LIVEWEIGHT GAIN AND FEED CONVERSION EFFICIENCY OF FINE OR BROAD WOOL STRAINS OF MERINO SHEEP

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SUMMARY

The hypothesis tested was that fine and broad wool Merino sheep, from within a stud, would have the same *ad libitum* feed intake, dry matter digestibility, liveweight (LW) change, and feed conversion efficiency. This was tested using sheep from a Bungaree and a Peppin stud known to produce relatively broad and fine wool, respectively. Within each stud sheep were selected which differed in fibre diameter (fine and broad groups), but not fleece weight or LW. Animals from the different studs had different mean fleece weights and LWs. The 4 groups of sheep (Bungaree fine, Bungaree broad, Peppin fine, Peppin broad) were fed a pelleted diet based on lucerne and lupin grain in an experiment that comprised 3 levels of feeding (1.5% or 2.2% of individual LW or *ad libitum)* and 3 periods of 8 weeks. The design was a double change-over latin square with each sheep receiving each diet in 1 of the periods. Because there were significant ($P < 0.01$) carryover-effects of the preceding treatment in periods 2 and 3, the results were analysed as 1.5% of LW to 2.2% and *ad libitum;* 2.2% to 1.5% and *ad libitum;* and *ad libitum* to 1.5% and 2.2%. There were significant ($P < 0.001$) differences in dry matter digestibility and LW change as a result of the 6 treatments. Within studs, the fine wool groups of sheep gained LW at a faster ($P < 0.01$) rate than the broad wool groups. The Peppin sheep fed *ad libitum* were more ($P < 0.01$) efficient in converting feed into LW than the Bungaree sheep. Animals fed at 1.5% of LW prior to *ad libitum* feeding were more efficient at gaining LW than animals fed at 2.2% prior to *ad libitum* feeding. There were no significant differences in dry matter digestibility or maximum feed intake within or between the 2 strains.

Keywords: merino, genotypes, fibre diameter, nutrition, liveweight.

INTRODUCTION

There have been a large number of studies on the effects of diet and feed intake on fibre characteristics of Merino sheep (eg. Allden 1979; Reis 1979). Most of these have been with sheep from flocks which have been closed or were single trait selection flocks. No attempt appears to have been made to classify the animals used - the assumption being that within a flock randomly chosen animals will be representative of the range of values for performance traits across different dietary treatments. To our knowledge, it is not clear whether there are real differences in feed conversion efficiency into liveweight (LW) between Merino strains. Selection programs aim to choose animals with the most desirable traits but they are generally undertaken with grazing animals where the nutritional history of individuals is unknown and genotypic variation within populations may be masked by environmental effects. The assumption in selection of grazing sheep for a particular trait is that animals maintain their ranking across different planes of nutrition. It is not known whether sheep of similar fleece weight and LW, but differing in fibre diameter would have the same dry matter digestibility (DMD), feed conversion efficiency and changes in LW at different levels of intake and whether their *ad Zibitum* intake would be the same.

The hypothesis tested in this study was that sheep with different fibre diameters within and between strains would increase or decrease in LW at the same rate when fed a ration at the same proportion of LW. Furthermore these sheep would consume similar amounts of feed when fed *ad Zibitum* and under these conditions the efficiency of conversion of feed to LW would be the same.

MATERIALS AND METHODS

At weaning 200 sheep were obtained from a Bungaree and a Peppin stud and were grazed together on annual pasture for 8 months. The 2 studs were chosen as they differed by 3 μm in mean fibre diameter (MFD) in a study of strain, stud and environmental effects on hogget performance (Lewer *et al. 1990).* Prior to the start of the experiment all animals were shorn and weighed. The MFD was measured on midside wool samples. At hogget shearing the mean greasy fleece weight, LW and MFD for the Bungaree strain were 3.8 ± 0.04 kg (± s.e.), 38.8 ± 0.33 kg and 25.4 ± 0.12 μm respectively compared to *3.0 ± 0.04* kg, 30.8 ± 0.23 kg and 20.7 ± 0.09 μm for the Peppins. Within each strain 24 sheep were selected into 2 groups which were fine and broad in MFD, but similar in mean fleece weight and LW.

The fleece weight, LW and MFD data for the fine and broad groups are given by Murray et al. (1994). These 48 sheep were allocated to single pens in an enclosed shed.

The experiment used a double change-over latin square design (Patterson 1952; Cochran and Cox 1957) with a 4 week introductory period then 3 periods of 8 weeks at 3 levels of intake (Table 1). There were significant carry-over effects of the preceding level of intake on DMD, LW change and feed conversion efficiency in the treatment being analysed. This meant that there were 6 treatments analysed: 1.5% of LW to 2.2% and *ad Zibitum;* 2.2% to 1.5% and *ad Zibitum;* and *ad Zibitum* to 1.5% and 2.2%. The assumptions made in the statistical analysis were that only the first residual effects were considered (residual effects came from the preceding period only) and these were independent of level of intake in the period in which they were observed.

Table 1. Double change-over design with 3 levels of intake, 3 periods, and 2 sheep/cell replicated 4 times (2 strains x 2 diameter extremes)

Period	Treatment sequences					
1	1.5%	2.2%	*ad libitum*	1.5%	2.2%	*ad libitum*
2	2.2%	*ad libitum*	1.5%	*ad libitum*	1.5%	2.2%
3	*ad libitum*	1.5%	2.2%	2.2%	*ad libitum*	1.5%

During the introductory period each sheep was offered the pelleted ration at 2% of LW. In each period 4 sheep from each group (Bungaree fine wool, Bungaree broad wool, Peppin fine wool, Peppin broad wool) were fed the pelleted diet at 1.5% or *2.2%* of LW or *ad Zibitum.* The 1.5% and 2.2% intakes were adjusted fortnightly to compensate for changes in LW. The pelleted diet (g/kg - lucerne chaff 600; lupin grain 150; bran 100; straw 100; vitamins/minerals 50) was 91% dry matter and had a calculated crude protein content of 16% and a calculated metabolisable energy content of 10 MJ/kg DM. Prior to the end of each period faeces were collected for 13 days from the animals fed *ad Zibitum* and 7 days from sheep on restricted intakes. The sheep were fed once daily with free access to water and all were weighed just before feeding every week. The LW change was calculated by regression using LW data from weeks 3 to week 8 inclusive for each period. Weeks 1 and 2 were excluded from the analysis due to the effect of gut fill for sheep that had completed or were starting their period of *ad Zibitum* feeding. Feed conversion efficiency to LW gain was only calculated for sheep fed *ad Zibitum.* General linear models (Minitab Release 8) were used to test strain, diameter extreme and treatment differences and interactions.

RESULTS

The average feed intake (kg as fed/day) increased throughout the experiment for the animals fed at 1.5% and 2.2% of LW (Figure 1). When fed *ad Zibitum* there were no significant differences in intake (kg as fed/day) between the strains nor diameter extremes over the 3 periods. This was also the case when intake (kg as fed) was expressed as a function of $LW^{0.75}$.

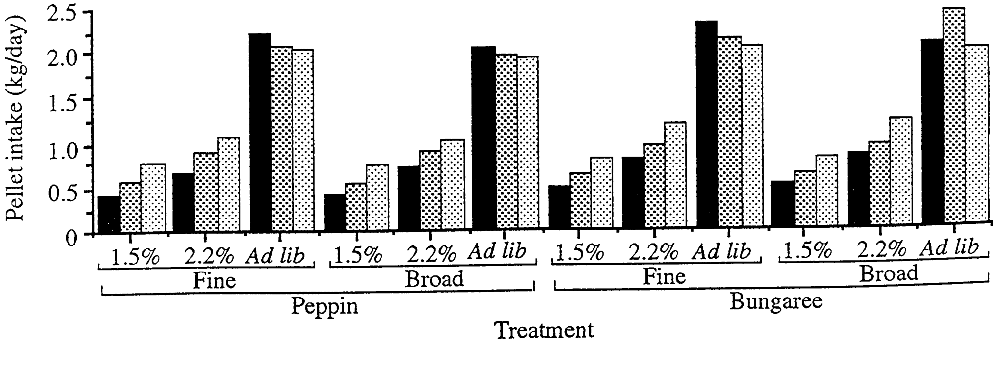

Figure 1. Pellet intake (kg/day as fed) of fine and broad wool groups of sheep from both Bungaree and Peppin strains for 3 levels of intake *(ad Zibitum,* 1.5% and 2.2 % of liveweight) for the 3 periods (Period 1 filled bars; Period 2 dark shaded bars; Period 3 light shaded bars)

There were no significant differences in DMD within or between strains. The DMD was higher where the change in diet was *1.5%* to *2.2%* of LW or *ad Zibitum* compared to a change from *ad Zibitum* to 1.5% or 2.2% of LW (P < 0.001; Table 2).

Table 2. Dry matter digestibility (%) of the diets for treatments *(ad Zibitum* to 1.5% and 2.2%; 1.5% to *ad libitum* and 2.2 %; and 2.2 % to *ad libitum* and 1.5 %)

Treatment	1.5% to 2.2%	1.5% to *ad lib*	2.2% to 1.5%	2.2% to *ad lib*	*ad lib* to 1.5%	*ad lib* to 2.2%
Digestibility	69.2	67.4	66.4	65.8	60.9	61.2

At the start of the experiment the average LWs for the Bungaree fine and broad wools were 35.2 ± 1.07 and 36.3 ± 1.03 kg (±s.e.) with the corresponding values for the Peppins of 29.9 ± 0.72 and 30.3 ± 0.71 kg. By the end of the experiment the 4 groups had increased in LW to 55.8 ±1.33, 56.3±1.44, 50.6 ± 1.03 and 49.2 ± 0.84 kg, respectively.

There was no significant difference in LW change between the strains on any treatment. There was a diameter group by treatment effect (P < 0.01) where the fine wool sheep gained LW at a greater rate than the broad wool sheep, this difference increasing when sheep were fed at a higher level than in the previous period (Figure 2). Across treatments, with increased intake, the sheep gained (P < 0.001) more LW.

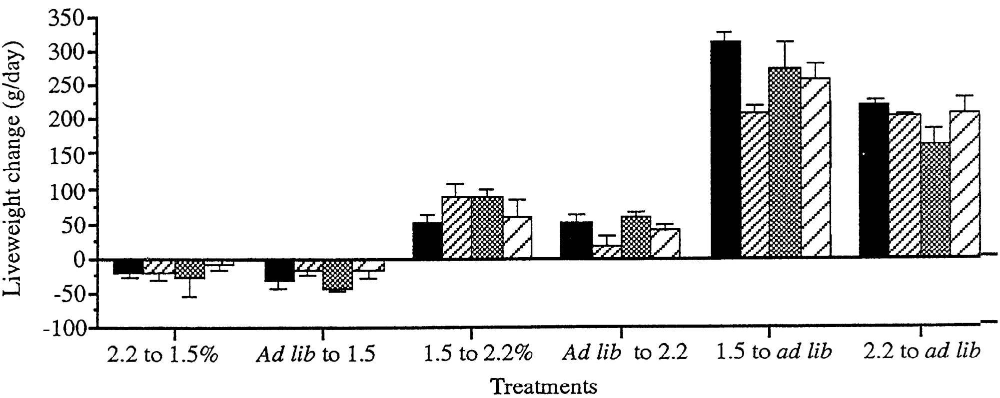

Figure 2. Liveweight change (g/day) of fine and broad wool groups of sheep from Bungaree and Peppin strains (Bungaree fine (dark shaded bars) and broad (bars with widely spaced diagonals); Peppin fine (filled bars) and broad (bars with closely spaced diagonals) for the 6 treatments *(ad Zibitum* to 1.5% and 2.2%; 1.5% to *ad libitum* and 2.2 %; and 2.2 % to *ad libitum* and 1.5 %)

The Bungaree strain were less efficient (P < 0.01) in converting feed into LW gain than the Peppin strain when fed *ad Zibitum* (Figure 3). Sheep fed 1.5% of their LW prior to the period of *ad Zibitum* feeding were more (P < 0.05) efficient in converting feed into LW gain than sheep fed 2.2% of their LW prior to *ad Zibitum* feeding. There was a diameter by treatment effect (P < 0.05) with the finer wool sheep from both strains having better feed conversion efficiency than the broad wool groups when fed *ad Zibitum.*

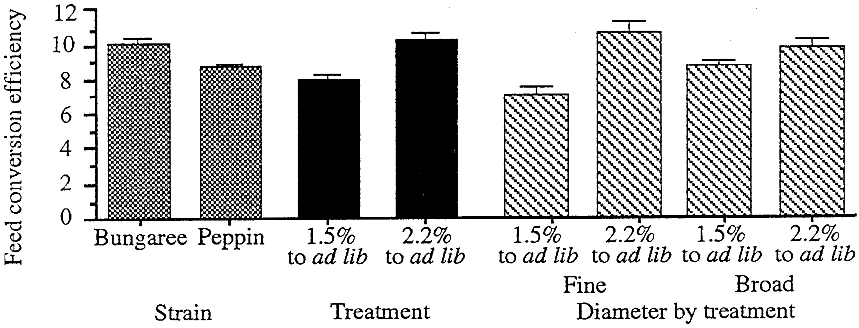

Figure 3. Feed conversion efficiency (g feed/g liveweight gain) of the Bungaree and Peppin sheep, the groups of sheep fed the 1.5 % to *ad Zibitum* and 2.2% to *ad Zibitum* treatments, and these treatments split into the fine and broad wool groups of sheep

DISCUSSION

The major finding of this experiment was that groups of sheep, within strains, selected on MFD may gain LW at different rates when fed common nutritional treatments. This was not the same for feed conversion efficiency as the Peppin sheep were more efficient than the Bungaree sheep. Previous studies (see Allden 1979; Reis 1979) have used sheep from closed selection flocks to provide information about the major determinants of wool growth, but these studies assumed that all sheep in a flock respond in a similar manner to nutritional changes. Our results suggest that under *ad Zibitum* feeding with animals eating similar amounts of feed, fine wool sheep gain more liveweight than broad wool sheep due to a better feed conversion efficiency. Furthermore, the generalisation that in "breeds and strains used mainly for wool production, those that are larger and have coarser wool tend to have greater appetite and be more efficient, although the differences are not always statistically significant" (Butler and Maxwell 1984) is not supported by the data from this experiment.

The results indicate that there was compensatory growth with animals gaining LW at a faster rate if they were poorly fed (at 1.5% of LW) prior to *ad Zibitum* feeding compared to animals fed at 2.2% of LW prior to *ad Zibitum* feeding. Compensatory growth in sheep fed *ad Zibitum* following periods of feed restriction (12 weeks) may be due to increased feed conversion efficiency rather than increased feed intake (Ryan *et al.* 1993). The results confirm that LW gain accelerates with increasing intake and that DMD of a diet decreases as intake increases.

This experiment highlights (1) the need to know the nutritional history of animals allocated into different treatments as any nutritional effect may be masked by the animals' previous diet and level of intake (see Murray *et al.* 1992) and (2) that groups of animals within populations may respond differently to nutritional treatments.

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