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The Effect of Dry Season Supplementation of *Lotus corniculatus* Hay on Body and Fleece Weights of Three Sheep Breeds Grazing Natural Pasture under Ethiopian Conditions

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ABSTRACT

A study was conducted to investigate four levels of *Lotus corniculatus* hay (0, 100, 200 and 400 g/d/h) on body weight change and fiber characteristic of three dual-purpose sheep breeds of Ethiopia. The sheep were grouped based on their body weight and respective breeds and was assigned to one of the four levels of lotus hay randomly. Growth rate was significantly different (p<0.05) among the feeding levels. Rate of gain for lambs supplemented with 200 gram (5.12 kg) and 400 g lotus hay/day (5.55 kg) were similar and did not differ significantly (p>0.05), but were found to be different than the levels of 100 g lotus hay/day (3.49 kg) and the zero level (1.65 kg). Within breeds, body weight changes were observed AxM breeds gained significantly higher (p<0.05) (5.44 kg) than Menz (4.13 kg) and Tukur (2.31 kg). The live gain between Menz (4.13 kg) and Tukur (2.31 kg) was also significantly different (p<0.05). With regard to fiber characteristics, AxM lambs showed their superiority in all fiber characteristics (p<0.05) than Menz and Tukur sheep while no difference was noted between Menz and Tukur sheep in greasy and clean fiber weights. Any of the lotus levels did not alter any of the fiber characteristics.

Key words: lotus hay, sheep, weight gain, dressing percentage, fleece characteristics

INTRODUCTION

In the central highlands of Ethiopia mixed farming is a way of life where both crop farming and animal keeping is complement to each other. In this part of the country, animals are entirely dependent on the use of native pastures and crop residues where seasonal patterns of rainfall play a great role in the biomass and nitrogen content of the pasture. Livestock is central to nutrient cycling and is important for stability and sustainability of farming systems (Ehui *et al.*, 1998). The sheep reared in the central highlands are of dual purpose (meat and fleece). The country produces 12500 tons of greasy wool per annum (Payne and Wilson, 1999) of which a great majority is used locally by artisans to manufacture carpet, hat, rugs and wall hangings (Galal, 1983).

Livestock production of the central highlands is severely limited by inadequate

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veterinary services, under nutrition and malnutrition, inbreeding, early marketing and low market weights (Tembley, 1998; Degefe and Nega 2000; Desta *et al*., 2000). The dominant feeds (pasture and crop residues) are not sufficient to provide the required level of nutrition. Benin *et al.* (2002) observed an increasing trend in use of purchased feed in areas where there was access to market. However, the practice of supplementing animals with commercial feeds is indeed low by the smallholders; this is mainly due to high cost and unavailability (Selishi and Bediye 1991). *Lotus corniculatus* a recommended herbaceous legume for the central highlands of Ethiopia (Sebsibe and Tsegahun, 1998), has got a wide acceptance by the farming community as it fits to the fallow system. This herbaceous legume could be produced under low fertility conditions, high water table, poor internal drainage or high salinity (Smethan, 1977).

L. corniculatus has a character of by pass protein (Smetham, 1977; Min *et al*., 1998) and its nutritional effects depend upon the concentrations of condensed tannins (CT) in the forage. Concentration of CT (50-100g extractable/kg dry matter) depressed voluntary feed intake and reduced digestibility (Barry and Duncan, 1984). However, the extractable CT in lotus, which is in the range of 20-40 g/kg DM is thought to beneficial (Terill *et al*., 1992) making lotus one of the best leguminous forage crops to be used as animal feed.

Live weight loss during the long dry months can be regained through compensatory growth during the subsequent period of good nutrition. But there is no evidence for compensatory wool growth (Coombe *et al*., 1987). Systematic supplementation of animals in the dry season assists to overcome weight loss and any cost incurred to produce better nutrition can be partly offset by the weight gain achieved. This study was therefore designed to investigate the role of *L. corniculatus* hay supplementation in arresting weight loss and its impact on fleece production in the long dry seasons of the central highlands of Ethiopia.

MATERIALS AND METHODS

The experiment was conducted in the central highlands of Ethiopia at Debre Berhan Research Center, located at 9°36′N latitude, 39 °38′E longitude with an altitude of 2780 m above sea level (asl), with a annual rainfall of 900 mm. Monthly minimum air temperature ranged from 0.86°C in December to 8.74°C in July, while monthly maximum temperatures ranged from 18.14°C in August to 21.90°C in June. Frost occurs usually between the months of October and January.

Three fat tailed sheep breeds namely Menz, Tukur, and first crosses of Awassi x Menz (AxM) crossbred were used for the experiment. The yearling Menz and Tukur male lambs were purchased from locations of their origin and the 50% crosses of A x M sheep were procured from the Sheno Agricultural Research Center (SARC) at the beginning of 2003. The lambs were drenched with antihelmintics and sprayed against external parasites before the commencement of the experiment following the SARC recommendation.

Sheep were grazed in day times for eight hours as a single group from 08:00 to 17:00 h, on unimproved natural grass dominated by *Andropogon* spp, *Trifolium simense* and *T. cryptopdium*. At night, the lambs were housed in individual pen placed in a large, well-ventilated room where supplemental feed was offered. Lotus was harvested and left on the field in the sun and turned over everyday until it was completely dry. The dried lotus hay was then stacked in sacks and kept under the roofed but open-sided hay shed.

Representative grazed pasture samples and lotus hay were analyzed for dry matter (DM), ash and crude protein (CP) according to AOAC (1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) were determined using the

Goreing and Van Soest (1970) method.

A total of sixty lambs, twenty from each of the three breeds were stratified in to four groups based on their body weight and breed. After two weeks of adaptation to the experimental condition each group was randomly assigned to one of the four treatments.

Treatment 1. Zero level of *L. corniculatus* hay + 8 hours grazing only

Treatment 2. Supplementation of 100 g/h/d *L. corniculatus* hay + 8 hours grazing

Treatment 3. Supplementation of 200 g/h/d *L. corniculatus* hay + 8 hours grazing

Treatment 4. Supplementation of 400 g/h/d *L. corniculatus* hay + 8 hours grazing

The animals were weighed fortnightly, between 8:00 and 8:30 am throughout the experimental period. At each weighing period, the animals were devoid of water and experimental feed at least for 12 to 14 hours prior to weighing. At the end of the experiment, the lambs were weighed prior to having water, feed, and slaughtered for carcass analysis. Records of slaughter, hot carcass and offal weights and dressing percentage were taken. Dressing percentage was calculated taking the hot carcass and body weight at slaughter.

Fleece yield was determined by shearing the sheep at the end of the experiment. Mid side of each flank of the sheep was clipped from an area of $10 \times 10 cm^2$. Clean fleece weight was determined after scouring in a degreasing solvent. Excess moisture was removed by drying in forced draught oven for 24h at 20°C. Wool length was determined by measuring the length of randomly chosen fibers from each sheep, while fiber diameter was measured using a stereo microscope.

The SAS (1999) statistical package was used for data analysis. Least square mean was employed to compare weight gain, carcass and fiber weights. Standard errors of the means were presented accordingly for the means.

RESULTS

Chemical composition of feeds

The chemical composition of *L. corniculatus* and the grazing pasture is given in Table 1. The herbage available for the experimental sheep was either dead or dormant and was low in its chemical constituents. The grazing pasture had lower CP and higher NDF, ADF and hemicellulose than the lotus hay.

Weight and carcass measurements

There was no refusal of lotus hay throughout the experimental period. So body weight gain and fiber yield differences primarily reflected differences in the allotment of feeds and efficiency of the breeds. The weight gain and carcass measurements obtained as a result of the feeding treatment are given in Table 2. The supplemental levels had effects on body weight and certain carcass measurements.

The un-supplemented group sustained a weight gain of 1.66 kg ($p<0.05$) during the experimental period while supplements with 100, 200 and 400 g lotus per day resulted in the average live weight gains of 3.49, 5.12 and 5.55 kg, respectively (Table 2). Weight gain of sheep on

Table 1 Chemical composition of grazing pasture and Lotus hay

	Composition (%DM basis)	
	Pasture	Lotus
DM	91.23	90.06
Ash	8.75	9.39
CP	5.91	13.94
ADF	47.78	27.61
NDF	69.22	38.78
Hemicellulose	21.44	11.71
Organic matter	82.48	80.67

the higher levels of 200 and 400 g/h/d were similar and significantly higher ($p<0.05$) than the un-supplemented group and from those receiving 100g lotus per head per day indicating a better response at the higher levels of supplementation. However, this high weight gain did not produce better dressing percentage (Table 2).

The effect of treatments on the sheep breeds is indicated in Table 3. Among the breeds of Tukur sheep were the least ($p<0.05$) in total weight gain (2.31 kg) and average daily gain (ADG) (19.22 g) compared to AxM and Menz sheep ($p<0.05$). AxM sheep performed better ($p<0.05$) in both weight gain and ADG than Menz sheep and no significant difference ($p>0.05$) was noted in the viscera empty weight among the breeds (Table 3). Dressing percentages of Menz and Tukur lambs were significantly higher ($P<0.05$) than that of the AxM breeds and there was no difference between Tukur and Menz lambs ($p>0.05$).

Both treatment and breed effects did not

Table 2 Effect of different levels of lotus hay supplemented to lambs on body weight and carcass characteristics.

Item	Lotus hay (g)				SE
	0	100	200	400	
Initial wt (kg)	20.92	20.67	19.63	20.29	0.80
Final weight (kg)	22.29^{b}	23.76^{b}	25.54^{a}	26.48^{a}	0.52
Empty body wt (kg)	20.65^{c}	21.42^{bc}	23.22^{ab}	23.87^{a}	0.85
Total weight gain per animal (kg)	1.66^{c}	3.49^{b}	5.12^{a}	5.55^{a}	0.32
ADG (g)	13.85^{c}	29.09^{b}	42.74^{a}	46.28^{a}	2.67
Hot carcass wt (kg)	8.68^{b}	9.15^{b}	9.66^{ab}	10.48^{a}	0.42
Dressing (%)	42.02	42.73	41.40	43.93	0.86
Viscera full (kg)	3.99	4.30	4.24	4.14	0.30
Viscera empty(g)	535.56	510.00	523.75	564.17	22.09
Leg (g)	530.00	506.83	495.00	540.00	23.61
Tail (g)	262.50^{c}	373.33^{bc}	421.67^{ab}	498.33^{a}	42.56

$^{a\ b\ c}$ means in a row having different superscripts differ ($p<0.05$).

Table 3 Body weight and carcass characteristics of lambs fed different levels of lotus hay.

Characteristics	Sheep breeds			SE
	AxM	Menz	Tukur	
Initial weight (kg)	19.78	20.25	21.09	0.69
Final weight (kg)	25.86^{a}	24.99^{a}	22.70^{b}	0.45
Empty body wt (kg)	23.32	23.04	21.50	0.73
Weight gain (kg)	5.44^{a}	4.13^{b}	2.31^{c}	0.28
Gain/day (g)	45.30^{a}	34.45^{b}	19.22^{c}	2.31
Hot carcass wt (kg)	8.95^{b}	10.29^{a}	9.24^{ab}	0.36
Dressing (%)	40.05^{b}	44.62^{a}	42.96^{a}	0.74
Viscera full (kg)	5.04^{a}	3.71^{b}	3.75^{b}	0.26
Viscera empty(g)	543.75	546.88	509.48	19.14
Tail weight (g)	350.00^{b}	459.38^{a}	357.50^{ab}	36.86

$^{a\ b\ c}$ means in a row having different superscripts differ ($p<0.05$).

AxM (Awassi x Menz) sheep

produce any significant difference (p>0.05) in any of the non-carcass traits (Table 4 and 5).

No significant variation was noted among the different levels of lotus in response to any of the fleece characteristics (Table 6). However, the trend indicated that total greasy and clean fleece production increased as the level of supplementation increased. Wool production of lambs in the un-supplemented followed by those in the 100 g was the least whereas those in the supplementation levels of 200 and 400 g/h/d were highest. With regard to fleece length and diameter, there was no clear indication either in increasing or decreasing as the levels of supplementation changed.

Means of fiber diameter, length, greasy

Table 4 Non-carcass composition of lambs supplemented with the different levels of lotus hay.

Item	Lotus hay level (g)				SE
	0	100	200	400	
Head	1.64	1.69	1.82	1.92	0.85
Feet	530.00	506.83	495.00	540.00	23.61
Skin (kg)	2.29	2.25	2.36	2.51	0.11
Heart (g)	113.33	138.33	10.00	100.83	15.53
Kidney (g)	62.50	57.50	62.50	63.33	4.95
Lung and trachea (g)	401.67	382.50	379.17	441.67	27.49
Spleen g)	51.67	47.50	55.00	54.17	5.49
Liver (g)	308.33	261.67	315.00	313.33	21.73

Table 5 Non-carcass parameters of the three sheep breeds offered different levels of lotus hay.

Item	Sheep breeds			SE
	AxM	Menz	Tukur	
Head (kg)	1.78	1.80	1.73	0.07
Feet (g)	539.50	482.50	531.88	20.50
Skin (kg)	2.31	2.43	3.75	0.10
Heart (g)	126.88	96.88	115.63	13.45
Kidney (g)	27.81	31.88	28.44	4.14
Lung and trachea (g)	436.88	389.38	377.50	23.81
Spleen (g)	51.25	50.63	54.38	4.75
Liver (g)	307.50	301.25	290.00	18.82

AxM (Awassi x Menz) sheep

Table 6 Fleece characteristics of lambs supplemented with different levels of lotus hay.

Characteristics	Lotus level (g)			
	0	100	200	400
Greasy weight (g)	722.61±70.96	838.36±67.32	892.88±70.96	873.38±70.05
Clean wool (g)	455.72±37.26	498.30±35.35	514.98±37.26	508.38±36.78
Length (cm)	8.78±0.62	9.72±0.62	9.17±0.62	9.00±0.62
Diameter (μm)	66.79±6.51	80.76±6.18	65.67±6.18	72.43±6.18

and clean weight of the fleece as measured for the three breeds are presented in Tables 7. Wool production (greasy and clean weight) from AxM sheep tended to be higher ($p<0.05$) than that of the Menz and Tukur sheep and no significant difference was noted between Menz and Tukur sheep. The fiber diameter was influenced by breed, and the finest fiber coming from AwassixMenz crosses (61.79 µm) followed by Tukur sheep (63.87 µm) which was significantly different from Menz sheep (88.63 µm; $p<0.05$). Breed also influenced fiber length. Fleece from AxM sheep was significantly longer ($p<0.05$) than those Menz and Tukur. Fiber length of Tukur sheep (9.29 cm) was also significantly ($p<0.05$) longer than that of Menz sheep (6.7 cm).

DISCUSSION

The low CP and high fiber content of the pasture could be attributed to the season, which was a normal phenomenon of grazing pasture of the area during the dry season. The potential of *L. corniculatus* hay in preventing weight losses due to nutritional stresses following critical feed shortage during the dry seasons was substantiated in the trial. Body weight of lambs was best maintained at the level of 200 and 400 g/h/d. This finding was in line with Douglas *et al*. (1995) who obtained a higher live weight gain from lotus as opposed to lucerene and lotus lucerene mixed pasture. The weight obtained from sheep supplemented with 200 and 400 g lotus hay was higher than that of the non-supplemented group by 30% and was consistent with the oats/vetch hay studies of Lemma (1995). The weight gain of the un-supplemented lambs (grazing only) (13.85 g/h/d) was by far less than what Lemma *et al*. (1991) found during the late rainy to early dry months which might be related with pasture availability and quality. The live weight change (g/d) reported by Said and Tolera (1993) for the herbaceous legumes of *Desmodium intortum*, *Stylosanthes guianensis* and *Macrotyloma axillare* at different feeding levels were lower than the current findings indicating the potential of lotus to be used as an alternate forage legume in the central highlands of Ethiopia where the environments limits production of a wide range of forage species. Lemma *et al*. (1991) obtained an average daily gain of 68 and 118 g/d for Menz and AxM sheep fed for 200 days with 300 g/h concentrate as opposed to 34.45 and 45.30 g/d, respectively of the two breeds in the current study. This indicated the potential of the breeds as respond to better feeding management.

The authors were not aware of any published result, of a full fledged experiment that indicated the amount and quality of fiber production from the indigenous sheep breeds of Ethiopia, except the few observations (Devendra and McLeroy, 1982; Galal, 1983; Lemma *et al*., 1989; 1991). Hence, this study happened to be the first of its kind in Ethiopia by reporting results of fleece yield with some of its characteristics. Fleece characteristics of sheep was not influenced by lotus supplementation (Table 6) which was in line with Douglas *et al*. (1995) and Waghorn and Shelton

Table 7 Fleece characteristics of the sheep breeds fed on lotus hay.

Characteristics	Sheep breeds		
	AxM	Menz	Tukur
Greasy weight (g)	$1037.98^{a}\pm60.68$	$698.17^{b}\pm62.97$	$796.77^{b}\pm58.30$
Clean wool (g)	$573.00^{a}\pm31.86$	$425.11^{b}\pm33.08$	$484.92^{b}\pm30.61$
Length (cm)	$11.50^{a}\pm0.54$	$6.70^{c}\pm0.54$	$9.29^{b}\pm0.54$
Diameter (?m)	$61.79^{b}\pm5.35$	$88.63^{a}\pm5.35$	$63.87^{b}\pm5.57$

$^{a\ b\ c}$ means in the row having different superscripts differ significantly ($p<0.05$).

(1997) who found no difference in wool length of sheep that grazed/supplemented with *L. corniculatus* and Walz *et al.* (1998) who obtained no difference by supplementing fish meal or sodium bentonite. Min *et al*. (1998) also did not obtain any effect of treatment on fiber diameter, length, bulk density and wool resilience though they found a reaction in wool production. Though the level of treatment did not have effect ($p>0.05$) on any of the fleece characteristics studied, fleece yield was observed to increase as the levels of lotus supplementation increased. One explanation for the no response to the levels of supplementation was that nutrient demands for growth was greater than for wool growth (Black and Reis, 1979) as cited by Walz *et al*. (1998). In this experiment, the young lambs might have partitioned nutrients toward body growth rather than to wool growth to a greater extent than adult sheep did (Walz *et al*., 1998).

The increase in fleece weight was accompanied by an increase in body weight gain which seemed to be influenced more by breeds rather than feeding regimes. Gatenby *et al*. (1997) found fleece to be influenced more by breed rather than treatments. In general, Ryder (1993) stated that lambs with heavier body weight produced correspondingly higher wool with the exception of Merino breeds.

With two times, shearing Devendra and McLeroy (1982) reported a fleece yield of 2 kg for Tukur and 1.0 – 1.6 kg for Menz sheep. This yield seemed quite high compared to the findings of this study (Table 7). The variance could be attributed to the difference in the number of cut and the age disparity. In the current experiment, yearling sheep were used while the ages of the sheep were not specified. The mean fleece yields expressed by (Galal, 1983; Lemma *et al*., 1989; 1991) concurred with the findings of this study.

None tested breeds were qualified the points given for a good quality wool by Onions (1962) cited by Gatenby (1999). According to Onions (1962), wool should have a diameter of at least 40-50 µm to be classified as carpet wool. Taking this measurement as a standard, none of the breeds produced the carpet wool implying the requirement for an integrated effort to improve the quality. With a strong backcrossing program, the fiber diameter could be improved within short period of time. The report of Devendra and McLeroy (1982) with regard to fleece length, 10 cm (Tukur) and 5-8 cm (Menz) sheep was in close agreement with this finding (Table 7). The length of the fiber might be further improved by adjusting the shearing dates If the market demands this deserves further investigation.

CONCLUSION

The results of this experiment clearly demonstrated the potential of *L. corniculatus* supplied at the rates of 200 and 400 g/h/d to arrest dry season weight loss when forage availability limited animal performance. Supplementation at the rates of 200 and 400 g/h/d resulted in 30% live weight gain. This can be taken as an indication of the existence of alternative feeding system for raising sheep in a better condition in the central highlands of Ethiopia. Hence, the farmers of the central highlands should be encouraged to use at least 200 g/h/day lotus for strategic dry season supplementation. By doing so animal performance will be definitely improved, which benefits farmers from the sale of well-conditioned lambs in the dry season when the demand is high. Further research is suggested to investigate the possibility of incorporating lotus hay to minimize cost.

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