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Effects of Supplementation with Cajanus Cajan, Lablab Purpureus or Their Mixture on Feed Utilization, Growth and Carcass Characteristics of Horro Sheep Fed A Basal Diet of Natural Grass Hay

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Abstract
The experiment was conducted at Bako Agricultural Research Center during 2013/14 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 feed utilization and growth performances 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 (i.e. six animals per treatment). 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. Furthermore, 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 a 7 days of digestibility trial. Feed offered and refused and feces voided were recorded throughout the respective study period; while body weight change and body condition score were recorded at 10 days interval. 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). The mean intake of basal DM in T1 (615±23.47g/d) was greater ($P<0.01$) than in T2, T3, T4 and T5 by 150, 112.5, 104.7 and 93.7g/day in that order. The supplemented animals had higher ($P<0.001$) total DM intake (909.8-979.3g/d (SEM±23.47) than the control (740±23.47g/d). Higher ($P<0.001$) total CP intake of 138.5, 142.9, 143.8 and 145.1g/d (SEM±2.75) for T2, T3, T4 and T5, respectively were recorded than T1 (93.9±2.75g/d). Supplementation significantly improved digestibility of DM and OM ($P<0.05$) and of CP ($P<0.01$). NDF digestibility was higher ($P<0.05$) in T3 (58±2.07) and T5 (58.4±2.07), while the lowest was recorded in T2 (49±2.07). Supplementation improved ($P<0.001$) final body weight (FBW), body condition score (BCS), average daily gain (ADG). 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 utilization of nutrients and animal performance 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 production.
Keywords: Cynodon dactylon, digestibility, Horro lambs, Multi-purpose tree foliage

1. INTRODUCTION

As an integral component of the overall farming system, livestock serve as a source of draught power for crop production, supply farm families with milk, meat, manure, and serve as source of cash income, a means of transport and minimize risk during times of crop failure and it plays significant role in the social and cultural values of the society (Azage *et al*., 2010; Adane and Girma, 2008; Wint and Robinson, 2007). 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. The estimated population of sheep and goats is about 66 million heads, of which about 35 million is sheep (Negassa *et al*., 2011) and they contribute about 46% of the national meat consumption and 58% of the value of hide and skin production (Awigichew *et al*., 1991). 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 , teff (*Eragrostis tef*), noug (*Guizotia abyssinica*), 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 follows;

T1: *Cynodon dactylon* + 125gm wheat bran (WB)
T2: *Cynodon dactylon* + 125gm WB + 236gm *Cajanus cajan*
T3: *Cynodon dactylon* + 125gm WB + 199.8gm *Lablab purpureus* + 94.4gm *Cajanus cajan*
T4: *Cynodon dactylon* + 125gm WB + 133.2gm *Lablab purpureus*+141.6gm *Cajanus cajan*
T5: *Cynodon dactylon* + 125gm WB + 333gm *Lablab purpureus*

2.5. Feeding Trial

The feeding trial was conducted for 90 days following 14 days of adaptation period. The amount of feed offered and the corresponding refusal was weighed and recorded for each sheep to determine feed intake. Daily feed offered and refusals were weighed and recorded for each sheep. Representative samples of feeds offered and refusal for each animal were collected and pooled per treatment and dried in an oven at 65°C for 72 hours. The partially dried sample of the feed offered and refusals were ground to pass through a 1mm sieve screen using Wiley mill and stored in plastic bags pending chemical analysis. Mean daily DM and nutrients intake was

determined as a difference of offered and that of refused. The daily DM intake expressed as percent of body weight and metabolic body weight of an animal was calculated by dividing the mean daily DM intake during 90 days of experimental period with respective body weight of sheep taken in the same period by employing the following formula:
Total DM intake (percent body weight) = DM intake (g)/ Body weight (kg) *100.
Total DM intake (metabolic body weight (g/kg$W^{0.75}$) = DM Intake (g)/$BW^{0.75}$ (kg).

2.6. Digestibility Trial

Following the feeding trial, the digestibility trial was conducted with the same animals used in the feeding trial. All experimental animals were harnessed with fecal collection bags for three days of adaptation period before the resumption of actual collection of fecal for seven days for the determination of digestibility. During the 7 days of the trial, daily total fecal output of each animal was weighed individually and recorded daily each morning before offering feed. The feces were then mixed thoroughly and 20% of the daily fecal output was taken and bulked across the experimental period to form a weekly fecal composite sample for each animal and kept in dip freezer at -20°C. On the last day of the collection period, the composite fecal samples were thawed and thoroughly mixed and a subsample was taken. Samples of feed offered and feed refused were also collected every day and sub-sampled at the end of the experiment. The composite sub-samples were dried in an oven at 65ºC for 72 hours to a constant weight. Partially dried fecal samples were ground to pass through a 1 mm sieve screen using Wiley mill and stored in airtight plastic bags pending chemical analysis. Samples of experimental feeds, refusals and fecal were taken to Holeta Agricultural Research Center Nutrition Laboratory for chemical analysis. The digestibility of DM and nutrients was determined as the difference between nutrients intake and that recovered in feces expressed as a proportion of nutrient intake.

The apparent digestibility co-efficient (DC) of DM and nutrients were calculated using the equation of McDonald *et al*. (2002) as follows;

$$\%DC = \frac{\text{Total amount of DM or nutrients in feed} - \text{Total amount of DM or nutrients in feces}}{\text{Total amount of DM or nutrients in feed}} \times 100$$

Digestible organic matter contents of treatment feeds was estimated by multiplying the OM content of feed by its digestibility coefficient.

The estimated metabolizable energy intake of sheep from treatment feeds was calculated using the formula:
ME (MJ/Kg DM) = 0.016 X DOMD, Where DOMD = is gram digestible organic matter per kilogram dry matter.

2.7. Body Weight Change and Feed Conversion Efficiency

The initial body weight of each animal was taken at the beginning of the trial and every 10 days interval during the 90 days to determine body weight change during the experimental period of the feeding trial. All animals were weighed after they were denied access to feed by removing feed not consumed until 6:00 pm on the day before the weighing day using spring balance (sensitivity of 100 gm). Average daily body weight gain was calculated as the difference between the final and initial body weight of the animals divided by the number of feeding days. Feed Conversion Efficiency (FCE) of the animals was determined as the proportion of daily weight gain to the total DM intake. Feed conversion efficiency (FCE) and feed conversion ratio (FCR) were calculated according to Gulten *et al.* (2000) and Brown *et al.* (2001) as follows:

2.8. 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.

2.9. 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;

Yij = response variable
μ = overall mean
ti = treatment effect
bj = block effect
eij = random error
Correlation analysis was employed to determine the relationship strength between the nutrient intake and its digestibility, live weight change and feed conversion efficiency.

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. Dry Matter and Nutrient Intake

Significant differences (P< 0.001) were observed among treatments in the mean daily DM and nutrient intakes (Table 2). The mean basal DM intake of the control group (T1) was greater (P<0.01) than the supplemented groups. However, the basal DM intake among the supplemented treatments was similar. This might be associated with the availability of CP in their diets. That means lambs offered with feed having low CP and high fiber content (T1) consumed relatively more CD hay to meet their nutrient requirements.

Table 2: Average dry matter and nutrient intake of Horro sheep fed *Cynodon dactylon* alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture

Parameters	Treatments						
	T1	T2	T3	T4	T5	SEM	LS
Dry matter intake							
Basal DM (g/d)	615.0^{a}	465.0^{b}	502.5^{b}	510.3^{b}	521.3^{b}	23.47	**
Supp. DMI (g/d)	0.0^{e}	236.0^{d}	294.0^{b}	274.5^{c}	333.0^{a}	0.0	***
Total DM (g/d)	740.0^{d}	825.5^{c}	921.5^{ab}	909.8^{b}	979.3^{a}	23.47	***
DM (%BW)	3.2	3.3	3.5	3.5	3.4	0.10	ns
DM (g/kg$W^{0.75}$)	70.3^{b}	74.4^{ab}	79.0^{a}	78.2^{a}	79.2^{a}	2.03	*
Total nutrient intake							
CP (g/d)	93.9^{b}	138.5^{a}	142.9^{a}	143.8^{a}	145.1^{a}	2.75	***
OM (g/d)	665.3^{c}	752.0^{b}	836.0^{a}	826.0^{a}	886.5^{a}	20.85	***
ME (MJ/d)	6.4^{d}	7.1^{c}	8.2^{b}	8.0^{b}	9.0^{a}	0.18	***
NDF (g/d)	500.3^{c}	490.3^{c}	551.0^{ab}	545.4^{b}	586.9^{a}	13.61	***
ADF (g/d)	316.9^{b}	318.5^{b}	350.6^{a}	349.8^{a}	369.0^{a}	8.83	**
ADL (g/d)	42.7^{c}	52.8^{b}	57.9^{a}	57.5^{a}	60.9^{a}	1.48	***
Ash (g/d)	74.7^{c}	73.5^{c}	85.5^{b}	83.7^{b}	92.8^{a}	2.39	***
HC (g/d)	183.5^{cd}	171.8^{d}	200.3^{b}	195.6^{bc}	217.9^{a}	5.09	***
Digestible (D) nutrient intake (g/d)							
DDM	427.3^{b}	455.1^{b}	546.1^{a}	537.2^{a}	586.8^{a}	21.44	***
DCP	52.4^{b}	88.2^{a}	92.7^{a}	92.1^{a}	90.6^{a}	2.75	***
DOM	401.5^{b}	442.6^{b}	521.3^{a}	509.3^{a}	553.7^{a}	19.22	***
DNDF	287.2^{b}	236.1^{a}	303.1^{a}	293.7^{a}	329.8^{a}	17.15	*
DADF	166.5	163.1	180.2	175.6	192.8	10.96	ns

^{a,b,c}Means within a row with different superscripts differ significantly (P < 0.05); * =(P < 0.05); ** = (P < 0.01); *** = (P < 0.001); SEM=standard error of means; SL= significance level; ns = non-significant; WB = wheat bran; DM=dry matter; BW = body weight; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; HC=hemi-cellulose; ADL = acid detergent lignin; ME= metabolisable energy; CD = *Cynodon dactylon;* CC=*Cajanus cajan*, LP=*Lablab purporeus;* T1=control (*CD*)+125gm WB; T2= T1+ 235.5gm CC; T3= T1 + 199.8gm LP + 94.2gm CC mix; T4= T1 + 133.2gm LP + 141.3gm CC mix, T5= T1 + 333gm LP.

The basal DM intake in T1 of the current study was higher compared to results reported by Assefu (2012) who used similar breeds of sheep used in the current study. The author fed proportion of concentrate in the fed rations containing different roughage to concentrate ratio.

In the present study, no significant difference was observed in the intake of wheat bran since equal amounts (125 gm) were offered across the treatment. No refusal was recorded in case of wheat bran as both groups (supplemented and non-supplemented groups) consumed the amount offered. There were significant (P<0.01) differences in supplement DM intake among the supplemented treatments. The highest DM intake was observed for lambs offered with T5 followed by T3. This is because of the difference in the CP content of the diets, since the amount of offer was on its nitrogenous basis. Thus, the dry matter offer amount for CC was lower than LP supplemented groups because of the relatively higher CP content in CC. The total DM intake in the current study was significantly (P<0.001) different among treatments in which supplemented (T2-T5) lambs consumed more total DM than the control group.

Significant (P<0.001) differences were also observed in total DM intake among the supplemented groups. Animals fed T5 (sole LP supplement) diet had higher total DM intake followed by T3 (and LP with CC combination in the proportion of 60% LP and 40% CC supplement) diet. T2 had lower total DM intake among the supplemented groups. This may indicate that supplementing CD hay with herbaceous legumes is more beneficial than supplementing with multipurpose fodder trees. Seid and Tolera (1993) reported that legumes supplementation improves voluntary feed intake. Similarly, Bonsi *et al.* (1996) reported that supplementation with a protein source increased total DM intake in sheep. Adugna and Sundstøl (2001) reported that supplementation with graded levels of desmodium hay improved total DM intake of sheep fed maize stover as a basal diet.

In agreement with the result of the present study, Melese *et al.* (2012) reported higher total DM intake in sheep supplemented with non-conventional feeds, but decreased intake of the basal diet because of the substitution effects of the concentrate supplements.

No significant difference (P>0.05) was observed in total DM intake as a percent of body weight among treatments. Results obtained were comparable with the values (ranging from 3.3 to 3.97 %) reported by Melese *et al.* (2012) and within the range of 2.5 to 3.9 % reported for various breeds of sheep and goats in the tropics (Devendra and Burns, 1983). Similarly, Yeshambel *et al.* (2012) reported total DM intake as percent body weight of 3 to 4% for Washera sheep fed mixtures of lowland bamboo (O*xytenanther abyssinica*) leaves and natural pasture grass hay at different ratios, which is in agreement with the current findings. Total DM intake across the feeding period has showed an increment for both supplemented and control groups (Figure 1).

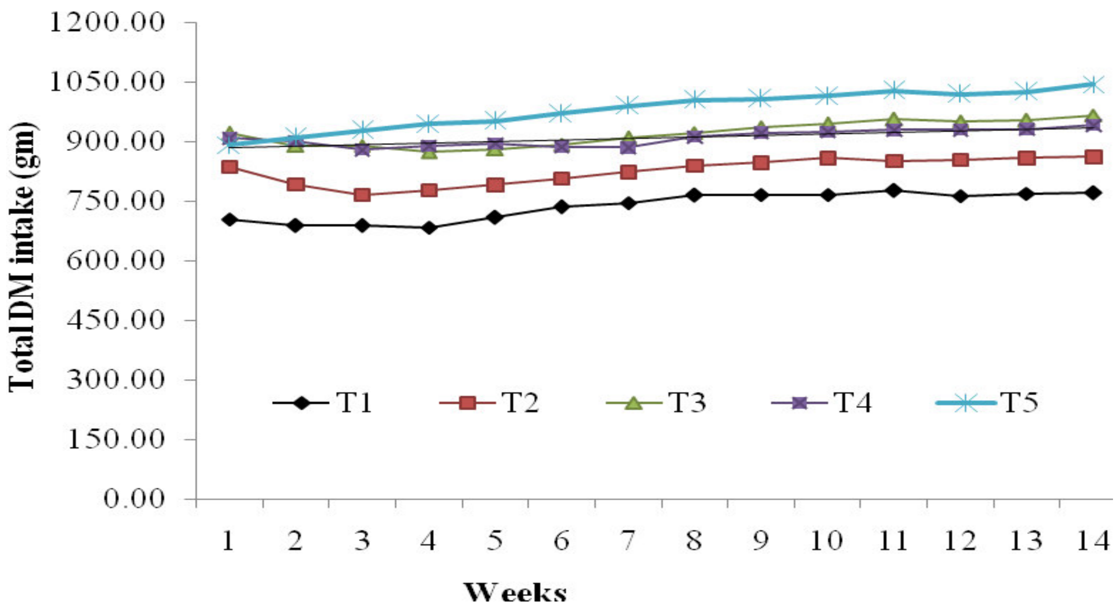

Figure 1: Trends in total dry matter intake of Horro lambs fed *Cynodon dactylon hay alone* or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture.

The total DM intake per unit metabolic body weight was significantly higher (P<0.05) for T3, T4 and T5 compared to T2 and T1. No significant difference was observed between T1 and T2. The results obtained (70.7 to 79.2gm/kg) in the current study was comparable to the 67.5 to 84.6gm/kg reported by Melese *et al.* (2012). Ewnetu (1999) also reported higher total DM intake per unit of metabolic body weight for Menz (75.5gm/kg) and Horro (78.3gm/kg) rams supplemented with 300 gm/day concentrate feeds. In previous studies (Nigussie *et al.,* 2000) showed improved feed intake in Ethiopian Highland sheep fed chickpea haulms and supplemented with different levels of leucaena (*Leucaena leucocephala*) leaf hay which is in agreement with the present study. Therefore, from these investigations it can be concluded that supplementation improves total DM intake of animals fed on poor quality basal diets. Dry matter intake is considered as an important factor in the utilization of roughage by ruminant livestock and is a critical determinant of energy intake and performance in small ruminants (Devendra and Burns, 1983).

Intake of CP was significantly affected (P<0.001) by treatment, it was higher in supplemented groups compared to the control group. However, no significant difference was observed among the supplemented groups. Absence of differences in CP intake among the supplemented groups could be attributed to the uniform amount of CP in supplementary feed offered. Even though, non-significant differences were observed among the supplemented groups in CP intake, an increasing trend was observed from T2 to T5.

The values of the CP intake in this study were higher than the values that ranged from 90.0-108.9gm/day reported by Yeshambel *et al.* (2012). According to Ranjhan (1997), the average daily CP requirement for maintenance of a sheep weighing 30kg was reported to be 36gm. From this it can be said that both the control and supplemented groups had likely received CP more than their maintenance requirement. According to Osuji *et al*. (1995), leguminous fodder trees increase protein supply to the host animal by creating a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis. Solomon *et al.* (2003) reported lower level of CP intake (8.3 - 11.2%) as percent of daily DM intake in animals supplemented with LP than other multipurpose trees *(L. pallid and S. sesban)* which is inconsistent to the present study. The possible reason for these differences in intake could be due to species differences as well as the quality of the legumes used and other factors that might–hinder feed intake like environments such as high temperature, ways of conservation mechanism from harvesting to feeding of the forage. Because of their higher CP concentrations, legumes hay supplementation increase N intake (Jamie *et al.,* 2009).

Intake of OM was significantly higher (P<0.001) in the supplemented groups as compared to the control group (T1). With the exception of T2 which had lower value, the value of OM observed in T3, T4, and T5 were not statistically different. Becholie *et al*. (2005) reported that supplementation with a protein source (tagasaste) increased total DM, OM, CP, and ADL intake in lambs fed a basal diet of grass hay. Significantly lower (P<0.001) ME intake was recorded in T1 than the supplemented groups. The highest value was recorded in T5 and the lowest in T2 among the supplemented groups. In the present study, the values of ME intake was higher than 5.2 to 6.4 MJ reported by Yeshambel *et al*. (2012) in Washera sheep fed mixtures of lowland bamboo (O*xytenanthera abyssinica*) leaves and natural pasture grass hay at different ratios. Ranjhan (1997) reported that the average energy requirement for maintenance of the sheep weighing about 30kg was 4.017 MJ ME. Similarly, McDonald (2002) estimated ME requirement of sheep weighing about 20kg and growing at a rate of 50gm per day are about 3.9 MJ for maintenance and 4.8 MJ for maintenance and growth. Therefore, values of ME intake reported in the current study for all treatments are likely above the required amounts for maintenance.

Higher (P<0.01) ADF intake were observed for the supplemented groups than T1, but no significant difference (P>0.05) was observed between T2 and the control group (T1). This might be due to the amount of fiber fractions that existed in the treatment feed which might have increased with the increasing amount of total DM intake in the supplemented groups. Total NDF intake was lower (P<0.001) for T1 than the supplemented groups, except in T2. There were significant differences (P<0.001) in the intake of Ash and HC among the treatments. Ash intake was highest for T5 and lowest for T2, whereas intermediate values observed for the other treatments. Similar trends were observed for the intake of HC. Significant difference (P<0.001) was observed in DCP intake. It was higher in the supplemented groups than the non-supplemented group (T1). On the other hand, no difference (P>0.05) was observed in DCP intake among the supplemented groups. Similarly, the intake of DDM and DOM were higher (P<0.001) in supplemented groups than in the control group (T1), except for T2 which was statistically similar values with the control treatment (T1). There was no significant (P>0.05) difference in DADF intake among the treatments. However, the lowest in take was recorded in T2 followed by the control group (T1). In line with the current findings, Akinyemi *et al.* (2010), Yeshambel *et al.* (2012) and Belete *et al.* (2013) noted significantly higher intake of crude protein, organic matter, metabolizable energy, dry matter and nutrient digestibility when lambs/kids were supplemented with herbaceous and multipurpose fodder legumes and other concentrate feeds.

3.3. Dry Matter and Nutrient Digestibility

The apparent digestibility coefficient of DM and OM were significantly different (P<0.05) among the treatments (Table 3). Lower digestibility of DM and OM was recorded for the control group as compared to the supplemented, except group of animals consumed T2 diet. No significant difference was observed between animals in T2 and T1 both in DM and OM digestibility. Similarly, no significant difference (P>0.05) was observed among the animals in T3, T4 and T5 concerning DM and OM digestibility. In line with the current findings, Getahun (2014) reported that lambs supplemented with 300gm/day of leucaena to untreated wheat straw significantly increased the apparent digestibility coefficients of DM and OM compared to the sole untreated straw. Umunna *et al*. (1995) also reported that sheep fed oat hay and supplemented with lablab, sesbania, tagasaste or wheat middling's showed improved DM and OM digestibility. Conversely, Assefu (2012) and Yeshambel *et al.* (2012) reported non-significant differences on the apparent digestibility of the same parameters among the supplemented and control treatments in Horro and Washera lambs fed feeds containing different roughage to concentrate rations, which could be an attribute of the types of supplements used.

Table 3: Nutrient digestibility coefficient (%) in Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture

Parameters	Treatments						
	T1	T2	T3	T4	T5	SEM	LS
DMD	57.7[b]	56.6[b]	62.5[a]	60.6[ab]	62.9[a]	1.35	*
OMD	60.4[b]	60.4[b]	65.7[a]	63.3[ab]	65.6[a]	1.38	*
CPD	55.9[b]	64.9[a]	68.4[a]	65.9[a]	68.3[a]	1.85	**
NDFD	57.4[a]	49.4[b]	58.0[a]	55.0[ab]	58.4[a]	2.07	*
ADFD	52.6	47.0	54.3	51.4	54.3	2.48	ns

[a,b]Means within a row with different superscripts differ significantly (P < 0.05); * =(P < 0.05); ** = (P < 0.01); SEM = standard error of mean; SL = significance level; DMD = dry matter digestibility; OMD = organic matter digestibility; CPD = crud protein digestibility; NDFD = neutral detergent fiber digestibility; ADFD = Acid detergent fiber digestibility; T1-T5 = Treatments.

Significant differences (P<0.01) were observed in digestibility of CP among the supplemented and non-supplemented groups in the current study. Animals of the supplemented groups had higher digestibility of CP than those animals in the control group. No significant difference and clear trend were observed among the supplemented groups in digestibility of CP. However, lambs fed T3 and T5 had higher values in digestibility of CP. This was attributed that as the concentration of LP increase in the supplement diets the digestibility of CP was increased.

The significant improvement of CP digestibility in the supplemented groups as compared to the control group is in agreement with literature reports (Tesfaye, 2007; Tewodrose, 2011; Yeshambel *et al.*, 2012; Getahun, 2014). The current result is also in agreement with research results reported by Berhanu *et al.* (2014). The authors reported higher digestibility of CP for supplemented groups compared to the non-supplemented group in Washera sheep breed fed with natural pasture hay as basal diet and supplemented with *Millettia ferruginea* (Birbra) foliage.

The difference in digestibility of CP obtained between supplemented and control groups in the current study could be due to the presence of high CP content in the diets of the supplemented groups compared to control group. Akinyemi *et al.* (2010) also observed higher CP digestibility in animals supplemented with '*Moringa'* than in the control group. The likely explanation may be *Moringa* fodder consists more degradable components especially crude protein. Yeshambel *et al.* (2012) reported that inclusion of lowland bamboo leaf hay significantly improved CP digestibility as compared to sole natural pasture grass hay in lambs of Washera sheep breed. Devendra (1982) also stated that supplementation with forage legumes increased the digestibility of poor-quality roughages. According to McDonald *et al*. (2002) protein rich feeds promote high microbial population in the rumen and also facilitate rumen fermentation. The authors also suggested that high CP intake is usually associated with better CP digestibility.

Significant differences (P<0.05) were observed in the digestibility of NDF among the different treatments. The lowest digestibility of NDF was recorded in T2, while the highest was recorded in T5 followed by T3. Almost comparable values were obtained in T3 and T5 (Table 3). Apparent digestibility of ADF was not significantly different (P>0.05) between control and supplemented groups. Though, no significant differences were observed among the treatments in case of ADF digestibility, animals in T2 had the lowest value preceded by those in T1. Similar to that of NDF, apparent digestibility of ADF was higher in T3 and T5. Similar to the present finding, Yeshambel *et al.* (2012) reported non-significant results on apparent digestibility of ADF between the supplemented and the control groups in Washera sheep fed mixture of lowland bamboo (*Oxytenanthera abyssinica*) and natural pasture grass hay. In contrary to the current study and that of Yeshambel *et al*. (2012) findings, Assefu (2012) reported significant (P<0.05) improvement in digestibility of ADF in Washera sheep breed consumed feeds containing different roughage to concentrate rations. The lacks of significant difference on the apparent digestibility of NDF and ADF among the supplanted and control treatments were attributed to the existence of some limiting factors in the supplementary diets such as condensed tannins that prevent the rumen microorganisms to efficiently utilize the fiber thereby hindering the digestibility of nutrients.

Despite the lower NDF and ADF concentrations in CC than LP in the present study, which may have attributed to improved digestibility of these fibers in CC supplemented diet than in LP, lower digestibility of NDF and ADF were observed in those animals fed T2 diet. Jamie *et al,* (2009) suggested that CC hay supplementation increased N retention, but did not improve DM intake and it reduced DM and nutrient digestibility. This indicated that higher existence of some limiting factors in the CC supplement diet than sole LP or a mixture of CC and LP.

3.4. Body Weight Change and Feed Conversion Efficiency

Mean initial body weight (IBW), final body weight (FBW), body weight change (BWC), average daily gain (ADG), feed conversion efficiency (FCE) and feed conversion ratio (FCR) were presented in (Table 4). Significant differences (P<0.001) were observed in all attributes considered among the different treatments. Lambs fed T5 diet had significantly higher (P<0.001) FBW than those animals in the other treatments. They were heavier by 5.4, 3.8, 2.1 and 2.1 kg than those fed T1, T2, T3 and T4 diets, respectively. The FBW of animals fed T3 and T4 diets were similar. Likewise, animals fed T5 diet displayed higher final body condition score than animals fed T2 and control group. The growth rate (ADG) of animals fed T5 was higher as compared to those fed the other treatment diets. They grew more by 59.6, 42, 25.2 and 22.6 g/day than the control, T2, T3 and T4 groups.

In agreement to this result, increased live weight gain of Horro sheep supplemented with different levels of concentrate on a basal diet of barley (mosnoo) straw was reported (Gemeda *et al*., 2003). Similarly, Gemeda *et al.* (2007) reported that live weight gain and body condition score were improved (P<0.05) with level of concentrate supplementation in the same sheep breed fed natural grass hay as basal diet. It was also reported for same sheep breed used in the current study and the study conducted by Gemeda *et al*. (2007) that supplementation with higher level of wilted *Leucaena pallid* leaf (410g/h/d) and 150g/h/d ground maize or maize-noug at a level of 300g/h/d had improved final body weight, total weight gain and average daily gain (Takele *et al.,* 2004). In disagreement to the results of the current findings, Temesgen *et al*. (2007) reported non-significant effect of CD hay supplemented with cowpea hay (*V. unguaculata*) and noug cake at different proportion on body weight change of yearling Horro rams.

Table 4: Body weight change and feed conversion efficiency of Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan, Lablab purpureus* or their mixture

Parameters	Treatment						
	T1	T2	T3	T4	T5	SEM	LS
Initial body weight	20.7	20.8	20.9	20.7	20.8	0.32	ns
Initial body condition score	2.75	2.75	2.83	2.83	2.75	0.10	ns
Final body weight (kg)	23.2[c]	24.8[bc]	26.5[b]	26.5[b]	28.6[a]	0.69	***
Final body condition score	3.08[c]	3.42[bc]	3.75[ab]	3.75[ab]	3.92[a]	0.13	***
Body weight change (kg)	2.5[c]	4.0[bc]	5.6[b]	5.8[ab]	7.8[a]	0.70	***
Average daily gain (g/d)	27.8[c]	45.4[bc]	62.2[b]	64.8[ab]	87.4[a]	7.74	***
Feed conversion efficiency	0.04[c]	0.05[bc]	0.07[ab]	0.07[ab]	0.09[a]	0.008	**
Feed conversion ratio	32.2[a]	24.4[b]	16.2[bc]	14.6[c]	11.9[c]	3.40	***

[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; T1-T5 = treatments.

Chala *et al*. (2004) who supplemented Horro steers with different concentrate feeds (ground maize grain and molasses as supplement with noug cake) also reported lack of significant difference among the supplemented and the non-supplemented groups in final body weight gain, total body weight gain and average daily weight gain. The values of ADG observed for supplemented groups in the current study were considerably higher than the highest value (36.7 gm/day) of ADG achieved at higher level of lowland bamboo leaf hay inclusion in Washera lambs fed mixtures of lowland bamboo leaf hay and natural pasture grass hay at different proportion (Yeshambel *et al.,* 2014) and the highest ADG value 47.2gm/day reported by Getahun (2014) for the Ethiopian highland sheep supplemented with 300g/day leucaena on urea treated and untreated straw. Similarly, lower ADG values (ranged from 33.3 to 58.7gm/day for Horro lambs and 40.2 to 48.7gm/day for Washera lambs) were reported by Assefu (2012) for lambs fed rations containing different roughage to concentrate ratios. The highest ADG value (87.4 g/d) observed in lambs fed T5 diet in the present study was within the range of the ADG values (ranged from 69.1-104.1g/day) reported by Belete *et al.* (2013) for Arsi-Bale kids supplemented with graded levels of pigeon pea in dry season. Likewise, comparative results of ADG values of 72 to 75gm/day was reported for Horro lambs supplemented with 300 gm/day concentrates to the basal diet of natural grass hay by Galal *et al*. (1979) and Demissie *et al*. (1987). The positive ADG observed for the control treatment is due to the supplementation with wheat bran. In the current study, an increasing trend was observed in body weight change from T1 to T5 (Figure 2) and animals fed T1 diet were lighter by 5.4kg than those fed T5 diet.

In the current study, FCE was significantly higher (P<0.01) for supplemented than the control groups (T1). Lambs fed T5 had higher (P<0.01) FCE than lambs fed T1 and T2 diets. Nevertheless, no significant difference (P>0.05) was observed among T2, T3 and T4. On the other hand, control treatment was significantly higher (P<0.001) in FCR than supplemented treatments. Lambs fed T5 had scored lower FCR value followed by lambs that assigned to T4, while comparable values were recorded for T2 and T3. Brown *et al. (*2001) pointed out that animals that have a high FCE and low FCR are considered as efficient users of feed. From this point of view, lambs fed with T5 diet was the best feed converters flowed by T4, T3 and T2. Similar findings of improved FCE in supplemented groups versus non-supplemented group were reported in literature (Biru, 2008;

Tewodros, 2011; Yeshambel *et al.,* 2012; Getahun, 2014).

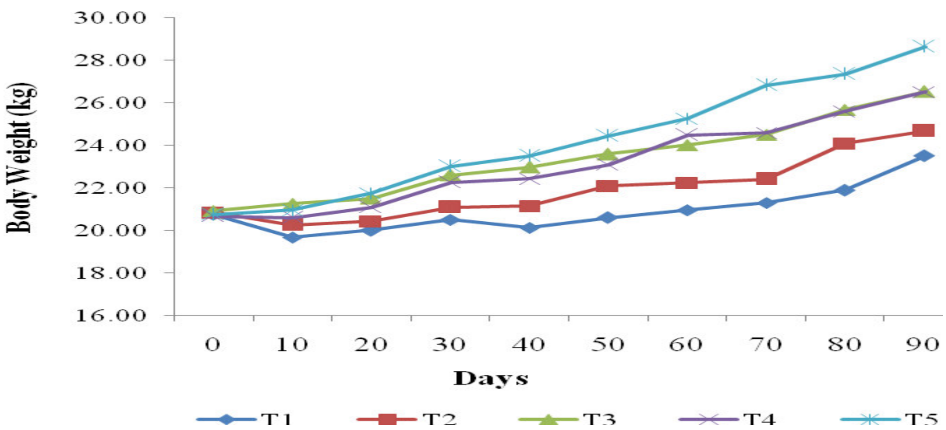

Figure 2: Trends in live weight of Horro Lambs fed *Cynodon dactylon* or supplemented with *Cajanus cajan, Lablab purpureus* and their mixture.

Generally, the results of the current study demonstrated that supplementation of forage legumes (CC and LP) to CD hay could improve FBW, BWC, ADG and FCE. Regardless of high N_2 concentration in CC leaf, low value of BWC, ADG and FCE were observed in lambs supplemented with sole CC supplement diet (T2) as compared to those animals supplemented with sole LP (T5) and/or combination of the two legumes supplement diet (T3 and T4).

4. Conclusion

From the results of the current study, supplementation with *Lablab purpureus* (LP) and *Cajanus cajan* (CC) of natural grass hay were significantly improved in almost all traits evaluated. Despite high N and OM concentration and relatively lower fiber fractions (NDF and ADF) in CC leaf, the actual feeding value was appeared to be low as compared to LP hay. This might be due to the presence of anti-nutritional factors in CC leaf that might have imposed limitations on the utilization of its CP, so demands further study to identify problems associated with its feeding value. On the other hand, this result were clearly showing potential significance of LP over CC in improving the nutritive value of low quality feed when supplemented in ruminant animal's diet. 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 utilization of nutrients and animal performance were observed in rams supplemented with 333gm LP, followed by 94gm and 200 gm of CC and LP mixture, thus this feeding system can be recommended for small scale sheep production.

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