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Effects of Supplementation with Cajanus Cajan, Lablab Purpureus and Cowpea on Feed Intake, Growth and Carcass Characteristics of Male Black Head Sheep Fed a Basal Diet of Rhodes Grass

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Abstract: An experiment was carried out using twenty eight male black head sheep with an average initial body weight 19.91±0.2 kg (mean±SEM) at Yabello Pastoral and Dryland Agriculture Research Center with the objective to investigate the effect of supplementation with Pigeon pea, Cowpea and Lablab on feed intake, body weight change and carcass parameters of black head sheep. The experiment was performed for one hundred five (105) days including with adaptation period of fifteen (15) days. A randomized complete block design (RCBD) was used. Four blocks of seven animals based on their initial body weight and the four treatments were randomly assigned to each animal in a block. The experiment layout consist of adlibitum feeding of Rhodes grass hay plus 200 g dry matter (DM) of wheat bran for all groups and additional supplementation forage legumes with 312, 340 and 352g DM per head per day of T2, T3 and T4 provided respectively. Rhodes grass hay intake was significantly different ($P<0.001$) between forage supplemented and control experiment. Sheep in the control consumed more dry matter of Rhodes grass hay as compared to the legume supplemented groups. There were significant differences ($P<0.001$) in total dry matter, crude protein, Ash, Organic matter and fiber intakes between the control (T1) and forage legumes supplemented animals (T2, T3 and T4). Highest average daily weight gain 88.13g/d recorded in sheep supplemented with wheat bran (200 g/d) + lablab (312 g/d) and lowest average daily weight gain 26.68 g/d was recorded in control treatment. Feed conversion efficiency (FCE) was higher in T2 ($P<0.11$) in forage legumes supplemented sheep compared to the T1, T3 and T4. Supplementation of wheat bran and forage legumes change growth performance, feed conversion ratio and feed conversion efficiency of experimental sheep. The smallest hot carcass weight (8.71 kg) was recorded for sheep under control treatment, whereas the highest hot carcass weight (14.46 kg) was recorded for sheep in the supplemented with lablab (T2). Dressing percentage on slaughter weight (SW) base was significantly higher ($P<0.001$) in supplemented sheep than the control group. A significantly higher dressed carcass weight ($P<0.001$) was achieved in forage legumes supplemented sheep compared to the control. Higher ribs eye muscle area was observed in order of T2>T3>T4 compared to the control. Therefore, T2 indicate more profitable regarding with growth performance as average daily weight gain, final body weight gain, feed conversion efficiency, carcass weight and net return among the supplemented forage legumes.

Keywords: Carcass, Cowpea, Lablab, Pigeon pea, Supplementation

1. Introduction

Poor nutrition results in low rates of production, often defined by growth and reproduction. It also affects the immune system and the ability of an animal to fight disease. In extreme conditions of malnutrition, death can occur. In many animal production systems, approximately two-thirds of improvements in livestock productivity can be attributed to improved nutrition. In economic terms, feed cost accounts for about 70% of the total cost of livestock production [3]. Pigeon pea produces forage quickly and can be used as a short-lived perennial forage crop. The leaves and young pods can be fed to the animals fresh or they can be harvested and conserve. The present high cost of animal sourced protein in feeds makes pigeon pea ideal as a good plant protein substitute as it is less expensive. The high protein content of pigeon pea leaves suggests that the optimum use of the crop for forage may be as a supplement protein source in compound diets to low quality forage.

Cowpea is an important component in mixed systems and in semi-arid regions of the tropics and is valued for its potential to produce high levels of fodder for livestock in addition to grain for people. Cowpea haulm addition improves nutrient supply and growth of livestock over the use of low quality forages alone but degree of weight change varies relative to total nutrient supply [8]. It should be noted that only a limited number of studies reported the specific variety of cowpea used and animal response has been reported to differ with variety and its associated forage quality [4]. 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 [20]. 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. It is commonly under sown in maize or sorghum at mid to high altitudes [2] and can provide forage for dry periods, could be a useful pioneer component of many pasture mixtures and also could serve as green manure [24] Once established, it is moderately tolerant to frost, has good drought tolerance and can survive where there is only 400 mm annual rainfall. The growth performance of animals on poor-quality roughage can vary with the protein source. These forage legumes 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. No study is conducted on those of improved forage on sheep as its nutrient content studied so far in the area. Therefore, it is important to supplement growing sheep with an appropriate protein source in order to increase the efficiency of growth to the desired market weight so that the economic benefit of sheep production can be enhanced. Therefore, this study was designed to assess the effects of supplementing Pigeon pea, Lablab (Lablab purpureus), Cowpea (Vignaunguiculata) and Rhodes grass hay on performance of sheep with the following specific objectives.

Specific objectives

1) To study the effect of supplementing Lablab, Pigeon pea and Cowpea on feed intake and body weight gain of male black head sheep.
2) To assess the economic feasibility of supplementations of Lablab, Pigeon pea and Cowpea.
3) To evaluate carcass parameters of black head sheep under feed treatment option.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Yabello Pastoral and Dryland Agriculture Research Center which is located 564 km from Addis Ababa. There are four major seasons in Borana. These are the long rainy season (March-May), the cool dry season (June-August), the short rainy season (September- November) and the warm dry season (December-February) (Coppock, 1994).

2.2. Forage Establishment

*Lablab purpureus (*147), Pigeon pea *(*11560), Cowpea *(*9333) was established on well prepared land in the study area through Rainfed on 1..5 hectare of land. Land preparation, Proper growth of forage and storage were applied following the recommendations for each forage species. The forages were harvested at 50% flowering.

2.3. Animals and Their Management

The experiment was conducted using twenty eight intact yearling growing indigenous sheep (Black head sheep) with an average body weight of 19.98± 0.2 SEM kg (mean ± SEM). The age of the animals was determined by dentition. The sheep were purchased from the local market and quarantined for 3 weeks. The experimental animals were treated for internal and external parasite and vaccinated for common diseases of the study area. The experimental animals were kept in individual pen with feed and water trough and identified by ear tag.

2.4. Feeds and Feeding Management

Rhodes grass hay used as a basal diet and forage legumes hay form were used as protein supplements. Wheat bran was purchased from Yabello flour factory and used for as energy source across the all experiments. The supplement forage species were harvested at flowering stage and sun dried under shade to make hay and manually chopped to 3-5 cm size to minimize selection of grass. Basal diet, forage legumes and wheat bran were offered in separate troughs, wheat bran once a day at 8:00 AM, whereas the hay and forage legumes twice a day at 8:30 AM and 14:00 PM. Experimental animals get common salt at all the time.

Figure 1. *Land preparation, forage growing, hay harvested and experimental animals.*

2.5. Experimental Design and Treatments.

Random complete block design was used with four dietary treatments and seven replication. Rhodes grass used as basal diet and forage legumes used as supplementation. An equal amount to wheat bran used in across the treatment as energy source.

T1 = RGHA+ 200 g WBC (Control)

T2 = RGHA + 200 g WBC + 312g Lablab

T3 = RGHA+ 200 g WBC + 340g Pigeon pea

T4= RGHA + 200 g WBC + 352 g Cowpea.

where, RHGA=Rhodes grass hay adlibitum and WB=wheat bran.

2.6. Feed Intake and Body Weight Gain

The daily amount of feeds offered and the refusal were weighed for each animal and recorded to determine the amount of feed consumed. Body weight of the animals was taken at the beginning of the trial and every 10 days during the 90 days of feeding period. All animals were weighed in the morning hours after overnight fasting using suspended weighing scale. Daily body weight gain (ADG) 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.

2.7. Carcass Analysis

All experimental animals were fasted overnight, weighed and slaughtered at the end of the feeding trial. The animals were killed by severing the jugular vein and the carotid artery with a knife. The blood was drained into a bucket and its weight was recorded. The skin was carefully flayed to prevent fat and tissue attachments. The skin was weighed with ears after the removal of legs below the fetlock joints. The gastro-intestinal tract with the exception of the esophagus were removed with its contents and weighed. Internal organs, namely, empty gut, heart and kidney were removed and weighed. The hot carcass weight was estimated after subtracting weights of the head, thorax, abdominal and pelvic cavity contents as well as legs below the hock and knee joints [14]. After evisceration, the carcass were weighed and cut perpendicular to the back bone between the 12th and 13th ribs to measure the cross-sectional area of the rib-eye muscle area. The rib- eye area was traced first on to a transparent paper then by counting the number of squares lying on the traced figure in the square paper and multiplied by the area of the single square. The empty body weight was calculated and total edible offal components (TEOC) was taken. The dressing percentage was calculated as a proportion of hot carcass weight and empty body weight and/or slaughter body weight [14].

2.8. Partial Budget Analysis

Partial budget analysis was performed to evaluate the economic advantage of the different treatments by using the procedure of [26]. he cost of the feeds was computed by multiplying the actual feed intake for the whole feeding period with the prevailing market price. The prevailing price of the feeds at the time of feed purchasing including the transportation cost incurred to move them to the experimental site were recorded. Partial budget method measures profit or loss, which is the difference between gains and expenses for the proposed change and includes calculating net return (NR), i.e., the amount of money left when total variable costs (TVC) are subtracted from the total returns (TR):

$$NR = TR\text{-}TVC,$$

$$\Delta NR = \Delta TR\text{-}\Delta TVC$$

The marginal rate of return (MRR) measures the increase in net income (ΔNR) associated with each additional unit of expenditure (ΔTVC). This is expressed in percentage as: MRR% = (ΔNR/ΔTVC) X 100.

2.9. Data Analysis

Data collected during the experimental period was subjected to the analysis of variance (ANOVA) using GLM procedures of [21]. The treatment means were separated by least significant difference (LSD). The model used for experiment was;

$$Y_{ij} = \mu + T_i + B_j + e_{ij} \text{ Where;}$$

Y_{ij} = Response variable μ = Overall mean;
T_i = the fixed effect of feed B_j = block effect;
e_{ij}= effect of random error.

3. Results and Discussions

3.1. Chemical Composition of the Experimental Feeds

The chemical compositions of the experimental diets (nutrient content) used in the experiment was presented in Table 1.

Table 1. *Chemical Composition of Experimental Feeds on dry matter basis.*

Feeds	Chemical Composition of Experimental Feeds					
	DM	CP	ASH	OM	ADF	NDF
Hay	91.23	7.78	9.17	90.83	47.23	68.28
Wheat bran	89.23	16.78	7.55	92.45	25.43	33.45
Cajanuscajan	91.93	17.89	8.05	91.95	27.03	35.34
Lablab	89.76	19.47	7.68	92.32	22.41	38.23
Cowpea	90.12	17.3	10.74	89.26	19.46	30.13

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

The nutrient content Rhodes grass hay used in this study was not similar with the crude protein content of good quality grass hay (11%) reported by [18], However within the range of 7.5-15.45% reported for Rhodes grass hay [25]. But, higher than the value of 6.56% reported by [23]. This variation may be due to soil and climatic condition of the area. Hay which contains a 7.78% crude protein has a potential to support the maintenance requirements experimental animals which agree with [28] a minimum of (7%) crude protein needed to support acceptable ruminal microbial activity and the maintenance requirement of the host ruminant.

The NDF content of hay used in this study (68.28%) was less than the value of 76.75% and 75.68% and reported by [20]. and [16].; but comparable with the value of 70.7% and 71.8% reported by [5] and [15]., respectively. Dry matter and crude protein content was lower than 93.5% DM, 23.08% crude protein and 43.83% ADL reported by [7], but higher in 87.38% dry matter contents reported by [13]. This variation may be due to the variety and the quality grain used in the milling factory.

The current finding crude protein content of lablab purpureus similar with that of value 19.23% reported by [16]. The current finding of crude protein content of Cajanus cajan similar with that of value 16.69 reported by [16]. Which is lower than 94.5DM%, 9.45% ash, 27.03% ADF, but higher 33.8% NDF [9]. Dry matter, organic matter, and acid detergent fiber, neutral detergent fiber, crude protein content of *pigeon pea* of current study was similar with finding reported by [16].

3.2. Feed and Nutrient Intake of Experimental Animals

Table 2. *Total daily feed and nutrients intake of male black head sheep fed Rhodes grass hay and supplemented with different forage legumes are presented in Table 2.*

Parameter	Treatments				SEM	SL
	T_1	T_2	T_3	T_4		
Total hay (g/day)	357.49^a	343.253^{ab}	329.01^b	294.401^c	5	***
Wheat bran (g)	200.00^a	200.00^a	200.00^a	200.00^a	0	ns
Lablab Supplement (g/day)	-	312^c	-	-	-	-
CC Supplement (g/day)			340^b		-	-
Lablab Supplement (g/day)				352^a	-	-
Total DMI (g/d)	557.5^c	855.25^{ab}	869.40^a	846.4^b	25.12	***
Total DMI (% BW)	2.49^c	3.10^b	3.28^a	3.26^a	0.07	***
Total DMI (g/kgW$^{0.75)}$	68.17^a	68.58^a	69.23^a	66.32^a	0.6	ns
Total OM Intake (g/d)	509.58^c	784.68^a	796.34^a	766.40^b	22.9	***
Total CP Intake (g/d)	61.19^c	120.84^a	119.82^a	117.21^b	4.8	***
Total ADF Intake (g/d)	219.70^d	282.897^b	298.15^a	258.40^c	5.8	***
Total NADF Intake (g/d)	310.99^b	420.55^a	411.7^a	373.97^b	8.5	***
Total Ash Intake (g/d)	342.92^a	353.84^a	344.172^a	323.01^b	3.5	***

a, b, c, d = means within a row not bearing a common superscript letter significantly differ, (***)=P<0.001; ns = not significant; DMI= dry matter intake; SEM= standard error of mean; CPI= crude protein intake; NDFI=neutral detergent fiber intake; ADFI=Acid detergent fiber intake; SL= significant level; T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea;.

According to the current finding there were significant differences (P<0.001) on intake of dry matter, crude protein, fiber, organic matter and ash among the treatment group of forage supplemented and control group. The highest total dry matter intake was observed in T3>T2>T4>T1 and treatment of T1 more intake of basal diet as compared to the forage supplemented of experimental animals. The reason of sheep in the control consumed more basal of Rhodes hay as compared to the legume supplemented treatments, were to meet their nutrient requirement through the intake of relatively more grass hay than the other treatments. The total DM intake obtained in the current study were consistent with that reported by [7] who found a total DM intake in a range of 738-964 g/day/head in Afar sheep fed urea treated teff straw and supplemented with different levels of wheat bran. The daily total DM intake based on metabolic body weight (g/kg W0.75) was not significance in the current finding. Therefore, supplementation of total dry matter intake provide crude protein and energy for the cellulolytic microbes up on degradation in the rumen and stimulate the growth of animals.

Total intake of crude protein intake of sheep in T2 and T3 was higher (P<0.001) than T1 and T4. According to experimental animals intake of crude protein the responses of nutritional value observed on growth performance. Crude protein intake of current finding varies from 117.12-120.24g of goats in all treatment is in surplus of that needed for maintenance and the target average daily gain. Fiber intake (ADF and NDF) of experimental animals was higher in treatment T2 andT3 (P<0.001) than sheep supplemented to the T4 and control. This situation consequently allocated with the total dry matter intake of the experimental animals.

Sheep supplemented with the forage legumes hay revealed the highest (P<0.001) daily DMI and crude protein than sheep fed Rhodes grass hay supplemented with wheat bran but highest basal diet intake. The higher (P<0.001) intakes of DM and crude protein sheep fed the legume supplemented diets was indicative of the better nutritive values of the legume supplemented diets than the basal diet supplemented with wheat bran alone (T1). The higher nutrient intakes particularly higher crude protein intakes helped the sheep acquire protein required for growth better than the sheep on Rhodes grass hay supplemented with wheat bran. This indicate the advantages of legume supplementation to improve intake of nutrients specially protein than basal diets.

3.3. Body Weight Change and Feed Conversion Efficiency

The mean initial and final body weight, average daily body weight gain (ADG) and feed conversion efficiency (FCE) are presented in Table 3. The final body weight of the sheep in the control experiment (T1) was lower (P<0.001) than final body weights of sheep fed cow pea, pigeon pea and lablab. Among the supplemented legumes, lablab resulted in higher (P<0.001) final body weights than T3 and T4. Following the variations in the final weights of sheep fed the experimental diets, there were also significant (P<0.001) variations in average daily weight gains (ADG) of sheep on the different diets. Sheep supplemented with pigeon pea and lablab had the highest (P<0.001) ADG and FCE (T2>T3>T4>T1). The ADG of sheep increased with the increase in crude protein contained in the experimental forage legumes.

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

Parameter	Treatments				SEM	SL
	T_1	T_2	T_3	T_4		
IBW (kg)	19.91^{a}	20.42^{a}	20.058^{a}	20.00^{a}	0.2	ns
FBW (kg)	22.31^{c}	28.36^{a}	27.30^{ab}	26.57^{b}	0.5	***
DFF (kg)	2.40^{c}	7.93^{a}	7.24^{ab}	6.57^{b}	0.4	***
ADG (g/day)	26.68^{c}	88.13^{a}	80.478^{ab}	73.02^{b}	4.7	***
FCE	0.048^{c}	0.11^{a}	0.09^{b}	0.09^{b}	0.005	***
FCR	21.53^{b}	9.56^{a}	10.62^{a}	11.56^{a}	1.08	***

a, b, c, d Means with different superscripts in the same row differ significantly; (***) = P<0.001; ADG=average daily gain; BWC=body weight change; FBW=final body weight; FCE = feed conversion efficiency; IBW=initial body weight; S.L =significance level T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea;

Generally, sheep fed the Rhodes grass hay supplemented with wheat bran (T1) had lower final body weights than sheep fed the legume supplemented diets (T2, T3 and T4). The result s of current study agree with finding of [25] and [23] in sheep supplemented with different proportion of peanut cake and wheat bran.

The higher final body weight and average of sheep supplemented with lablab. The differences in the final body weight and average daily weight gain among treatments was possibly attributed to the higher crude protein intake of the treatment groups. Generally, sheep fed the Rhodes grass hay supplemented with wheat bran (T1) had lower final body weights than other treatment. Likewise, Sheep in T1 had the lowest (P<0.001) average than sheep fed the legume supplemented diets. The higher final body weight and average daily weight gain of sheep supplemented with lablab was attributed to the higher crude protein content of the lablab.

3.4. Carcass Characteristics

The average slaughter weight (SW) and empty body weight (EBW) were significantly (P<0.001) higher for sheep supplemented with 312 g lablab as compared to sheep supplemented with 340 g cowpea, 352 g pigeon pea and the control treatment.

Table 4. *Carcass characteristics of Black head sheep supplemented forage legumes fed as Rhodesgrass hay as basal Diet.*

Parameter	Treatments				SEM	SL
	T1	T2	T3	T4		
PSW (kg)	22.32^{c}	28.36^{a}	27.30^{ab}	26.57^{b}	0.48	***
SBW (kg)	22.12^{c}	28.06^{a}	27.00^{ab}	26.27^{b}	0.47	***
EBW (kg)	15.92^{c}	21.76^{a}	20.500^{b}	19.7^{b}	0.46	***
HOCW (kg)	8.71^{c}	14.460^{a}	13.10^{b}	12.2^{b}	0.45	***
DPEBW	39.24^{c}	51.44^{a}	48.470^{b}	46.46^{b}	0.96	***
DPSBW	54.5^{c}	66.350^{a}	63.84^{b}	61.92^{b}	0.94	***
REA (cm^2)	7.61^{d}	11.45^{a}	10.40^{b}	10.20^{c}	0.59	***

a, b, c. d = means within a row not bearing a common superscript letter differ significantly; (***)= P<0.001; SEM = standard error of mean; SL= significant level; T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea.

The hot carcass weight (5.08 kg) recorded for sheep on the control treatment were smaller than the hot carcass weight (9.60 kg) recorded for sheep supplemented with lablab (T4). The average slaughter weight (SW) and empty body weight (EBW) were significantly (P<0.001) higher for sheep supplemented with 321 g lablab as compared to sheep supplemented with 340 g pigeon pea, 352 g Cowpea and the control treatment. The dressing percentage (DP) were also significantly (P<0.001) higher for sheep supplemented with 312g lablab as compared to sheep supplemented with 340g pigeon pea, 352g Cowpea and sheep in the control treatment. Treatment (T2) has higher dressing percentage as compared to the sheep supplemented forage legumes and control. Sheep in the control treatment had smaller rib- eye muscle area compared to those supplemented with forage legumes. In agreement with the present study, [12] reported that supplementation with barley bran; linseed meal and their mixtures of Arsi-bale sheep fed a basal diet of faba bean haulms had significantly higher slaughter weight, hot carcass weight, and dressing percentage than the non-supplemented sheep. [10] reported that rib-eye muscle area was improved in Adilo sheep supplemented with sweet potato tuber and haricot bean screenings. [6] observed that rib-eye muscle area was increased in Washera and Horro sheep fed different roughage to concentrate.

3.4.1. Edible Offal Components

Edible offal components of Black head sheep supplemented forage legumes are given in Table 4. Heart, kidney, empty gut, total fat, head and tongue, testis and ramp fat tail are considered as edible offal. Whereas gut content, blood, penis, skin and feet are considered as non-edible offal's based on the eating habit of people in the study area. The weight of liver, heart, blood, tongue total fat, rump fat tail was significantly higher (P<0.001) for the supplemented treatments compared to the control treatment. However, Kidney and testicle has not significant among the experimental diet. The result of this study is similar to that of [26] who reported supplemented Afar sheep had higher weight of blood, liver, heart and kidney than the control. Similarly, [23] reported a positive effect of supplementation on the weight of kidney, liver and blood. Higher weight of TEOC in the in current study indicated that supplementation has a positive effect on the growth performance of sheep. This was in agreement with the work of [7] and [18]. in Afar sheep and Sidama goats, respectively. However, T2 was higher in (P<0.001) TEOC but no significance difference among rest treatment and control.

Table 5. *Overall mean edible carcass black head sheep supplemented improved forage legumes fed native hay basal diet.*

Parameters	Treatment				SEM	SL
	T_1	T_2	T_3	T_4		
Liver (g)	423.85^{c}	503.71^{a}	467.42^{b}	461.42^{b}	6.36	***
Heart (g)	81.85^{c}	95.42^{a}	92.42^{a}	88.142^{b}	1.19	***
Kidney (g)	79.42^{a}	76.142^{a}	87.71^{a}	71.85^{a}	2.96	ns
EG (g)	1561.43^{c}	1697.14^{a}	1658.57^{b}	1578.57^{c}	11.69	***
Blood (g)	1214.71^{c}	1482.86^{a}	1350.00^{b}	1232.86^{c}	23.30	***
Tongue (g)	88.71^{c}	101.28^{a}	95.57^{ab}	94.14^{bc}	1.30	***
Total fat (g)	940.00^{b}	1298.57^{a}	944.28^{c}	677.85^{c}	73.90	***
Testicles (g)	220.00^{a}	244.28^{a}	152.73^{a}	295.71^{a}	66.73	ns
Tail (g)	2031.57^{b}	2307.14^{a}	2300.00^{a}	2292.86^{a}	23.95	***
TEO (kg)	6.64^{b}	7.81^{a}	7.20^{b}	7.10^{b}	112.61	***

a, b, c, d means the same row with different superscripts differ significantly; (***) = P<0.001; ns = not significant; TEOC= total edible offal component; SL= significant level; SEM= Standard error of mean; T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea

Total edible offal was higher for all the supplemented sheep. This indicate that the supplementation of increase the quantity and the percentage of edible components which agree with the finding of [23] reported that supplementation increase the total usable products.

3.4.2. Non-Edible Offal Components

Non-edible offal component of Black head sheep fed on forage legumes are given in Table 6. Penis, skin, head without tongue, feet and total non edible offal did not differ (p<0.001) among the legumes supplementation of experimental animals including the control animals. Non-edible offal (lung and pancreas) was significant among the experimental animals (T2> T4>T1). However, there is no significance difference between T1 and T4 regarding with lung and pancreases.

Table 6. *Non edible offal of sheep supplemented with forage legumes.*

Parameters	Treatment				SE	SL
	T_1	T_2	T_3	T_4		
Lung (kg)	318.56^{b}	327.71^{a}	323.80^{ab}	319.07^{b}	0.45	***
Pan (g)	66.057^{b}	69.771^{a}	67.486^{ab}	66.343^{b}	1.49	***
Hwt (kg)	1228.57^{a}	1240.00^{a}	1231.57^{a}	1237.14^{a}	0.46	ns
Skin (kg)	1228.57^{a}	1260.57^{a}	1292.86^{a}	1251.43^{a}	8.30	ns
Feet (kg)	571.43^{a}	579.29^{a}	560.86^{a}	571.43^{a}	16.28	ns
Gut fill (kg)	51.571^{a}	54.143^{a}	53.143^{a}	52.85^{a}	0.27	ns
Ubl (g)	19.571^{a}	20.714^{a}	19.857^{a}	19.286^{a}	1.21	ns
Pen (g)	51.571^{a}	54.143^{a}	53.143^{a}	52.857^{a}	0.48	ns
Tneo (kg)	3484.33^{a}	3552.20^{a}	3549.57^{a}	3517.56^{a}	20.96	ns

a, b, c, d means the same row with different superscripts differ significantly; (***) = P<0.001; ns = not significant; TEOC= total edible offal component; SL= significant level; SEM= Standard error of mean; T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea

Generally supplementation did not affect (P>0.001) total non-edible offal between the supplemented of experimental animals and the control. This agrees with the results reported by [7, 26] in Afar sheep [16] in black head sheep and [18] in Sidama goats who reported the absence of significance difference in total non edible offal component between supplemented and non supplemented treatment.

3.5. Partial Budget Analysis

Table 7. *Partial budget analysis of Black head sheep fed grass hay and supplements.*

Parameters	T1	T2	T3	T4
Purchased Price of Goats (ETB)	705	705	705	705
Number of Animals	7	7	7	7
Total Basal Diet Intakes (kg/ head)	32.66	30.51	29.61	26.90
Total wheat bran Intakes (kg/ head)	18	18	18	18
Total lablab Intakes (kg/ head)	-	28.08		
Total Cajanus Cajan Intakes (kg/ head)			30.6	31.68
Total Consumed supplement (kg/head)	18	46.08	38.06	49.68
Total Concentrate wheat bran (ETB/head)	117	117	117	117
Total Cost of Basal Diet (ETB/head)	90	85	85	80
Total Cajanus Lablab Intakes (ETB / head)	-	85		
Total Cajanus Cajanus Intakes (ETB / head)			85	
Total Cajanus Cowpea Intakes (ETB / head)				85
Cost of other Inputs (ETB)	60	80	80	80
Labor Cost Per Animals (ETB)	30	50	50	50
Total Variable Cost	297	417	417	412
Selling Price of Goat (ETB)	1004	1276	1228.5	1195.7
Total Return (ETB)	299	571	523.5	490.7
Net Return	2	154	106.5	78.7
Change In Return	-	152	104.5	76.2
Change In Total Variable Cost	-	120	120	115
Marginal Rate of Return	-	1.27	0.87	0.66

T1 = hay+200 g wheat bran; T2 = hay +200 g wheat bran + 312g lablab; T3 = hay +200 g wheat bran +340 g pigeon pea; T4= hay +200 g wheat bran +352 g cow pea

The result of partial budget analysis revealed that the high level of crude protein% lablab, 1.27 resulted in higher profit margin than pigeon pea, 0.78 followed by Cowpea, 0.66. Sheep fed Rhodes grass hay with wheat bran had the lowest net return and lablab group recorded the highest net return. The results suggested that supplementation of sheep fed hay basal diet with a forage legume; lablab was more profitable than supplemented with pigeon pea and cow pea. The difference in the net return among treatments could be possibly attributed to increased ADG due to the high crude protein.

4. Conclusion and Recommendations

4.1. Conclusion

The highest growth performance (daily live weight gain) was recorded in sheep supplemented with T2 (hay +200 g wheat bran + 312g lablab), T3 (hay +200 g wheat bran +340 g pigeon pea), T4 (hay +200 g wheat bran +352 g cow pea) and T1 (hay+200 g wheat bran) respectively. Average daily weight gain (26.68, g/d) was recorded which indicate Rhodes grass hay supplemented with 200 g wheat bran enough to meet daily nutrient requirement of sheep to keep losing body condition during the dry season. Feed conversion efficiency was significantly higher ($P<0.001$) in the order of T2 >T3 >T4>T1 respectively. The hot carcass weight based on slaughter body weight of experimental animals is not significantly ($P<0.001$) different among the forage supplanted group but difference was observed with the control treatment. The highest dressing percentage was recorded in T2 (hay +200 g wheat bran + 312g lablab) as compared to the control group. The mean rib eye muscle area was 7.61cm^2 for control sheep and 11.45 cm^2, 10.40 $cm^2$and 10.20 cm^2 for T2, T3 and T4, respectively.

The marginal rate of return indicated that each additional unit of 1 ETB per sheep cost increment1.27, 0.87 and 0.66 ETB benefit for T2, T3, and T4, respectively. The net return from the supplemented experimental treatments was 154, 106.5 and 78.7 ETB per head for T2, T3 and T4 respectively. The difference in net return was in a similar trend with their weight gain, i.e., sheep in control group almost remain the same weight and resulted in the lowest net return, while lablab group resulted in higher ADG and recorded the highest net return.

4.2. Recommendations

Based on the current study, treatment T2, T3, T4 and T1 were recommended according to their priority for pastoral and agro- pastoral community of the area based on biological and economical feasibility of the experiments respectively. Supplementations those promising plants at different level as protein and energy source under actual pastoralist's condition could be considered for further study in future.

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