

## Utilization of whole barley grain by mature ewes depending on forage type and concentrate-to-forage ratio in the diet

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### ABSTRACT

Digestion trials were carried out using 16 mature ewes fed diets based on grass or lucerne hay supplemented with 25 or 40% of either whole or crushed barley grain. The amount of whole grain voided in faeces was also evaluated. The study was conducted in two repeated Latin squares design separately for each type of hay, with treatments being two physical forms of grain and two concentrate-to-forage ratios.

Except for a slight decrease in dry matter and N digestibility in lucerne hay based diets, the physical form of grain did not affect DM and ADF digestibility or N balance, irrespective of the concentrate-to-forage ratio ( $P > 0.05$ ). The amount of whole grain voided in faeces was 4.7–10.2%, however considerable variation among ewes was observed. An increase in the level of grain in the diet from 25 to 40% increased DM digestibility ( $P < 0.01$ ), whilst the grain level had no effect on ADF digestibility. N balance was improved by increasing the level of grain only when grass hay diets were fed.

The results of this study show that, at levels up to 40% in the diet, whole barley grain can be effectively utilized by mature ewes fed hay based diets.

**KEY WORDS:** grass, lucerne hay, grain, physical form, digestibility, N balance

### INTRODUCTION

It is well recognized that whole grain can be effectively utilized by lambs (Ørskov, 1981; Tait and Beames, 1988). However, due to a larger reticulo-omasal orifice in mature sheep, feeding whole grain may increase the proportion of whole grain being voided in faeces. On the other hand, processed grain can negatively affect the environment in the rumen and through a decrease in pH, can lower intake and digestibility of fibre (Ørskov and Fraser, 1975). Grain processing itself also increases costs of feeding.

In typical sheep feeding practice in Poland, concentrates are provided as supplements to forages, including hay, straw or grass silages. There is some

evidence that the type of forage can influence the utilization of whole grain by mature sheep (Orr and Treacher, 1984; Tait et al., 1985; Vipond et al., 1985; Chestnutt, 1990), but more information is needed, particularly regarding the ratio of concentrate-to-forage in the diet. The digestibility of crude fibre together with forage dry matter intake are usually reduced by increasing the proportion of concentrates in the diet (Uden, 1984). Little is known about the interaction between the physical form of the grain and its level in the diet on nutrient utilization by mature sheep.

The present study was designed to investigate the effect of either whole or crushed barley grain when used as either 25 or 40% of the diet dry matter on digestibility and N balance in mature ewes. Sheep were offered diets based on two different quality forages: timothy (*Phleum pratense*) or lucerne (*Medicago sativa*) hay.

#### MATERIAL AND METHODS

Sixteen mature non-pregnant Dorset ewes (average 63 kg liveweight) were individually fed either grass (8 ewes) or lucerne hay (8 ewes). The hays were chopped to a length of approximately 30 mm. Ewes were also offered whole (W) or crushed (C) barley grain in the amount of 25 or 40% of the diet dry matter. Feeds were given in fixed amounts of approximately 1100 g and 1250 g of dry matter for the grass and lucerne hay diets, respectively. These levels were approximately 90% of *to appetite* intake and this level was adopted to minimize feed refusals. Mean dry matter intakes for both types of hay are presented in Table 1.

TABLE 1

Mean dry matter intake (g/day)

Treatments	Hay	Barley grain	Total	Forage : Grain
Grass hay				
25 W <sup>1</sup>	794.4	273.2	1067.6	74.4 : 25.6
25 C <sup>2</sup>	795.5	270.2	1065.7	74.6 : 25.4
40 W	644.2	438.4	1082.6	59.5 : 40.5
40 C	643.0	431.7	1074.7	59.8 : 40.2
Lucerne hay				
25 W	928.6	319.3	1247.9	74.4 : 25.6
25 C	933.8	316.2	1250.0	74.7 : 25.3
40 W	746.3	504.6	1250.9	59.7 : 40.3
40 C	746.9	510.7	1257.6	59.4 : 40.6

<sup>1</sup> — 25% of the diet, whole grain

<sup>2</sup> — 25% of the diet, crushed grain

The ewes were assigned randomly to treatments in two repeated Latin squares design, separately for each type of hay. In the square, treatments consisted of two physical forms of grain and two levels of it in the diet. The ewes were housed in individual pens during a 10-day adaptation period which was followed by 10 days of total faecal and urine collection. During the collection period the ewes were kept in individual metabolic cages. Faeces were weighted daily and two aliquots were taken for chemical analysis and for the determination of the amount of grain voided in faeces. Samples were stored at  $-20^{\circ}\text{C}$  until analysis. Separation of the intact grain was carried out on a bulk sample from the whole period; faeces were washed over a sieve of 1.5 mm diameter. Dry matter content of separated grain was determined by drying in a forced-draught oven at  $50^{\circ}\text{C}$  for 48 hours.

Feeds, faeces and urine conserved with 0.1 n  $\text{H}_2\text{SO}_4$  were analysed using standard procedures for DM and N (AOAC, 1975) and for acid detergent fibre (ADF) (Goering and Van Soest, 1970).

The data were subjected to analysis of variance for repeated Latin squares, with results being analysed as a  $2 \times 2$  factorial design for main effects of physical form and level of grain in the diet, together with their interaction. Statistical analysis were carried out separately for each type of hay (Steel and Torrie, 1960).

## RESULTS

The chemical composition of hays and barley grain used in the experiment is given in Table 2. The grass hay was of low quality containing only 6% of CP and

TABLE 2

Chemical composition of feeds

	Hay		Barley grain	
	grass	lucerne	whole	crushed
Crude protein (g/kg DM)	60.0	161.6	128.3	127.8
ADF (g/kg DM)	408.0	299.8	82.0	74.1

over 40% ADF. Crushing of barley grain did not change its CP content, but slightly lowered the ADF content (*av.* 10%).

The results of the digestibility and N utilization studies are given in Table 3. With the grass hay diets, the physical form of grain had no effect on DM, ADF and N digestibility and N balance. Increasing the level of grain in the diet from 25 to 40% significantly increased DM digestibility ( $P < 0.01$ ), whilst the level of grain had no effect on ADF digestibility. The higher level of grain also resulted in increases in N intake, apparent digestibility of N, urinary N output, retained

TABLE 3

The effect the physical form of grain and level of grain in the diet on digestibility and N utilization

	Treatments					Significance of effect		
	25 W	25 C	40 W	40 C	SEM	form	level	interaction
Grass hay diets								
Dry matter digestibility	0.627	0.644	0.674	0.667	0.0047		**	*
ADF digestibility	0.507	0.507	0.517	0.480	0.0074			
Total N intake (g/day)	13.2	13.1	15.4	15.2	0.23		**	
N digestibility	0.572	0.588	0.619	0.614	0.0077		**	
Urine N output (g/day)	5.3	5.9	5.4	6.4	0.20			
Retained N (g/day)	2.0	1.8	4.1	2.9	0.28		**	
Retained N % of N intake	15.3	13.6	26.4	18.9	1.82		*	
Retained N % of N absorbed	26.6	22.8	42.7	30.6	3.01		*	
Lucerne hay diets								
Dry matter digestibility	0.714	0.732	0.738	0.748	0.0039	*	**	
ADF digestibility	0.515	0.516	0.499	0.504	0.0063			
Total N intake (g/day)	30.3	30.6	29.6	29.5	0.17		**	
N digestibility	0.753	0.777	0.755	0.767	0.040	**		
Urine N output (g/day)	18.4	17.9	16.2	17.6	0.40		**	
Retained N (g/day)	5.1	5.9	6.2	5.0	0.39			
Retained N % of N intake	16.6	19.3	20.9	16.9	1.30			
Retained N % of N absorbed	21.9	24.7	27.7	22.1	1.67			

\* — P &lt; 0.05, \*\* P &lt; 0.01

N ( $P < 0.01$ ) and retained N as a percentage of N intake and N absorbed ( $P < 0.05$ ). With lucerne hay diets, feeding whole barley grain significantly reduced DM ( $P < 0.05$ ) and N digestibility ( $P < 0.01$ ), but did not affect ADF digestibility and other N balance parameters. Increasing the proportion of grain in the lucerne based diet significantly increased DM digestibility ( $P < 0.01$ ) and lowered the amount of N excreted in urine ( $P < 0.01$ ), with other parameters being unaffected.

The amount of intact grain voided in the faeces was 10.2 and 6.4% for the grass hay diets supplemented by 25 and 40% of whole barley grain, respectively (Table 4). With the lucerne hay diets the results were 8.1 and 4.7%. In each

TABLE 4

Whole grain voided in faeces

	Grain DM intake g/day	Grain voided in the faeces	
		g of DM/day	% of intake
Grass hay diets			
25 <sup>1</sup>	272.7 (0.91) <sup>2</sup>	27.8 (6.28)	10.2 (2.34)
40	438.6 (1.03)	25.7 (6.85)	6.4 (1.39)
Lucerne hay diets			
25	319.3 (0.95)	26.0 (6.32)	8.1 (2.00)
40	510.7 (1.43)	23.9 (5.46)	4.7 (1.13)

<sup>1</sup> — level of grain in the diet (%)

<sup>2</sup> — (Standard error)

treatment considerable variation among ewes was observed and differences between means were not statistically significant.

## DISCUSSION

Results of this study indicate that whole barley grain, when fed as a supplement to grass or lucerne hay, can be effectively utilized by mature ewes. It confirms earlier observations obtained with hay based diets (Mould et al., 1983; Tait et al., 1985; Chestnutt, 1990). The type of hay seems to have no effect on the efficiency of the utilization of whole grain, except for a slightly lower DM and N digestibility when whole grain was used to supplement lucerne hay. It is possible that both hay diets underwent similar rumination processes which could be responsible for whole grain mastication. Toland (1978) found that in cattle chewing played a dominant role during rumination in the process of digestion of whole oats grain, and was more important than rumen fermentation. Recently, Chestnutt (1990) suggested that a longer rumination time would increase the

possibility that grain would be broken during mastication. The size of the reticulo-omasal orifice in mature sheep seems to be small enough to prevent barley grain escaping from the rumen. This increases the chance of whole grain being broken during rumination.

Increasing the proportion of grain in the diet increased DM digestibility in both hay diets. However, it had no effect on ADF digestibility, which is not in agreement with the results of previous studies (Uden, 1984; Mayne and Gordon, 1985). Uden (1984) suggested that the depression in fibre digestibility was not linear and started at a level of approximately 30% concentrates. It is possible that the 25 and 40% levels of grain in the diet used in the present study were too low to detect an effect. The results obtained indicate that increasing the level of grain to 40% increased the N balance only with the grass hay diet. The grass hay quality was low (6% CP) and the addition of protein and energy to the rumen probably resulted in more efficient microbial protein synthesis.

The lack of a significant interaction between the physical form of grain and its level in the diet shows that whole barley grain can be effectively utilized irrespective of the concentrate-to-forage ratio. Surprisingly, the proportion of grain voided in faeces was higher at the 25% level in the diet compared to 40 per cent. This tendency was observed with both types of hay (Table 4). The large variation among ewes did not permit validation of these observations. Other authors have also demonstrated variation among animals (Vipond et al., 1985; Chestnutt, 1990). It is possible that the proportion of grain voidance is a characteristic of individual ewes (Vipond et al., 1985).

## CONCLUSIONS

The results obtained indicate that whole barley grain may be used in practical feeding of mature sheep when fed as a supplement to low or good quality hays. The amount of whole grain in the diet seems to be unimportant.

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## STRESZCZENIE

### **Wpływ rodzaju siana oraz udziału paszy treściwej w dawce na wykorzystanie całego ziarna jęczmienia przez dorosłe owce**

Doświadczenie przeprowadzono na 16 dorosłych owcach rasy Dorset, żywionych dawkami siana z traw lub lucerny uzupełnionych 25 lub 40% dodatkiem jęczmienia w postaci śruty lub całego ziarna. W doświadczeniu badano strawność składników pokarmowych, bilans N, natomiast u owiec żywionych całym ziarnem oznaczano ponadto ilość ziarna wydalonego w kale. Doświadczenie dwuczynnikowe (udział w dawce × postać ziarna) wykonywano w układzie powtórzonych kwadratów łacińskich tj.  $2 \times (2 \times 2)$ , oddzielnie dla każdego siana.

Z wyjątkiem nieznacznego obniżenia strawności suchej masy i białka przy skarmianiu całego ziarna w dawkach z sianem z lucerny, postać ziarna, bez względu na jego udział w dawce pokarmowej, nie miała istotnego wpływu na strawność składników pokarmowych i bilans N ( $P > 0,05$ ). Całe ziarno wydalane w kale stanowiło od 4,7 do 10,2% ziarna pobranego, chociaż obserwowano przy tym dużą zmienność pomiędzy owcami.

Wzrost udziału jęczmienia w dawce z 25 do 40% spowodował wzrost strawności suchej masy ( $P < 0,01$ ), jednakże nie miał wpływu na strawność ADF ( $P > 0,05$ ). Bilans N został poprawiony przez dodatek jęczmienia tylko w przypadku siana z traw.

Uzyskane wyniki wskazują, że całe ziarno jęczmienia może być wykorzystywane przez dorosłe owce żywione sianem.