GENETIC PARAMETERS OF FEED INTAKE AND DIGESTIVE EFFICIENCY IN TROPICAL SHEEP

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INTRODUCTION

Feed intake and efficiency of digestion of the consumed feed by the animal are very important factors affecting productivity in ruminants kept on roughage-based diets. Because the amount of nutrient available for metabolic activities and subsequent conversion to useful products such as meat, milk and fibre are dependent on the amount of feed consumed (where intake is a limiting factor) as well as proportion of feed retained in the body out of that consumed (feed digestibility). Feed digestibility is both an animal and a plant factor (Van Soest, 1982). However, there are evidences of genetic differences in the efficiency of digestion of the same feed (Maloiy**,** 1972 **;** Devendra, 1977 ; Migongo-Bake, 1992). However, majority of these studies were inter-species comparisons and, thus, there is limited information on within species and/or within breed differences in digestive efficiency of a common feed. Consequently, little is known whether it is possible to breed ruminants for a greater capacity for efficiency of feed digestion. The objectives of this study were, therefore, to estimate between- and within-breed differences in feed intake and digestive efficiency, in terms of apparent feed dry matter (DM) digestibility, in Menz and Horro sheep of Ethiopia.

MATERIALS AND METHODS

The data consisted of 452 Menz and Horro rams born from 63 sires and 369 dams in consecutive dry (October/November) and wet (June/July) seasons from October 1992 to July 1996 in eight lambing groups at the International Livestock Research Institute's (ILRI) Debre Berhan Research Station, Ethiopia. These were individually fed in metabolic crates from 13 months of age, for about three and-half months. The ration during the experimental period was *ad libitum* hay (5% CP) and 300 g/day per head concentrate supplement, consisting of wheat bran, maize and cotton seed cake, providing, on average, 180g CP/kg DM and 10.5 MJ ME/kg DM. Water was also provided freely.

Concentrate and hay offers and refusals were measured daily on individual animal basis.Faecal outputs were also collected on daily basis using faecal bags harnessed to each animal throughout the experimental period.

Statistical analyses. Data on offers and refusals were used to determine daily feed intakes.Daily DM intakes from hay and concentrates for each animal were pooled to give daily total DM intakes. Apparent DM digestibility noted ADMD was calculated as a percentage of feed DM retained (average daily total DM intake less average daily faecal DM output) from the total DM ingested.

Fixed effect model was fitted using PROC GLM of the SAS (SAS, 1986) software to investigate breed differences. The fixed effects fitted included breed, birth type (single and multiple), dam parity (1, 2, 3 and 4+), year-season of birth (eight classes) as well as one-way interactions found significant (P<0.05) in preliminary analyses.

Heritability estimates were estimated from individual animal model using DFREML as implemented by Meyer (1993). The fixed effects were breed, type of birth, dam parity and year-season of birth for all dependent variables.

Faecal output was not recorded in animals in the first lambing group (1992-dry year-season of birth, n= 57) that only 395 observations were used in the estimation of heritability of ADMD.

RESULTS AND DISCUSSION

Breed differences. Overall and sub-class least squares means (and s.e.), CV and F-tests for average daily feed DM intake and faecal DM output as well as percentage apparent DM digestibility are summarised in Table 1.

Table 1. Overall and sub-class least squares means (LSMs) and s.e. of breed, CV (%) and tests of significance for feed intake and faecal DM output (g/day) and ADMD [A)] (%)

Traits	Overall (±s.e)	CV	LSMs and SE		F-test [C)]
			Menz	Horro	
Concentrate DM Intake	277.6±0.7	3.5	277.2±0.8	278.1±0.9	NS
Hay DM Intake	539.7±4.3	10.9	520.3±4.4	559.8±6.0	**
TotDMI [B)]	817.2±7.3	7.3	797.3±4.5	837.8±6.1	**
Faecal DM output	377.4±3.6	12.8	358.6±3.7	396.6±5.2	**
ADMD	53.0±0.3	7.3	54.5±0.3	51.5±0.4	**

[A)]ADMD = apparent feed DM digestibility estimated as the percentage of feed DM retained in the body from that ingested.
[B)] TotDMI = average daily total DM intake from concentrate and hay;
[C)] NS = P>0.05 and ** P<0.01;

Breed difference in average daily concentrate DM intake (CDMI) was not significant (P>0.05). However, average daily hay DM intake (HayDMI) was about 40 g/day higher in the Horro than in the Menz (Table 1). Thus, total DM intake (TotDMI), the sum of concentrate and hay DM intakes, was higher (P<0.01) in the Horro. As gut size is the most important factor in limiting the voluntary consumption of roughage diets in ruminants (Grovum and Williams, 1977; Van Soest, 1982; Engelhardt *et al*., 1986), higher HayDMI and TotDMI in the Horro than in the Menz may be due to larger reticulo-rumen size in the former. Reticulo-rumen weight determined at slaughter was 0.60±0.004 kg (2.43% of empty body weight) in the Menz and 0.65±0.006 kg (2.63% of empty body weight) in the Horro (Ermias *et al*., 2000).

Average daily faecal DM output (FDMO) followed similar trend with HayDMI and TotDMI that it was significantly ($P<0.01$) higher in the Horro (Table 1). Consequently apparent feed DM digestibility (ADMD), the amount of feed DM retained in the body as a percentage of feed DM ingested, was significantly ($P<0.01$) higher in the Menz (Table 1). The inverse relationship between ADMD and TFDM was expected, as high TFDM is a result of poor ADMD. Large proportion of total DM intake in the Horro, compared to the Menz, being hay (relatively indigestible material) may have partly contributed to higher faecal loss and hence lower ADMD in the former. However, even when HyDMI intake was included as a linear covariate in the model, ADMD was significantly ($P<0.01$) higher in the Menz indicating significant breed effect on ADMD independent of the level of hay consumption. Similarly, in a study conducted at the same location as the present one, significantly ($P=0.06$) lower apparent ADMD was observed in the Horro compared to the Menz, even when the ratio of intake of concentrate to hay was higher in the former (Haile, 1999). Thus, differences in ADMD in Menz and Horro may possibly associated with differences in salivation, pattern of rumen fermentation, concentration of cellulolytic bacteria and rate of movement along the alimentary tract which are known to affect the efficiency of feed digestion (Grovum and Williams, 1977; Van Soest, 1982).

Heritability estimates. Heritability estimates for feed intake and ADMD are summarised in Table 2.

Table 2. Summary of heritability estimates

Traits [A]	No. of records	Heritability (±se)
Hay DM intake	452	0.26±0.14
Total DM intake	452	0.30±0.14
Apparent feed DM digestibility	395	0.47±0.16

[A] Heritability estimate for concentrate DM intake was not estimable and not presented.
TotDMI = average daily total DM intake from concentrate and hay; ADMD = apparent feed DM digestibility estimated as the percentage of feed DM retained in the body from that ingested.

Heritability estimates for total DM intake was 0.30±0.14 (Table 2). This was in closer agreement with Lee *et al*. (1995), who reported heritability of 0.24±0.12 for pasture intake estimated from faecal DM output marked by chromic oxide in grazing Merino ewes. However, Gallivan and Sullivan (1994) reported heritability estimate as high as 0.66±0.15 for total DM intake determined by computerised recording, in post-weaning lambs. The higher heritability estimates by Gallivan and Sullivan (1994), where intake was determined relatively precisely may suggest that measurement errors might influence the size of the parameter estimates. This seems to suggest that selection with regard to feed intake may be feasible as long as estimations are based on accurate intake recording.

Heritability estimate for ADMD was high and significant (0.47±0.16). High heritability estimate for ADMD indicate that the trait can be improved through selective breeding in Menz and Horro sheep. Genetic improvement for digestive efficiency, in terms of ADMD, in these breeds may allow utilisation of the low-quality feeds –the main feed resources in areas where these breeds are kept. Improving the ability of the animal to efficiently digest the available feed means that a greater proportion of the feed consumed is actually absorbed by the animal. Increasing the efficiency with which the animal digests the feed consumed may also allow efficient utilisation of roughage diets. Because, high intake of roughage diets could be maintained without consequent decline in apparent DM digestibility in genotypes with higher digestive efficiency.

CONCLUSION

Feed intake and digestive efficiency in terms of apparent feed DM digestibility could be improved through selective breeding in Menz and Horro sheep. Improving digestive efficiency in these breeds allow efficient utilisation of available feed resources.

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