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Replacing Cotton Seed Cake by Dried *Acacia saligna,* Sesbania Sesban and Cowpea on Productivity of Begait Sheep in North Ethiopia

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Abstract: The experiment was carried out at Humera Begait cattle and Small Ruminants Breeding and Multiplication Ranch of Tigray Regional Government. This study was designed to assess the effects of supplementing cotton seed cake, Dried *Acacia Saligna*, *Sesbania Sesban* and Cowpea (*Vigna unguiculata*) on feed intake and body weight gain of Begait sheep fed grass hay as basal diet and wheat bran as energy source. Twenty four yearlings Begait male sheep with an average initial body weight of 25 ± 1.39 kg (mean ± SD) were used in randomized complete block design (RCBD) that lasted for 90 days. Treatments consisted of ad libitum feeding of natural pasture grass hay plus 200g DM wheat bran and additionally supplementing with100g, 250g, 140g and 180g DM per head per day of cotton seed cake, *Acacia Saligna*, *Sesbania Sesban* and Cowpea (*Vigna unguiculata*) for T1, T2, T3 and T4 respectively, each calculated to give 67g CP on isonitrogenous basis. Lambs were categorized into six blocks of four lambs based on their initial body weight and the four feed treatments were randomly assigned to each animal in a block, giving six animals per treatment. The hay DM intake was lower ($P < 0.05$) for T2 as compared to the other three treatments. Total DM and OM intakes appeared to be highly impacted by the supplemental DM intake. T1 and T3 resulted in higher ($P<0.05$) final body weights than T4; However, the results of BWC, ADG and FCE in T1, T2 and T3 were not significantly different ($P > 0.05$) from each other. There were also similarities among T2 and T4 in BWC, ADG and FCE, which reflected that the supplements were comparable in their potential to supply nutrients to improve the weight gains of sheep. Therefore dried *A.saligna* and *S. sesban* foliages can be used to replace protein sources commercial concentrate.

Key words: Body Weight · Dry Matter · Feed Intake · Supplementation

INTRODUCTION

Ethiopia has the largest livestock population in Africa, with an estimated population of about 50.8 million cattle, 25.9 million sheep, 21.9 million goat, 0.8 million camels, 42 million poultry, 1.9 million horses, 0.3 million mules and 5.7 million donkeys [1,2].

Poor utilization of locally available feed resources leads to low performance of animals in general and high impact on overall livestock production and reduces the income of farmers and decreases the profitability of the sector. This is because animal production is a result of utilizing the right feed in terms of accessibility, profitability and animal preference. Utilization of concentrate feeds in developing countries like Ethiopia is difficult as they are very expensive and not easily accessible. In addition to this the population pressure harms the potential feed sources like pasture land, grazing land and the other resources. Tesfay [3] noted that with the steady increase in human population much of the grazing and browsing areas are put under arable farming for food crop production, which further aggravates the scarcity of feed resources.

Sheep production in East Africa and particularly in Ethiopia is characterized by low productivity levels in terms of growth rate, meat production and reproductive performance [4]. In general, livestock productivity in Ethiopia is one of the lowest in the world, with average

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carcass weights of 108, 10, 8.5 and 0.8 Kg/head for cattle, sheep, goats and chicken respectively; and with an average milk yield of 210 kg/year/cow, all of which are below the average productivity of all least developed countries[5,6].

Shortage of feed supply during the dry season and very poor quality of the available feeds are the prime limiting factors for increasing production and productivity of small ruminant in most of the agro-ecological zones in Ethiopia [4, 7, 8]. Especially, energy and proteins are the major factors affecting productivity of sheep [4, 9]. The lowest energy density at which sheep does not loss weight is between 8 and 10 MJ ME/kg DM and the minimum protein level required for maintenance is about 8% CP in DM [9]. Provision of appropriate and complementary supplementary feedstuffs would be the best alternative strategies to alleviate nutritional problems and enhance the productivity of sheep under smallholder farmers in Ethiopia. In order to mitigate the problems associated with the lack of protein supplements due to reasons of availability and high cost, there is a need to look for alternative protein sources such as supplementation with forage legumes that farmers can produce at their own farms. Among the forages, cowpea (*Vigna unguiculata*), *Sesbania sesban, A. saligna,* lablab (*Lablab purpureus*) and alfalfa could be easily grown at farmers levels and play an important role in supplementing diets of growing lambs as alternative to concentrate mixture supplements. These forages can improve the growth performance of young ruminant animals on fibrous diets through the provision of more nutrients and optimization of fermentative digestion in the rumen. This implies that among other things, it is important to supplement growing ruminants not only with energy sources, but also with protein sources in order to increase the efficiency of growth to the desired market weight so that the economic benefit of sheep production could be enhanced. Therefore, this study was designed to assess the effects of supplementing concentrate mixture, dried *Acacia Saligna*, *Sesbania Sesban* and Cowpea (*Vigna unguiculata*) on feed intake, body weight gain and feed conversion efficiency of Begait sheep fed grass hay as basal diet and wheat bran as energy source.

MATERIALS AND METHODS

Description of the Study Area: The experiment was carried out at Humera Begait cattle and Small Ruminants Breeding and Multiplication Ranch of Tigray Regional Government. The ranch was established on 2000 ha of land and it is located in western zone of Tigray national regional state, 570 km northwest of Mekelle. Its geographical location lies within the co-ordinates of 13^0 40'-14^0 27' north latitude and $36^0$27'-37'32' east longitudes. The mean annual rainfall and mean minimum and maximum

Temperatures are 448.8mm, 25oc and 32oc, respectively [10].

Feeds and Feeding Management: Natural pasture hay and the forage legume cowpea *(Vigna unguiculata)* harvested from the Ranch was used. The hay was chopped to a length of approximately 4-5 cm, weighed and offered to the sheep *ad libitum* as a basal diet throughout the experimental period. Wheat bran and cotton seed cake was purchased from Omona wheat flour milling factory and shire city market respectively. They were mixed in the proportion of 65 % wheat bran to 35 % cotton seed cake. The leaves of *A. saligna* and *S. sesban* were collected by hand stripping from area enclosures and individual farm boundaries. The leaves were subjected to air drying for about four - five days till the stage that leaves are crushed by twisting easily. The daily amount of natural pasture grass hay, forage feeds and concentrate mixture were offered in separate troughs. The lambs had free access to clean and fresh water and common salt at all the time.

Animals and Their Management: Twenty four yearling Begait male sheep with an average initial body weight of 25 ± 1.39 kg (Mean ± SD) were used for this experiment. The age of sheep was determined based on birth date record. The sheep were quarantined for 2 weeks in the experimental area. During the quarantine period, sheep were de-wormed and sprayed against internal and external parasites, respectively. They were also vaccinated against the common diseases prevailing in the area (Anthrax, Blackleg and Ovine Pasteurellosis). Then all sheep were transferred to individual pens.

Treatments and Experimental Design: The experiment was conducted using a randomized complete block design (RCBD) with four treatments and six replications (Table 1). The experimental sheep were blocked based on their initial weight in to six blocks of four animals each. Treatment diets were randomly assigned to each animal in such a way that each animal have equal chance of receiving one of the treatment diets.

Table 1: Arrangement of experimental treatments

	Type of feed	
Treatments	Basal feed	Supplement feed on DM bases (gm)
T1	Grass hay *	200 WB+ 100 CSC
T2	Grass hay *	200 WB + 250 ASL
T3	Grass hay *	200 WB + 140 SSL
T4	Grass hay *	200 WB + 180 COPL

ASL = *Acacia saligna* leaves, CSC= cotton seed cake, COPL= cowpea leaves, DM = Dry mater SSL= *Sesbania Sesban* leaves, T= Treatment, WB= wheat bran, *= *Adlibitum*.

Measurements and Laboratory Analysis

Feed Chemical Analysis: Dry matter (DM), ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of experimental feeds offered were analyzed using standard procedures of AOAC [11].

Feed and Nutrient Intake: The daily amount of feeds offered and the refusal were weighed for each animal and recorded to determine the amount of feed consumed as a difference between the feed offered and refused. Intake values for dry matter (DM), organic matter (OM), CP, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were calculated by multiplying feed intake by the corresponding percentage of each proximate component.

Body Weight Gain and Feed Conversion Efficiency (FCE): Body weight of the animals was taken at the beginning of the trial and every 10 days during the 90 days of feeding trial period. All animals were weighed in the morning hours after overnight fasting using suspended weighing scale with a sensitivity of 100 g. Daily body weight gain (ABDG) was calculated as the difference between final body weight and initial body weight divided by the number of feeding days. Feed conversion efficiency (FCE) was calculated by dividing average daily gain (ADG) by daily total DM intake.

Data Analysis: All data related to feed intake, body weight change and feed conversion efficiency were analyzed using Statistical Package for Social Sciences (SPSS 20.0 for windows, 2004). Significance differences among treatments means were separated using Tukey HSD at P<0.05.

The model used for the analysis of parameters feed intake, weight gain and feed conversion efficiency of the experiment was:

$$Y_{ij} = \mu + \alpha_i + \beta j + \epsilon_{ij}$$

Where: $Y_{i=}$ response variable
μ = overall mean
$\alpha_i = i^{th}$ treatment effect
βj = block effect
$\epsilon_{ij} = i^{th}$ random error

RESULTS

Chemical Composition of Experimental Feeds: The DM, CP, ash, NDF, ADF and ADL of the different experimental ingredients and grass hay are given in Table 2.Hay had lower CP and higher NDF and ADF content than the supplemental feeds. Although *A. saligna* was slightly lower and cotton seed cake was higher in CP content, the four supplemental diets are generally rich sources of CP. However, the NDF and ADF levels in *S. sesban* were lower than the other supplemental diets and the ADL content was lower for cotton seed cake.

Feed and Nutrient Intake: The daily DM and nutrient intakes of Begait lambs fed natural pasture grass hay and supplements are presented in Table 3. There was higher DM intake in T2 followed by T4 than in T1 and T3. Each treatment feeds calculated to give 67 g CP on isonitrogenous basis and the intake were 100% of the supplement offer for all treatments. The hay DM intake was lower ($P < 0.05$) for T2 as compared to the other three treatments. Total DM and OM intakes appeared to be highly impacted by the supplemental DM intake. As such total DM and OM intakes were the lowest for T1, intermediate for T3 and T4 and highest for T2 ($P < 0.05$). Total NDF and ADF intake was in the order of T2 > T4 > T3 > T1. Although T3 had slightly higher CP intake as compared to the other three treatments the numerical difference is not as such too big.

Body Weight Change and Feed Conversion Efficiency: The mean initial (IBW) and final body weight (FBW), body weight change (BWC), average daily body weight gain (ADG) and feed conversion efficiency (FCE) of Begait sheep was presented in Table 4. The initial body weight (IBW) was similar ($P > 0.05$) among treatments. However, treatments differ in FBW, BWC, ADG and FCE ($P < 0.05$). Sheep that received a commercial concentrate mixture (T1) and WB + S. sasban (T3) had higher FBW, FCE, BWC and ADG ($P < 0.05$) than those supplemented with WB + *A. saligna* leafs (T2) and WB + cowpea leafs (T4), but differences in BWC, ADG and FCE among T1, T2 and T3 were not significant ($P > 0.05$).

Table 2: Chemical composition of the experimental feeds on DM basis

	Chemical composition (DM %)						
Feeds	DM	OM	Ash	CP	NDF	ADF	ADL
G hay	94.61	91.77	8.23	6.04	76.15	50.62	10.43
wheat bran	93.58	93.73	6.27	16.2	25.54	12	4.35
cotton seedcake	89.52	94.49	5.64	35.5	41.76	25.78	5.8
Acacia saligna	93.00	85.5	14.50	14.20	44.29	32.02	9.25
Sesbanya sasban	92.0	87.95	12.05	25.3	21.23	18.04	9.08
Cowpae	88.44	85.92	14.08	19.5	24.1	21	16.3

ADF=Acid detergent fiber; ADL=Acid detergent lignin; CP=Crude protein; DM=Dry matter; NDF=Neutral detergent fiber and OM= organic matter.

Table 3: Daily feed and nutrients intake of Begait rams fed on basal diet of grass hay and supplemented with different forages

	Treatments					SEM
Intake (g/d)	T1	T2	T3	T4	SL	DM(g/d)
Hay DM	342^{bc}	339^{c}	366^{a}	350^{b}	*	0.89
Suppl DM	300^{d}	450^{a}	340^{c}	380^{b}	***	1.19
Total DM	642^{c}	789^{a}	706.4^{b}	730.3^{b}	**	1.4
			Nutrant intake (g/d)			
OM gh	313.76^{c}	311.71^{c}	336.00^{a}	321.15^{b}	**	0.82
OM wb	187^{a}	187^{a}	187^{a}	187^{a}	ns	0.00
OM ps	94^{d}	212^{a}	120^{c}	155^{b}	***	0.95
Total OM	595.76^{c}	711.67^{a}	643.94^{b}	663.15^{b}	***	1.20
CP gh	20.52^{ab}	20.32^{b}	21.96^{a}	21.00^{ab}	*	0.04
CP wb	32^{a}	32^{a}	32^{a}	32^{a}	ns	0.00
CP ps	35.5^{a}	35^{a}	35^{a}	35.5^{a}	ns	0.00
Total CP	88.50^{ab}	88.28^{ab}	89.96^{a}	88.13^{b}	*	0.04
NDF gh	260.41^{c}	258.63^{c}	278.83^{a}	266.50^{b}	***	0.68
NDF wb	51^{a}	51^{a}	51^{a}	51^{a}	ns	0.00
NDF ps	41.99^{c}	108.00^{a}	31.00^{d}	43.06^{b}	***	0.65
Total NDF	351.10^{c}	418.05^{a}	361.32^{b}	361.06^{b}	**	0.86
ADF gh	173.12^{c}	171.97^{c}	185.27^{a}	177.14^{b}	**	0.45
ADF wb	24^{a}	24^{a}	24^{a}	24^{a}	ns	0.00
ADF ps	25.99^{d}	76.00^{a}	27.00^{c}	38.00^{b}	***	0.43
Total ADF	223.06^{c}	272.06^{a}	236.93^{b}	239.11^{b}	**	0.58
ADL gh	35.50^{c}	35.30^{c}	38.11^{a}	36.38^{b}	**	0.09
ADL wb	9^{a}	9^{a}	9^{a}	9^{a}	ns	0.00
ADL ps	5.99^{d}	20.00^{b}	12.00^{c}	29.00^{a}	***	0.18
Total ADL	50.18^{d}	63.99^{b}	58.68^{c}	74.00^{a}	***	0.20

$^{a, b, c, d}$ = means within a row not bearing a common superscript letter significantly differ, ns = not significant; DMI= dry matter intake; SEM= standard error of mean; OMI= organic matter intake; CPI= crude protein intake; ADL= acid detergent lignin; SL= significant level, gh= grass hay, ps= protein supplement, wb= wheat bran.

Table 4: The effect of experimental diets on body weight change

Parameter	T1	T2	T3	T4	S.L	SEM
IBW (kg)	26.17	25.33	26	26	ns	0.00
FBW (kg)	32.33^{a}	30.67^{ab}	31.83^{a}	30.17^{b}	*	0.37
BWC(kg)	6.33^{a}	5.33^{ab}	5.83^{a}	4.50^{b}	**	0.22
ADG (g/d)	70.5^{a}	59.33^{ab}	66.17^{a}	49.17^{b}	*	2.28
FCE	0.109^{a}	0.075^{ab}	0.093^{a}	0.067^{b}	**	0.73

a, b, c, d Means with different superscripts in the same row differ significantly; (***) = P<0.05; ADG=average daily gain; BWC=body weight change; FBW=final body weight; FCE = feed conversion efficiency; IBW=initial body weight; S.L =significance level; SEM= standard error of mean

DISCUSSIONS

Chemical Composition of Experimental Feeds: The DM content of the basal diet was comparable to the DM contents of 94.3% reported by Hagos [12] and 94.71% Gebreslassie [13] for natural grass hay. On the other hand, the DM content of the basal diet was higher than 89% DM reported by Nigussie [14]. The CP content of the hay used in this study was to be comparable with 6.55 % Gebreslassie [13] and higher CP values 7.56% Hagos [12] and 7.78% Hunegnaw and Birhan [15]. In this study CP content of grass hay used as basal feed was below the requirement for maintenance,. The hay was generally rich in NDF, ADF and ADL content, which might be due to the over maturity of hay at harvest. The CP content of wheat bran in this study was comparable to the values of 15.7 %, 16.41%, 16.82% reported by Michaele [16], Awet [17] and Gebreslassie [13] respectively, but lowers than the values of 21.23% and 20.1% reported by Genet [18] and Simret [19] respectively. The variation might be due to the effect of processing in milling industries and the quality of the original grain used in the milling industries.

The CP content of the cotton seed cake in our study was higher than the CP content of CSC reported by McDonald *et al*. [20] which was 23.9 and lowers than the result reported by Bhuyane *et al*. [21] and Temesgen [22] with values of 41.02 and 44.5%, respectively. This difference could be due to the absence of dehulling during the process of oil extraction.

The CP content of *Acacia saligna* was higher than 12.06 %, reported by Shumye [23] and comparable to that of 13.11% and 14.34% reported by Ahmed [24] and Gebreslassie [13]. NDF, ADF and ADL content of *Acacia saligna* used in the current study were 44.29%, 32.02% and 9.25%. This NDF content is comparable to 45.2% and 46.2 % reported by Getachew [25] and Moujahed *et al*. [26] respectively. The ADF content of this study is similar to the 29.48% reported by Shumuye [23]. But, higher than 25.9% and 24.7% reported by Ahmed [24] and Getachew [25] respectively and less than 34.9 % reported by Moujahed *et al*. [26]. The CP content of S.sesban leaf in the present study is within the range of 23.8-31.7% indicated by Mekoya [5]. The value was also comparable with 24.8% noted by Tibebu [27]. The NDF and ADF value of S.sesban leaf in our study are lower than 39.9% and 29.9% reported by Debela *et al*. [28]. On the other hand, our ADL content of S. sesban was higher than 4% and 5.1-5.7% indicated by Mekoya [5] and Debela *et al*. [28] respectively; but lower than the 27.2-28.2% reported by Solomon *et al*. [29]. According to Ajebu *et al*. [30] higher (53.7 %) NDF, comparable (33.9%) ADF and lower (7.56%) ash contents obtained in cowpea. All the above differences in nutritional composition of Acacia saligna, S.sesban and cowpea may be attributed to differences in accession, stage of plant growth, cutting frequency and harvesting regimen, soil type and fertility status and parts of the plant (Leafs, twigs, whole forage and green pods etc.) included during feeding and chemical analysis.

Feed and Nutrient Intake: Total DM and OM intakes appeared to be highly impacted by the supplemental DM intake in the current study. As such total DM and OM intakes were the lowest for T1, intermediate for T3 and T4 and highest for the T2 ($P < 0.05$). Total NDF intake was in the order of T2 > T4 > T3 > T1 and that of ADF intake was in the order of T2 > T4 > T3 > T1, both of which appeared to be associated with the level of NDF and ADF in the supplemental diets. Feed intake in all treatments increased steadily with advance in the experimental period. Generally the average total DM intake of sheep in our study was about 716.75 g/day, which was comparable with results of many studies of Hagos [12], Michaele and Yayeneshet [16] and Gezu [31] with different Ethiopian sheep breeds. Conversely, lower total DM intake [32, 33] and high total DM intake [34, 35] by sheep as compared to this study has been reported. Of course, variations in the type and amount of the basal diet as well as the supplement, breed of sheep, growth stage of the animal and other similar factors may contribute to differences in DM intake observed among the studies. Although T3 had slightly higher CP intake as compared to the other three treatments the numerical difference is not as such too big and this slight variation in CP intake is associated with differences in the basal diet DM intake.

Body Weight Change and Feed Conversion Efficiency: Among the supplemented feeds, T1 and T3 resulted in higher ($P<0.05$) final body weights than T4. The higher performances (FBW, BWC, ADG and FCE) of sheep in T1 and T3 as compared to sheep in T4 might be due to the lower cell wall fiber contents and higher nutrient digestibility in the concentrate mixture and S.sasban than the *cowpea* containing diet. However, the results of BWC, ADG and FCE in T1, T2 and T3 were not significantly different ($P > 0.05$) from each other. There were also similarities among T2 and T4 in BWC, ADG and FCE, which reflected that the supplements were comparable in their potential to supply nutrients to improve the weight gains of sheep. The trend in live weight change of sheep over the experimental period shows consistent increase in live weight gain throughout the feeding period. A number of studies on small ruminants in Ethiopia showed significant change in body weight gain when sheep with poor quality roughages are supplemented with diets rich in protein [16, 12, 33, 36]. The results of this study agreed with the finding of Nigussie [14], Hunegnaw and Birhan [15] and Abebe *et al.* [37]. The ADG of sheep in T1 was comparable with 62.8 g/day gain indicated by Michaele and Yayeneshet [16] for Tigray highland sheep fed with concentrate mixture. In agreement to the current study in T2, Gebreslassie [13] also reported 42.78 - 62.22 g/day gain for Tigray highland sheep fed grass hay and supplemented with wheat bran and different levels of A.saligna leaves. The mean daily gain (66.17 g/day) of sheep in T3 in the present study is higher than the findings of Solomon *et al.* [29] who reported 33.4-35.7 g/day gain for Menz sheep fed *teff* straw and supplemented with sole *S. sesban*; but Tibebu [27] reported higher ADG (83.3-99.8 g/day) for local sheep fed mixtures of 70-90% Napier grass and 10-30 % *S.sesban.* In summary, results of feed intake and body weight in the current finding outlined that, multipurpose trees (*A.saligna*) leaf as a sole supplement could be comparable to the supplementary value of improved multipurpose trees (*S. sesban*) and commercial concentrate feeds to improve sheep performance. Therefore, it could be said that *A.saligna* leaf can substitute the feeding value of other improved tree legumes and protein rich non-conventional feeds. Similarly, improved browse foliages like *A.saligna* and *S. sesban* can also replace the highly valued commercial concentrate feeds because of their similar performance effects on Begait sheep in this experiment.

CONCLUSION

The CP content of grass hay used as basal feed was below the requirement for maintenance, indicating the need for supplementation of grass hay based diets with protein riche feeds. Forages such as cowpea (*Vigna unguiculata*), *S. sesban* and *A. saligna* have optimum nutrient profile. Replacement of cotton seed cake (100g) by *Sesbania sesban* (140g), *A. saligna* (250g) and *cowpea* (180g) has improved intake and resulted in increased body weight gain and feed conversion efficiency of Begait sheep. Total DM and OM intakes appeared to be highly impacted by the supplemental DM intake. Total DM and OM intakes were the lowest for T1, intermediate for T3 and T4 and highest for the T2 ($P < 0.05$). However, a superior daily body weight gain was recorded in lambs supplemented with T1, T2 and T3. It was concluded that supplementation of 250 g *A. saligna* with 200 g wheat bran and 140g *Sesbania sesban* with 200 g wheat bran per day and per head can serve as an economical and locally available replacement to expensive concentrates. Alternatively, supplementation of 180 g cowpea with 200 g wheat bran per day and per head could be recommended for Begait lambs fed grass hay for improved feed and nutrient intake, body weight gain and feed conversion efficiency.

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