THE EFFECT OF SCREEN SIZE WHEN GRINDING THE ROUGHAGE COMPONENT IN SHIPPING PELLETS FOR EXPORT SHEEP

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SUMMARY

Export wethers (30) in single pens were offered, over a 4 week period, 1 of 5 pelleted diets (6 sheep/diet) prepared to meet the National Standards for Livesheep Export but with the roughage component ground through different screen sizes. Feed intake increased ($P < 0.05$) from about 1400 g/day to 1530-1600 g/day as the size of the screen increased from 9-12 mm to 15 -20 mm. Weight gain for the sheep on the larger screen size diets was also 40-60 g/day greater ($P < 0.05$) than for those on the smaller screen sizes. While intake increased, digestibility of the diets did not change and was similar over the 4 weeks of the experiment and over all diets (57 ± 0.5%). In 20 sheep (5/treatment) over 120 h following dosing with Cr-mordanted samples of the roughage component of 4 of the diets (9, 12, 15, 17 mm), Cr excretion rates were the same, indicating similar rumen turnover rates for these diets. The good growth performance of the sheep in this experiment compared to performance in previous experiments in this series, suggests that conditions of export have a large influence on efficiency of feed utilisation.

Keywords: particle size, pellets, shipping wethers.

INTRODUCTION

Sheep under simulated live export consume up to twice their expected maintenance requirements without significant weight gains or marked changes in the digestibility of the diet (McDonald *et al.* 1990). The reasons for this are uncertain. One factor which may influence intake and digestibility is the fineness of the roughage component (Doyle *et al.* 1991). However, literature on the effects of particle size in roughage based diets is ambiguous because of variations in particle size reduction achieved even when the roughage is ground through a particular screen size (Owen 1978) and perhaps because of differences related to sieving techniques (Allen *et al.* 1984). Further, while reducing the particle size of roughage material should lead to an increase in intake through increased flow rates, there may sometimes be a confounding of the effects from pelleting of the diets (Owen 1978).

This experiment was undertaken because of concern expressed by the live shipping industry that particle size may influence both pellet quality and sheep performance, and because of the high feed intakes found in previous experiments. The aim was to determine the effect of grinding the roughage component of the feed through different screen sizes, prior to pelleting, on the intake, digestibility of the diets and liveweight of export wethers.

METHODS AND MATERIALS

Five diets were prepared at the same mill, from the same ingredients, to meet the National Standards for Livesheep Export. Diet composition was 55% straw, 25% lupins, 12% oats and 7% barley with calcium hydroxide (0.7%) as a binding agent. All diets contained 1.85 ± 0.036% nitrogen, 60.1 ± 1.52% neutral detergent fibre and 6.7 ± 0.38% ash. Within each diet the roughage component (straw) was ground to a different degree of fineness (9, 12, 15, 17 and 20 mm screen sizes, diets l-5 respectively) in a tub grinder. All diets were pelleted with steam injection, through the same die of 9 mm diameter.

Thirty Merino wethers of sirnilar liveweights and from the same source, were randomly allocated to individual 1.5 by 0.9 m pens in an enclosed shed with a slatted floor. All sheep were fitted with harnesses for total faecal collection. Water was continuously available&d sheep were fed once daily (0900 hours). For the first week of the 6-week experimental period, all sheep were offered *ad libitum* the same standard diet (diet 1, 9 mm screen size).

At the beginning of the second week, all sheep were weighed and allocated to 5 treatment groups (6 sheep/group) on a stratified scale to give approximately equal mean group weights (56.2 ± 1.9 kg). Experimental diets were offered at 1.25 *x* the previous day's intake for the next 4 weeks. Feed residues were collected daily, dried, weighed and bulked for each sheep within each l-week period. Total faeces were collected daily, weighed and a 10% subsample taken for drying at 85°C in a forced draft oven; subsamples for each sheep were bulked during each week. On the first day of each week all sheep were weighed prior to feeding.

Feed subsamples were taken from each bag of pellets on opening, bulked within diets and retained

for analysis of pellet durability (Holmen Pellet Tester, Holmen Chemicals Ltd., Basingstoke, Hants) and chemical composition. The effect of grinding the roughage component through different screen sizes on particle size of the diets was examined by the dry sieving method of Tetlow (1974) using nested sieves of 4, 2, 1.4 and 1 mm.

For 8 days from the end of week 5 (week 6 + 1 day), each sheep was offered 1500 g per day of its diet. On the third day of this regimen, chromium mordanted fibre (Uden *et al.* 1980), on samples of the roughage taken after grinding through 4 of the screen sizes (9, 12, 15 and 17 mm), was given to 5 sheep in each of the 4 groups immediately prior to feeding. Total faeces were collected from each sheep over the next 120 h (6, 9, 12, 15, 18, 22, 26, 30, 36, 42, 48, 54, 60, 66, 72, 96 and 120 h post feeding) and analysed for chromium content.

All results were tested using analysis of variance.

RESULTS

Dry sieving of the diets showed no difference ($P > 0.05$) in particle size distribution with 1–5, 15-30, 23-3 1 and 16–23% of the samples being retained on 4, 2, 1.4 and 1 mm sieves respectively. From 25–39% of particles were less than 1 mm. However, DM intake and liveweight gain, were significantly ($P < 0.05$) less at the finer screen sizes (9 and 12 mm) than at the coarser ones (15, 17 or 20 mm, Table 1). All treatments showed a trend for DM intake to increase with time, but there was no significant treatment x time interaction ($P > 0.05$). The pooled results show that DM intake increased (P c 0.05, s.e.m. ± 49.4 g DM/day between weeks) from week 1 (1266 ± 95.9 g DM/day) to week 2 (1454 ± 105.6 g DM/day), and to week 3 (1583 ± 122.9 g DM/day), but week 4 (1658 ± 114.7 g DM/day) did not differ from week 3 ($P > 0.05$).

There was a non-significant ($P > 0.05$) decline in the feed conversion ratio (FCR, g DM intake/g gain) from 13.2 to 8.7: 1, as screen size increased from 9 to 15 mm. Although DM intake increased with increasing screen size and with time, there was no effect ($P > 0.05$) of either on digestibility (Table 1).

Table 1. Intake, weight gain and feed conversion ratio (FCR), over a 4-week period, of sheep fed pelleted diets with the fibre (roughage) component ground to different lengths, and digestibility of pellets

Means with the same or no letters are not significantly different ($P > 0.05$)

Screen size (mm):	9	12	15	17	20	Mean	s.e.m.
Intake (g DM/day)	1383a	1406a	1530b	1615b	1517b	1490	55.2
Weight gain (g/day)	105a	135a	176b	190b	164b	154	15.8
FCR (g DM intake/g gain)	18.1	11.5	8.9	9.6	13.0	12.2	2.69
Digestibility (%)	56.7	55.0	58.5	56.6	57.6	57.0	0.54

There was no effect of screen size ($P > 0.05$) on pellet durability with 75.6 ± 2.64% of the feed being recovered as whole pellets. There was also no significant ($P > 0.05$) effect of screen size on retention time of the fibre component in the rumen (Fig. 1). Chromium was detected in the faeces from 9 h post-dosing, and reached a peak level at about 30-40 h. Over 90% of ingested chromium had been excreted within 96 h post-feeding.

DISCUSSION

Dry sieving indicated there were no differences in the particle sizes of the various diets. However, Allen *et al.* (1984) and Mertens *et al.* (1984) suggest that particle length is probably more closely related to residence time in the rumen than is minimum cross-sectional diameter, the dimension effectively measured by sieving. There appear to be, at present, no entirely suitable methods available to describe particle size reduction of fibre-based diets. Never the less, there was a 10–14% increase in DM intake and a 40–45% increase in liveweight change as screen size increased from 9-12 mm to 15-17 mm. This implies a substantial benefit to the livesheep export industry if 15-17 mm screen sizes are used to grind the roughage component. However, the good liveweight change of the sheep, compared to those of McDonald *et al.* (1990) under simulated export, suggests that the conditions of export have a large effect on feed utilisation and this may override any benefits from coarser grinding. In addition, it is unusual for feed manufacturers in W.A. to use screen sizes of greater than 12 mm for shipper pellets.

Even though DM intake increased with increasing screen size, feed intakes of about 1400 g/head.day, and liveweight gain of 100-135 g/head.day, on the 9 and 12 mm diets were more than satisfactory for the livesheep export industry. At an intake of 1400 g/head.day of 57% digestible feed, a

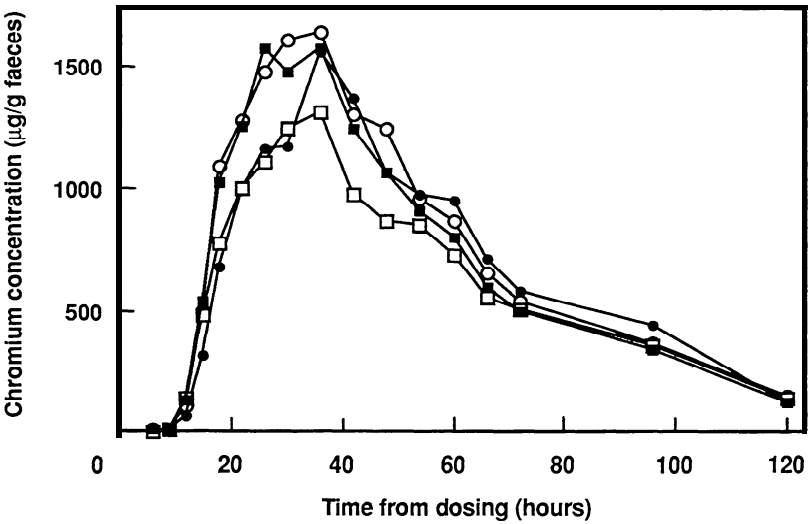

Fig. 1. Chromium excretion (µg/g faeces) over 120 h from sheep given a discrete dose of chromium mordanted fibre. Screen sizes used to prepare diets were: 9 (○), 12 (●), 15 (□) and 17 mm (■).

55 kg wether should increase in weight at about 50-100 g/head.day (MAFF 1977) so the performance of the experimental sheep was better than can be predicted from the literature. This may have been due to the milling and pelleting, but it follows that the large maintenance requirements found by McDonald *et al.* (1990) were probably due to the conditions of simulated live export, rather than fineness of the diet or other dietary factors.

The similar excretion rates of chromium for the different diets was unexpected as an examination of the literature would suggest that larger particles may be broken down more slowly and thus retained for longer in the rumen. In this instance this was not evident although much of the reported work is with considerably smaller sreen sizes. Doyle *et al.*(1991), in a review of the literature on the pretreatment of roughages, suggest that increases in the intake of digestible organic matter due to grinding and pelleting are dependent on the characteristics of the feed being treated. They cite work which showed that grinding by the methods used in the production of animal feeds only resulted in moderate increases in the exposed cellulosic surface area and consequently the rate of hydrolysis of cell walls would not be markedly increased. It may be that differences in the particle size of our diets was inadequate for physiological effects on rumen function to be obvious even though intake of the diets from the larger screen sizes was greater. Pelleting of the diets may have masked some of the effect, although there is no clear evidence to show pelleting influences feeding value of roughage based diets. The similarity in digestibility of all diets over the term of the experiment further supports the evidence of similar rumen turnover rates for the fibre component of the diets.

The durability of all pellets was poor with only 76% of feed being recovered as whole pellets. This level of durability would lead to inefficiencies in the live sheep export industry and high levels of dust contamination when handling the pellets. Manufacturers aim for whole pellet recoveries of 85–90% and Brennan (1988) found durabilities of from 89.8 to 98.6% (determined by the tumbler method, McEllhiney 1985) for samples of pellets being loaded on-board ship for export sheep. It is likely the reason for the poor quality of the pellets in this instance was due to the manufacturing process, rather than to the length of the fibre.

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