of the feeding cycle than on Day 1 and Day 2. The rate of rumen digestion of the pasture hay was increased by the two oilseed supplements, possibly because the NH_3-N substrate availability (75-81 mg N/l) was less than that required for maximal rate of fermentation (Alvarez et al. 1983; Krebs et al. 1984) or due to provision of other microbial substrates such as peptides and amino acids. The decrease in the rate of rumen fermentation with the BAR supplement was probably due to changes in the microbial populations associated with starch ingestion (El-Shazly et al. 1961) and the depression in rumen pH (Mould and Orskov 1983/84; Dixon 1986).

All of the supplements were associated with increases in intake of total DM by 42-64% over the 3 day feeding cycle, and most of this increase

occurred on Day 1 of the feeding cycle. However the similar amounts of wet and dry digesta DM in the rumen 23.5 and 71.5 h after providing supplements (Table 6) indicated that the "rumen fill" was similar for the NIL and the supplemented diets by this interval after offering supplements. A similar pattern occurred when the pasture hay was supplemented with the oilseeds. It would appear that an increased rate of fibre digestion allowed roughage intake to be maintained or increased. However a decreased rate of rumen digestion of hay and a decrease in hay intake were observed with the BAR supplement. Similar observations have been made by Orskov and Fraser (1975) where greatest depressions is roughage intake occurred when rate of rumen fibre fermentation was most severely reduced by pH depressions. The changes in rate of digestion of fibre in the rumen was probably an important factor contributing to the changes in roughage intakes which were observed. The greater amount of SAF supplement than of LIN supplement and the higher content of indigestible fibre in SAF supplement did not affect the intake of either the straw or of the pasture hay, or the LW change of the sheep.

When a basal diet of barley straw or oat straw was fed supplements which constituted 15-24% of total DM intake were able to change a severe LW loss to LW maintenance, and almost double wool growth. Most importantly the fortified barley grain supplement was almost as effective as the oilseed meal supplements to avoid the LW loss, and for practical feeding would be much lower in cost than oilseed meals. Possibly the physical form of the barley grain and urea were important. The wet mixture tended to be eaten slowly by the sheep and the grain was fed whole; both of these factors would probably have contributed to slow fermentation of the barley grain in the rumen and the avoidance of severe depressions of rumen pH. A major practical disadvantage of the BAR supplement is that the mixture contained on a DM basis 7% urea. No cases of urea toxicity have been observed in our laboratories with this mixture, but obviously there is some risk of urea toxicity. However the results do indicate that where low levels of N supplements are given with cereal straw to achieve LW maintenance there is no advantage in including UDP rather than RDN in the supplement.

Where the basal diet consisted of a medium quality pasture hay which could support LW maintenance and supplements were intended to increase productivity, there was a major advantage of the oilseed meal supplements over the BAR supplement to stimulate LW gain. Wool growth was not increased by the BAR supplement, and was increased most by the LIN supplement which had the highest UDP content. Coombe (1985) similarly observed substantial increases in intake, LW gain and wool growth when sunflower meal or rapeseed meal replaced a starch-urea mixture in oat straw based diets. The present experiment supports the concept that where LW gain or wool growth is required from young sheep fed roughage diets, supplements containing high levels of UDP are likely to have a substantial advantage and may well be more cost-effective than supplements containing high levels of RDN.

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