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The Effects of Maize and Napier Grass Ensiled with Dolichos Lablab on Feed Intake Growth Performance and Carcass Traits of Horro Lambs

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ABSTRACT

The study was conducted at Bako Agricultural Research Center with the aim to evaluate the effects of Maize and Napier grass ensiled with 40% of Dolichos lablab on intake, digestibility, weight gain and carcass parameters. Each forage material was processed, diced in to smaller pieces separately, combined based on treatment combinations and then ensiled. Twenty male yearling Horro breed with an average initial body weight of 21.35 ± 2.66 kg were employed. Randomized complete block designs were used with four treatment and five replications in which they were randomly assigned to the dietary treatments. Dietary treatments were arranged as T1 and T2 for Napier grass and Maize ensiled alone, while, T3 and T4 for Maize and Napier grass ensiled with 40% of Dolichos lablab respectively. Experimental animals in all treatments were supplemented with wheat bran at 1.5% body weight. The study comprised 90 days of feeding trial followed by 7 days of digestibility trial and evaluation of carcass parameters at the end. The values of DM, CP and OM increased with the inclusion of Dolichos Lablab in both Napier Grass and Maize. Ensiling of Dolichos lablab with Napier grass and Maize influenced the intake of dry matter, crude protein, organic matter, acid detergent lignin, neutral detergent fiber, and acid detergent fiber without influencing the intake of metabolizable Energy. Higher DM, OM, CP, NDF, ADF and ADL intake were observed for lambs fed diet in T4. Except CP apparent nutrient digestibility coefficients were not significantly ($P>0.05$) influenced across all the treatment diets. Lambs fed diet in T4 had higher digestibility of CP than those Lambs in T2 and T1 group implying higher body weight change and average daily body weight gains. Empty gut and omasum-abomasum edible offal components were significantly influenced ($P<0.05$) by dietary treatments. Therefore, ensiling of both Maize and Napier grass with 40% of Dolichos lablab enhanced the nutritive value of the silage thereby, increasing the nutrient intake and digestibility for better growth and carcass yields of sheep.

INTRODUCTION

Like other developing countries in sub Saharan Africa, small ruminant production is a major component of the livestock sector in Ethiopia. According to CSA (2020) report, the overall population of small ruminants in Ethiopia is estimated to be 90.39 million, of which 39.89 million are sheep. Sheep are the main source of food security for small holders, providing funds for a variety of purposes such as savings, cash income, buying fertilizer, and socio-cultural roles (Solomon *et al.*, 2013). However, the productivity of sheep per head is low mainly because of inadequate year round nutrition, both in terms of quantity and quality, unimproved genetic potential and due to prevalence of diseases and parasites (Markoset *et al.*, 2006).

Nowadays most of natural pasturelands are put under intensified crop production due to the increasing human population pressure. The remaining land is heavily grazed and cannot meet the nutritional requirement of livestock, resulting in reduced growth rate, low production, poor fertility and high mortality particularly in the dry season (Solomon, 2004). Aftermath grazing and crop residue accounts for 60 to 70% of available basal diet in the highlands of Ethiopia. Such feeds are inherently low in nutritive value such as protein, digestible energy and minerals, which may result in sub-optimal rumen fermentation and lowered animal performance. As a result, animals could not realize their genetic potential within the growth period for the breed.

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. However, they are costly and not readily available everywhere. The other option of increasing livestock production can be achieved through cultivation of high-quality forages with high yielding ability that are adapted to biotic and abiotic environmental stresses (Muiaet *et al.*, 2001; Tessemaet *al.*, 2010). Improved pasture crops have many advantages such as providing quality feed and improving soil fertility. The cost incurred for perennial pasture production is high only during the establishment year (Jφrgensenet *et al.*, 2010) but declined thereafter which could serve for the way forward in feed resources improvement strategies in Ethiopia at large. Amongst the promising forage species promoted in Ethiopia, Elephant grass could play an important role in providing a significant amount of high-quality forage to the livestock industry (Ndikumana, 1996;

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Tessema, 2005) both under the smallholder farmer and intensive livestock production systems with appropriate management practices (Alemayehu, 2004).

Uses of improved forage and tree legumes as supplementary options for livestock have been investigated in Ethiopia and elsewhere in Africa (Solomon *et al.*, 2004; Ajebu *et al.*, 2008 and Adegun, 2014). Improved forages could be fed to the animals by direct grazing, cut and carry, or stored and conserved as hay or silage. The potential of legumes for grazing is limited due to their susceptibility to trampling and the preferential grazing by livestock that adds pressure to legumes (Phelan *et al.*, 2015). Additionally, fresh feeding of legumes is limited due to the seasonality of rain which reduces the independence from protein-rich feedstuffs during the dry season. Moreover, legumes feeding as hay restricted by high dry-matter losses occurring during drying, transport and storage furthermore, because of the practical implications of season and plant physiology that may prevent a timely harvest/drying at the optimal time for hay making (Titterton & Bareeba, 1999).

The limitations due to leaf shattering, harvest timing and availability in the dry season are minimized when forages are conserved as silage, making this probably the most suitable option to feed tropical legumes to ruminants. The development of small-scale intensive systems and the rising costs of concentrate feeds, made the conservation of forage crops an integral part of livestock production (Mapiye *et al.*, 2007). Conserving high quality forages reduces the need to purchase concentrates for use in ruminant rations. Surplus and cultivated quality forages should be conserved during the wet season for use during the dry season. To this effect, silage-making is a common means of preserving surplus forage which could be fed to livestock during periods of scarcity. By conserving excess forage produced during the wet season to silage, the low production and productivity of livestock during the dry season due to scarcity of forage can be ameliorated (Wong, 2000). Conservation of cereals/grasses produces silages of high energy but low protein concentration (Mhere *et al.*, 2002). On the other hand, legumes alone do not ensile well owing to their high moisture content and high buffering capacity, resulting in high effluent losses and unstable silage of high pH (Pahlow *et al.*, 2002). Incorporation of legumes in cereal silage increases protein concentration improves silage intake and its nutritional quality thereby enhances ruminant animal performance (Ngongoni *et al.*, 2008). A number of legumes and grasses were proved for their Dry matter yield and wide range of adaptation in our country. However, they contribute little to the much needed improvement of livestock production because data regarding the conservation of mixed grass-legume forages as silage was scarce. Similarly, feeding of silage in general and grass-legume mixed silage in particular for sheep as a basal diet is barely practiced in the study area. Therefore, study on the conservation of grass-legume mixed silage as an alternative feed resource and its nutritional values in relation to enhance productivity of sheep are very important. Thus, the study was undertaken with the Objective to determine the effects of Maize and Napier grass ensiled with Dolichos lablab on feed intake, digestibility, growth performance, carcass characteristics and net return of Horro sheep supplemented with concentrate diet.

MATERIALS AND METHODS

Location of the Study Area

The study was conducted at Bako Agricultural Research Centre (BARC) belonging to Oromia Regional State, Ethiopia at about 258 km from Addis Ababa to the west on the main road to Nekemte town, located at geographical coordinates9^{0}6'N latitude and 37^{0}9'E longitude at an altitude range of 1579 to 1789 m.a.s.l. It lies between The area receives an average annual rainfall of about 1238 mm and a hot humid weather of minimum 13.3^{0}C and a maximum of 34^{0}C temperature.

Forage Production and Preservation

Preexisting Napier grass Bako-01 Variety established on 0.5 ha was used. While, Dolichos lablaband Maize waseach sown on 0.5 ha. Napier grass Bako-01 Variety was harvested at 1.5m height. Whereas, Maize and Dolichos lablabharvested at dough and 50% blooming stage respectively for silage making. All forages was separately chopped in to smaller pieces, mixed according to treatment combinations and ensiled.

Chemical Analysis

After the representative samples were prepared; The N, DM, OM and ash content was analyzed according to AOAC (1990). The CP content was calculated by multiplying N content with a factor of 6.25. NDF, ADF, and 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.

Experimental Design and Treatments

A total of 20 uncastrated male yearling Horro sheep with average initial body weight of 21.35 ± 2.66 kg were used in the trial. From the acquisition of the animals and during the experimental period, experimental animals received all routine health treatments and control of endo-and ecto-parasites. All animals were individually identified, through a numbered ear tags. Randomized complete block design (RCBD) was used. The experimental animals were grouped into five blocks of four animals each based on their initial body weight. Animals in blocks were assigned to one of the four treatments and all experimental animals in the treatments were supplemented with wheat bran at 1.5% of their body weight. The body weight of the animal was determined by taking the average of two consecutive weights after overnight fasting at the end of the quarantine period. The supplement was prepared following the recommendations for nutritional requirements of small ruminants according to the

National Research Council (1981), in order to meet the nutritional requirements. The dietary treatments were arranged as follows;

T1: Napier grass ensiled alone + 1.5% body weight wheat bran

T2: Napier grass ensiled with 40% Dolichos Lablab (60:40) + 1.5% body weight wheat bran

T3: Maize ensiled alone + 1.5% body weight wheat bran

T4: Maize ensiled with 40% Dolichos Lablab (60:40) + 1.5% body weight wheat bran

Feeding Trial

The actual 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 experimental animal to determine feed intake. Representative samples of feeds offered and refused for each animal were collected and pooled per treatment and dried in an oven at 65^{0}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. The amount of silage offered was adjusted daily based on the amount of refusal left from previous day intake and water was provided as free access for each animal. Mean daily dry matter and nutrient 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 were 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 (McDonald *et al.* (2002):

Total DM intake (Percent BW (g)=(DM intake (g))/(BW (kg))×100

Total DM intake (Metabolic BW (g/kg $W^{0.75}$)=(DM intake (g))/($BW^{0.75}$ (kg))

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 the 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 be mixed thoroughly and 20% of the daily fecal output taken and bulk 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 will thaw and thoroughly mixed and a representative subsample was taken.

Samples of feed offered and feed refused were also be collected every day and sub-sampled at the end of the experiment. The composite sub-samples dried in an oven at 65^{o}C for 72 hours to a constant weight. Partially dried fecal samples will be 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 had taken to Laboratory for chemical analysis. The digestibility of DM and nutrients were determined as the difference between nutrients intake and that recovered in feces expressed as a proportion of nutrient intake. The total amounts of nutrient apparent digestibility were calculated by using the following equation according to (Ranjihan, 2001).

Nutrient digestibility coefficient (%)=(Nutrient intake-Nutrient excreted)/(Nutrient intake)×100

Digestible organic matter contents of treatment feeds were 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.

Body Weight and Feed Conversion Efficiency

The initial body weight of each animal was taken at the beginning of the trial and every 15 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 are 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 (ADG) and Feed conversion efficiency (FCE) was calculated according to Gulten *et al.* (2000) and Brown *et al.* (2001).

ADG=(Final weight gain (g)-Initial body weight gain (g))/(Period of experiment (90days))

Feed conversion efficiency=(Daily body weight gain (g))/(Daily feed intake (g))

Where: ADG is Average Daily Body Weight Gain

Carcass Trait Analysis

At the end of digestibility trial, all the experimental animals were slaughtered by severing the jugular vein using sharp knives after an overnight fasting. During slaughtering, the blood was drained and weighed. Weight of visceral organs like kidneys, liver with gall bladder, lungs with trachea, kidney fat, abdominal fat, omental fat, heart, spleen, genital organs, the entire alimentary canal (esophagus, reticulo-rumen, omasum and abomasums, small intestine and large intestine), full gut, empty gut, tail, tongue and head were recorded separately. The weight of the gut contents was measured by differences (full gut contents minus empty gut contents). Empty body weight was determined by subtracting the gut fill from slaughter body weight. Hot carcass weight was computed by excluding contents of thoracic, abdominal and pelvic cavities, head, skin with feet (cut off at the proximal end of cannon bone) and tail of the animal. Dressing percentage was calculated as a ratio of hot carcass weight to slaughter weight and empty body weight multiplied by 100. The rib-eye muscle area of each animal was determined by tracing the cross sectional areas of the 12th and 13th ribs after cutting perpendicular to the back bone. The left and right rib-eye muscle areas was traced on a transparent water proof paper and the area was calculated as recommended by Torell and Suverly (2004). The value for rib-eye muscle area is the average of the right and left sides on 12th rib.

Total edible offal (TEO) components was taken as the sum of blood, liver, kidney and kidney fat, heart, omental fat, abdominal fat, tongue, reticulo-rumen, omasum and abomasums, large and small intestine and tail. Total non-edible offal components (TNEO) compute as the sum of spleen, pancreas, head without tongue, skin and feet, genital organs (testis and penis), lung with trachea, and gut content. Useable product (UP) was taken as the sum of hot carcass weight, TEO and skin.

Statistical Data Analysis

Data obtained was subjected to Analysis of Variance (ANOVA) following the Linear Model procedure of R Programming. Differences among treatment mean were tested using LSD test.

RESULTS AND DISCUSSION

Chemical Composition of Experimental Feeds

The chemical composition of the diet used in the current study was presented in Table 1. The values of DM, CP and OM increased with the inclusion of Dolichos Lablab in both Napier Grass and Maize. This shows that ensiling

Table 1: Chemical composition of experimental feeds

Feed Samples (Treatments)	DM%	Chemical Composition, (% DM)					
		Ash	CP	OM	NDF	ADF	ADL
T1 (NG ensiled alone)	36.54	17.22	4.9	82.78	67.56	49.19	2.63
T2 (Maize ensiled alone)	40.35	9.5	7.33	90.5	68.03	44.73	7.74
T3 (NG ensiled with 40% DL)	41.68	12.63	9.53	87.37	71.83	47.67	7.04
T4 (Maize ensiled with 40% DL)	43.73	9.89	10.93	90.11	70.35	44.73	8.73
Wheat Bran	90.76	6.09	19.37	93.91	27.36	15.21	3.88
Refusal							
T1	81.79	11.68	4.5	88.32	74.58	44.41	4.39
T2	83.56	10.06	6.9	89.94	71.94	44.91	6.83
T3	83.28	12.08	8.76	87.92	74.45	50.83	7.35
T4	85.68	10.25	9.45	89.75	70.73	52.43	9.38

DM= dry matter; OM= organic matter; NDF=neutral detergent fiber; ADF=acid detergent fiber; ADL= acid detergent lignin; CP= crude protein; NG= Napier grass; DL= Dolichos lablab; T1 to T4= treatments.

Table 2: Dry Matter and Nutrient Intake of Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Parameters	Treatments				
	T1	T2	T3	T4	SL
Dry Matter Intake (g/day)					
Silage	400.0^{c}	472.5^{c}	608.0^{b}	740.0^{a}	***
Wheat bran	253.3^{a}	245.0^{a}	172.0^{b}	172.0^{b}	***
Total Daily Intake	653.3^{b}	715.0^{b}	784.0^{ab}	914.0^{a}	**
%BW basis	2.737^{b}	2.95^{b}	3.68^{a}	3.814^{a}	*
g/KgW0.75 basis	60.0^{b}	67.5^{b}	80.0^{a}	82.0^{a}	**
Total Nutrient Intake (g/day)					
CP	49.93d	63.92^{c}	80.06^{b}	104.19^{a}	***
OM	558.14^{c}	658.25^{bc}	695.01^{b}	831.04^{a}	**
Ash	79.65a	48.86^{b}	74.02^{a}	69.19^{a}	**
NDF	285.83^{c}	342.42^{c}	447.26^{b}	535.71^{a}	***
ADF	229.49^{b}	233.06^{b}	299.45^{a}	330.81^{a}	**
ADL	16.78^{c}	47.84^{b}	48.98^{b}	69.99^{a}	***
ME(MJ/Kg DM)	8.95	9.2	9.17	9.19	NS

*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; NS = non-significant; %BW basis =dry matter intake on BW basis; g/KgW0.75= per unit metabolic body weight basis; OM=organic matter; NDF=neutral detergent fiber; ADL=acid detergent fiber; ADL= acid detergent lignin; CP=crude protein; WB=wheat bran; BW =body weight; ME=metabolizable energy; T1 to T4= treatments.*

of Dolichos lablab with Napier grass and maize was effective in improving nutrient values. In consistent to present study, Ferreira *et al.* (2017) reported that inclusion of 40% dehydrated barley in the murandu grass silage increased proportion of dry matter content from 24.13 to 43.9%. But, in the present study the DM content was slightly higher than the report of Olusola (2011) which was the DM of Napier grass silage increased from 18 to 30% with addition of 50% cassava peel in the mixture.

The CP content of ensiled material in the present study was ranged from 4.9 to 10.93%. The minimum CP required for microbial protein synthesis in the rumen that can support at least the maintenance requirement of ruminants should be above 7% (Van Soest, 1994). Therefore, based on the results of CP content supplementation of current diet containing Napier grass ensiled alone (T1) with concentrate feed is mandatory. Furthermore, silage with a high level of CP is beneficial because it allows for increased proteolysis, which results in a buffering effect that hinders the reduction of the pH to levels that are optimum for fermentation (Napasirth *et al.*, 2015).

Ensiling of Dolichos lablab with Elephant grass and Maize influenced the intake of dry matter, crude protein, organic matter, acid detergent fiber, acid detergent lignin, neutral detergent fiber, and acid detergent fiber without influencing the intake of metabolizable Energy Table 2.

The silage DM intake was significantly higher (P<0.001) for lambs fed T4 diet than those in T1, T2 and T3 with no statistical difference (P>0.05) between lambs fed in T1 and T2 diet. The total DM intake of the present study showed that lambs fed diets in T4 and T3 were statistically non-significant (P>0.05) and higher than the rest of treatments. The difference could be attributed to the high digestible protein content of the T4 and T3 diet compared to other dietary treatments, which might have enhanced the efficiency of rumen microorganism that increase fiber degradability and digestibility thereby, improving feed intake (McDonald *et al.*, 2002). Because all the experimental lambs consumed wheat bran based on their body weight, total DM intake showed the same pattern as silage DM intake. Inclusion of legumes in Elephant grass silage based diets has previously been shown to increase dry matter intake Abdulrazak *et al.* (1996), which has been attributed to improved palatability and digestibility. This observation has also been shown for wheat-pea silage fed to sheep and cattle Adesogan *et al.* (2002) and for maize stover-Leucaenadiversifoliafed to sheep (Hindrichsen *et al.*, 2002).

The mean feed intake as a proportion of percent body weight (p<0.05) and per unit metabolic body weight (p<0.01) revealed significance difference among dietary treatments, where lambs fed diet in T3 and T4 performed similarly (P<0.05) in %BW basis and significantly higher than, lambs in T1 andT2 diet. Whereas, significant (P<0.01) difference in per unit metabolic body weight basis was observed for lambs fed diet in T3 and T4 as compared to T1 and T2 group. The total DM intake on %BW basis of the present study was within the range of 2 to 6% recommended by the ARC (1980) and suggested by Susan (2003) 2 to 4% of body weight.

Similarly, the DM intake per unit metabolic BW0.75 ranged between 60.0 and 82.0 g/kg obtained in the current study was slightly lower than the finding of Birhanu *et al.* (2013) and Jalel (2013) who reported in range from 75.02 to 86.66 g/kg for Black Ogaden sheep and 76.2 to 85.9 g/kg for Horro sheep, respectively. The DM intake on percent BW and per unit metabolic body weight basis recorded in the present study was comparable with the findings of Mekonnen *et al.* (2016) and Abuye *et al.* (2018a) who reported 3.2-3.5% and 70.3–79.2 g/Kg and 3.45-3.81% and 75.23-81.69 g/Kg for the same sheep breed, respectively. The observed variations among the studies emanated from the differences in the quality of the feeds used, animal factors (age and physiological status of the animals), rumen fill, rate of passage of articulate matter and rate of digestibility of experimental feeds used.The higher intake of legume forages relative to grass forages is linked to their chemical degradation and physical breakdown within the rumen. These operate through effects on rumen fill. Differences have been attributed to both faster rates of fermentation (Beever and Thorp, 1996) and more rapid particle breakdown and clearance from the rumen (Moseley & Jones, 1984; Waghorn *et al.*, 1989; Jamot & Grenet, 1991). Dewhurst *et al.* (2003b) suggested that fermentation rate may be more important for WC, whilst rapid particle breakdown may be more important for LUC. Clearly there will be an interrelationship between chemical degradation and particle breakdown. Differences in particle breakdown and rumen passage rate are partly related to plant anatomy.

Table 3: Apparent nutrient digestibility coefficient (%) in Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Apparent Digestibility (%)	Treatments				
	T1	T2	T3	T4	SL
DM	58.85	58.59	63.02	64.13	NS
OM	55.92	57.54	57.31	57.47	NS
CP	94.26b	94.27b	94.5ab	94.72a	*
NDF	27.6	27.69	28.61	31.06	NS
ADF	50.25	51.02	51.44	51.12	NS

*a,b,c,d =Means within a row not bearing a common superscript differ significantly; *=(P<0.05); **=(P<0.01); ***=(P<0.001); DM= dry matter; OM= organic matter; NDF=neutral detergent fiber; CP= crude protein; SL= significance level; T1 to T4= treatments.*

Except CP apparent nutrient digestibility coefficients were not significantly (P>0.05) influenced across the treatment diets. Significant differences (P<0.001) were observed in digestibility of CP among dietary treatments. Lambs fed diet in T4 had higher digestibility of CP than those Lambs in T2 and T1 group with no significant difference (P>0.05) between T2 and T3. Banamanaetal. (1990) reported that increasing CP in the diet increased the digestibility of OM, ADF and CP. Mulligan *et al.* (2001) also reported that increasing dietary CP content increased the digestibility of low quality feeds. In agreement with the present study, significantly different apparent digestibility of CP was reported by Berhanu *et al.* (2014) in Washera sheep. Firisaet *et al.* (2013) also reported significantly improved digestibility of CP in Horro lambs supplemented with graded level of *V. amygdalinaleaves* and sorghum grain mixture. Furthermore, Abuye *et al.* (2018a) reported that digestibility of CP for sheep fed basal diets of natural grass hay were improved when supplemented with Gebisa-17 and Beresa-55 cultivars of *L. purpureusand* concentrate mixture.

Present study shows that initial body weight and final body weight of lambs assigned to dietary treatments were not significantly different (P>0.05) in all groups. Significant difference between dietary treatments were recorded on body weight change (P<0.05) and average daily body weight gains (P<0.01). Comparative to present study results ADG values ranged from 33.3 to 58.7g/day, 27.8 to 87.4, 29.33 to 75.56 g/day for the same breed and32.33 to 85.11 g/day for Nellore ram lambs were reported by Assefu (2012), Mokennen *et al.* (2016), Abuye *et al.* (2018), Malisetty *et al.* (2013) for lambs fed rations containing different roughage to concentrate ratios.The values of ADG ranged from 25.55 to 64.00 g/day observed in the current study were considerably lower than the values ranged from 43.55 to 98.22 g/day for the same breed, 69.1 to 104.1 g/day and 49.33 to 116.22 g/day for Arsi breed reported by Gemechu *et al.* (2020), Belete *et al.* (2013) and Firaol (2017) respectively. In the present studyFCE was significantly different (P<0.05) among dietary treatments with the lowest values recorded lambs fed diet in T1. The reduction in FCE for lambs fed in T1 diet was probably the result of low protein intake and high fiber content of the diet that might have caused the net efficiency of use of metabolizable energy to be depressed slightly. Lambs fed legumes have more efficient dietary protein utilization and grow faster than lambs fed grass, in part due to a more rapid rate of digestion (Howes, 2015).

Table 4: Body weight change and feed conversion efficiency of Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Parameters	**Treatments**					
	T1	**T2**	**T3**	**T4**	**CV**	**SL**
Initial Body Weight (Kg)	21.9	21.1	20.6	21.8	14.22	NS
Final Body Weight (Kg)	24.00	25.00	25.2	27.56	12.47	NS
Body Weight Change (Kg)	2.3^{c}	3.9b	4.6^{ab}	5.76^{a}	0.422	*
Average Daily Weight Gain (g/day)	25.55^{c}	43.33^{b}	51.11^{ab}	64.00^{a}	26.49	**
FCE	0.047^{b}	0.065^{ab}	0.067^{ab}	0.075^{a}	-	*
FCR	21.41^{a}	16.26^{ab}	14.69^{b}	13.67^{b}	-	*

*a,b,c,d =Means within rows for different groups with different superscripts differ (P<0.05); *=(P<0.05); **=(P<0.01); ***=(P<0.001); SEM=standard error of means; SL= significance level;. FCE= feed conversion efficiency; FCR= feed conversion ratio; T1 to T4= treatments.*

Carcass Characteristics

Main Carcass Characteristics

There were significant effects of ensiling Dolichos lablab with Maize and Elephant grass at 40% on slaughter weight (P<0.05)and rib eye muscle area (P<0.05) without showing effects on empty body weight, hot carcass weight, Hind quarter, fore quarter, dressing percentage both on slaughter and empty body weight basis.

The present study result for slaughter body weight was within the range of the values noted by Gemechu, *et al* (2020) which was ranged from 23.52 to 28.04 kg for the same breed. Lambs that was assigned to fed T4 diet was significantly (P<0.05) higher than T1 but statistically comparable with other groups. In the present study, rib-eye muscle area was significantly (P<0.05) influenced by dietary treatments. According to the report of Wolf *et al.* (1980), greater rib-eye muscle area is associated with a higher production of lean in the carcass and higher lean to bone ratio. Lambs assigned to T4 diet showed relatively higher REMA, which is a reflection of increase in lean meat. In the current study rib-eye muscle area ranging from 5.4 to 8.93cm^2 was obtained which was comparable to 7.4 to 8.9 cm^2 reported by (Assefu, 2012) and 6.0 to 9.5cm^2 reported by Mekonnen *et al.* (2017) for the same breed. But,Abuye *et al.* (2018b) noted rib eye area ranging from 7.04-9.54 cm^2 for the same breed which is higher than current study result.

Except for empty gut and omasum-abomasum edible offal components of lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab were not significantly influenced (P>0.05). The highest value of empty gut contents weight were recorded for lambs assigned to fed T4 and T2 diet. The heaviest empty gut content of lambs fed T4 and T2 diet may be due to the higher roughage or relatively poor quality feed used

Table 5: Carcass components of Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Parameters	Treatments					
	T1	T2	T3	T4	SEM	SL
Slaughter Body Weight (Kg)	23.30[b]	26.50[ab]	26.17[ab]	27.45[a]		*
Empty Body Weight (Kg)	20.37	21.40	18.12	22.01		NS
Hot Carcass Weight (Kg)	10.80	11.30	9.15	10.90		NS
Fore Quarter (Kg)	5.93	6.15	5.025	5.95		NS
Hind Quarter (Kg)	4.87	5.15	4.12	4.95		NS
Rib-eye area (cm2)	5.4[b]	6.53[b]	6.90[ab]	8.93[a]		*
Dressing Percentage on						
Slaughter Weight basis	41.04	42.54	39.29	39.52		NS
Empty Body Weight basis	52.84	52.74	50.42	49.27		NS

*a,b,c,d =Means within a row not bearing a common superscript differ significantly; *=(P<0.05); **=(P<0.01); ***=(P<0.001); SEM=standard error of means; SL= significance level; T1 to T4= treatments.*

Table 6: Edible offal of Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Edible Offal Components (g)	Treatments				
	T1	T2	T3	T4	SL
Blood	306.67	500.00	300.00	450.00	NS
Heart	120.00	120.00	112.00	111.25	NS
Heart fat	41.5	27.00	32.5	21.67	NS
Liver	373.33	388.75	337.5	392.5	NS
Full gut	7366.67	6850.00	6750.00	7375.00	NS
Empty gut	1566.67[b]	1750.00[ab]	1575.00[b]	1937.5[a]	*
Reticulo-rumen	633.33	625.00	550.00	637.5	NS
Omasum-abomasum	243.33[b]	250.00[b]	270.00[ab]	337.5[a]	*
Omental fat	75.00	57.5	81.25	83.75	NS
Right testicle	143.33	167.5	118.75	175.00	NS
Left testicle	116.67	163.75	131.25	167.5	NS
Tongue	100.00	113.00	110.00	100.00	NS

*a,b,c,d =Means within a row not bearing a common superscript differ significantly; *=(P<0.05); **=(P<0.01); ***=(P< 0.001); SL= significance level; T1 to T4= treatments.*

Table 7: Non Edible offal of Horro Lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Non-Edible Offal Components (g)	Treatments					
	T1	T2	T3	T4	SEM	SL
Skin	2333.33	2512.5	2150.00	2600.00		NS
Gut contents	5800	5100	5175	5437.5		NS
Lung with trachea	475.00	445.00	433.33	425.00		NS
Spleen	40.00	62.5	58.75	56.25		NS
Pancreas	30.00	41.25	28.75	32.5		NS
Penis	55.00	67.5	55.00	47.5		NS

*a,b,c,d =Means within a row not bearing a common superscript differ significantly; *=(P<0.05); **=(P<0.01); ***=(P< 0.001); SEM=standard error of means; SL= significance level; T1 to T4= treatments.*

because the empty gut content is the difference of full gut and gut content that was discarded. This was agreed with the views of VanSoest (1994) and pond *et al.* (1995) in that non supplement animals fill their gut with less digestible roughage, which would retain in the gut for longer time to be degraded by rumen microbes.

All the parameters considered as non-edible offal of Horro lambs fed Maize and Napier grass ensiled alone

Table 8: Partial budget analyses of Horro lambs fed Maize and Napier grass ensiled alone and with 40% of Dolichos lablab

Items (ETB/lamb)	Treatments			
	T1	T2	T3	SL
Purchase price of lambs	3285	3165	3090	3270
Cost of Silage	360	552.825	820.8	1332
Cost of WB	1139.85	1102.5	774	774
Total Variable Cost (TVC)	1499.85	1655.325	1594.8	2106
Selling price of lambs	4800	5000	5040	5520
Total return	1515	1835	1950	2250
Net return	15.15	179.675	355.2	144
Change in total return (ΔTR)	-	320	115	300
Change in total variable cost (ΔTVC)	-	155.475	-60.525	511.2
Change in net return (ΔNR)	-	164.525	175.525	-211.2
Marginal rate of return (MRR)	-	1.058209	-2.90004	-0.41315
MRR (%)	-	105.8209	-290.004	-41.3146

ETB/lamb = Ethiopian birr per lamb; MRR=marginal rate of return; WB=wheat bran; T1 to T4= treatments.

and with 40% of Dolichos lablab were not significantly (P>0.05) influenced among treatment groups.

CONCLUSION

Generally, the study revealed that ensiling of 40% Dolichos lablab with both Napier grass and Maize implies the improvement of silage nutritional concentration, increased intake of DM, CP and OM. Consequently, the growth performance, average daily gain and carcass characteristics of Horro sheep was improved. The partial budget analysis result suggests that lambs fed diets in T2 (Maize ensiled alone) shows positive marginal rate of return. While, the experimental animals fed diet in T4 shows negative values of partial budget which can be tolerable since it is higher in biological values. Therefore, ensiling of 40% Dolichos lablab with Maize had beneficial effects on silage properties, intake and digestibility of the nutrients which was also feasible for lambs.

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