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Supplementary value of two *Lablab purpureus* cultivars and concentrate mixture to natural grass hay basal diet based on feed intake, digestibility, growth performance and net return of Horro sheep

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This study was undertaken with the aim to determine the supplementary value of Beresa-55 and Gebisa-17 cultivars and concentrate mixture to a basal diet of natural pasture hay based on growth performance, feed utilization, digestibility and net return of Horro sheep. A total of twenty five yearlings Horro sheep were stratified into five groups based on initial body weight in randomized complete block design and animals were assigned to the dietary treatments randomly: (T1) (Control): ad-lib natural grass + concentrate mixture at 2% BW, (T2): ad-lib natural grass + Gebisa-17cultivar at 1.5% BW, (T3): ad-lib natural grass + Gebisa-17 cultivar at 2% BW, (T4): ad-lib natural grass + Beresa-55 cultivar at 1.5% BW and (T5): ad-lib natural grass + Beresa-55 cultivar at 2% BW. Basal hay DM intake was relatively higher in T2 and T4, while total DM and CP intake was higher in T1 and T5. Similarly, significantly higher digestibility of DM, CP and organic matter (OM) was obtained in T1 and T5. Dietary treatments also significantly (P<0.01) influenced the weight gain of lambs. Lambs in T1 and T5 had shown better (P>0.01) weight gain and enhanced comparable growth performance than in the other treatments. However, partial budget analysis indicates that, T5 is more profitable and thus, can be used as a priority supplement in feeding of Horro sheep.

Key words: Horro sheep, *Lablab purpureus,* weight gain, digestibility, feed intake.

INTRODUCTION

Small ruminant production is an important agricultural activity and has a substantial contribution to smallholder farmers in generating income and securing food in developing countries (Kosgey et al., 2006). In Ethiopia, like other developing countries in sub Saharan Africa, small ruminant production is a major component of the livestock sector. According to CSA (2016) report, the total small ruminant population in Ethiopia is estimated to be

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about 60.9 million, out of which 30.7 million (about half) own sheep. Reports of Gizaw et al. (2013) indicated that, at the smallholder level, sheep are the major source of food security serving a diverse function including cash income, savings, cash for fertilizer purchase and socio-cultural functions.

Although, the contribution of sheep to the household economy is considerable, in the country however, their production is characterized by low productivity levels in terms of growth rate, meat production and reproductive performance (Adugna et al., 2000). Although, there are various and complex constraints which contribute to these reduced productivity of sheep, inadequacy of feed in terms of both quality and quantity is considered to be the most important limiting factor (Adane and Girma, 2008).

Maximization of livestock productivity in the tropical region largely depends on the efficiency of utilization of locally available protein sources (Kaya et al., 2006; Gul et al., 2010; Mulat et al., 2011). Concentrate feed resources especially grains are expensive and highly valued as human food. Therefore, it is imperative to look for other cheap and alternative feedstuffs to sustain and improve ruminant productivity. According to FAO (2002) suggestion, 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. In this regard, the use of leguminous forage crops such as *Lablab purpureus* capable of yielding quality herbage is crucial.

Gebisa-17 and Beresa-55 cultivar of *L. purpureus,* proved to produce high yields of dry matter, was released as a new variety for the study area as well as agro-ecologies similar to the study area. However, they contribute little to the much needed improvement of livestock production, because data regarding the supplementary value of these cultivars was scarce. With this in mind, this study was carried out to evaluate the supplementary value of these cultivars (Beresa-55 and Gebisa-17) and concentrate mixture supplemented on Horro sheep kept on basal diet of natural grass hay in varied levels in growth performance, feed utilization efficiency, digestibility and net return.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Bako Agricultural Research Center (BARC). The location represents mid-altitude sub-humid maize growing agro-ecology of western Oromia, Ethiopia. The center is situated at latitude and longitude 9°06'N and 37°09'E, respectively, and it lies at an altitude of 1650 m above sea level with a mean monthly minimum and maximum temperatures of 11.23 and 31.74°C, respectively. During the study period, the area receives an annual rainfall of about 1316.7 mm where the highest rain was received between May and September.

Experimental feed preparation

Natural pasture grass was harvested manually from a naturally available grazing land found in the Center (Bako Agricultural Research Center) when it reached 40 to 50% flowering stage. Whereas, two newly released cultivars of *L. purpureus* labeled Beresa-55 and Gebisa-17 were established on about 0.5 hectare of land at livestock farm land of the center in early June 2016 cropping season. It was harvested at 50% flowering, chopped with chopping machine to 3-5 cm length, field-cured 2-3 days, baled and stored in a roofed hay barn. Wheat bran (WB) and linseed cake (LSC) sufficient for the entire experimental period were purchased and stored at animal farm feed storage site.

Experimental design and treatments

Randomized complete block design was used for the study in which experimental lambs were blocked in to five groups each containing five lambs. Grouping of lamb into the respective blocks were done based on their initial live weight taken in the morning before feeding and watering. The natural pasture grass composed of mainly *Cynodon dactylon*, which is a common diet that the livestock in the study area graze, this was fed *ad libitum* (allowing for a 20% refusal on DM basis). However, supplemental feeds were offered on body weight basis considering 1.5 and 2%. The composition of linseed cake (LSC) and wheat bran (WB) was calculated based on their CP content obtained from laboratory analysis with the proportions, LSC 30%; WB 70%, chosen to provide 19.93% CP to make it isonitrogenous level with one of the cultivar containing higher CP, Beresa-55 cultivar contained 19.93% CP.

Amount of supplemental feeds were adjusted every fifteen (15) days according to the body weight change. Therefore, the dietary treatments were: *Ad-lib* natural grass + concentrate mixture at 2% BW (T1); *Ad-lib* natural grass + Gebisa-17cultivar hay at 1.5% BW (T2); *Ad-lib* natural grass + Gebisa-17cultivar at 2% BW (T3); *Ad-lib* natural grass + Beresa-55 cultivar at 1.5% BW (T4) and *Ad-lib* natural grass + Beresa-55 cultivar at 2% BW (T5).

Experimental animal and their management

A total of twenty five (25) yearling Horro Lambs weighing initial body weight of 18.5 ±1.99 kg (mean ± standard deviation) were purchased in two rounds from the local market in Gobu Seyo District, western Oromia, Ethiopia. All lambs were ear tagged for ease of identification, de-wormed with antihelmintics (Fasionox 250 mg) to control internal parasites and sprayed with accaricides (Betazone diluted at 1.6 ml/L of water) for external parasites control as prescribed by the manufacturer before the commencement of the trial on their arrival at the center. At the end of the quarantine period, all lambs were tied in to their respective individual pens and offered the experimental diet for 15 days to get them accustomed to the experimental feeds before commencing the actual feeding trial lasting for 90 days.

Measurements and observations

Feeding trial

At the end of the adaptation period, the actual feeding trial took place by offering the experimental diet for 90 days. Experimental diets were offered as per the respective treatment in two equal portions at 08:00 and 16:00 h, respectively. For each experimental lamb, the amount of feed offered and the corresponding refusals were recorded daily to measure daily feed intake as a difference between feed offered and refused over the experimental period.

Samples of feed offered and refusal were pooled per treatment, thoroughly mixed and sub sampled at the end of the experiment for chemical analysis. Data on feed intake was taken on daily basis. The daily DM intake expressed as percent of body weight and metabolic body weight of lambs were calculated by dividing the mean daily DM intake during 90 days of experimental period with respective body weight of lambs taken in the same period by employing the following formula:

$$\text{Total DM intake (percent body weight)} = \frac{\text{DM intake (g)}}{\text{Body weight (kg)}} \times 100$$

$$\text{Total DM intake (metabolic body weight (g/kgW}^{0.75}) = \frac{\text{DM intake (g)}}{\text{BW}^{0.75}\text{ (kg)}} \times 100$$

Digestibility trial

Digestibility trial was started following the completion of the growth trail. Before the commencement of the actual digestibility trial, lambs in all groups were fitted with fecal collection bags and allowed to adapt for three days. Thereafter, the actual data collection was followed for another 7 days. Within these days, excreted feces were collected, weighed, recorded and thoroughly mixed per day from each lamb separately. Then, twenty percent (20%) of these daily fecal outputs of each lamb were sub-sampled and pooled in plastic bags and stored deep frozen at -20°C. The daily obtained sub-samples were thoroughly mixed and pooled for individual lamb at the end of digestibility trial for chemical analysis. The apparent digestibility coefficients of nutrients and estimated metabolizable energy intakes were calculated by using the equation of McDonald et al. (2002):

$$\text{Apparent digestibility coefficient (\%)} = \frac{\text{Nutrient in feed} - \text{Nutrient in feces}}{\text{Nutrient in feeds}} \times 100$$

Estimated metabolizable energy intakes of lambs from experimental feeds were also estimated using the formula: ME (MJ Kg^{-1} DM) = DOMD × 0.016: Where DOMD is gram digestible organic matter per kilogram dry matter. Digestible organic matter contents of treatment feeds were estimated by multiplying the OM content of feed by its digestibility coefficient.

Body weight change

Lambs in all groups were weighed on the first day of the actual feeding trial to get their initial body weight. Thereafter, weight record was taken every fifteen (15) days interval in the morning before the morning feeding and watering. Average daily BW gain, FCE and FCR for each lamb were determined using the following equation (Gulten et al., 2000; Brown et al., 2001):

$$\text{Average daily BW gain} = \frac{\text{Final body weight - initial body weight}}{\text{Number of feeding days}}$$

$$\text{FCE} = \frac{\text{Body weight gain (g/day)}}{\text{Body weight gain (g/day)}}$$

And

$$\text{FCR} = \frac{\text{DM intake (g/day)}}{\text{DM intake (g/day)}}$$

Chemical analysis

Chemical analyses of the experimental feeds and feces were conducted at Holeta Agricultural Research Center National Animal Nutrition Laboratory, Holeta, Ethiopia. Samples of feeds offered, refusals and feces were collected, dried in an oven at 65°C for 72 h and ground to pass through 1 mm sieve screen size. Dry matter (DM), nitrogen content (N) and ash were analyzed according to AOAC (2005) procedure, and organic matter (OM) was calculated by deducing the value of ash content from 100. Crude protein (CP) was estimated by multiplying N value by a factor of 6.25 as N × 6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the procedures of Van Soest et al. (1991). The *in vitro* DM (IVDMD) digestibility was determined using Tilley and Terry (1963) method.

Partial budget analysis

The partial budget analysis was done according to Upton (1979) to determine the economic advantage of supplementing the two *Lablab purpureus* cultivars and concentrate mixture on pasture grass based diets of lambs in varied level. The partial budget analysis was based only on the variable cost of lambs, feeds and benefits from the result, without considering other cost like labor, housing, watering and veterinary service which was common for all treatments. The difference between purchasing and selling price of sheep were taken as total return (TR) in the analysis. Hence, the net income (NI) was calculated as the difference between total return (TR) and total variable cost (TVC) while, the change in net income (ΔNI) was calculated as difference between change in total return (ΔTR) and change in total variable cost (ΔTVC).

Statistical analysis

Analysis of variance (ANOVA) following the General Linear Model (GLM) procedure of SAS (SAS, 2002, version 9.1.3) was used to analyze the data. To describe the effect of CP intake on average daily body weight gain, regression analysis was also employed. Significantly different treatment means were separated using least significant difference (LSD) test at 5% level of significance. The model fitted for the experiment was:

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

Where, Yij = response variable, μ = overall mean effect, Ti = treatment effect, Bj = block effect, Eij = random error.

RESULTS AND DISCUSSION

Chemical composition of feeds

For all experimental feeds, the dry matter (DM) and organic matter (OM) content was almost similar however, variation was observed in the remaining nutrient components. Crude protein (CP) content of Beresa-55 (19.93%) cultivar was comparable to the value 19.92 and 20.2% reported by Worknesh (2014) and Hunegnaw and

Berhan (2016), respectively. However, Gebisa-17 (16.06%) cultivar used in the current study had relatively lower CP value than the value reported by these authors. Norton (1982) reported that, most herbaceous legumes have CP 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. Hence, the CP content of the two *lablab* cultivars used in the current study agrees with this report and thus, can be used as a supplement to low quality feedstuff.

The linseed cake meal used in this study had higher level of DM (92.33%), CP (29.43%), ADF (19.2%) and ADL (7.17%) than the result reported by Abebe (2006) for the same nutrient types. However, higher value of NDF (39.9%) and OM (93.1%) was reported by the same authors as compared to the result obtained in the current study. The CP (15.98%) value of wheat bran used in this study was higher than 13 and 15.24% reported by Teklu (2016) and Abebe (2006), respectively. However, it was lower than the level of 17.4 and 17.9% reported by Worknesh (2014) and Dereje (2015), respectively. On the other hand, the DM, ash, DOMD, ADL, ADF and NDF obtained in the current study for WB was higher than the values, in percentage, of 88.09, 4.89, 72.35, 3.07, 13.97 and 43.73 as reported by Mekonnen et al. (2016).

Natural grass hay used in the present study contained lower levels of CP (7.07%) and DOMD (35.44%), but higher value of NDF (52.82%) as compared to the rest treatment feeds. Diriba et al. (2013) who conducted study around the current study area, reported higher value of DOMD, ADF, NDF and ash ranging in percentage from 59.3 to 61.5, 39.7 to 50.3, 55.7 to 72.1 and 9.5 to 10.1%, respectively. But, relatively lower level of ADL (5.4 to 6.5%) and CP (5.2 to 6.4%) and comparable level of DM (90.2 to 93.7%) was also reported by the same authors. Regarding hay refusal, the CP and DOMD content was reduced and that of NDF, ADF and ADL was increased as compared to the hay offered, indicating selectivity by animals for nutritious parts of the hay, although there was an attempt to decrease selectivity by chopping in this study.

Dry matter and nutrient intake

There was a significant difference (P<0.05) in hay and total dry matter intake among treatments (Table 2). Lambs in T2 and T4 had shown similar (P>0.05) intake of basal hay and significantly higher (P<0.05) than lambs in T3, but not statistically different from those in T1 and T5 (P>0.05). In line with the present study result (411.61 to 531.14 g/day), basal hay intake ranging from 365.8 to 540 g and 336 to 591 g was reported by Fentie (2007) and Berhanu et al. (2014) for Farta and Washera sheep, respectively. However, the basal hay intake reported by Jalel (2013) and Mekonnen et al. (2016) for the same sheep breed was within the range of 591.9 to 698 g and 465 to 615 g, respectively, which is somewhat higher than the values obtained in the current study. This difference could possibly be associated with provision of supplements based on BW for all treatment groups in the current study.

Lambs in T1 had consumed more total DM (P<0.05) as compared to those in T2, T3 and T4. However, the total DM intake of lambs in T1 had no significant difference (P>0.05) from lambs in T5 whereas, equal (P>0.05) amount of total DM intake was consumed among lambs in T2, T3, T4 and T5. The total DM intakes of the current study (783.57 to 893.91 g) fall within the range of values of 575 to 844.16 g and 190.1 to 883 g reported by Yohannes (2011) and Firisa et al. (2013), respectively for Black head Ogaden sheep fed different level of corn silage with linseed meal and Horro lambs fed graded level of *Vernonia amygdalina* leaves and sorghum grain. Mulat (2006) also reported DM intake of 480 to 498 g/day for local lambs fed finger millet straw basal diets and different level of concentrate supplements, which is lower than the values of the current study.

The result of total DM intake as a proportion of percent BW and per unit metabolic body weight basis of the current study had shown no significant variation (P>0.05) across treatments. Devendra and Burns (1983) reported that, the total DM intake on %BW basis was within the range of 2.5 to 3.9% for various breeds of sheep and goats in the tropics, which is in agreement with the current study (3.45 to 3.81%). Similarly, the DM intake per unit metabolic BW (75.23 to 81.69 g/kg) based on the current study agreed with the finding of Birhanu et al. (2013) and Jalel (2013) who reported 75.02 to 86.66 g/kg for Black Ogaden sheep and 76.2 to 85.9 g/kg for Horro sheep, respectively.

In the current study, dietary treatments significantly influenced intake of ADF, OM and ash but not NDF and ADL. Lambs fed concentrate mixture diets in T1 had lower value of ADF and ash intakes as compared to the rest treatment groups. The likely reason for this difference could be related to the lower content of ADF and ash in WB and LSC as compared to that contained in the two *Lablab* cultivars. The OM intake in the current study was higher for lambs fed diets in T1 and T5 than lambs fed in the other treatments which followed the same trend for DM intake as it is the reflection of total DM intake.

Intakes of CP was also significantly affected (P<0.001) by treatment diet; it was higher for lambs in T1 (116.36 g/day) fed concentrate mixture followed by those in T5 (109.68 g/day) fed Beresa-55 cultivar. However, with the exception of T2 (81.7 g/day) which had lower CP intake, no significant difference (P>0.05) in CP intake was obtained between lambs in T3 and T4. The higher value of CP intakes by lambs in T1 and T5 might be associated with their higher total DM intake attributed to their level of

Table 1. Chemical composition of experimental feeds

Feed samples	DM (%)	Nutrient composition (DM%)						
		Ash	CP	NDF	ADF	ADL	OM	DOMD
Beresa-55	91.51	9.50	19.93	41.01	37.57	6.31	90.50	55.13
Gebisa-17	92.10	9.53	16.06	45.00	39.63	7.90	90.47	57.07
LSC	92.33	7.02	29.43	34.56	19.20	7.17	92.98	71.04
WB	92.88	5.25	15.98	46.08	14.74	3.93	94.75	76.78
NG	92.71	8.40	7.07	52.82	37.59	6.71	91.60	35.44
Hay refusal								
T1	90.67	7.10	5.83	63.99	53.71	10.73	92.90	30.12
T2	92.32	7.98	5.98	67.85	52.19	10.38	92.02	31.97
T3	90.13	7.03	6.09	65.09	54.83	11.79	92.97	31.35
T4	92.07	7.55	6.17	68.8	49.89	12.01	92.45	32.07
T5	91.52	7.61	5.69	64.52	52.47	11.91	92.39	31.55

LSC = Linseed cake; WB = wheat bran; NG = natural grass; DM = dry matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; OM= organic matter; DOMD = digestible organic matter in dry matter; ME = metabolizable energy; T1 to T5 = treatments.

supplements (2% of their BW) as well as higher CP content of their supplements. Comparable values to the current study were reported by Abraham (2015) who reported CP intake of 54.78 to 114.91 g/day for Begiat sheep. However, Firisa et al. (2013) and Mekonnen et al. (2016) reported CP intake ranging from 11.2 to 86.9 and 93.9 to 145.1 g/day, respectively. CP intake of the present study was lower in the case of the first author but higher than result of the second author. The possible reason for this difference could be possibly related to the type and quality of feeds supplemented for sheep in the study.

Intake of ME also significantly varied ($P<0.001$) among treatments, where significantly higher ($P<0.001$) value was recorded for lambs in T1 (7.69 MJ/day) followed by T5 (6.02 MJ/day) and the least one was obtained from lambs in T4 (5.31 MJ/day). The higher ME intake of lambs in T1 could most probably be related to the DOMD content of their supplemental feeds (Table 1). Comparable level of ME intake with the current study was reported by Fentie (2007) for Farta sheep (4.55 to 7.52 MJ/day) supplemented with noug seed cake (*Guizotia abyssinica*), wheat Bran and their mixture. Moreover, Yeshambel et al. (2012) also reported ME intake of 5.2 to 6.4 MJ/day for Washera sheep fed mixture of lowland Bamboo (*Oxytenanthera abyssinica*) leaves and natural pasture grass hay at different ratios, which is in agreement with the present study result.

Dry matter and nutrient digestibility

Significant differences were observed among treatments in digestibility of DM, CP and OM. However, treatment effect was not significant for digestibility of NDF and ADF ($P>0.05$). Lambs fed diets in T1 had significantly higher digestibility of DM ($P<0.01$) and OM ($P<0.05$) as compared to those lambs in T2, T3 and T4, but not different from lambs in T5 ($P>0.05$). The relatively higher digestibility value of DM and OM in T1 and T5 than the rest treatments could be associated with increased nutrient, such as CP and ME (Table 2) supply to rumen microbes for their proliferation to be presented abundantly to colonize and digest more of the DM or OM consumed (Bonsi et al., 1996). Similar to the current study, Awet and Solomon (2009) reported significant variation in apparent digestibility of DM and OM for Afar sheep fed urea treated teff straw supplemented with graded level of wheat bran. Similarly, Getahun (2014) reported that lambs supplemented with 300 g/day of leucaena to untreated wheat straw significantly increased the apparent digestibility coefficients of DM and OM compared to the sole untreated straw. However, contrary to the previous authors and the current study, Dawit and Solomon (2009) reported non-significant difference in the digestibility of the same nutrients in Arsi Bale sheep fed urea treated barley straw supplemented with Lucerne or vetch hay. The difference might be related to the age of animals, level of feeding, feed and ration composition used for the study (Rajihan, 1999).

Significant variation ($P<0.05$) in digestibility of CP was also observed among treatments, where statistically higher value was obtained from lambs fed diets in T1 followed by lambs in T4 and T5. In agreement with the present study, significantly different apparent digestibility of CP was reported by Berhanu et al. (2014) in Washera sheep. Firisa et al. (2013) also reported significantly improved digestibility of CP in Horro lambs supplemented with graded level of *V. amygdalina* leaves and sorghum grain mixture. Furthermore, Mulat (2006) reported that

Table 2. Nutrient intake of Horro lambs supplemented with Gebisa-17 and Beresa-55 cultivars of *L. purpureus* and concentrate mixture.

Intake (g/day)	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
DM intake (g/day)							
Basal hay	482.71^{ab}	531.14^{a}	411.61^{b}	498.99^{a}	459.89^{ab}	25.64	*
Beresa-55	-	-	-	281.00	387.20	-	-
Gebisa-17	-	274.90	372. 00	-	-	-	-
Concentrate mixture	411.20	-	-	-	-	-	-
Total DM intake	893.91^{a}	806.03^{b}	783.57^{b}	779.94^{b}	847.10^{ab}	25.64	*
DM intake (%BW basis)	3.52	3.81	3.55	3.45	3.51	0.11	Ns
DM intake (g/kgW$^{0.75}$)	79.00	81.69	76.91	75.23	77.82	2.10	Ns
Nutrient intake (g/day)							
NDF	430.30	404.30	384.79	378.78	401.71	13.54	Ns
ADF	247.54^{b}	308.60^{a}	302.13^{a}	293.12^{a}	318.35^{a}	9.64	**
OM	829.60^{a}	735.22^{b}	713.55^{b}	711.34^{b}	771.68^{ab}	23.49	*
Ash	64.31^{c}	70.81^{ab}	70.02^{ab}	68.60^{bc}	75.42^{a}	2.15	*
ADL	52.53	57.36	57.00	51.21	55.29	1.72	Ns
CP	116.36^{a}	81.70^{d}	88.84^{c}	91.27^{c}	109.68^{b}	1.81	***
ME (MJ/day)	7.69^{a}	5.52^{c}	5.73b^{c}	5.31^{c}	6.02^{b}	0.15	***

^{a,b,c,d}Means within a row with different superscripts differ significantly (P < 0.05); *P < 0.05; **P < 0.01; ***P < 0.001; SL: significance level; SEM (Mean $\pm$ SE) = standard error of means; ns = non-significant; T1 to T5 = treatments; BW = body weight; DM = dry matter; CP = crude protein; OM = organic matter; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; ME = metabolizable energy.

digestibility of CP for sheep fed basal diets of finger millet straw were improved when supplemented with different protein sources. However, non-significant variation of CP digestibility was reported by Diriba et al. (2015) who supplemented Hararghe highland sheep with fig (*Ficus sur*). This difference in CP digestibility could be due to supplements used and level of supplementation provided.

Body weight change and feed conversion efficiency

Statistically significant (P<0.01) difference were seen among experimental lambs in their final body weight (FBW) gain. The higher FBW was displayed by lambs in T1 (25.4 kg) and T5 (24.17 kg). However, lambs in T2, T3 and T4 had almost similar FBW (P>0.05) of 21.24, 22.07 and 22.64 kg, respectively. Lambs in T2, T3 and T4 grew lower by 4.1, 3.33, 2.76 and 2.93, 2.1, 1.53 as compared to the growth rate of lambs fed treatment diets in T1 and T5, respectively. Similar trend was also observed among all treatments in BW change and ADG attributes, which took similar trend like that of FBW. This appears to be consistent with difference in nutrient digestibility like, DM, CP and OM (Table 3) that might have resulted in difference in nutrient intake available for absorption and metabolism.

The absence of statistical variation in FBW, BWC and ADG attributes observed among lambs fed concentrate mixture (T1) and Beresa-55 cultivar (T5) showed that, the supplements were comparable in their potential to supply nutrients for improving the weight gains of the lambs. According to Nsahlai and Umunna (1996), the nitrogen in *L. purpureus* is rapidly degradable in the rumen which is valuable to meet the requirements of rumen microorganisms for efficient degradation of low quality roughages. Similar to this result, Koralagama et al. (2008) found no significant differences in ADG of Ethiopian sheep fed maize stover basal diet supplemented with commercial concentrate and either cowpea type (genotype 12688 and IT96D-774) at high level or between cowpeas at low level of supplementation. Similarly, Worknesh (2014) also reported the absence of significant difference in the FBW and ADG among dorper×afar f1 sheep supplemented with 300 g/day concentrate mixture and those fed 299 g/day of *Leucaena leucocephala*.

The ADG of lambs in T1 (75.56 g/day) fed concentrate mixed ration in the present study were higher than the value reported by Shashie et al. (2017). The author reported a daily live weight gain of three Ethiopian sheep breeds fed hay supplemented with concentrate mixture at two levels, 1.5 and 1.75% BW, was 59.8, 49.2 and 43.3 g/day for Horro, Black Ogaden and Washera breeds, respectively. The variation in ADG might be obtained from difference in the level of supplements, which was

Table 3. Digestibility coefficient (%) in Horro lambs supplemented with Gebisa-17 and Beresa-55 cultivars of *Lablab purpureus* and concentrate mixture

Parameters	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
DM	67.62[a]	55.18[c]	59.21[bc]	55.17[c]	64.71[ab]	2.27	**
CP	69.91[a]	53.45[c]	60.36[bc]	62.13[ab]	64.21[ab]	2.84	*
OM	68.10[a]	55.93[c]	60.76[bc]	57.37[bc]	63.04[ab]	2.33	*
NDF	56.70	48.16	44.35	46.78	52.51	3.57	Ns
ADF	44.88	47.16	42.38	43.65	50.24	3.33	Ns

[a,b,c]Means within a row with different superscripts differ significantly ($P < 0.05$); *$P < 0.05$; **$P < 0.01$; SL: significance level; SEM (Mean ± SE) = standard error of means; ns= non-significant; T1 to T5 = treatments; DM= dry matter; CP= crude protein; OM = organic matter; NDF= neutral detergent fiber; ADF = acid detergent fiber.

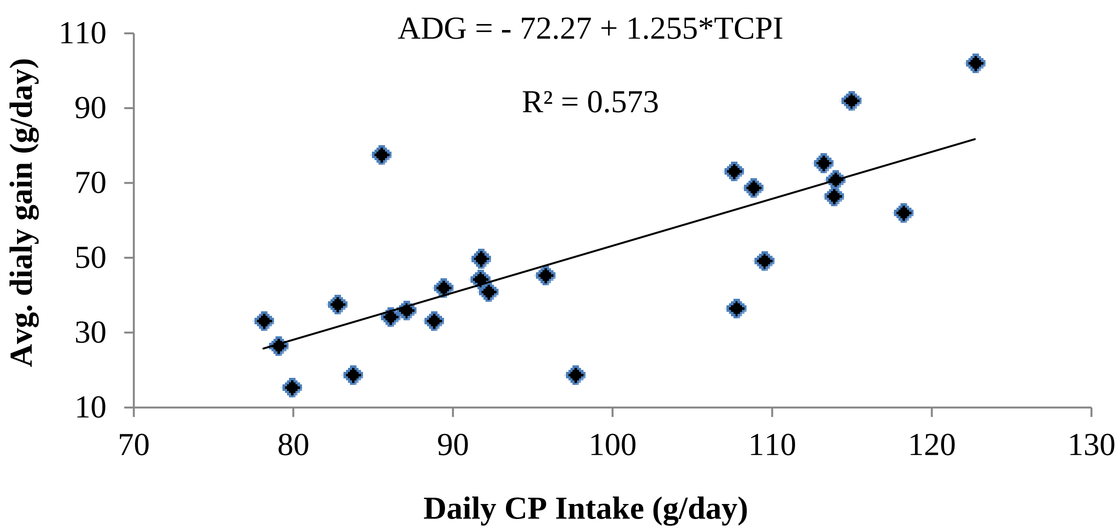

Figure 1. Regression of body weight gain on CP intake of Horro lambs supplemented with Gebisa-17 and Beresa-55 cultivars and concentrate mixture.

2% BW in the present study. On the other hand, Ermias (2008) reported higher value of ADG (87.8 g/day) for Arsi-Bale sheep fed faba bean haulms supplemented with different proportion of Barley bran and lean seed meal as compared to lambs in T1 of the present study. This variation might be the result of the variation in the basal diets used between experiments.

Similarly, lambs fed Beresa-55 cultivar in T5 of the current study had ADG of 64.11 g/day which is lower than the value reported by Mekonnen et al. (2016) who found 87.4 g/day for Horro sheep supplemented with *L. purpureus, Cajanus cajan* and their mixture. The lower ADG in the present study might be due to the lower CP intake of lambs, 109.68 g/day than 145.1 g/day reported by Mekonnen et al. (2016). However, lower value of ADG of 34.7, 20.33 and 49.36 g/day for Wollo sheep supplemented with pigeon pea (*C. cajan*), cowpea (*Vigna unguiculata*) and lablab (*L. purpureus)* respectively was reported by Hunegnaw and Berhan (2016) as compared to lambs in T5 of the present study. Moreover, Jalel (2013) who fed wild silver leaf Desmodium (*Desmodium unicinatum*) in graded level to the same sheep breeds used in the current study reported ADG of 68.9 g/day which is almost comparable value to the average daily gain obtained in T5 of this study.

The regression of ADG on the crude protein intake (Figure 1) indicated the role of CP intake on daily live weight gain which is explained by the value of coefficient of determination (r^2 = 57.3%). Thus, it can be considered that the higher daily weight gain of lambs in T1 (75.56 g/day) and T5 (64.11 g/day) might be most probably associated with their higher CP intake (Table 2). This in part could also be due to the higher digestibility of CP (Table 3) of lambs in this treatment as compared to the rest treatments. In agreement with the pattern observed in the current study, Biru (2008) reported that crude protein intake had contributed much which is about 64.38% of daily weight gain of Adilo sheep supplemented

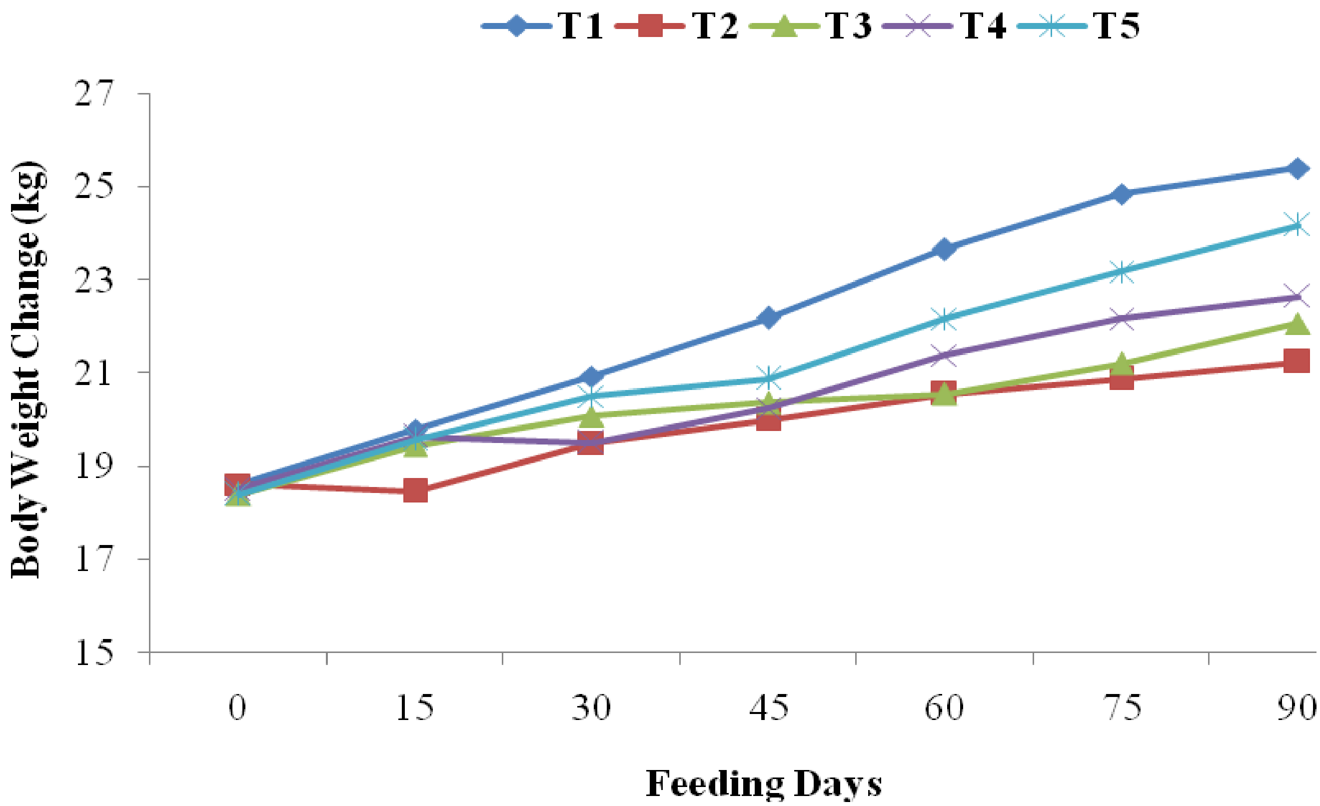

Figure 2. Body weight change trend of Horro lambs supplemented with Gebisa-17 and Beresa-55cultivars of *Lablab purpureus* and concentrate mixture

Table 4. Body weight gain of Horro lambs supplemented with Gebisa-17 and Beresa-55 cultivars of *L. purpureus* and concentrate mixture

Parameters	Treatments					SEM	SL
	T1	T2	T3	T4	T5		
Initial body weight (kg)	18.60	18.60	18.40	18.50	18.40	0.86	Ns
Final body weight (kg)	25.40[a]	21.24[c]	22.07[c]	22.64[bc]	24.17[ab]	0.68	**
Body weight change (kg)	6.80[a]	2.64[c]	3.67[c]	4.14[bc]	5.77[ab]	0.64	**
Average daily gain (g/day)	75.56[a]	29.33[c]	35.89[c]	46.00[bc]	64.11[ab]	7.33	**
Feed conversion efficiency	0.08[a]	0.04[b]	0.05[b]	0.06[ab]	0.07[a]	0.01	*
Feed conversion ratio	12.12[b]	30.10[a]	23.62[ab]	21.57[ab]	14.53[b]	4.18	*

[a,b,c]Means within a row with different superscripts differ significantly ($P < 0.05$); *$P < 0.05$; **$P < 0.01$; SL: significance level; SEM (Mean $\pm$ SE)=standard error of means; ns= non-significant; T1 to T5 = treatments

with sweet potato tuber and Haricot bean screening.

In the present study, higher value in FCE was obtained by lambs in T1 (0.08) followed by T5 (0.07) > T4 (0.06) > T3 (0.05) > T2 (0.04). Contrary to this, higher value for FCR was obtained by lambs fed T2 (30.10) diets followed by T3 > T4 > T5 and the least by T1. As reported by Brown et al. (2001), animals that have a high FCE and low FCR are considered as efficient users of feed. Hence, based on the finding of this study, it can be concluded that, lambs fed diets in T1 and T5 were more efficient in their feed utilization potential than those lambs fed on other treatment groups.

In general, the trend of body weight change (kg) across the ninety (90) feeding days (Figure 2) showed that, growth performances of sheep positively increased. Higher growth rate was noticed for lambs in T1 relative to those in T5 followed by T4 > T3 > T2 in their respective order (Table 4). Nevertheless, from the current study, it can be generalized that, all treatment diets positively promoted FBW, ADG and FCE which suggests the

Table 5. Partial budget analysis of Horro lambs supplemented with Gebisa-17 and Beresa-55 cultivars of *L. purpureus* and concentrate mixture.

Parameters	Treatments				
	T1	T2	T3	T4	T5
Purchase price per lamb (ETB/lamb)	740	720	725	745	730
Hay consumed (kg/lamb)	43.44	47.8	37.04	44.91	41.39
Concentrate consumed (kg/lamb)	37.01	-	-	-	-
Beresa-55 (kg/lamb)	-	-	-	25.29	34.85
Gebisa-17 (kg/lamb)	-	24.74	33.48	-	-
Feed cost (**ETB/lamb**)					
Cost of hay	86.88	95.6	74.08	89.82	82.78
Cost of concentrate	203.56	-	-	-	-
Cost of Beresa-55	-	-	-	75.87	104.55
Cost of Gebisa-17	-	74.22	100.44	-	-
Total Variable Cost (TVC)	290.44	169.82	174.52	165.69	187.33
Selling price of lambs	1400	1300	1320	1330	1360
Total return (TR)	660	580	595	585	630
Net return (ETB/lamb)	369.56	410.18	420.48	419.31	442.67
Change in total return	-	-80	-65	-75	-30
Change in net return (ΔNR)	-	40.62	50.92	49.75	73.11
Change of total variable cost (ΔTVC)	-	-120.62	-115.92	-124.75	-103.11

ETB/lamb = Ethiopian birr per lamb.

comparative nutritional values of the two *L. purpureus* forage cultivars in general and Beresa-55 cultivar in particular relative to the concentrate feeds used in the current study if supplemented on local lambs fed with poor quality feed resources.

Partial budget analysis

Partial budget analysis was done to determine the economic advantage of supplementing either the two *L. purpureus* cultivars or concentrate mixture to Horro lambs based on basal diets of natural grass hay and to select and recommend the best treatment with better growth performance, low cost and high net return.

In the current study, the partial budget analysis revealed that, the value of total return was higher for lambs in T1 and T5 than for lambs in the other treatments (Table 5). However, lambs in T5 (442.67 ETB/lambs) had the highest net return, whereas, the lowest net return was received by lambs fed concentrate mixture diets in T1 (369.56 ETB/lambs). In general, the partial budget analysis result suggests that, Beresa-55 cultivar fed to lambs in T5 at 2% BW resulted in relatively lower feed cost (lower by 35.5%), higher net return (higher by 19.78%) as compared to the conventional concentrate mixture based diets fed to lambs in T1. Thus, supplementation with Beresa-55 cultivar at 2% BW had high profit margin in the diets of Horro sheep based on basal diets of natural grass hay than the rest supplemental regime.

Conclusion and recommendation

Generally, for almost all measured parameters, no appreciable differences ($P>0.05$) in terms of sheep performance were observed among experimental sheep that received concentrate mixture (T1) and Beresa-55 cultivars (T5). Based on biological performance result, lambs in T1 and T5 induced comparable response and were better than lambs fed the other treatment diets. However, partial budget analysis result revealed that, lambs in T5 exhibited lower feed cost and higher net return as compared to those in T1, signifying the need to seize the opportunity to replace conventional and most expensive protein supplement with cost effective on-farm grown herbaceous forage legume under Ethiopian condition. Therefore, it can be concluded that supplementation of Beresa-55 cultivars (T5) at 2% body weight resulted in more profit, and could be used as an alternative feed supplement for low quality roughage in feeding Horro lambs. However, to generate additional information and fill the gap of the current study, on farm research on the supplementation to locally available crop residue and grazing has to be investigated under actual farmer management conditions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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