Original Research Article

Effect of Cowpea (*Vigna unguiculata*) Hay, Wheat Bran and Their Mixtures Supplementation on Dry Matter and Nutrient Digestibility of Begait Lambs Fed Grass Hay as a Basal Diet

ABSTRACT

Aim/Objective: to evaluate effect of supplementing wheat bran (WB), cowpea hay (CPH), and mixes of the two on dry matter and nutrient digestibility of Begait lambs fed grass hay as a basal diet.
Study design: Randomized Complete Block Design (RCBD) with five blocks of five treatments was used.
Place and Duration of Study: Humera Agricultural Research Center farm in northern Ethiopia, from December 2016 until November 2017.
Methodology: Twenty five intact male Begait lambs with an average body weight of 28.02 ± 1.49 kg (mean ± SD) and 5 to 6 months of age were purchased from the local market. They were divided into five groups based on initial body weight and randomly assigned to the five treatments. *Ad libitum* feeding of grass hay was used as the basic diet for T1, T2, T3, T4, and T5, along with supplements of 300 g CPH, 225 g CPH + 75 g WB, 150 g CPH + 150 g WB, 75 g CPH + 225 g WB, and 300 g WB DMday^{-1}. All lambs in each treatment were fitted with a fecal-collection bag for three days followed by seven days of total feces collection to assess nutrient utilization.
Result: Differences were observed in DM, CP (P<.001), OM and ADF (P<.01) digestibility among the treatment groups. Low OM and CP digestibility were recorded in T1. Higher (P<.001) DM and CP digestibility, respectively were recorded in T5 and T3, compared to the other treatment groups. Digestibility of ADF was higher for T5 compared to the sheep in T1, T2 and T4, and no difference between T5 and T3.
Conclusion: The study suggested that feeding equal amount of cowpea hay to wheat bran and 300 g of wheat bran improved dry matter and nutrient digestibility of Begait lambs.

Keywords: *Begait lamb; digestibility, Vigna unguiculata; wheat bran.*

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1. INTRODUCTION

The world population is expected to increase in the upcoming years. As a consequence, the demand for livestock and livestock products will also increase. The development of efficient and sustainable feeding systems is required to meet this demand.

In tropical areas, rangelands with native heterogeneous vegetation, including grasses, legumes, trees, and shrubs, are the primary forage source for ruminants. During dry seasons, pasture availability decreases, and ruminants depend on perennial grasses and agricultural by-products, which include crop residues and agro-industrial by-products. Crop residues are fibrous byproducts and their feeding value are limited by their poor voluntary intake, low digestibility and low nitrogen, energy, mineral, and vitamin contents [1]. Similarly, Forage availability and quality are not favorable year round and hence gains made in the wet season are totally or partially lost in the dry season [2]. Thus, efforts have been done to improve the nutritional value of these fibrous feeds. Supplementing with herbaceous legume forages could be one option.

As intervention strategies, Humera Agricultural Research Center (HuARC) introduced numerous/ various improved herbaceous legume forages like cowpea, lablab, and clitoria to the area. According to monitoring and evaluation of the varieties, one cowpea variety named as *Temesgen* was registered in the national variety release in 2014 G.C as best feed resources of the area as well other similar agro-ecologies of the country [3]. It is an excellent human food and livestock feed, and its dual-purpose nature makes it an important crop.

Temesgen is characterized by its high herbage DM yield and crude protein content which are 11.9 t ha^{-1} and 17.15% CP, respectively. Its high protein content implies that the potential for use as a protein supplement for ruminants on low quality roughages [4, 5] such as matured natural pasture hay [6]. Since there is no much written document regarding its importance in improving dry matter and nutrient digestibility, it was crucial to undertake feeding trial on animals for proper utilization. Therefore, this study was conducted to determine effect of cowpea *(Vigna unguiculata)* hay, wheat bran and their mixtures supplementation on dry matter and nutrient digestibility of Begait lamb fed grass hay as a basal diet.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

This study was carried out on-station at Humera Agricultural Research Center (HuARC), western zone of Tigray, Northern Ethiopia. It is situated at an altitude of 608.9 m.a.s.l and latitude of 14º15' N and longitude of 36º37' E. The dominant soil type is Vertisol. The site has a semi-arid climate with unimodal rainfall pattern. The mean maximum and minimum temperature varied from 33 to 41.7 and 17.5 to 22.2°C, respectively and 581.2 mm was the mean annual rainfall, which was received during the summer/rainy season [7].

2.2 Experimental Animals' Management

Twenty five intact male Begait lambs with an average body weight of 28.02 ± 1.49 kg (mean ± SD) and 5 to 6 months of age were purchased from the local market. Information on age was provided by the owner which was verified using dentition. As soon as the lambs were arrived at the center, they were provided 20% of ox tetracycline to minimize stress due to transport. /Neck-chain was used as a means of identification. . They were quarantined for 21 days to the new environment, experimental diets and to observe their health status and followed by 15 days of acclimatization period. During that time, lambs were drenched with a broad spectrum anthelmintic (Ivermectin) to treat internal and external parasites and sprayed with accaricide (Diazzinole) 1ml $head^{-1}$ against external parasites. After ten days of deworming, they provided Ovine pasteurelosis type A vaccine subcutaneously against Ovine pasteurelosis, which was one of the common diseases of the area. Lambs were kept in individual pens, which were equipped with feeding troughs for hay and plastic buckets for supplements and watering separately.

2.3 Experimental Design and Treatments

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Randomized Complete Block Design (RCBD) with five blocks of five treatments was used (Table 1). Lambs were blocked according their initial body weight, which was determined as a mean of two consecutive weighing after overnight fasting at the beginning of the feeding trial. Lambs in each block were randomly assigned to one of the five treatment diets. They were allocated in individual pen with a dimension of 85 cm wide and 115 cm long in a naturally ventilated shed. All lambs had free access to common salt, and clean and fresh water. The experiment was run for 10 days, consisted of 3 and 7 days for fecal-collection bag fitness and actual feces collection, respectively.

Table 1. Experimental Treatments

Treatment	Grass hay	Amount of CPH supplement (g)	Amount of WB supplement (g)	Supplement amount (g head^{-1}day^{-1})	CP (g)	ME (MJ)
1	*Ad libitum*	300	0	300	51.4	6.7
2	*Ad libitum*	225	75	300	50.9	7.9
3	*Ad libitum*	150	150	300	50.5	7.9
4	*Ad libitum*	75	225	300	49.9	7.2
5	*Ad libitum*	0	300	300	49.5	8.2

CPH= cow pea hay; WB = wheat bran

2.4 Digestibility Trial

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Lambs were subjected to digestibility trial to evaluate the utilization of different dietary nutrients. All lambs in each treatment were fitted with a fecal-collection bag for three days followed by seven days of total feces collection. Feed offered and refused were recorded and sampled on daily bases. All the daily fecal output were collected and recorded for each animal. The total fecal outputs were collected by emptying the bag per day per animal each morning prior to offering feeds and water. The feces output from each animal were mixed thoroughly and 20% was sampled daily and stored at -20^{0}C deep freezing in labeled plastic bags until required for analysis.

The samples were pooled per animal over the collection period and 20% of the composite sample was taken, weighed and partially dried to a constant weight in a forced draft oven at 60°C for 72 hours. The dried fecal samples were milled to pass through a 1mm sieve and were stored in airtight polyethylene bags for further chemical analysis. Apparent digestibility of DM and other nutrients was determined as a percentage of the nutrient intake not recovered in the feces using the following formula:

ADDM (%) = [(DM in Feed –DM in Feces)/ DM in Feed] X 100 (1)
Where, ADDM = Apparent digestibility of Dry Matter

ADN (%) = [(Nutrient Intake – Nutrient in Feces)/ Nutrient Intake] X 100 (2)
Where, ADN = Apparent Digestibility of Nutrients

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2.5 Chemical Analysis

Representative samples of feed and feces were taken to Haramaya University animal nutrition laboratory center to determine nutritional content. Analysis for DM, ash and N contents was done according to Association of Official Analytical Chemists [8] procedures. Dry matter and ash contents were determined by oven drying at 105^{0}c overnight and by igniting in a muffle furnace at 550^{0}c for 6 h, respectively. Nitrogen (N) content was determined by using Kjeldahl method and crude protein (CP) was calculated as

N×6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and Acid detergent lignin (ADL) were determined by using the procedures of [9]. Organic matter was computed as 100 minus ash.

2.6 Statistical Analysis

Data on apparent digestibility were subjected to analyses of variance (ANOVA) procedure according to a Randomized Complete-Block Design using the Generalized Linear Model (GLM) of the Statistical Analysis System for windows (SAS, 2002) to detect treatment effects. Treatment means were compared using Fisher's Least Significant Difference (LSD) Test at 5% level of probability.

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The statistical model used for the analysis of the experiment was:

$$Y_{ij} = \mu + T_i + B_j + \varepsilon_{ij} \quad (3)$$

Where: Y_{ij} = response variable
μ = the overall mean
T_i= the i^{th} treatment effect
B_j = the j^{th} block effect (initial BW)
ε_{ij}= i^{th} random error

3. RESULTS AND DISCUSSION

3.1 Dry Matter and Nutrient Digestibility

Differences were observed in DM, CP (P<.001), OM and ADF (P<.01) digestibility among treatment groups (Table 2). Low OM and CP digestibility were recorded in T1. Higher (P<.001) DM and CP digestibility, respectively were recorded in T5 and T3, compared to the other treatment groups. Digestibility of ADF was higher for T5 compared to the lambs in T1, T2 and T4, and no difference between T5 and T3.

Digestion in the rumen is dependent on the activity of micro-organisms. It also requires energy, nitrogen, minerals and a suitable medium to enable the microbes perform well [10]. Higher DM and CP digestibility observed in T5 and T3, respectively could be due to the lower NDF and ADF contents of WB (Table 3) and higher CP intake (Table 4). Higher CP digestibility in T3 indicated the combination of the two supplements in equal amount might have favored high rumen fermentation and facilitated good synthesis of volatile fatty acids (VFAs) for absorption and increased production of rumen biomass [11]. On the contrary, low digestibility of DM and ADF observed in T4 could be due to lower CP intake (Table 3).

The DM digestibility values obtained fall within the range of 60 to 69% deemed as indicative of fairly high digestible level [12]. Absence of significant difference in NDF digestibility in the current study indicated similar level of nutrient supply from the different combinations of the treatment diets. Similar results have been reported before [13-15]. Moreover, [16] noted absence of significant difference in NDF and ADF digestibility and explained by possible reduction in rumen pH which has a depressing effect on the population of cell wall fermenting rumen microbes as a result of feeding more digestible supplement to the animals.

Table 2. Apparent digestibility of dry matter and nutrients of Begait lambs fed grass hay and supplemented with Vigna unguiculata hay, wheat bran and their mixes

Digestibility (%)	Treatments						
	T1	T2	T3	T4	T5	SL	PSE
DM	61.36^{b}	61.29^{b}	62.69$^{b`}$	`61.57^{b}	69.94^{a}	***	0.981
OM	60.75^{b}	68.45^{a}	67.73^{a}	69.05^{a}	70.15^{a}	**	0.988
CP	58.84^{c}	66.06^{b}	70.87^{a}	62.92^{b}	65.15^{b}	***	1.139
NDF	60.10	65.53	65.08	66.21	66.41	ns	2.554
ADF	53.89^{b}	52.65^{b}	54.16^{ab}	50.68^{c}	55.79^{a}	**	0.511

*a-c, means with different superscripts in a row are significantly different; *** = (p<.001); **= (p<.01); ns: non-significant; PSE: pooled standard error of mean; SL: level of significance; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; DM: dry matter; OM: organic matter; T1: received 300g cowpea hay; T2: received 225g cowpea hay + 75g wheat bran; T3: received 150g cowpea hay + 150g wheat bran; T4: received 75g cowpea hay + 225g wheat bran; T5: received 300g wheat bran*.

Table 3. Chemical composition of experimental feeds

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Feed offered	DM %	CP	NDF	ADF	ADL	Ash
		DM %				
Cowpea hay	88.75	17.15	60.00	50.30	14.50	12.50
WB	88.22	16.50	38.46	16.35	5.75	6.45
Grass hay	90.65	5.46	77.15	53.28	14.76	9.13

CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin; DM: dry matter; WB: wheat bran

Source: [7]

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Table 4. Daily dry matter and nutrient intake of Begait lambs fed grass hay and supplemented with Vigna unguiculata hay, wheat bran and their mixes

Intake (gday^{-1})	T1	T2	T3	T4	T5	SL	PSE
Grass hay DM	387.11^{b}	369.41^{b}	419.41^{a}	330.99^{c}	373.47^{b}	***	6.801
Supplement DM	300.00	300.00	300.00	300.00	300.00	ns	0.000
Total DM	687.11^{b}	669.41^{b}	719.41^{a}	630.99^{c}	673.47^{b}	***	6.801
Total DM (%BW)	2.21^{a}	2.08^{bc}	2.17^{ab}	2.01^{c}	2.11^{b}	**	0.099
Nutrient							
Total OM	682.07^{a}	669.35^{bc}	723.27^{a}	641.55^{c}	689.30^{ab}	**	7.625
Total CP	84.800^{ab}	82.631^{ab}	85.38^{a}	79.218^{c}	82.338^{b}	**	0.599
Total NDF	526.79^{a}	491.04^{a}	514.64^{a}	422.66^{b}	445.37^{b}	***	9.754
Total ADF	400.50^{a}	358.35^{b}	353.70^{b}	277.08^{c}	279.21^{c}	***	11.109
ME(MJday^{-1})	6.74^{c}	7.91^{ab}	7.85^{ab}	7.24^{bc}	8.17^{a}	**	0.160

*a-c, means with different superscripts in a row are significantly different; ***= (p<.001); **= (p<.01); PSE: pooled standard error of mean; SL: level of significance; ME: metabolizable energy; ns: not significant difference; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; DM: dry matter; OM: organic matter; T1: received 300g cowpea hay; T2: received 225g cowpea hay + 75g wheat bran; T3: received 150g cowpea hay + 150g wheat bran; T4: received 75g cowpea hay + 225g wheat bran; T5: received 300g wheat bran.*

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4. CONCLUSION

This study indicated that diet influenced dry matter and nutrient digestibility of Begait lambs with the exception of NDF. Higher DM and CP digestibility was observed in lambs fed 300 g of wheat bran and equal proportion of wheat bran and cowpea hay, respectively. Therefore, the study suggested that feeding equal proportion of cowpea hay to wheat bran (150 g + 150 g) and 300 g of wheat bran improved dry matter and nutrient digestibility of Begait lambs.

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COMPETING INTERESTS

The author has declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

The author, Gebreslasie Gebrekidan, carried out the experiment's design and execution, as well as the data analysis and interpretation and article writing.

ETHICAL APPROVAL

"The author hereby declares that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee".

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APPENDIX

List of Tables in the Appendix

Appendix Table 1. Summary of ANOVA for apparent digestibility of dry matter and nutrients of experimental lambs

Digestibility	DF	MS	F-value	Pr >F	SL	CV (%)
DM	10.0	41.455	11.49	0.0009	***	2.997
OM	10.0	41.696	10.94	0.0011	**	2.904
CP	10.0	58.231	14.62	0.0004	***	3.082
NDF	10.0	20.371	0.16	0.955	ns	17.556
ADF	10.0	10.836	9.42	0.002	**	2.007

DF: error degree of freedom; MS: mean square of treatments; Pr: probability; CV: Coefficient of variance; SL: significant level; ns: non-significant; ADF: acid detergent fiber; CP: crude protein; NDF: neutral detergent fiber; OM: organic matter; DM: dry matter

Appendix Table 2. Summary of ANOVA for total dry matter and nutrient intake of experimental sheep

Intake (gd^{-1})	DF	MS	F-value	Pr >F	SL	CV (%)
Hay DM intake	20.0	5103.94	13.91	<.0001	***	5.09
Total DM	20.0	5103.94	13.91	<.0001	***	2.833
Total OM	20.0	4435.838	5.18	0.0050	**	4.298
Total CP	20.0	29.657	6.10	0.0022	**	2.662
Total NDF	20.0	9998.526	11.70	<.0001	***	6.089
Total ADF	20.0	14556.837	18.39	<.0001	***	8.429
ME (MJ/d)	10.0	1.0062	7.31	0.0051	**	4.894

DF: error degree of freedom; DM: dry matter; MS: mean square of treatments; Pr: probability; CV: Coefficient of variance; SL: significant level; ADF: acid detergent fiber; CP: crude protein; NDF: neutral detergent fiber; OM: organic matter; ME: metabolizable energy

List of Figures in the Appendix

Appendix Fig. 1. Arrangement of lambs in the pen

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Appendix Fig. 2. Feces collection procedure/method