
Replacement of Commercial Concentrate with *Acacia nilotica* Pod Meal on Feed Intake, Digestibility and Weight Gain of Boer x Woyto-Guji Crossbred Goats

Denbela Hidosa^{1,*}, Deribe Gemiyo²

¹Livestock Research Process, Jinka Agricultural Research Center, Jinka, Ethiopia

²Livestock Research Process, Areka Agricultural Research Center, Areka, Ethiopia

Email address:

denbelahidosa@gmail.com (D. Hidosa)

*Corresponding author

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Abstract: The study was conducted to evaluate supplementation effect of graded levels of *Acacia nilotica* pod meal on feed intake, nutrient digestibility and weight gain of Boer and Woyto-Guji (50%) crossbred goats. Twenty four Boer and Woyto-Guji crosses with initial weight of 15.20 ± 0.67 kg were used for the experiment. The experimental diets comprised of T1 = 58% of graded *Acacia nilotica* pod + 40% of wheat bran; T2= 38% of *Acacia nilotica* pod + 60% of wheat bran; T3=19% of *Acacia nilotica* pod + 80% wheat bran; T4= Commercial concentrate. Wheat bran is offered as a source of energy supplements. Six goats were randomly assigned to one of the four diets in Completely Randomized Block Design (RCBD). After 15 days of acclimatization periods, feeding trial had lasted for 90 days and followed by seven days of digestibility trial. The results indicated that goats supplemented with T1 consumed higher ($P < 0.001$) total DM, CP and ME than T2 and T3. The apparent CP digestibility coefficient showed significant variations ($P < 0.001$) among experimental diets. Conversely, the nutrient digestibility coefficients indicated that goats supplemented with T1 digested more CP than T2 and T3. Likewise, goats supplemented with T1 had attained higher ($P < 0.01$) ADG than those supplemented with T2 and T3. Results indicated that strategic supplementation of goats with 58% inclusion level of *Acacia nilotica* pod in goat diets as a protein supplements is promising to replace commercial concentrate in pastoral communities in to study area.

Keywords: *Acacia nilotica* Pod, Feed Intake, Nutrient Digestibility, Weight Gain

1. Introduction

Small ruminant production have been played significant role in economies through the provision of meat, milk, household income, manure and skin in addition to contribute a larger proportion of readily available meat in the diets of pastoralists [1]. Majority of the small ruminants reared in arid and semi-arid areas of Ethiopia are kept by smallholder farmers. Small ruminants in these areas, particularly in southern Ethiopia where pastoral community dominates, are threatened by environmental factors such as erratic rainfall, intermittent droughts and diseases [1]. Such environmental factors put pressure on livelihood of pastoralists and agro-pastoralists. Natural pastures (browse) comprising 80-90% of

the ruminant feed resource [2]. However, natural pasture is usually poor in nutritional quality and is deficient in protein and energy, below the minimum nutrient requirement in ruminant animals [3]. Poor nutrition leads to undernourishment, slow growth, low body weight gain, loss of body condition and prolonged time to reach market weight [4], which reduces the benefits made from goat production in the area [2]. According to CSA [5] the annual off-take rate of indigenous goat is estimated to be 33% with accounts for 16.8% of the total meat supply [6] lower than most sub-Saharan African countries. Goats in South Omo, are phenotypically described and known as Woyto-Guji or Konso

goats and genetically identified as one of the indigenous goat breeds of the country [7]. To improve meat and milk production performances of Woyto-Guji goats by crossbreeding, Southern Agricultural Research Institute in collaboration with the Regional Bureau of Agriculture imported Boer goats from South Africa. A crossbreeding program has been carried out at Key Afer goat research station in the past five years and 50% crossbreds of Boer and Woyto-Guji were obtained. Crossbred kids need more care compared with indigenous to optimize productivity. In addition to energy requirements, protein is a critical element in animal diet. However, commercial concentrates are either expensive or not accessible to pastoral and agro-pastoral communities. While tree legume forages such as acacia species have indispensable role as protein for strategic supplementation to mitigate the problems. *Acacia nilotica* pod has been exploited as source of considerable amount of crude protein [8]. Reports are not available on most commonly known protein rich tree fodder, *Acacia nilotica*, in South Omo region, known fodder in drought prone and feed scarcity regions [9], [10]. Therefore, this study is aimed at evaluating effects of replacement of commercial concentrate with graded level of *Acacia nilotica* pod on feed intake, nutrient digestibility and weight gain of Boer x Woyto-Guji crossbred (50%) goats.

2. Materials and Methods

2.1. Description of Study Area

Bena-Tsemay Woreda is located in Southern Nations, Nationalities and People's Region (SNNPR), south Ethiopia. The district is situated between 5°01' and 5°73' North latitude & 36°38' and 37°07' East longitude. The climate of the district varies from warm to hot semi-arid with altitudinal variation ranges between 500 and 1800 meters above sea level. Rainfall in the district is bimodal, the main rain from March to May and the short rain from September to October. The ten years (2000 to 2010) mean annual rainfall in the upper part of Bena-Tsemay district was 1400 mm and the average daily temperature ranges from 15.6°C to 26.5°C. The vegetation of the district is dominated by varying densities of *Acacia* (*Acacia spp*), *Grewia* (*Vernonia amygdalina*) and *Solanum* woody species (eg, *Solanum dulcamara*) and over 35 herbaceous species of grasses and legumes [2]. Over 48% of the total land area of the district is used for grazing or browsing by cattle, sheep and goats [2].

2.2. *Acacia nilotica* Pod Collection

Acacia nilotica pod was collected from the Dizi Aman peasant association of Bena-Tsemay Woreda while wheat bran which was used as energy source was purchased from Licha-Hadiya farmers' cooperative union. After of the collected *Acacia nilotica* pods were crushed into 5cm size using electrically crushing mills and allowed to sun-drying on a concrete floor for 7 days. Drying *Acacia nilotica* pod was wilted for a couple of days to reduce ant-nutritional

factors. [11] [10]. Then the pod was separately milled using grinding mill and thoroughly mixed with wheat bran.

2.3. Feeding Management and Experimental Design

A total of twenty four intact yearling male Boer x Woyto-Guji crossbred (50%) goats were used for the experiment. All experimental goats had relatively similar age with an average body weight of 15.20 ± 0.67 kg. All goats were ear tagged and housed in individual pen made from locally available woody material. They were dewormed against internal and external diseases and parasites. After two week of acclimatization, the animals were randomly assigned to one of the four experimental diets. Then all goats had free access to pasture hay and supplemented with graded level of *Acacia nilotica* and commercial concentrates for 90 days. The experimental diet was offered twice a day (10:00 AM morning and 4:00 PM afternoon). All goats had free access to clean water. The goats were blocked into four groups, six goats per group based on their initial body weight and penned in individual cage using Randomized Complete Block Design (RCBD). The experimental diets formulation was adjusted to meet the daily protein and energy requirement of goats according to recommendation of [12]. The experimental diets were comprised of: Pasture hay + 58% of *Acacia nilotica* pod meal + 40% WB+ 2% of salt and limestone (T1), Pasture hay + 38% of *Acacia nilotica* pod meal + 60% of WB + 2% salt and 1 lime stone (T2), Pasture hay + 19% of *Acacia nilotica* pod meal + 80% of WB + 1% salt and 1% limestone (T3), pasture hay + commercial concentrate (T4) as control. During acclimatization period and experimental period, the amount offered and the corresponding refusals were recorded daily throughout the experimental period (90 days) per each experimental goat to determine daily feed intake. Representative samples of feed offered per goat per block were taken each time and was weighed pooled per goats in each block. Similarly, the refusals were taken and pooled over the experimental period per goats for determination of chemical composition of feed offered and refusals.

2.4. Digestibility Study

Fecal samples were collected from all experimental goats were harnessed with fecal collection bag for seven consecutive days for determinations of DM and nutrient digestibility. Daily fecal sample per each goat was weighed, 10% of fecal samples collected, and stored in deep freeze at -20°C until the end of the collection period and was pooled over per each goat per experimental group. Then 20% of samples pooled per group were oven dried at 65°C for 48 hours. From partially dried fecal sample, 10% was used per experimental groups for absolute dry matter determination and remaining 10% used for nutrient digestibility. The apparent digestibility co-efficient (ADC) of DM and nutrients were calculated using the equation as follows; % ADC = (Total amount of DM or nutrients in feed – Total amount of DM or nutrients in feces X 100)/Total amount of DM or nutrients in feed. The digestible organic matter

contents were estimated by multiplying the OM content of experimental treatment by its digestibility coefficient. The estimated metabolizable energy intake (ME) of goats from treatment feeds was calculated using the formula: ME (MJ/Kg DM) = 0.016 X DOMD, Where DOMD = digestible organic matter per kilogram dry matter [13].

2.5. Laboratory Analysis

Samples of partially dried feed offered, refusals and fecal samples were grounded by using a Willey Mill UK to pass through a 1 mm sieve size. DM, OM, CP and ash were analyzed according to procedures of [14]. The NDF and ADF were analyzed procedures of [15].

2.6. Statistical Analysis

Data on DM and nutrient intake, body weight gain and nutrient digestibility were subjected analyzed of variances (ANOVA) followed by General Linear Model (PROC GLM) procedure of SAS version 9.3 [16]. Experimental diets were considered as fixed effects while block considered as random effect. Differences between treatments means were separated using Duncan's multiple range tests. The statistical model was:

$$Y_{ijk} = \mu + A_i + B_{ij} + e_{ik}$$

where; Y_{ijk} = individual values of the independent variables; μ = Overall mean of response variables; A_i = effect of treatment diets, B_{ij} = effect of block factor and e_{ik} = Random errors.

3. Result

3.1. Chemical Composition of Experimental Diets and Refusals

The chemical composition of feed offered and refusals is presented in Table 1 and 2. *Acacia nilotica* pod had higher ash and CP content but lower neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents than wheat bran. The pasture hay used as basal diet in this study had lower crude protein (CP) and higher fibers and ash contents than *Acacia nilotica* pod and wheat bran. Feed refusals had higher NDF

and ADF contents but lower CP contents compared with offered diets.

Table 1. Chemical Composition of Feed ingredients and Experimental diets offered in DM basis.

Experimental diets	Chemical composition					
	DM%	Ash	OM	CP	NDF	ADF
<i>Acacia nilotica</i> pod	91.4	6.80	93.20	16.55	30.25	15.78
Wheat bran	96.71	4.00	96.00	15.97	48.56	22.55
Pasture hay	90.60	10.50	90.50	6.80	65.22	45.38
T1	90.60	8.25	91.75	16.00	38.82	18.89
T2	94.25	8.49	93.71	15.98	45.85	21.83
T3	93.58	10.35	90.65	15.92	53.58	27.03
T4	92.23	8.68	91.38	16.80	45.38	18.08

DM= dry matter; OM = organic matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

Table 2. Chemical composition (%) of experimental feed refused on DM basis.

Experimental diets	Chemical composition (%)					
	DM	Ash	OM	CP	NDF	ADF
T1	92.73	6.38	93.62	14.20	43.32	24.68
T2	90.83	7.45	93.55	13.45	55.15	27.85
T3	94.53	8.83	91.27	12.43	62.48	30.84
T4	91.43	6.58	93.42	18.20	50.68	38.05
Pasture hay	92.24	8.52	91.48	2.82	75.60	50.88

DM= Dry matter percentage; OM = Organic matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber

3.2. Dry Matter and Nutrients Intake

The results obtained for dry matter (DM) and organic matter (OM) intake showed that there was significant difference ($P < 0.001$) among the experimental diets (Table 3). Goats supplemented with T1 consumed significantly higher ($P < 0.001$) DM, ME and OM than those supplemented with T2, T3 and T4. However, goats supplemented with T3 consumed relatively lower DM and OM than goats supplemented with T1, T2 and T4 diets. The CP and ME (MJ/kg, DM) intake obtained from the current study showed that the experimental goats supplemented with T1 consumed significantly higher ($P < 0.001$) CP and ME than those supplemented with T2, T3 and T4.

Table 3. Dry matter and nutrients intake (g/day) of Boer x Woyto-Guji goat crosses fed on a basal diet of pasture hay and supplemented with graded level of *Acacia nilotica* pod meal.

Intake(g /day)	Experimental treatments				SEM	Sign. level
	T1	T2	T3	T4		
Dry matter intake						
Supplements	446.11 ^B	465.29 ^A	425.45 ^C	478.38 ^A	9.69	***
Pasture hay	375.98 ^A	316.56 ^B	329.33 ^B	280.30 ^C	12.61	***
Total DM intake	822.09 ^A	781.85 ^B	754.79 ^C	758.68 ^B	13.56	***
OM intake						
Supplements	451.77 ^B	462.67 ^{AB}	412.13 ^C	473.97 ^A	9.64	***
Pasture hay	375.56 ^A	316.21 ^B	328.97 ^B	279.99 ^C	12.06	***
Total intake	827.34 ^A	778.89 ^B	741.10 ^C	753.96 ^{BC}	13.53	***
CP intake						
Supplements	71.38 ^C	74.35 ^B	67.73 ^D	87.07 ^A	3.87	***
Pasture hay	25.57 ^A	21.53 ^B	22.39 ^B	19.06 ^C	3.32	***
Total intake	106.13 ^A	95.88 ^B	90.13 ^C	96.94 ^B	4.35	***
ME intake (MJ/day)	9.64 ^A	6.24 ^B	4.45 ^C	8.09 ^A	2.60	***

Intake(g /day)	Experimental treatments				SEM	Sign. level
	T1	T2	T3	T4		
NDF intake(g/day)						
Supplements	173.18 ^C	213.34 ^B	227.96 ^A	217.09 ^B	6.63	***
Pasture hay	245.21 ^A	206.46 ^B	214.79 ^B	182.81 ^C	10.23	***
Total intake	418.39 ^B	419.79 ^B	442.75 ^A	399.89 ^C	10.63	***
ADF intake (g/day)						
Supplements	115.27 ^C	101.57 ^B	84.27 ^A	86.49 ^C	4.58	***
Pasture hay	127.62 ^A	143.66 ^B	170.20 ^C	127.20 ^C	8.25	***
Total intake	242.20 ^B	245.23 ^B	254.89 ^A	213.69 ^C	8.43	***

Mean values in a row having different superscripts differ significantly each other; ***= $P < 0.001$; SEM= Standard error of mean; NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

3.3. Dry Matter and Nutrient Digestibility

The DM and nutrient digestibility coefficient (% DM) of Boer and Woyto-Guji crossbred goats fed on a basal diet of pasture hay and supplemented with graded level of *Acacia nilotica* pod meal was presented in Table 4. The DM and OM digestibility

were higher ($P < 0.001$) for those goats supplemented with T1 than those supplemented with T2 and T3 while similar ($P > 0.001$) to those goats supplemented with T4. Similarly, also for those goats supplemented with T1 had digested higher ($P < 0.001$) CP than those supplemented with T2 and T3 but it was lower than those goats supplemented with T4.

Table 4. Dry matter and nutrient apparent digestibility coefficient (% DM) of Boer and Woyto-Guji crossbred goats fed on a basal diet of pasture hay and supplemented with graded level of *Acacia nilotica* pod meal.

Apparent digestibility (%)	Experimental treatments				SEM	Sign level
	T1	T2	T3	T4		
Dry matter	66.73 ^A	52.21 ^B	45.02 ^B	69.89 ^A	3.87	***
Organic matter	69.02 ^A	52.29 ^B	42.11 ^C	69.96 ^A	3.24	***
Crude protein	78.44 ^B	67.67 ^C	61.73 ^D	83.06 ^A	2.67	***
NDF	54.55 ^A	50.00 ^C	48.10 ^D	56.12 ^A	0.99	***
ADF	47.50 ^A	42.00 ^B	38.20 ^C	47.78 ^A	1.25	***

Mean values in a row having different superscripts differ significantly to each other; ***= $P < 0.001$; SEM= Standard error of mean; NDF = Neutral detergent fiber; ADF = Acid detergent fiber

3.4. Body Weight Change and Nutrient Conversion Efficiency

The final body weight change, daily weight gain and feed conversion efficiency of Boer and Woyto-Guji crossbred goats fed on a basal diet of pasture hay and supplemented with graded level of *Acacia nilotica* pod meal was presented in Table 5. Those goats supplemented with T1 had higher ($P < 0.01$) ADG than those fed on T2 and T3 but similar ($P > 0.01$) to those goats fed on T4. However, those goats supplemented with T2 and T3 had attained similar ($P > 0.01$) ADG.

Table 5. Body weight change, average daily gain and feed conversion efficiency of Boer X Woyto-Guji crosses fed a basal diet of pasture hay and supplemented with graded level of *Acacia nilotica* pod meal.

Growth indices	Experimental treatments				SEM	Sign. level
	T1	T2	T3	T4		
Initial body weight (kg)	16.50 ^A	15.25 ^B	15.25 ^B	14.75 ^B	0.67	***
Final body weight (kg)	21.96 ^A	19.25 ^B	17.25 ^C	20.25 ^{AB}	1.47	***
Body weight change (kg)	5.46 ^A	4.00 ^B	3.75 ^B	6.25 ^A	1.27	*
Average daily gain (g/day)	60.65 ^A	44.44 ^B	41.67 ^B	69.44 ^A	3.65	**
FCE (ADG/Total DM Intake)	0.07 ^A	0.06 ^B	0.05 ^B	0.09 ^A	0.02	**

Mean values in a row having different superscripts differ significantly each other; ***= $P < 0.001$; **= $P < 0.01$; * = $P < 0.05$; FCE = Feed conversion efficiency; SEM = Standard error of mean

4. Discussions

4.1. Chemical Compositions

The CP content for *Acacia nilotica* pod obtained from the current study is comparable to value reported by [8]. CP content of *Acacia nilotica* pod is higher than the minimum values that required by rumen microbes and their host animal for maintenance requirement. [15] [17]. The high fiber

Contents in the refusals than the offered feed demonstrated

that goats had better ability of select more cell content than cell wall in order to attenuate their energy requirements. According to the report of [18] goats have a selective behavior to specific protein content of the diet which supports the current study.

4.2. DM and Nutrient Intake

The higher DM and OM intake for those goats supplemented with T1 is due to mainly the experimental diet

they supplemented had relatively lower NDF contents than the T2, T3 and T4. Generally, the total DM intake obtained from the current study had demonstrated that inclusion level of *Acacia nilotica* pod in the experimental diets increasing from 19% to 58%, the total DM intake was linearly improved which corresponds to what [8] reported which had demonstrated that when inclusion level of *Acacia nilotica* pod increased from 25% to 50%, the total DM intake of Red Sokoto goats increased and then decreased as inclusion level of *Acacia nilotica* pod in diets increase from 50% to 100%. Moreover, the current result is comparable with reports of [19] that showed an increased the total DM intake by the experimental goats with an increase in the amount of *A. tortilis* pods in the ration up to 75% and then declined as increasing inclusion rate in diets. The decreased in total DM intake by the goats as increase inclusion level of *Acacia nilotica* in the diet might be due to the anti-nutritional factors found in *Acacia* species. [20] had stated that if the amount of condensed tannin contents in diets up to 5.5% is tends to stimulate the secretion of saliva and increase appetite of animal which encourage consuming more dry matter in the beginning and falls afterwards if the contents is above 5.5% in diets. The higher CP and ME for those goats supplemented with T1 is due to higher total DM intake. Those goats supplemented with T3 had lower CP than those goats supplemented with T1, T2 and T4. This might be attributed due to the lower intake of supplementary diets and higher intake of basal diet. Generally, the total CP intakes obtained from this study were within values ranging from 80 - 90 g/day recommended by [21] for goats weighing 15 kg in order to attain 50g/day of body weight gain under tropical conditions. However, it was higher than values which ranging from 65–70 g/day suggested by [11] for goats weighing 20–25 kg under tropical condition. The ME intake in this study is within range of recommendation for goats supplemented with different levels of acacia pod for growing yearly goats under tropical condition [12].

4.3. Digestibility

Goats that supplemented with T1 and T4 is higher in digestibility of DM and OM is due to lower intake of ADF contents from the diets. [11] had stated that feed that had more ADF contents had been impaired the digestibility nutrient which is supports findings obtained from the currents study. The DM digestibility for goats supplemented with T1 is lower than value of 55.5% [8] for Sokoto goats fed on a basal diet of sun dried sweet potato vine and supplemented with 50% *Acacia nilotica* pod. The other inconsistency to reports of [8] is also might be related to breed and age difference other than level of feeding [10]. Moreover, for CP digestibility, those goats supplemented with T1 had higher than those fed on T2 and T3 but lower than those fed on T4. This is due to higher total DM intake which donated higher CP contents in to rumen microbes and hence higher digestibility of CP. The CP digestibility value obtained from current study was higher than values of 52% and 56.20% reported by [8] and [20] for Sokoto goats supplemented with

50% of *Acacia nilotica* pod and desert sheep supplemented with *Acacia Seyal pod* respectively.

4.4. Body Weight Change and Nutrient Conversion Efficiency

The higher ADG (g/day) for T1 than T2 and T3 is due to higher total DM and ME intake and digestibility. The [17] report had demonstrated that feed with higher crude protein content could promote higher microbial populations and growth thereby facilitation of rumen fermentation and better digestibility. The ADG (g/day) had obtained from the current study for goats supplemented with T1 were comparable with reports of [8] and [10] for Sokoto goats supplemented meals had 50% of *Acacia nilotica* pod and Tigray highland sheep fed on hay based feed as basal diet and supplemented with 75% *Acacia Seyal pod* respectively. Furthermore, the similarity in ADG between goats supplemented with T2 and T3 is due to ability of goats similarly digested total DM. The ADG found for goats supplemented with T2 and T3 from the current study was relatively comparable to previous reported value of 42.67g/day by [8] for Sokoto goats supplemented meals had 75% of *Acacia nilotica* pod inclusion rate.

5. Conclusions and Recommendations

The results had obtained from the current study indicated that goats fed on a basal diet of pasture hay and supplemented with diet inclusion level of 58% *Acacia nilotica* pod had attained higher feed intake, nutrient digestibility and ADG performances. Hence, it was concluded that 58% inclusion of *Acacia nilotica* pod meal as cheapest and accessible protein supplements could be a promising options to replace commercial concentrate in pastoral and agro-pastoral goat production system where commercial concentrates are not available to the area.

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