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Effect of Feeding Cotton Seed Cake, Dried *Acacia saligna*, *Sesbania sesban* or *Vigna Unguiculata* on Growth and Carcass Parameters of Begait Sheep in North Ethiopia

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Abstract: The present study was designed to assess the effects of replacing cotton seed cake by Dried *Acacia Saligna*, *Sesbania Sesban* and *Vigna unguiculata* (cowpea) on growth and carcass characteristics of Begait sheep fed grass hay as basal diet and wheat bran as energy source. Twenty four yearling 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 Dry matter (DM) wheat bran and additionally supplementing with 100g, 250g, 140g and 180g DM per head per day of cotton seed cake (CSC), *Acacia Saligna* (AS), *Sesbania Sesban* (SS) and Cowpea (VU) respectively, each calculated to give 67.6g CP on iso-nitrogenous basis. Lambs were categorized into six blocks of four lambs each based on their initial body weight. CSC and SS resulted in higher ($P<0.05$) final body weights than VU; However, the results of body weight change, average daily gain and feed conversion efficiency in CSC, AS and SS were not significantly different ($P>0.05$) from each other. Hot carcass weight ranged from 14 kg to 16 kg. Slaughter weight, empty body weight and dressing percentage on slaughter body weight were higher in CSC (cotton seed cake), SS (*S. sasban*) and AS (*A. saligna*) as compared to lambs supplemented with VU (cowpea) while VU was not significantly different with AS and SS, Which reflected that the supplements were comparable in their potential to supply nutrients to improve the growth and carcass parameter of sheep. Therefore dried *A. saligna* and *S. sesban* foliages can be used to replace commercial concentrate feeds as protein sources.

Keywords: Body Weight Gain, Dressing Percentage, Edible Offals, Hot Carcass Weight, Non-edible Offals, Slaughter Weight

1. Introduction

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 [1]. In general, livestock productivity in Ethiopia is one of the lowest in the world with average 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 [2, 3].

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]. Especially, energy and proteins are the major factors affecting productivity of sheep [5, 1]. 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 [5]. 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 (*Vignaunguiculata*), *Sesbaniasesban*, *Acaciasaligna,* 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 compare the effect of supplementation with iso-nitrogenous levels of concentrate mixture, Dried *Acacia Saligna*, *Sesbania Sesban* and cowpea on growth and carcass parameter of Begaitsheep fed grass hay as basal diet and wheat bran as energy source.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was carried out at HumeraBegait cattle and Small Ruminants Breeding and Multiplication Ranch. The ranch was located in western zone of Tigray national regional state, 570 km northwest of Mekelle. Its geographical location lies within the co-ordinates of 13° 40'-14° 27' north latitude and 36°27'-37°32' east longitudes. The mean annual rainfall and mean minimum and maximum Temperatures are 448.8mm, 25°C and 32°C, respectively [6].

2.2. Feeds and Feeding Management

Natural pasture hay and the forage legume cowpea harvested from the Ranch was used. The hay was chopped to a length of approximately four- five cm to decrease refusal, weighed and offered to the sheep *ad libitum* as a basal dietthroughout the experimental period. 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. Wheat bran and cotton seed cake was purchased from Momona wheat flour milling factory and shire city market respectively.

The amount of concentrate mixture in this experiment was determined to be 300g in the proportion of 65% wheat bran to 35% cotton seed cake on DM basis based on the research findings of Michaele and Yaynishet [7] for Tigray highland sheep and by considering their body weight and the expected weight gain. Samples of treatment feeds were analyzed for dry matter (DM) and crude protein (CP) content before commencement of the experiment to determine the amount of the experimental rations. The concentrate mixture was formulated to give 67.6 g/day CP on DM basis. To supply the same amount of CP on iso-nitrogenous basis, 450 g (wheat bran + *acacia saligna* leaf), 340 g (wheat bran + *S. sesban* leaf) and 380 g (wheat bran + cowpea leaf) on DM basis were supplied for sheep in the other treatments. The daily amount of natural pasture grass hay and supplemental feeds were offered in separate troughs. The lambs had free access to clean and fresh water and common salt.

2.3. Treatments and Experimental Design

The experiment was conducted using a randomized complete block design (RCBD) with four treatments and six replications. 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 the treatment in such a way each animal have equal chance of receiving one of the treatment diets.

Table 1. *Arrangement of experimental feeds.*

Treatments	Type of feed	
	Basal feed	**Supplement feed on DM bases (gm)**
CSC	Grass hay	200 WB+ 100 cotton seed cake
AS	Grass hay	200 WB + 250 Acacia saligna
SS	Grass hay	200 WB + 140 Sesbania. S
VU	Grass hay	200 WB + 180 cowpea

AS=*Acacia saligna*; CSC=cotton seed cake**;** DM=Dry matter; SS=*Sesbania Sesban*; WB=wheat bran; VU=cowpea.

2.4. 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 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. Then all sheep were transferred to individual pens.

2.5. Body Weight Gain and Feed Conversion Efficiency

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 (DBWG) 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.

2.6. Carcass Analysis

At the end of the feeding trial, experimental animals were fasted overnight and slaughtered. Slaughter weight (SW) was taken 30 minutes before slaughter. Pre-slaughter body weights, hot carcass weights, empty body weight and rib-eye muscle area were measured.

Empty body weight was determined by reducing the gut fill from slaughter body weight. Dressing percentage was calculated on the bases of slaughter and empty body weight using the formula:

$$\text{Dressing Percentage} = \frac{\textit{Hot carcass weight}}{\textit{Slaughter body weight}} X100 \quad (1)$$

$$\text{and} = \frac{\textit{Hot carcass weight}}{\textit{Empty body weight}} X100 \quad (2)$$

Rib-eye muscle area (REMA) was traced on transparency paper between the eleventh and twelfth ribs of the left and right half sides of the carcass after freezing and the area was measured using planimeter. The value for the rib-eye area was taken as the average of the two sides of the ribs.

Total edible offal component (TEOC) was taken as the sum of liver, testis, empty gut, visceral fat (kidney fat + omental fat), kidneys, head with tongue and tail. Total non-edible offal component (TNEOC) was computed as the sum of lung with trachea and esophagus, blood, spleen and pancreas, skin with feet, penis and total gut fill using sensitive balance weighing from 0.00g to 5 kg.

2.7. Data Analysis

All data related to growth and carcass parameter 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 was:

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

Where: $Y_{i=}$response variable
μ=overall mean
α_i=ith treatment effect
βj=block effect
ε_{ij}=ith random error

3. Results and Discussion

3.1. Chemical Composition of Experimental Feeds

The DM, CP, ash, NDF, ADF and ADL contents of 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 used in this study, and the ADL content was lower for cotton seed cake.

The CP content of hay used in this study was 6.04%. It was comparable with results of Hunegnaw and Birhan. T [8]; Hagos. H [9] and Gebreslassie [10] but higher CP values Hagos [11] as compared to the value noted in this study was also reported. The hay was generally rich in NDF, ADF and ADL content, which might be due to the over maturity of hay at harvest.

Table 2. *Chemical composition of the experimental feeds on DM basis.*

Feeds	Chemical composition (DM%)						
	DM	OM	Ash	CP	NDF	ADF	ADL
Grass hay	94.6	91.8	8.20	6.04	76.2	50.6	10.4
wheat bran	93.6	93.7	6.27	16.2	25.5	12.0	4.35
cotton seedcake	89.5	94.5	5.64	35.5	41.8	25.8	5.80
Acacia saligna	93.0	85.5	14.5	14.2	44.3	32.0	9.25
Sesbaniasasban	92.0	87.9	12.1	25.3	21.2	18.0	9.08
Cowpea	88.4	85.9	14.1	19.5	24.1	21.0	16.3
Treatment Feeds							
WB +CSC	92.2	93.9	6.06	22.6	30.9	13.0	2.31
WB + AS	92.7	88.8	11.2	15.0	35.5	19. 9	5.02
WB +SS	93.2	90.3	9.70	20.0	24.2	11.8	4.20
WB +VU	91.6	90.7	9.28	17.8	25.0	15.7	9.03

ADF=Acid detergent fiber; ADL=Acid detergent lignin; AS=*Acacia saligna*; CP=Crude protein; CSC=cotton seedcake; DM=Dry matter; NDF=Neutral detergent fiber and OM=organic matter; SS=*sesbaniasasban*; WB=wheat bran; VU=cowpea.

The CP content (22.6%) of concentrate mixture (65% wheat bran to 35% cotton seed cake) used in this study appeared to be comparable to the 25.09% CP content noted by Michaele and Yaynshet [7] for a concentrate mixture of wheat bran and cotton seed cake with the ratio of 3:1 on DM bases, respectively. Similarly, the NDF, ADF and ADL values of the concentrate mixture used was comparable to the abovementioned ratio of concentrate mixture by the same author. Generally the concentrate mixture used in this study was rich in CP and low in fiber content.

The CP content of *Acaciasaligna* in this study was higher than 11.40% and 12.06%, reported by Krebs [12] and Shumuye [13] respectivelybut comparable to that of 13.11% and 14.34% reported by Ahmed [14] and Gebreslassie [10] respectively. The CP content of *S. sesban* leaf in this study is within the range of 23.8-31.7% indicated by Mekoya [2]. The value was also comparable with 24.8% noted by Tibebu [15].

3.2. Body Weight Change and Feed Conversion Efficiency

The mean initial body weight (IBW), final body weight

(FBW), body weight change (BWC), average daily body weight gain (ADBG) and feed conversion efficiency (FCE) of Begaitsheep was presented in Table 3. Sheep that received a commercial concentrate mixture (CSC) and WB + *S. sasban* (SS) had higher FBW, FCE, BWC and ADBG (P<0.05) than those supplemented with WB + *A. saligna* leafs (AS) and WB + cowpea (VU).

Table 3. *The effect of experimental diets on body weight change.*

Parameter	CSC	AS	SS	VU	S. L	SEM
IBW (kg)	26.2	25.3	26.0	26.0	ns	0.00
FBW (kg)	32.3^{a}	30.7^{ab}	31.8^{a}	30.2^{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}	59.3^{ab}	66.2^{a}	49.2^{b}	**	2.28
FCE	0.11^{a}	0.08^{ab}	0.09^{a}	0.08^{b}	**	0.73

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

The higher performances (FBW, BWC, ADG and FCE) of sheep in CSC and SS as compared to sheep in VU 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 CSC, AS and SS were not significantly different (P>0.05) from each other. There were also similarities among AS and VU 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. The ADG of sheep in CSC was comparable with 62.8 g/day gain indicated by Michaele and Yaynshet [7] for Tigray highland sheep fed with concentrate mixture. In agreement to the current study in AS, Gebreslassie [10] 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 SS in the present study is higher than the findings of Solomon et al [16], who reported 33.4-35.7 g/day gain for Menz sheep fed teffstraw and supplemented with sole *S. sesban*; but Tibebu [15] reported higher ADG (83.3-99.8 g/day) for local sheep fed mixtures of 70-90% Napier grass and 10-30% *S. sesban.*

3.3. Carcass Characteristics

The average slaughter weight (SW) and empty body weight (EBW) were (P<0.05) higher for lambs supplemented with CSC (cotton seed cake), SS (*S. sasban*) and AS (*A. saligna*) as compared to lambs supplemented with VU (cowpea) Table 4.

Table 4. *Carcass characteristics of Begaitlambs fed on grass hay and supplements.*

Parameter	CSC	AS	SS	VU	S. L	SEM
Slaughter weight (kg)	32.3^{a}	30.5^{ab}	31.5^{ab}	30.3^{b}	**	0.51
Empty body weight (kg)	26.3^{ab}	25.5^{ab}	26.5^{a}	24.0^{b}	*	0.54
Hot carcass weight (kg)	15.3	15.0	15.6	14.0	Ns	0.47
Dressing percentage on Slaughter weight base	47^{b}	48.5^{ab}	49.7^{a}	46.5^{b}	*	0.91
Empty body weight base	58.5	58.8	60	58.5	Ns	0.74
Rib-eye area (cm^2)	11	10.5	11.3	10	Ns	0.14

$^{a, b}$ mean values in a row having different superscripts differ significantly; ns=not significant; *=significant at P<0.05; AS=*Acacia saligna*; CSC=cotton seed cake; SEM=standard error of mean; SS=*Sesbania Sesban*; S. L=significance level; VU=cowpea.

The DP on slaughter body weight basis in the current study was higher (P<0.05) for the lambs supplemented with SS (*S. sasban*) as compared to CSC (cotton seed cake) and VU (cowpea). In the present study, the DPSW bases ranged between 46.5-49.65%, which is in agreement with the 47.3-48.6% Amare [17] and 46.0-49.0% HagosHadgu [9] for Tigray highland sheep and Local sheep respectively. Relatively lower dressing percentages of 28.73%, - 37.55%, 36-38.4%, 36-42% and 39.8-43.7% on slaughter weight basis than the present study were reported by Michaele and Yaynshet [7] for Tigray highland sheep, Mulu [18] for Wegera sheep, Takele and Getachew [19] for Horro sheep and Gebresilassie [10] for highland sheep, respectively. Generally, the variations in carcass traits in this study and other results of previous studies might be due to variations in age, breed of sheep and quantity and quality of basal and supplement feeds used for the experiment. In agreement with this, McDonald et al [20] noted that, nutrition; age, sex, genetics, season and other related factors affect the growth and carcass traits of animals.

The rib-eye muscle area in the present study was ranged between 10 -11.25 cm^2. Comparable results to this study were reported by Mulu [18], 13 - 13.5 cm^2, forWegera sheep, Gebresilassie [10], 13.83 -15.57 cm^2 for highland sheep and Zemichale [21], 11.5-12.75 cm^2, for Local sheep respectively. But lower results was reported by Michaele and Yaynshet [7] (5 – 8.73 cm^2) for Tigray highland sheep Hagos H (2014) (6.9-7.7 cm^2) for Local sheep and Hirut [22] 7-8.4 cm^2 Hararghe Highland sheep, respectively. In the current study, there was no significant difference in rib-eye muscle area (p>0.05) between the supplemented treatments. This was an implication of lambs supplemented with different protein source feeds were able to accommodate better lean flesh.

3.3.1. Edible Offal Components

Edible offal components of Begaitlambs fed on grass hay and supplements are given in Table 5. Heart, liver, empty gut (reticulo-rumen + omaso-abomasum + small intestine + large intestine), visceral fat (kidney fat + omental fat), tail, head with tongue, testicles and kidneys are considered as edible offal based on the eating habit of the study area.

Table 5. *Edible offal components of Begaitlambs fed on grass hay and supplements.*

Parameter	CSC	AS	SS	VU	S. L	SEM
Heart (g)	217^{a}	161^{bc}	197^{ab}	128^{c}	**	10.5
Liver (g)	497	437	462	462	ns	16.1
Kidney (g)	140	142	130	180	ns	52.2
Empty gut (kg)	2.13	2.38	2.15	2.10	ns	9.24
Total fat (g)	250^{a}	192^{ab}	190^{ab}	177^{b}	**	13.3
Head &tongue (kg)	1.45	1.48	1.52	1.43	ns	12.4
Testis (g)	362^{ab}	330^{b}	398^{a}	326^{b}	**	57.6
Tail (g)	387	382	410	395	ns	9.27
TEOC(kg)	5.43	5.49	5.46	5.19	ns	0.12
TEOC (%)	16.8	18.0	17.3	17.0	ns	-

a, b mean values in a row having different superscripts differ significantly; ns=not significant; **=significant at P<0.05; AS=*Acacia saligna*; CSC=cotton seed cake; SEM=standard error of mean; SS=*Sesbania Sesban*; S. L=significance level; TEOC=Total edible offal components; VU=cowpea.

In the current study, the size of heart, total fat and Testis were significantly (p<0.05) affected by supplementation (Table 5). There was no significant difference (p>0.05) on the combined weight of Head with tongue, empty gut (reticulo-rumen + omaso-abomasum + small intestine + large intestine), Liver, tail and kidney in the current study due to supplementation. This was in harmony with the findings of Mulu [18] who reported, the weights of offal components rich in bone or offal components with a low metabolic activity like (head, feet and lungs) varied slightly with diet, as these organs are early maturing parts. Kirton et al [23] reported that live weight and nutritional status of the animals can affect the production efficiency of carcass offal's. The higher weight of visceral fat in CSC may also be due to higher digestible OM and CP intake, and higher OM and CP digestibility, which promoted higher internal fat deposition in different organs (omentum, kidney and heart) in CSC compared to VU. Higher weights of testes (P<0.05), were observed in SS and CSC than AS and VU.

3.3.2. Non Edible Offal Components

Non-edible offal component of Begaitlambs fed on grass hay and supplements are given in (Table 6). Weight of Blood, gut contents and skin with feet components were significant (P<0.05), the skin and feet weight of CSC were higher than VU; and similarity was observed between AS, SS and VU. The difference in skin weight may be due to the better subcutaneous layer fat deposition of sheep supplemented with concentrate mixture. Higher weights of blood were also observed in CSC followed by AS and SS and the lowest was recorded for VU. The amount of gut content was showed significant difference (p<0.05) in the order of CSC>VU>AS>SS. The difference in gut contents in this study might be due to differences in the degradability and escape of the supplemented feeds that neither of the feeds staying longer in GIT.

Table 6. *Non-edible offal components of Begaitlambs fed on grass hay and supplements.*

Parameter	CSC	AS	SS	VU	S. L	SEM
Gut content (kg)	6.22^{a}	5.27^{b}	5.12^{b}	6.1^{a}	**	1.5
Lung TE (g)	665	540	652	610	ns	24.3
Blood (g)	960^{a}	900^{ab}	900^{ab}	712^{b}	**	36.5
Penis (g)	51.3	46.2	53.7	48.7	ns	1.58
Skin and feet (kg)	3.35^{a}	3.22^{b}	3.23^{b}	3.20^{b}	**	83.6
Spleen &panc (g)	95	77	65	73.7	ns	4.72
TNEOC(kg)	11.3	10.0	10.4	10.6	ns	0.21
TNEOC (%)	35.2	32.9	33	35	ns	-

a, b mean values in a row having different superscripts differ significantly; ns=not significant; **=significant at P<0.05; AS=Acacia saligna; CSC=cotton seed cake; SEM=standard error of mean; SS=Sesbania Sesban; SL=significance level; TNEOC=Total Non-edible offal components; VU=cowpea

4. Conclusion

The results indicated that protein concentration of ration have positive effect on growth and carcass characteristics of Begait sheep. Carcass parameters (slaughter weight, empty body weight, hot carcass weight, dressing percentage and rib-eye area) were higher for sheep supplemented with concentrate mixture and lower for sheep supplemented with cowpea leaf; however sheep supplemented with concentrate mixture and cowpea leaf show similar results of carcass parameters with those supplemented with A. saligna and S. sesban leaf. Therefore it was concluded that supplementation of 250 g *A. saligna* with 200 g wheat bran and 140g *Sesbaniasesban* with 200 g wheat bran per day and per head can serve as an economical and locally available replacement to expensive concentrate feeds. Alternatively, supplementation of 180 g cowpea with 200 g wheat bran per day per head could be recommended because of their similar effects on the growth and carcass parameters of Begaitsheep.

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