A Comparative Study on Digestive Parameters in an Indigenous Fat-tailed and a Conventional Dorper Sheep Fed on Maize Stover Crop Residue

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ABSTRACT : The intake, dry matter (DM) digestibility, total mean retention time (TMRT) and weight changes were investigated in four fat tailed and four Dorper sheep fed on a maize stover crop residue. Animals were subjected to five dietary treatments, which were: 90, 135 and 180 g DM/kgBW$^{0.75}$/day of chopped maize stover offered with urea, and in subsequent dietary treatments 180 g DM /kgBW$^{0.75}$/day of stover supplemented with either dried bean husks or poultry manure. Although not statistically different (p>0.05) fat tailed sheep had higher maize stover intake than the Dorper sheep when expressed per metabolic body weight. The DM intake and digestibility increased significantly (p<0.001) in both sheep breeds when the maize stover offer levels were increased from 90 to 135 g /kgBW$^{0.75}$/day. Dorper sheep had significantly (p<0.001) higher DM digestibility and longer total mean retention times for both the liquid and solid matter than the fat-tailed sheep. Fat-tailed sheep gained 4.75 kg while Dorper sheep gained 3.75 kg over the entire experimental period. The weight change per dietary treatment was affected by the amount of maize stover and the type and amount of supplement consumed. The higher DM digestibility and longer total mean retention time in Dorper sheep shows that the breed has adapted to utilize the low quality roughage diets. An indigenous fat tailed, has the potential to ingest high volumes of fibrous feed and has higher voluntary intakes relative to its body size. The two sheep breeds are a valuable genetic resource in sub Saharan Africa that is characterized by long dry season with no readily available and affordable conventional feeds for small ruminants. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 4 : 529-533)***

Key Words : Intake, Digestibility, Total Mean Retention Time, Sheep Breeds, Maize Stover

INTRODUCTION

Small ruminants are an integral but dormant component of a complex agricultural system in developing nations. Crop residues such as cereal stovers are the main, often the only feed ruminants get during the six to eight months dry season in the tropical regions (ILCA, 1992). However crop residues are high in fiber and low in nitrogen and could only provide maintenance or even less the animal's requirements.

The physiology of the digestive system of indigenous fat-tailed sheep found in Eastern, Central and Southern African countries have not been extensively studied. It has been pointed out (Owen et al., 1989) that increased animal production from crop residues could be achieved by exploiting their selective eating behavior.

Animal species and breeds differ in their capacity to utilize low quality feeds and consistent animal differences have been reported in sheep (de Jong and Van Bruchem, 1993; Mwenya et al., 1995). A number of observations suggest that differences between breeds within species on digestive capacity may be of the same magnitude as differences between species (Ndosa, 1980; Calhourn et al., 1984; Silanikove, 1986).

The objective of this study was to examine the potential differences between the conventional Dorper sheep and the indigenous fat-tailed sheep on the intake, digestibility and digesta retention time when offered a basal diet of low quality maize stover fed with urea, bean husks or poultry manure.

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MATERIALS AND METHODS

The study was carried out at Bunda College of Agriculture in Malawi, which lies between latitude 14°C 35 min south, and longitude 33°C 50 min east at 1,200 m above sea level.

Animals and diet

Eight intact male sheep of about one year old were placed in individual metabolic cages facilitating the separate collection of urine and feces. Four indigenous fat-tailed Malawi sheep (15.8±2.1 kg) common to the sheep found in other parts of Eastern, Central and Southern African, and four conventional Dorper sheep (25±5.7 kg) which is a cross between the Dorset and a Blackhead Persian breed were subjected to five dietary treatments. Dietary treatments were: 90, 135, 180 g DM/kgBW$^{0.75}$/d of maize stover offered with compacted urea in cups, and 180 g DM/kgBW$^{0.75}$/d of maize stover offered with either dried bean husks or poultry manure.

Chemical composition of maize stover, urea block, bean husks and poultry manure (Table 1) were analyzed according to the association of official analytical chemistry (AOAC, 1990) and van Soest and Robertson (1986).

Experimental procedure

Each dietary treatment period lasted for 28 days with 21 days adaptation period followed by 7 days collection period. Maize stovers chopped (10 cm) were weighed and offered three times daily, the refusals being removed and weighed before new stover was given. During urea supplementation, urea in cups was offered two times daily for 1 h where as 200 g/d of dried bean husks and poultry manure were supplied once per day during treatments 4 and 5 respectively.

Markers

Two external markers of chromium mordanted maize stover stem husks (Cr-mordant) and a complex of Co-EDTA were prepared according to Uden et al. (1980). The Cr-mordant, which was intended to mark the particulate matter, was prepared by washing the chopped (5 mm) maize stover stem husks with sodium lauryl sulfate. They were then labeled by soaking them in $Na_2Cr_2O_7$ solution (Uden et al., 1980). After soaking for 24 h at 100°C, the husks were thoroughly washed under running tap water and then suspended in ascorbic acid. The test for mordant stability was done by digesting the maize stem husk mordants for 48 h *in vitro* with rumen inoculum.

The Co-EDTA intended to mark the liquid phase of the digesta were prepared from cobalt acetate, EDTA and sodium hydroxide in 6.25:7.3:1 proportions (Uden et al., 1980).

Marker administration and sample collection

The Cr-mordant and Co-EDTA were made into pellets and orally administered (5 g for Cr-mordant and 1.5 g Co-EDTA) with the help of molasses on the last day of the collection period during the dried bean husks and poultry manure supplementations (treatment 4 and 5 respectively). The fecal grab samples were obtained 6, 12, 24, 36, 48, 60, 72, 84 and 96 h after marker administration.

Analytical methods

Total fecal output for each animal per day was dried at 65°C for 48 h during each collection period. Sub samples of feed offered, refusals and feces were later pooled for the whole collection period for DM determination. Intake was calculated as the difference between the amount of feed offered and the amount refused. DM digestibility was calculated as a ratio of total DM intake less the fecal DM output to the total DM intake.

One-gram sample of grabs were ground (1 mm) and digested with 100 ml 2 M H_2SO_4 for 1 h (Lindberg, 1988). After cooling 25 ml $CaCl_2$ containing 4,000 ppm of calcium to reduce interference when analyzing for chromium (William et al., 1962). The chromium and cobalt concentration were assayed using an atomic adsorption spectrophotometer (Perkin-Elmer, 560 model).

Table 1. Chemical composition (%) of maize stover, urea block, bean husks and poultry manure

	DM	CP	NDF	ADF
Maize stover	95.8	3.6	71.5	47.8
Urea block	93.2	36.3	16.9	6.7
Poultry manure	93.8	17.9	69.1	18.5
Bean husks	94.1	4.9	62.4	38.2

Calculations

The retention times in the total digestive tract were calculated according to Thielemans et al. (1978) as follows:

$TMRT=\Sigma (t_i C_i \triangle t_i)/\Sigma(C_i \triangle t_i)$, where t_i is time (hours) elapsed since dosage of marker to the i^{th} collection interval, C_i is marker concentration in the i^{th} sample and $\triangle t_i$ the fecal collection interval (hour).

Statistical analysis

The data from the experiment were statistically analyzed by ANOVA using a General Linear Model procedure of SAS (1994) computer package. The factors were breed (Dorper vs fat-tailed) and diet (level of maize stover and type of supplement). Fat-tailed and Dorper sheep as well as dietary treatments were compared using least square means for all variables of interest with all p-values less than 0.05 considered as statistically significant.

RESULTS AND DISCUSSION

Maize stover intake

The DM intake of maize stover increased significantly ($p<0.001$) from 34.66 to 55.17 and from 33.72 to 53.67 g/kgBW$^{0.75}$/d for fat-tailed and Dorper sheep respectively when the amount of stover offered were increased from 90

Table 2. Dry matter intake of maize stover, urea, bean husks and poultry manure (g/kgBW$^{0.75}$/d) in fat-tailed and Dorper sheep during the five dietary treatments

Diet	Fat-tailed	Dorper	SED
90 g/kgBW$^{0.75}$/d stover	34.66	33.72	1.09
Urea	2.22	1.13	0.2**
135 g/kgBW$^{0.75}$/d stover	55.18	53.67	1.63
Urea	13.10	10.76	0.82*
180 g/kgBW$^{0.75}$/d stover	58.21	55.09	1.65
Urea	6.84	5.83	1.10
180 g/kgBW$^{0.75}$/d stover	47.98	48.74	2.68
Dried bean husks	20.65	8.80	0.68**
180 g/kgBW$^{0.75}$/d stover	52.01	45.94	1.75*
Dried poultry manure	21.73	12.46	0.87**

* $p>0.05$.

** $p<0.001$.

to 135 g/kgBW$^{0.75}$/d (Table 2). Similar results have been reported (Methu et al., 1996; Owen, 1994) where increase in stover intake were observed by excess offer of sorghum or maize stover to ruminants. The remarkable increase in stover intake shows that at 90 g/kgBW$^{0.75}$/d, both groups of sheep were under nourished although the amount was meant to meet the maintenance requirement (according to the *in vitro* analysis) due to high amounts of refusals. No significant increase in stover intake was observed when the amount offered was raised from 135 to 180 g/kgBW$^{0.75}$/d. However, the amount refused increased from 81 to 124 g/kgBW$^{0.75}$/d. The stover intake decreased significantly ($p<0.01$) during the dried bean husks and poultry manure supplementation due to substitution effects.

Dry matter digestibility

When averaged over all dietary treatments Dorper had significantly ($p<0.001$) higher DM digestibility than fat-tailed sheep (54.6 vs 60.9%). In all dietary treatments except during bean husks supplementation, Dorper sheep had consistently higher DM digestibilities (Figure 1). The higher DM digestibility in Dorper sheep may not be due to their better selective capability than fat-tailed sheep since the botanical fractionation of the refused stover did not reveal any breed differences. However, there was a significant ($p<0.001$) increase in DM digestibility in both groups when the amount of maize stover offered was raised from 90 to 135 g/kgBW$^{0.75}$/d. This was probably due to higher intake of leaves as a result of better selection opportunity from excess stover as evidenced by Osafo et al. (1997).

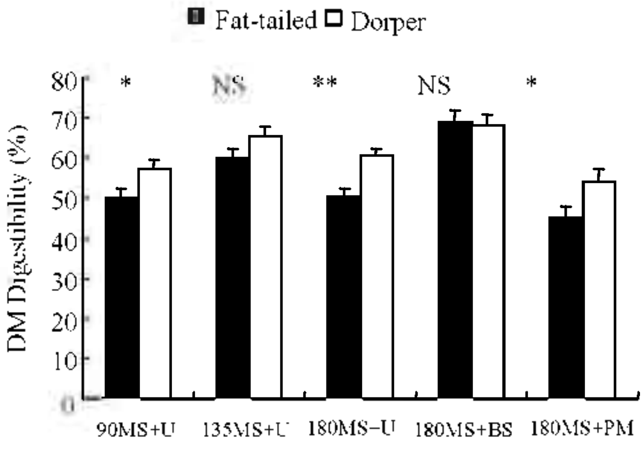

Figure 1. Dry matter digestibility (least-square and standard errors) of fat-tailed and Dorper sheep fed on maize stover (MS, g/kgBW$^{0.75}$/day) with urea (U), dried bean husks (BS, 200 g/day) or poultry manure (PM, 200 g/day).
NS: Not significant, $p>0.05$, * $p<0.05$, ** $p<0.001$.

High dry matter digestibility and longer total mean retention times were observed in Dorper sheep. Higher digestibilities on same feed are due to longer rumen retention times (Faichney and Gharardi, 1986; Orskov et al., 1988).

Total mean retention time

Averaged over the two digesta kinetics measurements, both the liquid and solid phase total mean retention times where higher in Dorper sheep than in fat-tailed sheep (45.9 vs 51.6 h $p>0.05$, for liquid marker and 53.6 vs 55.8 h $p>0.05$, for solid phase in fat-tailed and Dorper sheep respectively (Figure 2). In contrast, Weyreter et al. (1987) observed significantly longer retention time of particles in the total digestive tract of an indigenous Heidschnucken sheep than Blackface sheep when fed exclusively on straw diet. Mann et al. (1986) reported significantly ($p<0.05$) higher total mean retention times in the tropical breed (Blackbelly) than in the European breed (Dorset) and the cross between Blackbelly and Dorset when fed coastal bermudagrass pellets.

Body weight change

The percentage body weight change in fat- tailed and Dorper sheep is presented in Figure 3. During the first dietary treatment period of 90 g/kgBW$^{0.75}$/d of stover feed with urea, the fat-tailed sheep lost 1.5% of their body weight while Dorper sheep gained 2.9%. When the stover offered was increased to 180 g/kgBW$^{0.75}$/d in the subsequent period, the Dorper and the fat-tailed sheep gained 4.2 and 2.4% of their body weights respectively. Washed et al. (1990) also observed increased weight gain from a 0.1 kg loss to 2.5 kg gain when barley straw offered

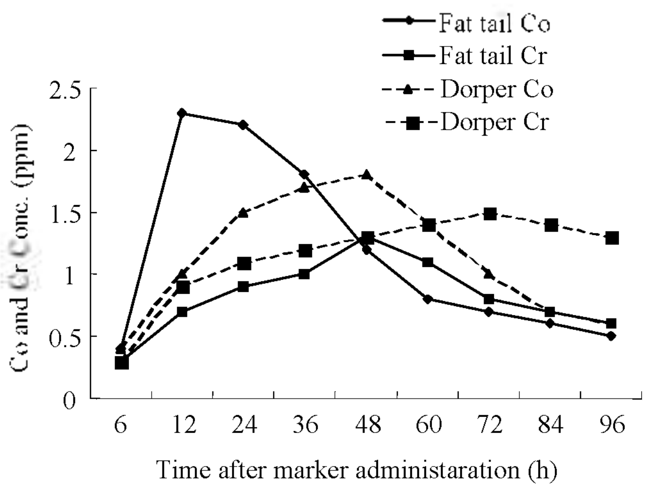

Figure 2. Excretion curves of Co-EDTA and Cr- mordant as liquid and solid phase markers respectively, in fat-tailed and Dorper sheep fed on maize stover with either bean husks or poultry manure.

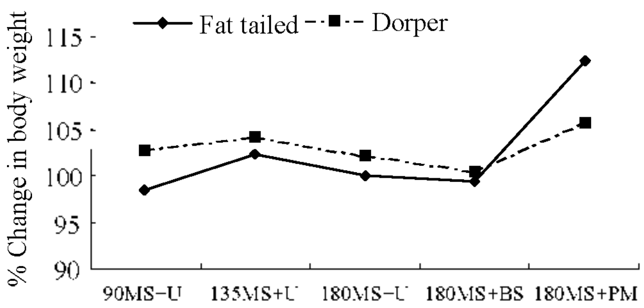

Figure 3. Percentage change in body weight of the Dorper and fat-tailed sheep fed on maize stover (MS, g/kgBW$^{0.75}$/day) basal diet supplemented with urea (U), dried bean husks (BS, 200 g/day) and poultry manure (PM, 200 g/day).

was increased from 18 to 24 g/kg live body weight/day in goats. However, when stover offered was raised to 135 g/kgBW$^{0.75}$/d during the third dietary treatment, both sheep breeds reduced their body weight. The reduction in the weight gain despite the increase in the stover offered could be due to the reduction in the urea intake. The fat-tailed sheep reduced the urea intake from 13.1 to 6.8 g/kgBW$^{0.75}$/d and the Dorper reduced from 10.8 to 5.8 g/kgBW$^{0.75}$/d. Body weight gain continued to decline during dried bean husks supplementation. There was a considerable gain in weight during poultry manure supplementation, with fat-tailed gaining 12.4% of their body weights and Dorpers gained 5.8%. The higher body weight gain in fat-tailed compared to Dorper sheep during the last dietary treatments agrees with the findings of Weyreter et al. (1986), who reported that the indigenous Heidschnucken adapted to poor feed diets better than the conventional Blackface sheep.

Findings from the present study reveals that both the fat-tailed and Doper sheep could be sustained during the long dry season on a basal diet of maize stover crop residue if supplemented with some locally available nitrogen source. Higher DM digestibility as well as longer total mean retention times of digesta through the gastrointestinal tract shows that the Dorper breed though conventional has adapted to tropical environments characterized by low nutritive feed. Fat tailed sheep, which are indigenous, have higher gastro intestinal tract relative to their body size and are capable of ingesting larger volumes of low quality feeds as reported by Mould et al. (1982) on bangali cattle. Due to larger amounts of maize stover refusals, which are mainly stems, it is important to offer excess stover to the animals. For increased productivity on maize stover it is important to retain as many leaves as possible during the collection and storage of the crop residue.

Both the fat tailed and Dorper sheep are valuable genetic resource to sheep production in sub tropical Africa that has a long spell of dry season with virtually no commercial feed supplements for small-scale sheep farmers.

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