Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.7, No.19, 2017

Effect of Supplementing Improved Forage Legumes (Cajanus cajan and Lablab purpureus) on Carcass Characteristics of Horro Sheep Fed A Basal Diet of Cynodon dactylon Hay

Mekonnen Diribsa
Oromia Agricultural Research Institute, Bako Agricultural Research Center, P.O.Box 03, West Shoa, Bako, Ethiopia

Abstract
The experiment was conducted at Bako Agricultural Research Center during 2014 using thirty intact male yearling Horro sheep to evaluate the effect of supplementing a basal diet of natural grass hay with Cajanus cajan (CC), Lablab purpureus (LP) and the mixture of CC and LP on carcass characteristics of growing Horro lambs. The experimental animals were grouped into six blocks, and each animal was randomly assigned to one of the five dietary treatment feeds. The treatments were: feeding of Cynodon dactylon (CD) hay as control (T1), and supplementation of basal diet with mixture of CC and LP at 100:0, 40:60, 60:40 and 0:100%, respectively. Accordingly, 236, 294, 274 and 333gm of the supplement foliages were offered to T2, T3, T4 and T5 animals, respectively on dry matter (DM) bases. Likewise, 125gm wheat bran (WB) was offered across the treatments mainly to reduce weight lose in the control group. The experimental animals were adapted to their respective experimental feeds for 14 days. The feeding trial was conducted for 90 days followed by carcass evaluation in which all animals were slaughtered. The CP contents of CC, LP, WB and CD hay were 26.41, 18.67, 17.46 and 11.72%, respectively. Organic matter ranged from 88.84 (CD hay) to 95.11% (WB). Supplementation highly increased ($P<0.001$) slaughter weight, empty body weight, hot carcass weight, rib-eye muscle area and weights of most of the edible and non-edible offal than control group (T1). Therefore, it can be concluded that, supplementation with forage legumes (Lablab purpureus and Cajanus cajan) can enhance the utilization of poor quality roughages under smallholder mixed farming systems for better growth and carcass yield of Horro sheep. Better carcass traits were observed in rams supplemented with 333gm LP, followed by 94 and 200 gm CC and LP mixture, thus this feeding system can be recommended for small scale farmers who engaged in sheep fattening program.
Keywords: Supplementation, Cynodon dactylon, carcass, Horro lambs, improved forage

1. INTRODUCTION

Among the livestock species, sheep and goats are widely reared in a crop-livestock farming systems and are distributed across different agro-ecological zones of Ethiopia. Sheep and goats, with their higher reproductive capacity and growth rates, are ideally suited to production by resource-poor smallholders (Markos, 2006). They require smaller investments, have shorter production cycles and greater environmental adaptability, and hence have a unique niche in smallholder agriculture. Small ruminants also suffer far less mortality during periods of drought than large ruminants (Galal, 1983; Wilson, 1991). In addition, subsistence farmers prefer small ruminants as the risk of large ruminants dying and leaving them with nothing is too great (Solkner *et al*., 1998). The relative importance of small ruminants and their products varies from region to region and are largely determined by ecological and economic factors. Traditionally, keeping large number of small ruminants was considered as an expression of status in the rural community. However, with ever-increasing human population and drastically shrinking farmlands, sheep and goat production is becoming a means of survival particularly for the landless youth and female headed households in the rural areas. As a result, the contribution of small ruminants is increasing whereas sustaining large ruminants are facing difficulty during season of critical feed shortage (Desta and Oba, 2004; Legesse *et al.,* 2008). Although diverse sheep and goats resources are found in Ethiopia, their productivity is low mainly because of inadequate year round nutrition, both in terms of quantity and quality, unimproved genetic potential due to absence of strategic selection and mating and due to prevalence of diseases and parasites (Markos *et al*., 2006). In Ethiopia, most feed resources are characterized by inherent nutritional deficiencies, and are generally low in nitrogen, energy, vitamins and minerals (Solomon, 2001), which affect microbial growth and fermentation in the rumen, resulting in low feed intake and digestibility, leading to reduced reproductive capacity, decline in growth rates and increased mortality rates. The decline in growth rates of animals delays the attainment of slaughter weight and adversely affects meat/mutton yield and quality (Muchenje *et al*., 2008).

The crop-livestock farming systems in the Ethiopian highlands are under stress because of shrinking cultivated areas per household, land degradation, and reduced pasture land (Funte *et al*., 2010). Gemeda (2010) also pointed out that shortage of feeds is exacerbated by the increase in human and livestock population and expansion of croplands, resulting in shrinkage of grazing lands in the western highlands of Ethiopia. This has lead to reduction in grazing areas and consequently to shortage of feeds. To solve this problem, there are options like supplementing animals with agro-industrial by-products such as different oil seed cakes and brans from edible oil and flour processing industries, respectively. However, they are costly and not readily available everywhere. As a result, production and feeding of herbaceous and fodder tree legumes through integration with food crops were suggested as some of the potential options to improve the nutrient supply to livestock (Solomon, 2001). Uses of improved forage and tree legumes as supplementary options for livestock have been investigated in Ethiopia (Solomon *et al.,* 2004; Ajebu *et al.,* 2008). Supplementation of *Panicum maximum* and cassava peels basal diet with *Moringa oleifera* or *Gliricidia sepium* fodders improved the intake of basal diet and enhanced better nutrient utilization of West African Dwarf sheep (Adegun Maria Kikelomo, 2014). Moreover, many other studies (Solomon and Simret, 2008; Tesfaye, 2008) reported increased average daily gain and final body weight in sheep supplemented with concentrate mixture than those fed only the basal diet. FAO (2002) also suggested that high quality feed for ruminants in developing countries can be achievable through intensive utilization of multipurpose trees and shrubs as they are easily produced and managed by livestock producers and have better nutritional quality nearly equivalent to grain based concentrates. Nevertheless, the adoption rate and wider use of multipurpose trees by livestock keepers in Ethiopia is not significant probably because of paucity in information regarding the feeding value and less dissemination of these fodders. The present study was, therefore, conducted with the objective of investigating the effect of supplementing a basal diet of natural grass hay with protein rich forage species (*Cajanus cajan*, *Lablab purpureus or their mixture*) on feed utilization and growth performances of growing Horro lambs.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The experiment was conducted at Bako Agricultural Research Center (BARC) located in east Wollega zone of Oromia regional state, western Ethiopia from June 2013 to January 2014. The location represents mid-altitude sub-humid maize growing agro-ecology of Ethiopia. The centre is located at a distance of 260 km to the west of Addis Ababa on the main road to Nekemte. The area lies at latitude and longitude of 9°06'N; 37°09'E, respectively, at an altitude of 1650 m above sea level. The area receives an annual rainfall of about 1200 mm, 90% of which falls between June and September. Average temperature of the study area is about 27°C ranging from 22°C to 31°C (BARC, 2003). About 60% of the soil of BARC is reddish brown in colour, and clay-loam in texture. Dominant soil types are Nitosols with fertile alluvial soils in valley bottom. The area is known for its mixed crop livestock farming system in which cultivation of maize, sorghum, finger millet, sesame, hot pepper, soybean, common bean, mango, banana, and sugar cane are the major crops in their order of importance. Major animal feed resources are natural pasture (*Cynodon dactylon)***,** improved forage grasses (Napier grass, Rhodes grass, panicum spps, bracharia spps, etc), herbaceous legumes (*Lablab purpureus, cowpea, Stylosanthes spps, desmodium spps, vicia spps, etc.*) and multipurpose trees and shrubs (lucaena spps, *Cajanus cajan*, *Sesbania Sesban*, *Gliricidia sepium* etc.). Cattle and sheep are important livestock species abundantly found in the areas.

2.2. Experimental Animals and Their Management

Thirty intact male yearling Horro sheep with initial body weight of 20.87±1.94 kg (mean ± SD) were purchased from the surrounding market. Age of the animals was determined by their dentition and based on information obtained from owners. The experimental animals were quarantined for fifteen days and vaccinated against common infectious diseases in the area, namely sheep pox, ovine pastriollosis and anthrax and observed for any other health problem. During the quarantine period, animals were ear-tagged for identification, treated with fasinex and sprayed with accaricide (diazzinon 60%) against external parasites and de-wormed against internal parasites using antihelmintics (Albendazole). Thereafter, the experimental animals were assigned into different treatments after which the animals were randomly put into a separate well aerated pen having a feed trough. Floor of the pens was concrete and roof was covered with corrugated iron. Each animal offered feeds allotted for its respective treatment. Feed offered and left was recorded. The animals drank water from the big watering trough found close to the experimental house and they were let to drink water twice a day, in the morning at 0900 am and in the afternoon at 1500 pm. Pen cleaning was done every morning before offering feed. Animals were adapted to the experimental feeds for 14 days.

2.3. Feed Preparation and Feeding

The experimental feeds were composed of Natural grass (*Cynodon dactylon (*CD*)*) hay as a basal diet and leguminous forage (*Lablab purpureus (*LP*)* and *Cajanus cajan (*CC*))* as supplement. The natural pasture (*Cynodon dactylon)* grass species dominated hay was harvested manually at a height of about 25 cm above the ground from BARC farm. It was harvested at an early stage of maturity with high proportion of leaf than stem. The grass hay was chopped manually into small pieces of about 6-8 cm to minimize preferential selection and wastage, dried under shade and stored in separate house till the feeding was started. To prevent bleaching that may happen during drying, the harvested grass was turned up frequently and dried within three days. Seeds of legumes were sown at the recommended rate for 90% viability, that is 15-20 kg/ha for LP and 6 kg/ha for CC in the center's farm. CC was sown at 50 cm within rows and 100 cm between rows with estimated population of 20,000 plants/ha. Both legumes received 100 kg/ha single super phosphate fertilizer at sowing time. Hand weeding and hoeing were continued until the crops reach for harvest. The legumes were harvested as per their respective recommended harvesting times, which were at 50% blooming stage for LP and at first pod setting for CC. Edible leaves and twigs for LP and leaves with very soft twigs for CC were harvested at the mid and end of September 2013, respectively. Mechanical chopping was done to 6–10 cm length and the chopped materials were dried under shade and stored in a cool dry place until use for feeding. Wheat bran meal adequate for the entire feeding period was purchased from Guder town, located at about 120 km from Addis Ababa, on the main road to Nekemte and equal amount was offered to all animals across the experimental period. Individual feed trough was used to offer the feeds. Feed offered and refused were weighed. The daily feed supplements were offered twice a day at 0800 am and 1600 pm. Grass hay was provided to all animals *ad libitum* at a rate of 20% refusal as a basal diet. Common salt block was available to the animals all the time throughout the experimental period.

2.4. Experimental Design and Treatments

The experimental design was a randomized complete block design (RCBD). The experimental animals were grouped into six blocks of six animals each based on their initial body weight that was determined by taking the averages of two consecutive weights after overnight fasting at the end of the quarantine period. Animals in a block were randomly assigned to one of the five experimental treatments. Thus, there were six animals per treatment. The basal diet natural grass hay was fed to all animals *ad libitum* and supplemental feeding was on DM basis. Furthermore, Hundred twenty five (125) grams of wheat bran (WB) was offered across the treatments mainly to reduce weight lose in the control group. The total amount of LP and CC supplemented as sole or in mixture was determined based on the CP requirement of the animals, in such a way that the supplement should provide 62.2 gm of CP per day to the animals. Accordingly, about 236 to 333 gm of the sole or mixture of the legume forages were given to the animals. The actual amounts offered were set after the determination of the CP of the feeds in laboratory. The fodder combinations of LP and CC were thoroughly mixed manually to minimize animal preference in treatment 2 and treatment 3.

The dietary treatments were as: T1: *Cynodon dactylon* (CD) + 125gm wheat bran (WB), T2: CD + 125gm WB + 236gm *Cajanus cajan* (CC), T3: *CD* + 125gm WB + 199.8gm *Lablab purpureus* (LP) + 94.4gm *CC,* T4: *CD* + 125gm WB + 133.2gm LP+141.6gm CC, T5: CD + 125gm WB + 333gm LP

2.5. Chemical Analysis

Samples of feed offered, refused, and feces were dried in an oven at 65ºC for 72 hours and ground to pass 1 mm sieve screen size. The ground samples were kept in air-tight plastic bags pending chemical analysis. The nitrogen (N), Dry matter (DM), Organic matter and ash content were analyzed according to AOAC (1990). The crude protein (CP) content was calculated by multiplying N content with a factor of 6.25. Neutral detergent fibers (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed based on the method of Van Soest and Robertson (1985). Hemi-cellulose and cellulose contents were calculated as NDF minus ADF and ADF minus ADL, respectively.

2.6 Statistical Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) following the General Linear Model (GLM) procedure of SAS version 9.0 (SAS, 2002). Differences among treatment means were tested using Least Significant Difference (LSD). The model for data analysis was:

$Y_{ij} = \mu + t_i + b_j + e_{ij}$: where; Y_{ij} = response variable, μ = overall mean, t_i = treatment effect, b_j = block effect, e_{ij} = random error

3. RESULTS AND DISCUSSIONS

3.1. Chemical Composition of Experimental Feeds

The nutrient compositions of the feeds used in the current study were presented in (Table 1). Variations were observed in chemical compositions. For instance, CP ranged from 11.72 to 26.41%. Lowest CP was obtained from *Cynodon dactylon* (CD) hay while the highest CP was obtained from *Cajanus cajan* (CC) foliage. On the contrary, the lowest NDF was obtained from CC and the highest from CD hay. Organic matter ranged from 88.84 (CD hay) to 95.11% (wheat bran) and ash from 4.89% (wheat bran) to 11.16% (CD hay). Wheat bran was the lowest in ADF content while CD hay was the highest. No different value was observed in dry matter concentrations among the supplemental feeds, but CD hay recorded the highest value in DM, ash, NDF and ADF than other feeds (Table 1). Whereas CP, OM and DOMD of the other feed staffs were higher when compared with the CD hay. Wheat bran exhibited the highest DOMD followed by *Lablab purpureus* (LP) and the lowest DOMD was obtained from the CD hay.

Table 1: Chemical composition of experimental feeds offered to Horro lambs

		Chemical composition (%DM)							
Feed samples	DM %	Ash	OM	NDF	ADF	He-C.	ADL	CP	DOMD
CD hay	92.62	11.16	88.84	72.46	48.68	23.78	6.32	11.72	49.90
LP	88.79	8.57	91.43	46.41	29.37	17.04	7.25	18.67	62.03
CC	88.81	6.56	93.44	41.91	31.72	10.19	8.32	26.41	51.78
WB	88.09	4.89	95.11	43.73	13.97	29.76	3.07	17.46	72.35

Where DM= dry matter; OM= organic matter; NDF=neutral detergent fiber; ADL=acid detergent fiber; He-C=hemicelluloses; ADL= acid detergent lignin; CP= crude protein; DOMD= digestible organic matter in dry matter; CD = *Cynodon dactylon;* WB = wheat bran.

The higher DOMD obtained from the two feed staffs may be attributed to their lower NDF and ADF concentrations. ADL was lowest in wheat bran and highest in CC. *Cajanus cajan* leaf had the highest CP and the lowest NDF compared to other feed staffs used in the current study. The proportion of CP obtained in the CC leaf used in the study was within the range (21 to 38%) reported in literature (Cook *et al*., 2005; Belete *et al*., 2013; Diriba *et al*., 2013). Diriba *et al*. (2013) who conducted study in similar area with the current study reported lower CP, which was about 24.2%, but comparable DM which was about 90.7% for CC. They also reported about 60.3% of NDF, 35.6% of ADF and 12.4% of ADL for CC that were higher values as compared to the results of the current study. The CP, OM, NDF and ADF values obtained from CC in the current study were higher than values reported by Belete *et al*. (2013). The authors reported in percentage about 21.3, 90.55, 33.8 and 29.4 for CP, OM, NDF, and ADF, respectively. Nevertheless, lower values of DM, Ash and ADL were recorded in the current study than those reported by same authors.

The value of CP in LP hay used in the present study was higher than the 16.8% reported by Tadele *et al.* (2004), but lower than the 25.1% reported by Diriba *et al.* (2013). The NDF, ADF, ADL and DM contents of LP (77.4, 47.3, 16.3 and 94.7 %, respectively), reported by Diriba *et al.* (2013) were higher than values obtained for the same nutrients in the current study. However, values obtained in the current study were higher than values reported by Tadele *et al.* (2004) for the same nutrients. In terms of chemical constituents, herbaceous legumes are primarily characterized by high N content. Crude protein content of herbaceous legumes under local conditions varied from 15% in trifolium to 26% in vicia with a mean of about 19% (Seyoum, 1995). According to Norton (1982), most herbaceous legumes have crude protein content which is usually required to support lactation and growth (greater than 15%), suggesting the adequacy of herbaceous legumes to supplement basal diets of predominantly low quality pastures and crop residues. Wheat bran had high OM concentration, but lower ADF and ADL when compared with the other feed staffs investigated in the current study. It had also higher DM and NDF and comparable CP with values reported by Tadele *et al*. (2004). The current CP value for wheat bran agrees with values reported in literature (Ensminger, 2002; McDonald *et al*., 2002). In the current study, different nutrient constituents of the CD hay were evaluated. DM content of the CD hay was greater than 90.2% and it is disagreement with the lower values (ranging from 92.3 to 93.7%) reported in literature (Biru, 2008; Tewodrose, 2011; Diriba *et al.,* 2013).

On the other hand, OM content of the CD hay obtained in the current study was higher than the 80.5% reported by Tewodrose (2011), the 88.8% reported by Bimrew (2008) and the 90.5% reported by Diriba *et al.* (2013*).* It was, however, comparable with the 92.4% reported by Biru (2008). Diriba *et al.* (2013) reported, respectively, about 55.7%, 39.7%, and 5.4% of NDF, ADF and ADL for CD hay in Bako area, which were lower as compared to values reported in the current study. Similarly, CP content of CD hay obtained in the current study was greater than 5.2% reported by the same authors. The CP value is, however, far lesser than values (ranging from 14.9 to 17.5%) reported by Hill *et al*. (1997) for three Bermuda grass cultivars ('Tifton 78', 'Tifton 58' and 'Coastal'). The authors reported comparable value for NDF (71.0 to 72.5%) and lower ADF values (ranging from 32.1 to 33.1%). The relatively higher percentage of CP and intermediate fiber fraction content of the CD hay may be occurred from early harvesting stage. As plants mature, the cell wall constituent increases and therefore, the structural carbohydrates such as cellulose and lignin increase and the percentage of the CP normally decreases (McDonald, 2002).

3.2. Effect of supplement on Carcass Components

Mean values of main carcass components of Horro sheep fed a basal diet of CD hay and WB or supplemented with CC*,* LP or their mixture are presented in Table 7. Slaughter weight (SW), empty body weight (EBW) and hot carcass weight (HCW) and rib-eye muscle area (REMA) were highly influenced (P<0.001) by treatments. Similarly, fore- and hind quarters displayed significant (P<0.001) variations among treatments. All the supplemented groups performed better in SW, EBW, HCW, REMA, fat thickness (FT), and fore- and hind quarters than those animals in the control group (T1), except lambs fed T2 which recorded similar values in SW with T1. Significant differences (P<0.001) were also observed among the supplemented groups for the same parameters. Animals fed with T5 diet performed better in most parameters (Table 7) than those fed other treatment diets, except in dressing percent expressed as percentage of slaughter weight (DSW) and FT in which no statistical difference were observed among the supplemented groups. EBW, HCW, hind- and fore-quarters have showed a clear increasing trends from T1 to T5, indicating that performances of the parameters have increased with increased proportion of LP diet in supplementation.

Earlier studies have showed that supplementation had significant effect on slaughter weight, empty body weight, hot carcass weight, rib-eye muscle area (Abebe, 2006; Matiwos *et al*., 2008; Wondesen, 2008; Tewodros, 2011) which are in agreement with the current study where supplementation of CD hay with nitrogen rich leguminous forage has significantly improved the parameters indicated. The results of the present study revealed that the average weight recorded in SW, EBW, HCW, fore- and hind-quarters weight of the supplemented lambs have showed similar to the trends observed in final body weight gain and average daily gain. In contrary, Alemu *et al*. (2014) reported that values obtained in body weight change for the different treatment groups were not reflected on the carcass parameters on the corresponding treatment groups for Washera sheep fed natural pasture grass hay supplemented with *Millettia ferruginea* leaf hay.

Rib-eye muscle area was significantly (P<0.001) influenced by treatment diets. Animals assigned to T5 performed better than those animals fed T2 and T1 diets. Nevertheless, no significant difference was observed among those fed T3, T4 and T5 diets. Values recorded for rib-eye muscle area of the supplemented treatments in the current study were higher than the rib-eye muscle area (7.4 to 8.9cm^2) reported by Assefu (2012). Comparable values for rib-eye muscle area (6.7 to 10.4cm^2) were reported by Emebet (2008) for Black Ogaden sheep fed a basal diet of haricot bean haulms with mixture of wheat bran supplemented with brewers dried grain. Temesgen *et al.* (2007) noted that a basal diet of *Cynodon dactylon* with either cowpea or noug cake supplementation resulted in 9.3 to 10.9cm^2 rib eye area for the same breed of sheep used in the current study. On the other hand, Simret and Solomon (2008) reported that supplementation did not affect rib-eye muscle area in Somali goats fed hay and supplemented with different levels of peanut cake and wheat bran mixture at ratio of 3:1.

Table 1: Carcass components of Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture.

Parameters	Treatmentes						
	T1	T2	T3	T4	T5	SEM	SL
Slaughter weight (kg)	22.2^c	23.5^c	25.7^{ab}	25.5^b	27.5^a	0.68	***
Empty body weight (kg)	16.2^c	18.7^b	20.0^b	19.8^b	21.7^a	0.47	***
Hot carcass weight (kg)	7.6^c	8.6^b	9.3^b	9.3^b	10.3^a	0.26	***
Dressing percentage (%)							
Slaughter weight basis	34.2	36.6	36.2	36.5	37.5	0.76	ns
Empty body weight basis	46.9	46.0	46.5	47.0	47.5	0.52	ns
Fore quarter (kg)	3.8^c	4.4^b	4.7^b	4.7^b	5.2^a	0.12	***
Hind quarter (kg)	3.7^c	4.2^b	4.6^b	4.6^b	5.1^a	0.14	***
Rib-eye area (cm^2)	6.0^c	8.1^b	9.5^{ab}	9.1^{ab}	10.6^a	0.56	***
Fat thickness (mm)	4.3^b	6.0^{ab}	7.3^a	7.5^a	8.1^a	0.77	*

^{a,b,c}Means within a row with different superscripts differ significantly (P < 0.05); * =(P < 0.05); ***=(P < 0.001); ns= non significant; SEM=standard error of means; SL: significance level; T1-T5 = treatments.

Previous studies (Steal, 1996; Gatenby, 2002) indicated that dressing percentage of sheep generally range between 40 to 50% (in EBW base). In the current study DP in EBW basis fall within this range. In agreement with the current study, Assefu (2012) also reported lack of effect of diet on dressing percentage both on slaughter and empty body weights in both Horro and Washera lambs fed rations containing different roughage to concentrate ratios. Similarly, Abebe (2006) reported absence of effect of supplementation on DP as calculated on slaughter and empty body weight bases in Arsi-Bale sheep fed hay and supplemented with linseed cake, wheat bran and their mixture at different proportions. Furthermore, Gebregziabher *et al.* (2003) reported non-significant differences in dressing percentage for Horro young rams fed a mixture of noug cake and *Sesbania sesban* as supplementation. Gemeda *et al.* (2003) who reported dressing percentages for animals of different ages and sexes found greater dressing percentage for castrates than intact and ewe lambs of Horro sheep. Demisse *et al.* (1989) also reported lower dressing percentage in intact males than castrates for Horro sheep. The growth curve of Horro sheep shows an increasing trend until at about 3-years of age at which Horro sheep is believed to achieve its mature weight (Solomon and Gemeda, 2000). Solomon and Solomon (1995) also reported that carcass weight and dressing percentage of Horro rams increased linearly with increasing body weight and age has positive correlation until maturity.

3.3. Edible Offal

Mean edible offal components of Horro lambs were shown in (Table 8). The weights of heart, kidney fat and abdominal fat, liver and liver with gall bladder were significantly higher (P<0.001) for the supplemented groups as compared to the control group. Lambs fed T4 and T5 had heavier heart than those fed T2 among the supplemented groups; whereas no significant difference (P>0.05) was observed among animals fed T3, T4 and T5 diets. Significant difference (P<0.001) was observed in weight of kidney fat and abdominal fat among animals fed different treatments diets. Animals fed T3, T4 and T5 diets had higher kidney fat than animals on T1 and T2 diets. No significant difference (P>0.05) were observed among animals fed T3, T4 and T5 diets in weight of kidney fat. Likewise, T1 and T2 had similar values with the same parameter. Animals fed T5 have the heaviest abdominal fat while animals in T1 and T2 have the lightest abdominal fat. T3 and T4 have intermediate values for this parameter.

Table 2: Edible offal of Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture

Parameters weight	Treatments						
	T1	T2	T3	T4	T5	SEM	LS
Heart (g)	108.0^{c}	121.4^{b}	125.3^{ab}	130.0^{a}	130.7^{a}	2.41	***
Kidneys fat (g)	37.8^{b}	29.8^{b}	47.7^{a}	52.1^{a}	51.0^{a}	3.23	***
Abdominal fat (g)	21.4^{d}	27.3^{d}	49.8^{b}	36.6^{c}	65.3^{a}	2.58	***
Liver (g)	351.4^{c}	445.3^{a}	425.4^{b}	429.0^{ab}	440.6^{ab}	5.64	***
Liver with gall-bladder (g)	359.2^{c}	456.0^{a}	438.8^{b}	442.6^{ab}	450^{ab}	5.27	***
Tail (g)	356.7^{c}	573.8^{b}	791.7^{a}	690.0^{ab}	791.7^{a}	73.00	**
Diaphragm (g)	91.2^{b}	95.5^{b}	98.9^{b}	97.9^{b}	118.6^{a}	3.63	**
Blood (g)	1060.0^{b}	1191.7^{ab}	1240.0^{a}	1240.0^{a}	1308.3^{a}	53.30	*
Tongue (g)	73.8^{b}	75.3^{b}	95.4^{a}	76.3^{b}	96.1^{a}	5.65	*
Small & Large intestine(g)	798.3^{c}	1030^{ab}	1133.3^{ab}	961.7^{bc}	1186.7^{a}	61.3	**
Reticulo-rumen (g)	490.0	571.7	536.7	550.0	551.7	29.10	ns
Omasum & abomasum (g)	351.7	383.3	401.7	370.0	395.0	16.27	ns
Heart fat (g)	31.4	48.1	41.7	83..4	47.2	14.62	ns
Omental fat (g)	25.7	31.6	23.2	31.6	34.9	4.27	ns
Kidneys (g)	111.9	108.4	128.7	121.8	114.9	8.60	ns
Total edible offal (kg)	4.3^{d}	5.2^{c}	5.6^{ab}	5.3^{bc}	5.8^{a}	0.10	***

^{a,b,c}Means within a row with different superscripts differ significantly (P < 0.05); * =(P < 0.05); ** = (P < 0.01); *** = (P < 0.001); SL: significance level; T1-T5 = treatments

The weight of liver with gall-bladder of the lambs followed the trend of the liver weight. Various studies (Assefa, 2007; Tewodrose, 2011; Alemu *et al.,* 2014) reported an increasing trend in weight of liver with increase in the supplementary diets and suggested that this phenomenon could happen due to the storage of more reserve substances such as glycogen in the liver. Gebregziabher *et al.* (2003) also reported higher liver weight in Horro sheep fed with sesbania forage compared to those fed ground maize grain and grass hay, which supports the present finding.

Tail weight was significantly higher (P<0.01) for supplemented groups than the control (T1). On the other hand, weight of diaphragm was significantly different (P<0.01) between T5 and animals fed the other treatment diets. Diaphragm of animals in T5 was heavier by 27.4, 23.1, 19.7 and 20.7g than T1, T2, T3 and T4, respectively. Blood and tongue were also affected (P<0.05) by the treatment diets. Weight of the blood was lower for T1 than the supplemented groups except for animals in T2, which was not significantly different from the control group (T1). Significant difference was observed in weight of tongue among animals fed different treatments. Tongues of animals fed T5 and T3 were heavier than animals fed T1, T2 and T4 diets. No likely explanation for the non-consistent differences observed in tongues weight. Consistent to the present study, Getahun (2001) reported that most of the non-carcass components of supplemented treatments showed significant difference (P<0.05) for extensively managed goats.

Small and large intestines were also significantly higher (P<0.01) for the supplemented groups than the control treatment (T1). However, no clear trend was observed from T1 to T5. Reticulo-rumen, omasum-abomasum, heart fat, omental fat and kidneys were not significantly different (P>0.05) among the treatments and no clear trend was observed (Table 8). Total edible offal (TEO) have shown highly significant (P<0.001) variations among treatments. Animals in T5 have the heaviest TEO followed by those in T3 while animals in the control treatment have the lightest TEO. In agreement with the results of the current study, Tesfaye (2007) and Getahun (2001) reported lower TEO components in control group as compared to supplemented groups in rams of Afar sheep breed and Somali and mid-rift valley goats, respectively.

3.4. Non Edible Offal

Experimental animals were significantly differed (P<0.001) in the mean weights of skin, head, tests, pancreas and feet with values being lower for the control group (T1) and higher for the supplemented groups. Significant differences were also observed among the supplemented groups in the same parameters. Lambs in the control group (T1) had lower (P<0.001) skin weight than the supplemented animals, except those animals in T2. Lambs fed T5 had the heaviest skin than the other treatments. The skin from animals fed T5 diets was heavier by 771.7, 596.7, 290, and 380 gm than those recorded by skin obtained from T1, T2, T3 and T4, respectively. The weight of head was significantly higher (P<0.001) for lambs in the T5 followed by those in T4 and lower for animals fed T1 diet. Likewise, weight of feet was also the heaviest for T5 and the lightest for T1. Animals in T4 and T3 displayed higher pancreas weight than the animals in the other treatments.

The lightest testis (P<0.001) was observed for the control group (T1) and the heaviest for animals fed T5 diet. Gemeda *et al*. (2002) reported that testis weight differences between the animals in the different treatments may reflect the body weight differences among the different treatments. In the current study, animals fed T5 diet were superior in most of the attributes considered including body weight and ADG. Solomon *et al.* (2003) pointed out that rams supplemented with *Sesbania sesban* had higher testis weight compared to the control group. Several authors indicated that rams with larger testes size have either greater sperm production or higher daily sperm output (Cameron *et al*., 1984; Purvis *et al*., 1984 as cited by Solomon *et al.,* 2003). Schoeman and Combring (1987) also indicated that testis size serves as an indicator of ram fertility and that testis size was positively related to ewe fertility under heavy breeding pressure. Thus, herbaceous legumes and multipurpose trees can be used as a protein supplement to breeding rams to increase flock fertility. The weight of spleen is significantly higher (P<0.01) for supplemented groups than the control group (T1), but variation among the supplemented groups was not significant. Similarly, bladder and penis were significantly affected (P<0.05) by treatments. The highest weight of bladder was registered in lambs assigned in T4 and lowest for the control group.

Table 3. Non-edible offal of Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture.

Parameters weight	Treatments						
	T1	T2	T3	T4	T5	SEM	LS
Skin (g)	2000.0^{c}	2175.0^{c}	2481.7^{b}	2391.7^{b}	2771.7^{a}	61.60	***
Head (g)	1245.0^{d}	1451.7^{b}	1350.0^{c}	1505.0^{ab}	1526.7^{a}	24.71	***
Feet (g)	438.3^{d}	465.0^{c}	511.7^{b}	505.0^{b}	555.0^{a}	7.83	***
Pancreas (g)	6.7^{c}	11.8^{b}	19.9^{a}	22.3^{a}	8.5^{c}	0.84	***
Tests (g)	237.2^{c}	289.7^{ab}	319.2^{a}	303.3^{ab}	285.8^{b}	10.21	***
Spleen (g)	36.0^{b}	55.2^{a}	58.3^{a}	56.1^{a}	63.3^{a}	4.49	**
Bladder (g)	14.8^{b}	17.1^{b}	20.2^{ab}	23.8^{a}	15.9^{b}	1.93	*
Penis (g)	37.1^{c}	45.7^{abc}	42^{bc}	46.9^{ab}	51.2^{a}	2.90	*
Lung with trachea (g)	308.3	380.0	373.3	381.0	396.7	23.79	ns
Gut content (g)	5988.0^{a}	4790.0^{b}	5645.0^{ab}	5673.0^{ab}	5765.0^{ab}	333.40	*
TNEO (kg)	10.3^{bc}	9.7^{c}	10.8^{ab}	10.9^{ab}	11.4^{a}	0.38	*
TUP (kg)	13.8^{d}	16.0^{c}	17.3^{b}	17.0^{bc}	18.8^{a}	0.35	***

[a,b,c]Means within a row with different superscripts differ significantly (P < 0.05); * =(P < 0.05); ** = (P < 0.01); *** = (P < 0.001); ns= non-significant; SEM=standard error of means SL: significance level; TNEO = total non-edible offal; TUP = total usable product; T1-T5 = treatments.

The highest mean weight of penis was obtained in lambs assigned to T5 and the lightest from lambs fed T1 diet. On the other hand, supplementation did not affected weight of lung with trachea in the present study. Significant difference was observed among animals assigned to T2 and those assigned to the other treatments in weight of gut content. The heaviest gut content was from animals fed T1 and the lightest from those fed T2 (Table 9). The heaviest gut content of animals fed T1 diet may be due to the higher roughage or the poor quality feed used. This was agreed with the views of Van Soest (1994) and Pond *et al.* (1995) in that non-supplemented animals fill their gut with less digestible roughage, which would retain in the gut for a longer time to be degraded by rumen microbes.

In the case of total non-edible offal, the control group had lower total non-edible component as compared to the supplemented groups, except for animals fed T2 diets. There was no significant difference between animals in T1 and T2 in total non-edible component. There was also no significant difference among T3, T4 and T5 in total non-edible offal. Total useable products showed highly significant (P<0.001) variations among treatments. Total usable product (TUP) was significantly lower (P<0.001) for non-supplemented group than the supplemented groups, but no clear trend was observed among the supplemented groups.

4. CONCLUSIONS AND RECOMMENDATIONS

Supplementation significantly improved (P<0.001) SW, EBW, HCW, REMA, FT, and fore- and hind quarters among the treatments. Animals fed T5 diet performed better in most parameters than those fed the other treatment diets. Rib-eye muscle area was significantly higher (P<0.001) for lambs fed T5 as compared to those fed T2 and T1. Nevertheless, no significance difference was observed among those fed T3, T4 and T5 in rib-eye areas. Supplementation significantly improved (P<0.001) weights of edible and non-edible components and total usable products among the treatments. Nevertheless, no significant differences (P>0.05) were observed in reticulo-rumen, omasum & abomasums, heart fat, omental fat, kidneys, Lung with trachea and gut content among the treatments. Therefore, it can be concluded that, supplementation with forage legumes can enhance the utilization of poor quality roughages under smallholder mixed farming systems for better growth of Horro sheep. Better improvements of animal performance and carcass treats were observed in rams supplemented with 333gm LP, followed by 94gm and 200 gm CC and LP mixture, thus this feeding system can be recommended for small scale sheep fattening program. As scope of future work: despite of its high CP and OM contents, the actual feeding value of *Cajanus cajan* leaf appeared to be low in almost all traits evaluated, and demands further study to identify problems associated with its feeding value.

5. ACKNOWLEDGEMENT

The Author would like to acknowledge Oromia Agricultural Research Institute for financial support, Bako Agriculture Research Centre (BARC) for granting access to necessary facilities at the center and providing logistic support and a good intellectual environment for this research work. Finally, I thankfully recall and highly admire the help provided by Animal Nutrition Research Team of BARC in doing everything they could throughout the study period.

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