

INFLUENCE OF ROUGHAGE QUANTITY AND QUALITY ON ENERGY INTAKE AND ADAPTION OF CASHMERE WETHER GOATS FED BARLEY-LUPIN PELLETS

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SUMMARY

The effect of different levels of roughage on the voluntary food intake of adult cashmere wether goats (mean \pm sd, liveweight 43.3 ± 4.3 kg) fed pelleted ground barley (73.5%) and lupin (24.5%) grain was investigated. Five levels of chopped barley straw (0%, 2%, 6%, 12% and *ad libitum*) and 2 types of roughage quality (barley straw and persian clover hay fed at 12%) provided 6 treatments. The experiment used 36 goats, housed indoors, for 47 days. Provision of *ad libitum* straw (33.7% of dry matter intake (DMI)) maximised total DMI and metabolisable energy intake. Provision of roughage, at various amounts, or provision of high quality persian clover hay at 12% of intake, did not influence the intake of pellets. The intake of the pellets was affected by bouts of feed rejection which reduced intake of the pellets and liveweight gain. The implications of these results for fibre goats adapting to cereal diets, and for feedlot, live export, meat production and other feeding programs are discussed.

Keywords: roughage, concentrate, inappetence, nutrition, goats.

INTRODUCTION

A major limitation to rapid growth rates of ruminating fibre goats is their low energy intake relative to their maintenance requirements (McGregor 1985). In controlled experiments Australian cashmere and Angora goats have rarely eaten more than twice maintenance despite the *ad libitum* offering of highly digestible forage (eg. McGregor 1988), grain (McGregor 1984a) or pellets (McGregor 1984b). Using barley-lupin whole grain diets it was found that 13% roughage (hay) was sufficient for goats to express maximum voluntary food intake (McGregor 1984a). This appears different to work with sheep (Weston 1974), where whole wheat based diets fed with finely ground straw suggested the roughage requirement of the ruminant lamb did not exceed 2 g/100 g diet. It is arguable whether the finely ground straw acted as a true roughage and it is probable that the whole wheat grains provided sufficient tactile stimulation of the rumen. Thus Weston (1974) concluded that with ground wheat diets higher levels of roughage may be required. A knowledge of the requirements for dietary roughage of fibre goats when fed pelleted grain diets will assist in the development of effective feeding programs for fibre and meat production, supplementary feeding strategies, drought feeding, lot feeding and live export of goats. This work was undertaken to more clearly define the roughage requirements of adult cashmere goats and to provide information on ways to maximise voluntary food intake of cashmere goats when fed pelleted grain based diets.

MATERIALS AND METHODS

Design and diets

A 6 x 6 factorial design was used, consisting of 6 treatments (a basal diet, BD, with various amounts of chopped roughage, R) each with 6 replicates of individual goats. Goats were stratified on liveweight, blocked and randomly allocated to treatment within location blocks. The BD was 73.5% ground **barley** grain, 24.5% crushed lupins (*Lupinus angustifolius*) and 2% mineral supplement (see McGregor and Hodge 1988) pelleted through a 12 mm die. Roughage was either barley straw (S, *Hordeum vulgare*) or persian clover hay (P, *Trifolium resupinatum*), chopped to an average length of approximately 1.5 cm. The treatments were C (control), 100% BD; S2, 98% BD + 2% S; S6, 94% BD + 6% S; S12, 88% BD + 12% S; SAL, BD + *ad libitum* S; P12, 88% BD + 12% P.

Animals and management

Cashmere wether (castrated males) goats, 2.5 years of age grazed pasture between December and February. In February, while grazing, they were offered pellets and 5 non-eaters were identified and rejected. On 6 March the goats were weighed (mean \pm sd, liveweight 43.3 ± 4.3 kg), and housed indoors on slatted floors (1.6 m x 1.6 m pens). Each pen had 2 metal feeders and fresh water. Goats were fed daily at 0900 hours.

On the first 2 days of a 12 day introductory period goats were fed *ad libitum* S. Based on mean S intake, 10% of mean intake was replaced by BD each day until the desired diet composition was reached (day 11 for S12 and P12 and day 12 for C, S2 and S6). The SAL stabilised when S residues ceased to

be found and S provision was then increased. Residues were removed daily and weighed. Rations were then adjusted daily by increases of up to + 30 g in BD to allow maximum intakes to be expressed. If large residues of BD occurred BD provision was reduced rapidly (-200 to -400 g) and S or P reintroduced usually at 100 g. The introductory period procedure was then followed. Residues of R in restricted R treatments resulted in reduced feeding of BD. The experiment ran for 35 days. Goats were weighed at 0900 hours prior to feeding on days 20 and 34.

Statistical and chemical analysis

Analysis of variance to determine treatment effects and regression analysis to estimate the influence of the proportion of intake as dietary roughage on intake of BD and R were performed. Bouts of dramatic declines in feed intake (feed inappetence or rejection) were investigated and documented and differences between treatments tested by the Friedman statistic (Lehmann 1975). Data from 5 goats were rejected. These goats had large residuals in analysis of variance and had failed to adapt to BD with long periods of low intake (< 200 g/day). All intake measurements are presented on a dry matter (DM) basis. Feed samples were analysed for nitrogen (micro Kjeldahl using dry block procedure), acid-detergent fibre (see McGregor 1988), DM digestibility and metabolizable energy (ME) by near infra-red spectrophotometry.

RESULTS

Ration

The chemical composition (% w/w) of the pellets, barley straw and persian clover hay was: dry matter digestibility 64.1, 53.1 and 70.3; crude protein 15.91, 3.11 and 21.45; oil 3.47, 2.11 and 3.33; acid detergent fibre 9.71, 44.54 and 29.15; ash 4.03, 6.90 and 11.67; and ME (MJ/kg DM) 11.6, 7.0 and 12.8.

Health and feed rejection

Animals showed no sign of depression or diarrhoea. No deaths occurred. Bouts of feed rejection were frequent (Table 1) but there was no significant difference between treatments ($P = 0.15$). Most bouts occurred in the first week of the experiment (29/55). Bouts of feed rejection occurred following (mean \pm se) increases in intake of the BD of 21 ± 2 g/day. With 12 bouts no increases in provision and intake of BD occurred, compared to the previous days' provision. The mean (\pm se) depression in BD intake was 407 ± 22 g/day. Only 6 goats did not exhibit feed rejection. Two goats had 4 cases at approximately 7 day intervals. The DM intake (DMI, mean \pm se) of BD associated with the first case ($n = 30$) was 531 ± 16 g, the second case ($n = 16$) 526 ± 24 g, and the third ($n = 7$) 448 ± 34 g. Appetite was reduced for 2 days. The SAL had only 1 case in the last 30 days.

Intake and liveweight change

Data are presented for the 35 day experimental period and the final 14 days, which allows a further 21 days for the goats to adapt to the diets. Provision of R and R quality did not influence intake of BD (Table 1). Intake of R and total DMI was affected by treatment ($P < 0.001$). Mean total DMI and DMI for the last 14 days of SAL, was significantly greater ($P < 0.05$) than treatments other than P12, primarily because intake of roughage was significantly higher in SAL than in other treatments ($P < 0.05$, Table 1). The ME intake of SAL was only greater than S2, S6 and S12 ($P < 0.05$). Despite bouts of feed rejection continuing during the last 14 days, mean intake of BD was 22% greater than intake of BD during the first 3 weeks. Within SAL, intake (mean \pm se) of S was $33.7 \pm 4.3\%$ (range 18.4-44.4%) but for the last 14 days was $27.0 \pm 6.3\%$ (range 4.4-38.0%). As the percentage of R increased in SAL the mean intake of BD fell from 676 to 253 g/day. Liveweight of goats declined in all treatments during the introductory period and the first 3 weeks of the experiment. Liveweight change during the last 14 days was highest in SAL and P12, the treatments with the highest DMI, but was erratic in other treatments owing to bouts of feed rejection. For example, S12 had 4 goats "losing liveweight" in the last 14 days following bouts of feed rejection.

Linear regressions relating the percentage of intake as roughage, as a predictor of DMI, intake of BD, DMI during the last 14 days or liveweight change were all very poor predictors ($R^2 < 0.25$).

DISCUSSION

The intermittent occurrence of feed rejection and the high incidence of reduced appetite for 2 days and then a gradual increase in BD intake suggests the likely cause was failure to adapt to the diets. Hungerford (1975) describes grain poisoning and acidosis in sheep and cattle as being characterised by depression and diarrhoea, and in severe cases death, features not recorded in this closely monitored experiment. The consequences of the high incidence of feed rejection were i) a reduced mean intake of BD; ii) with C, S2 and S6, a higher intake of S occurred, primarily during the 3 weeks following the introductory period, than was designed, as additional S was fed to assist recovery from feed rejection; iii)

Table 1. Mean dry matter intake (DMI), metabolizable energy intake (ME), liveweight change and bouts of feed rejection for cashmere wether goats fed barley-lupin pellets (BD) with roughage (R; barley straw, S; or persian clover hay, P) at 0% (C), 2% (S2), 6% (S6), 12% (S12 and P12), or *ad libitum* (SAL), for 35 days following a 12 day introductory period

Treatment	C	S2	S6	S12	SAL	P12	LSD ^A
<i>Mean DMI</i>							
BD (g/day)	408	319	330	402	462	487	161
R (g/day)	40 ^b	60 ^b	60 ^b	70 ^b	229 ^a	65 ^b	47
Total DMI (g/day)	449 ^{bc}	378 ^c	389 ^c	472 ^{bc}	691 ^a	552 ^{ab}	144
R (% of total)	8.9 ^b	15.8 ^b	15.4 ^b	14.8 ^b	33.7 ^a	11.8 ^b	12.8
<i>DMI last 14 days^B</i>							
BD (g/day)	519	446	449	436	542	534	175
R (g/day)	0 ^b	17 ^b	31 ^b	53 ^b	208 ^a	66 ^b	68
Total DMI (g/day)	519 ^b	463 ^b	479 ^b	490 ^b	750 ^a	600 ^{ab}	172
(g/kg ^{0.75} .day)	6.17 ^b	5.77 ^b	5.82 ^b	5.85 ^b	8.57 ^a	6.99 ^{ab}	1.80
ME intake (MJ/day)	6.80 ^{ab}	6.03 ^b	6.17 ^b	6.16 ^b	8.64 ^a	7.92 ^{ab}	2.26
R (% of total)	0 ^c	3.4 ^{bc}	5.9 ^{bc}	11.0 ^b	27.0 ^a	11.2 ^b	8.5
<i>Liveweight change</i>							
Allocation to day 21 (kg)	-7.8	-8.5	-8.4	-7.3	-5.3	-7.1	2.86
Last 14 days (g/day)	4	62	64	-34	119	78	128
<i>Feed rejection</i>							
Animals affected	4	5	6	5	5	5	
Total bouts	8	10	9	10	6	12	
Bouts last 14 days	4	3	3	5	0	7	

^AMeans across rows with different superscripts are significantly different ($P < 0.05$).

^BExcludes 5 non-eaters.

loss of gutfill and reduced liveweight. The high incidence of feed rejection was unexpected as similar pellets had been fed to lighter goats on other occasions, at higher levels of intake, without feed rejection (McGregor 1984b). Adaption to barley-lupin pellets was not improved by the addition of roughage or by improving roughage quality. Further work is required to clarify the causes of feed rejection, including measures of rumen pH and blood D-lactate. If subclinical acidosis was the cause of feed rejection then these goats were susceptible at relatively low levels of processed cereal grain intake (< 450 g DM/day) and it would be advisable that use of similar pellets should include a pH modifier, such as slaked lime (McGregor *et al.* 1994), to reduce the potential frequency and impact of acidosis. In addition, despite continuing bouts of feed rejection, the mean intake of BD increased with the passage of time. This suggests goats may require longer periods for adaption to barley-lupin pellets than the 12 days provided, possibly as much as 5 weeks.

Intake of BD was not increased by increasing roughage quantity although during the first 3 weeks mean intake of S2 and S6 was reduced compared to other treatments. Maximum intakes occurred when S was fed *ad libitum*. This observation differs from previous work which suggested 13% roughage was sufficient for goats to express maximum voluntary intake (McGregor 1984a) when fed whole grain. It is possible that the increased requirement was related to a lack of rumen stimulation when the ground barley-lupin pellets were eaten compared to the probable effect of whole grains (Weston 1974).

Intake of BD was not increased by improving roughage quality. Roughage of higher digestibility has the potential to increase intake by reducing mean rumen retention time and increasing rate of passage of digesta. While P12 exhibited an intake of BD 20% greater than S12, this difference was not statistically significant. The large number of bouts of feed rejection in P12 would have restricted the ability of P12 to exhibit greater DMI.

In this experiment, the objective of which was to increase concentrate intake by increasing quantity of roughage, roughage was additive, as there was no substitution of roughage for pellets when roughage

intake was increased to *ad Zibitum*. Lack of substitution when roughage was increased in this research and low rates of substitution with oat and lucerne diets (18%, McGregor and Hodge 1988) suggests that goats do have a higher requirement for roughage. Based on the response of adapted goats to the addition of *ad Zibitum* barley straw, or persian clover, to pasture hay (McGregor 1984a) and to lucerne (McGregor and Hodge 1988) it is suggested that goat feed managers can maximise the voluntary ME intake by goats with the incorporation of between 12% and 27% of the diet as highly digestible roughage with relatively minor levels of substitution. The data of these experiments also suggest that goats have a different roughage requirement to that of sheep. Velazquez and Owen (1992) have reported that when both dairy goats and Suffolk sheep were offered various amounts of long barley straw and concentrate the goats consumed more straw than sheep.

In conclusion, when adult goats were fed barley-lupin pellets with various amounts of roughage, the highest levels of feed intake occurred when *ad Zibitum* barley straw (34% of DM intake) was fed. Increasing the provision of barley straw from 0% to *ad Zibitum* or provision of high digestibility persian clover hay at 12% of intake did not increase intake of the barley-lupin pellets. A period of up to 5 weeks may be required for adult goats to adapt to processed cereal grain pellets. Increasing provision of roughage did not improve adaption to processed cereal grain pellets.

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