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Evaluation of Forage Legumes on Feed Intake, Growth Performance and Economic Feasibility of Borana Bucks Supplemented Natural Grass Hay as Basal Diet

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Abstract: The current experiment was performed using twenty (20) Borana bucks with 17.12 kg initial live body weight at on-station of Yabello Research Center. The aim of this experiment was to conduct the live weight change, nutrient and dry matter intake within economic viability of Borana bucks feed Lablab purpureus, Cowpea (Vigna unguiculata) and their mixture fed a basal diet of natural grass hay. Experiment consist seventeen (70) days feeding trial excluding two weeks of adaptation period to treatment diet. Experimental animals grouped into four blocks of five animals in each block to their respective treatment diet according to their body weight. Treatments diet arranged as T1 (400gm Cowpea+ ad-lib Natural grass hay), T2 (300gm Lablab + ad-lib Natural grass hay), T3 (267gm Cow pea+100gm lablab + ad-lib Natural grass hay) and T4 (100gm Cow pea+225gm lablab + ad-lib Natural grass hay). All Experimental bucks had free access to hay. Daily feed intake was measured and live body weight changes of experimental bucks were taken ten by ten days interval. The basal diet intakes of experimental bucks were higher in T2, T4 T3 and T1 accordingly. Experimental bucks had significantly affected by treatments and nutrient composition. Therefore, experimental bucks under T2 had higher (69.6g/d) than T4 (64g/d), T3 (53.22g/day) and T1 (51.79 g/day) respectively. Besides to this T1 (0.09) and T3 (0.08) shows lowest feed conversion efficiency and highest feed conversion ratio as compared to the other treatments. Treatment T2 (0.09) and T4 (0.08) shows highest feed conversion efficiency and lowest feed conversion ratio as compared to the other treatments According to the current finding total dry matter intake based up on percent body weight (%BW) and dry matter intake based on metabolic body weight (g/kg$W^{0.75}$) indicate significance difference in the treatments groups.. T1 has highest total variable cost in the current study followed by experimental animals in T4, T2 and T3 respectively. Bucks under T2 with T4 had indicates more profitable marginal rate of return more than T1 and T3. So, providing additional feed through preserving/growing forage during rainy season especially at lowland area is crucial. Therefore, the current study indicate that supplementation of forage legumes during dry season is biologically acceptable and economically tangible especially an area where feed shortage is critically scarce.

Keywords: Cow Pea, Lablab Purpureus, Marginal Rate Return, Viable

1. Introduction

Quantity and quality of feed resource during feed shortage especially at the time of the dry season is one of the most critical problems of livestock production constraints. Because, the availability of feed resource depends on the quantity and distribution of the rain fall and seasonality of plant growth is a reflection of the rain fall distribution [3]. Most of the goats and sheep in rural areas of depend on available low quality roughages during winter and dry months. These low quality roughages are limiting in a number of nutrients, for example proteins, vitamins, etc., thus, they are characterized by low intake and digestibility values when eaten alone by ruminant animals [20]. Low productivity is the end result of using low quality roughages as feed and any means of improving their feeding value is potentially valuable.

The most livestock abundant feed resources in Ethiopia are natural grass (grazing land) and crop residue. CSA [7] reported on livestock feed usage and experience by small holders indicates, grass land is the major type of feed resources (56.33%) followed by crop residue (30.06%). The use of leguminous forage crops such as *Lablab purpureus* capable of yielding quality herbage is urgently required. Some earlier studies [4, 22, 2] demonstrated that, supplementation of forage legumes to grass or crop residue based diets of ruminant increases the weight and productivity of the animals. Lablab is a dual-purpose legume crop that has high seed and forage yield as well as good hay curing ability [1] and it is a source of major minerals, which are likely to be deficient in the dry season fodder residues [13]. Lablab is a fast growing legume and grazing or cutting can start at 7-10 weeks after sowing. It has been well accepted in food security and soil and water conservation programs.

As herbaceous forage legume, *Lablab purpureus* forage has an average protein content of about 18% of DM, which varies from 13 to 24% depending on local conditions and stage of harvest [16]. Cowpea also a drought-tolerant crop with a higher protein content and lower soil fertility requirements than many other crops. Cowpea forages have been looked at as possible alternative sources of protein and energy for livestock during winter and dry seasons [14].

Therefore, the use of Cowpea and lablab nutritional value for protein source on animal responses has not been investigated in lowland of Borana zone. Therefore, it is significant to capture the nutritional value of this forage on growing condition of animals. So, this feed experiment was intended to supplementing Lablab purpureus, Cowpea (Vigna unguiculata) and their mixture supplementation, natural pasture hay as basal diet on performance of bucks with the following specific objectives.

1) To evaluate supplementation of lablab (*Lablab purpureus-11614*), Cowpea (*Vigna unguiculata-9333)* and their mixture on live weight change and feed utilization of yearling Borana bucks.
2) To estimate the cost-effective supplementation of forage legumes on yearling Borana bucks.

2. Materials and Methods

2.1. Description of Study Area

Yabello located 1350-1800m above sea level and located between latitude of 4°30’55.81″and 5°24’36.39″N and longitude 7°44’14.70″and 38°36’05.35″E. [6]

2.2. Experimental Feed Preparation

2.2.1. Natural Grass Hay Harvesting and Storage

Natural pasture grass hay was collected and Preserved on-station of small ruminant. Hay was harvested at the maturity stage of flowering plants. Harvested natural grass was sun dried for about 2 to 3 days and dry under shade to preserve its chemical composition. During feeding preserved hay was chopped to the size of 5-10cm. Hay was weighed, and offered to animals during the experimental period.

2.2.2. Cowpea and Lablab Hay

Improved forage *Lablab purpureus and cowpea* were cultivated on about 1.5 hectare of land at Yabello Research center at livestock farm site during main rain season. During sowing, all recommended agronomic practices of forage was followed. Both forage were planted at a distance of 40 cm among forage and 50 cm among within rows. The cultivated forage Legumes was harvested at flowering stage to maintain its quality.

2.3. Experimental Design

Experimental animals were grouped according to their initial live body weight. Based on this four blocks with five animals in each block were allocated. Experimental animals were allocated to the four experimental treatment randomly distributed to each buck in the block. Supplementary treatments (T1-T4) were based on Iso-nitogeneous to achieve estimated body weight gain recommended by [19].

Experimental layout as followed;

T1: Cowpea 400gm + *ad-lib* natural grass hay.
T2: Lablab 300+ *ad-lib* natural grass hay.
T3: Cow pea 267 gm +100gm lablab+ *ad-lib* natural grass.
T4: Cow pea 100gm +225gm lablab+ *ad-lib* natural grass.

2.4. Feeding Trail

2.4.1. Bucks and Their Management

Twenty (20) yearling male Borana bucks weighing 17.12 kg initial live body weight experimental animals were purchased from Yabello districts of haro bake and Elwoye. During purchasing age of experimental bucks were taken based on the dentition of bucks. All bucks were quarantined for 10 days before allocating them to the different experimental treatments. During this period, the bucks were closely observed for any health problems. All bucks were ear tagged, de-wormed and sprayed before the actual beginning of the experiments. Pen cleaning was done every morning before watering and feeding.

Figure 1. *Individual feed trough of experimental animals.*

2.4.2. Feeding Management

The experimental bucks were allowed to have water and mineral salt until the end of experimental period. the amount of experimental diet provided to the experimental animals during the morning and evening. The amount of feed offered

and intake was measured to know the amount of feed refused during the experimental period. Total dry matter intake was calculated through the experimental period of each experimental animals calculated as follow.

Total DM intake (percent body weight) =DM intake (gm) x100/Body weight (kg)

Total DM intake (metabolic body weight (g/kgW$^{0.75}$) =DMIntake (gm) x100/BW$^{0.75}$ (kg)

Figure 2. *Feed storage for experimental animals.*

2.4.3. Body Weight Change and Feed Conversion Efficiency

Experimental bucks were weighed during the actual feeding experiment was started. During the experimental period the growth change of experimental bucks was measured within ten days interval to know the change of experimental bucks. Weight gain of experimental animals and their feed consuming potential of each buck were calculated based on the equation [10].

$$\text{Change in daily gain} = \frac{\text{final weight} - \text{Initial weigh}}{\text{Number of feeding days}}$$

FCE=Weight gain (gm)/day/DM intake (gm)/day.

2.5. Chemical Analysis

Chemical analysis of the experimental feeds was conducted at Holeta National Animal Nutrition Laboratory. Samples of feeds offered and refusals were collected, dried in an oven at 65°C for 72 hours and ground to pass through 1 mm sieve screen size. The ground samples were kept in air-tight plastic bags and pending for chemical analysis. Dry matter (DM), Nitrogen content (N), Organic Matter (OM) and Ash were analyzed according to [26] (2005) procedure. CP was estimated by multiplying N value by a factor of 6.25 as N*6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the procedures of [25].

Figure 3. *Feed preparation for chemical analysis at Yabello laboratory.*

2.6. Eonomic Analysis

Economic analysis was calculated basing on [24], to evaluate the advantages of fed experimental animals. All variable cost of experiment animals were captured to determine its economic viability. Cost of natural grass hay was estimated based on the selling price of grass hay practiced by agro-pastoralists around the study area. Price for *Lablab purpureus* and Cowpea was estimated by considering the biomass production of forage to the cost of natural grass hay estimated the area per hectare of land. Purchasing price of bucks were determined by weighing balance based their body weight and the selling prices of bucks also determined by weighing balance based on body weight. The variation of price of purchasing and selling of bucks considered as total return. The following formulas were used to evaluate economic viability of experimental feed.

$$NI=TR-TVC$$

$$\Delta NI=TR-TVC$$

$$\Delta MRR\ (\%) = \Delta NI / \Delta TVC*100$$

where MRR= Marginal rate of return
NI= net income
TVC= Total variable cost
TR= Total return

2.7. Statistical Analysis

Intake of feed and live body weight of experimental animals analyzed by using ANOVA by general linear model (GLM) procedure was used [21]. Significance differences among the treatment, means were separated by using the least square difference (LSD).

The model fitted for this study was:

$$Yij= \mu + Ti + Bj + Eij,$$

Where; Yij= responses variable
μ= overall mean of effect
Ti= treatment effect
Bj=block effect
Eij=random error

3. Results and Discussions

3.1. Chemical Composition of Experimental Feeds

Chemical Composition of experimental diet used in these experiments are given in table 1**.** Basal feed consist of 91.51, and6.8% of dry matter and crude protein DM basis respectively. The basal diet of the current result dry matter content of basal diet was similar with the result reported by

[8] which was 90.0% and 90.85% respectively. 6.8%CP content of basal diet. therefore, basal feed does not meet the daily nutrient requirement of animals for their physiological function which indicates the crude protein content not fulfill the need of rumen micro-organisms. Because basal diet having a less than 7%crude protein cannot meet acceptability of ruminal microbial activity and maintenance requirement of the host animals. The crude protein content of basal diet in the current study based on the chemical composition higher than the crude protein content of 5.6% and 4.2% reported by [9] and [15] respectively. The result of this variation may be based on soil type plants/forages types and preservation method. Therefore, the current experiment agree with result of [12] reported that plant maturity increases the nutritive value decreases.

ADF and NDF contents of basal diets were 37.57, and 41.01 of dry matter basis respectively. The fiber (NDF) content of basal diet in this finding was less than the value of [15, 11] reported that 76.75% and 75.68%of natural grass hay. Acid detergent fiber of the current results (37.57%) value was less than (51%) reported by [17]. Additionally, the composition of basal diet used in this experiment was low content of crude protein and medium fiber content.

Cowpea and Lablab contain 18.24 and 24%on dry matter basis (DM%) the current study. Cowpea contain 91.77% and 18.24%, DM and C on dry mater (DM%) basis respectively. Lablab purpureus in the current study contain 17.4% crude protein.

Table 1. *Chemical composition of experimental feed for experimental animals.*

Type of feed	Nutrient (DM% basis)					
Forages	**DM**	**Ash**	**CP**	**NDF**	**ADF**	**ADL**
hay	91.51	9.50	6.8	41.01	37.57	6.31
Cowpea	91.77	11.07	18.24	22.90	20.63	6.42
Lablab purpureus	91.96	9.53	24	44.53	24.53	4.86

DM= dry matter, CP= crude protein, NDF= neutral detergent fiber, ADF= Acid detergent fiber, ADL= acid detergent lignin.

3.2. Nutrient Intake of Experimental Animals

Dry matter and nutrient intake of experimental animals supplement Lablab purpureus, Cowpea and their mixture is presented in table 2. Experimental animals under treatment Lablab 300+ ad-lib natural grass hay and Cow pea 100gm +225gm lablab+ ad-lib natural grass indicate no significance difference (P>0.05) on hay intake. However, the significance intake of basal diet in T2 andT4 as compared to treatment T1 and T3 might be associated palatability of supplemented diet. In the present study the range of basal diet intake was (335-389g/d). Significant differences was observed in total dry matter intake among the experimental animals which ranges (735-789g) which agree the values 575-844.16g reported by [27] for Borana bucks fed graded level of Vernonia amygdalina leaves. Experimental animal in T2 supplemented with 300g/day lablab purpureus consumed more nutrient and dry matter as compared to experimental animals under treatment T1 and T3.

Table 2. *Dry matter and nutrient intake of experimental animals supplemented forage legumes.*

Feed intake (g/day)	Treatments				
	T1	**T2**	**T3**	**T4**	**SL**
Daily feed intake (g/day)					
Hay intake (g/day)	335.00^{c}	489.00^{a}	394.20^{b}	446.40^{a}	**
Lablab purpurues (g/day)	0.00^{d}	300^{a}	100^{c}	225^{b}	***
Cowpea (g/day)	400^{a}	0^{d}	267^{b}	100^{c}	**
Forage mixture (g/day)	0^{b}	0^{b}	367^{a}	325^{a}	**
Total feed (DM) intake	735.00^{c}	789^{a}	661.20^{b}	771.40^{ab}	**
DM intake (% BW basis)	3.5^{b}	3.59^{a}	3.63^{a}	3.55^{ab}	**
Dry Matter intake (g/kgW$^{0.75}$)	74.58^{a}	77.67^{a}	77.59^{a}	70.29^{b}	**
Nutrient intake (g/day)					
Acid detergent fiber	208.15^{d}	242.65^{a}	220.82^{b}	244.27^{a}	**
Neutral detergent fiber	230.57^{d}	337.49^{a}	261.27^{c}	317.69^{b}	***
Crude protein	94.45^{d}	118.78^{a}	99.56^{c}	114.26^{b}	***
Ash	64.08^{c}	81.03^{a}	76.24^{b}	74.86^{b}	**
Organic Matter	640.45^{b}	692^{a}	683.06^{a}	685.95^{a}	**
Acid detergent lignin	25.68^{a}	19.44^{d}	24.12^{c}	21^{c}	**

^{a,b,c,d} means within a row with different superscripts differ significantly **=(p<0.05), ***=p(0.001), T1-T4=treatment, BW= body weight, DM=dry matter.

According to the current finding total dry matter intake based up on (%BW) and (g/kgW$^{0.75}$) indicate significance difference in the treatments groups. Daily DM intake of current study based on the percent body weight based on percent body weight (3.5-3.63%BW) of experimental animals higher than range of 2.6-3.2 reported for small east African goats and their crosses with Norwegian goat fed hay and supplemented with concentrate. However, the current study was higher than the 2.3-2.6% finding of goats fed untreated wheat straw and concentrate mixture [18]. DM intake based on per unit metabolic BW (70-77 g/kg) basis of the current study was higher than the

finding of [23] stated that66.45-70.14 g/kg for Borana bucks.

Experimental animals fed Cowpea treatment in T1 had less nutrient of ADF as compared to other treatment groups fed the lablab purpureus. This may be due to less chemical composition of Cowpea and less intake of basal diet as compared to others. More CP intake observed in lablab (300g) (118 g/d) fed) followed by T4 (114.26g/day) fed 225g of lablab with 100g of cowpea. Experimental animals under treatment T2 and T4 had higher intake of crude protein this might be due to higher intake of basal diet intake and the lower CP intake from bucks in T1 and T3 due to low intake of basal diet. However, based on these reports it can be concluded that, CP intake in the current study (94.45-118 g/d) in all experimental animals are vital/enough for both maintenance and growth.

3.3. Live Weight Performance of Experimental Animals

Growth condition of experimental animals fed on supplemented *Lablab purpureus, cowpea* and their mixture is presented in table 3. Significance variation was observed based on total weight gain, final body weight gain and average daily weight of experimental animals according to the current study. The highest final live body weight gain ($P<0.05$) were captured on experimental animals under treatment (T2) buck (22 kg) feed 300g of lablab followed bucks in T4 (21.65 kg) feed 225g of lablab and 100g of Cow pea. However, buck in T1 and T3 had result similar final body weight of 20.75 and 21kg, respectively. The highest ADG was captured in T2 and T4 than those bucks in T1 and T3. Therefore, bucks in T2 had higher ADG (69.6 g) relative to those bucks in T1 having ADG of 51.79g. Non-significancedifference between experimental animals in T1 and T3 as well asT2 and T4 in average daily weight gain.

Table 3. *Live weight performance of experimental animals supplemented Cowpea, Lablab purpurues and natural grass hay as basal diet.*

parameters	Treatment				
	T1	T2	T3	T4	SEM
Initial live body weight gain (kg)	17.13	17.12	17.28	17.15	0.04
Final live body weight gain (kg)	20.75^{b}	22^{a}	21.00^{b}	21.65^{a}	0.14
Total weight gain (kg)	3.62^{b}	4.9^{a}	3.72^{b}	4.5^{a}	0.15
Average daily weight gain (g/day)	51.79^{b}	69.6^{a}	53.22^{b}	64.00^{a}	2.20
Feed conversion efficiency	13.59^{ab}	11.28^{b}	14.42^{a}	11.9^{bc}	0.44
Feed conversion ratio	0.08^{bc}	0.09^{a}	0.07^{c}	0.08^{ab}	0.002

$^{a.b.c}$ means within row with different superscript differ significantly, T1-T4= treatments, sem=standard error of the mean.

Weight change of experimental animals (FBW and ADG) of bucks in treatment T1, T3 comparing with T2 and T4 might be related to the digestibility of crude protein in lablab purpureus supplementation. Generally supplementation of experimental animals in all treatment indicates positive responses in average daily weight gain.

Significant difference was observed among the experimental bucks regarding with their FCE and FCR. There, higher value was obtained by bucks in T2 (0.09) and T4 (0.08) followed by T3 (0.07). As it is reported by [5] animals that have a high feed conversion efficiency and low feed conversion ratio are considered as efficient users of feed and those with high feed conversion and low feed conversion efficiency are considered as inefficient users. From the current study, bucks supplemented under in T2 and T4 was more efficient in their fed uses but experimental animals under treatment T1 and T3 shows lower feed utilization efficiency. However, body weight change (kg) during the experimental period indicates that, live weight change of experimental animals was positively changed. From the current finding all experimental diets, positively increased body weight change (FLBW, ADWG and total weight gain) experimental animals supplemented to local bucks fed on poor quality of basal diet.

3.4. Economic Analysis

Cost analysis of current experimental was presented table 4. The result of economic analysis is to recommend best treatment with best body weight change with low cost and high net of return of the experimental animals.

Table 4. *Partial budget analysis of experimental animals feed with lablab purpureus and Cowpea and their mixture.*

Items	T1	T2	T3	T4
Purchased (ETB)	618.00	618.00	618.00	618.00
Number of Animals	5	5	5	5
Total Basal Diet Intakes per goat	90.65	108.79	100.52	103.39
Total Consumed cowpea (kg)	112		84	28
Total Consumed lablab (kg)	0	112	28	84
Total Cost of Basal Diet (ETB)	60.00	70.00	65.00	67.00
Total cost of Cowpea hay (ETB)	140.00	0.00	105.00	35.00
Total cost of lablab (ETB)		140.00	35.00	105.00
cost of other Inputs (ETB)	10	4	8	8
Labor Cost Per Animals (ETB)	37.5	37.5	37.5	37.5
Total Variable Cost	187.50	181.50	185.50	185.50
Selling Price of Goat (ETB)	830	880	840	866
Total Return (ETB)	211.88	261.88	221.88	247.88
net return	24.38	80.38	36.38	62.38
Change in net return	-	56.00	12.00	38.00
Change total in variable cost	-	6.00	2.00	2.00
Marginal rate return (%)	-	9.33	6.00	19.00

T1 has highest total variable cost in the current study followed by experimental animals in T4, T2 and T3 respectively. The feed cost (variable) incurred for buck in all treatment is equal without addition of basal diet. The highest TVC of bucks in T1 could be possibly resulted due to the cost of other inputs. The selling price of bucks in the present study was higher for bucks in T2 and T4 relative to bucks in the rest treatment groups. This difference was most

probably resulted due to the higher final body weight of bucks in these treatment groups as the result of total dry mater intake and better fed conversion efficiency. Experimental animals in T2 (80.38ETB/bucks) supplemented with 300g lablab provided moderate net return whereas experimental animalsT1 (24.38) the lowest. The change in rate return and marginal rate of shows that per one ETB invested to purchase to produce to attain required body weight by could return 56, 12, and 38 for T2-T4. Experimental animals fed on 300g of lablab and 225g lablab +100g cow pea captured moderate benefit compared to the rest treatment.

4. Conclusion

Experiment was performed to investigate the advantages of fed of supplementation on live weight change, feed intake and economic advantages of Borana goats supplemented forage legumes species. Twenty intact male Borana goats 17.12 kg live weight were used during the actual commencement of the experiment under four treatments with five experimental animals in each block. Each block was assigned according to their initial live weight based on this the experimental animals randomly allocated to each diet. These were T1= (400gm cow pea) +hay adlibitum, T2=300gm lablab + hay adlibitum, T3= (267 gm cow pea + 100gm lablab) + hay adlibitum, and T4= (225gm lablab+100 cow pea) + hay adlibitum. All experimental animals get access to mineral and water once a day freely. Before the commencement of experiment, experimental animals adapted to their feed type for two weeks. Significance variation was observed on dry matter intakes of experimental animals (723.75, 788.75, 759and 769g/day among the treatment group.

No significant differences between the experimental diets were captured in their growth performance under T2 and T4 as well as T1 and T3. However, experimental animals under treatment T2 get high body weight gain and better net return as compared to the rest treatments. T4 had also good daily weight gain (64g/d), 56 changes in net return and net return 80 ETB). Treatment four (T4) had good daily body weight change (64/day), net return (62), 38 changes in net return.

From the present experiments, providing of additional feed resources based on the daily nutrient requirement of animals like Cowpea and Lablab indicated good biological parameters in growing goats, and it reduce cost of production (feed cost) and increase profitability. Generally, supplementation of this different legumes forage had positive effect. Supplementation of T2 and T4 indicates moderate growth performance as compared to goats supplemented Cowpea.

5. Recommendation

Based on their body weight change and economic feasibility of experimental, Goat producers and fatteners can use any treatment option. However, according biological and economic priority, treatment two (T2) 300g of lablab supplementation indicated high body weight change (4.9kg) followed treatment four (T4) 225g lablab + 100g cow pea (4.5kg), treatment three (T3) 267g cow pea +100g lablab (3.73kg) and treatment one (T1)(3.63kg) respectively.

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