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Digestion, Intake and Live Weight Changes of Horro Lambs Fed Vetch (*Lathyrus sativus*) Haulm Basal Diet Supplemented with Sole Wheat Bran, *Acacia albida* Leaf Meal or Their Mixture

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Abstract: Twenty five yearling male Horro lambs with initial body weights (IBW) of 23.14±2.45 kg (mean±SD) were used to determine effect of supplementation of wheat bran (WB), Acacia albida leaf meal (AA) or their mixture on nutrient digestibility, feed intake and growth performance of yearling Horro lambs fed a basal diet of vetch (*Lathyrus sativus*) haulm (VH). Animals were blocked into 5 based on IBW and were randomly assigned to treatments. Treatments were ad libitum feeding of VH either without supplement (T1) or with daily supplement of 300 g DM of sole WB (T2), sole AA (T5), or mixture of the two at 2:1 (T3) or 1:2 (T4) ratios of WB:AA. The study had 7 days digestibility and 84 days feeding trial. The VH, WB and AA had crude protein (CP) contents of 6.5, 16.0 and 19.5%, respectively. Supplementation did not impact ($P > 0.05$) dry matter (DM), neutral detergent fiber and acid detergent fiber digestibility but significant increased ($P < 0.05$) organic matter and CP digestibility. Intake of the basal diet DM was not affected by supplementation. Intake of total DM and nutrients increased by supplementations. Supplementation also increased average daily gain (ADG), and animals on sole VH diet lost weights of 40.95 g daily while gains of 39.52, 52.86, 42.38 and 28.09 g/day were recorded for T2, T3, T4 and T5, respectively. Among the supplemented treatments, T3 showed higher final weight, total gain and ADG ($P < 0.05$) than T5, but means for other supplemented groups were similar ($P > 0.05$). Positive and significant ($r=0.82$, $P < 0.05$) correlation was observed between ADG and CP digestibility. This relationship might have caused growth performance differences among treatments.

Key words: Acacia albida, digestibility, growth performance, Horro lamb

INTRODUCTION

In areas where livestock are closely integrated with crop production, crop residues are considered as valuable sources of ruminant feeds. The tendency of increased acreage of cropping land is always at the expenses of decreased available grazing lands, thus boost the importance of straws as animal feed resources. However, crop residues are of generally low in nutritive value and are fibrous having low digestible (<500 g digestible organic matter per kg Dry Matter (DM)) and low Crude Protein (CP) content (<50 g/kg DM) (Emyr, 1994). Nevertheless, pulse crop resides/haulms have relatively better nutritive value than cereal straws but hardly supply animals' maintenance requirements (De Leeuw, 1997). Thus, supplementation of crop residues with agro-industrial by-products and/or plant protein sources will alleviate CP deficiency in fibrous feeds (Solomon, 2001). FAO (2002) suggested that the urgent need of the farmers for high quality feed for ruminants in developing countries can be achievable through intensive utilization of multipurpose trees and shrubs as they have better nutritional quality nearly equivalent to that of grain based concentrates. According to Shayo (1998), leaves of multipurpose trees are highly digestible; contain high concentration of CP and minerals and low cell wall contents. Among the well known multipurpose tree in Ethiopia, *Acacia albida* is one potential multipurpose tree capable of producing leaves and pods of high nutritive value. According to Hassan *et al*. (2007) and NFTA (1997) *A. albida* is known to produce leaves and pods during dry season when most trees shade their leaves. This important characteristic of the plant is a key attribute that makes *A. albida* worthy of investigation as feed for ruminants. Therefore, this study was carried out with the objective of investigating the effect of supplemental wheat bran, *A. albida* leaf meal and their mixtures on digestibility, feed intake and weight gain yearling Horro lambs fed *L. sativus* haulm basal diet.

MATERIALS AND METHODS

Study site, feeds, feed preparation and feeding: The study was conducted at Ambo University, Ambo *Woreda*, Oromia Region, Ethiopia which is located at 115 km West of Addis Ababa. The site is situated at 8°17'N-9°56'N latitude and 37°1'E-38°45'E longitude and at mid altitude that ranges from 1,380 to 3,300 meter above sea level. The mean annual rainfall was 1079 mm and the mean minimum and maximum daily temperatures of the area were 12 and 26 °C, respectively.

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The basal diet, Vetch Haulm (VH) used for the study was collected from randomly selected peasant association in Ambo *Woreda* and hand chopped approximately to 4-5 cm length to increase its intake and decrease rate of selectivity by lambs and the processed haulm was thoroughly mixed and stored on concrete floor house until used. *Acacia albida* leaf meal was collected from Ambo University campus. Small side branches with green was cut when leaf mass was maximal. The branches were stripped off the leaves and were air dried by spreading them thinly on plastic sheets under a shade for a period of 5-6 days. Dried leaves were finally ground with traditional mortal to prepare the leaf meal that was used as supplement for the study. Leaf meals prepared in different batches were mixed at the end to have a uniform leaf meal supplement. Wheat bran was purchased from Teltele flour factory found in Ambo town. Lambs were adapted to their respective experimental feeds for 15 days before the 7 days digestibility test and 84 days of feeding trails. The supplements were offered in two equal portions at 0800 and 1530 h daily while the basal diet was offered once in the morning. Water and mineral salt licks were accessed freely to all lambs.

Animals, experimental design and treatments: Twenty five yearling entire male Horro lambs with initial body weights of 23.1±2.45 kg (mean±SD) having relatively similar body condition were used in randomized complete blocked design with five teammates of five animals each. The lambs were quarantine for 21 days and treated with 300 mg albendazole bolus for internal and with acarimic spray for external parasites, respectively. Lambs were blocked on the basis of overnight fasting of their initial body weight and the five treatments were randomly assigned to animals in the block. Lambs were housed in concrete floor that penned individually.

Treatments were *ad libitum* feeding of VH either without supplement (T1) or with daily supplement of 300 g DM of sole wheat bran (T2), sole *A. albida* (T5), or mixture of the two at 2:1 (T3) or 1:2 (T4) ratios of wheat bran: *A. albida*.

Fecal collection: Lambs were acclimatized to fecal collection bags for five days that followed by successive 7 days of total fecal collection for each lambs. After weighing the daily total fecal output of each animal, the feces were thoroughly mixed and a sub-sample of 10% of the daily fecal voided was taken to make a single weekly composite fecal sample for each lamb. Composite samples were taken in air-tighted plastic bags and refrigerated at -4°C and/or frozen between and after collection pending chemical analysis. Feed offered and corresponding refusals were weighed daily.

Feed intake and live weight changes: Feeds offered to experimental lambs and corresponding refusals were weighed and recorded daily throughout the experimental period. Grab samples of feeds offered and refusal were pooled over experimental period for each feed and animal. The composite refusal samples were pooled per treatment. Feeds and refusal samples were placed in air-tighted plastic bags and stored refrigerated pending chemical analysis. The daily dry matter and nutrient intakes of the lambs were calculated as a difference between that offered and refused.

Initial body weights were measured at the beginning of the trial and fortnightly thereafter by a suspended 50 kg balance with 200 g sensitivity. At fortnightly weighing, all lambs were fastened overnight and weights were recorded before the offer of morning meal while water and salt lick remain accessed. Average daily weight gain was calculated as a difference between the final and initial body weights divided by the number of feeding days. Feed conversion efficiency was estimated as a ratio of daily body weight gain per units of feed consumed daily.

Laboratory analysis: Samples of feed offered and refusals, both in the digestion and feeding periods and feces were dried in a forced draft oven at 60°C for 72 h and ground to pass a 1 mm screen and stored in air-tight plastic bags pending laboratory analysis. All samples were analyzed for DM, ash and Kjeldahl N (AOAC, 1990), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) (Van Soest and Robertson, 1985). Acid Detergent Lignin (ADL) was also determined (Van Soest and Robertson, 1985) for feed samples only. For tannin analysis, total phenolic compounds were extracted with 70% aqueous acetone from the samples. Then total tannin was determined by the total butanol-HCl assay (Makkar *et al.*, 1995). Energy value of the feed was estimated according to McDoland *et al.* (2002) as metabolizable energy (MJ/kg DM) = 0.016DOMD; where DOMD being g digestible OM intake per kg DM.

Statistical analysis: Data collected in the experiment were subjected to Analysis of Variance (ANOVA) using the GLM procedure of Statistical Analysis System (SAS, 1999, version 6.12). Treatment means were separated using least significance difference test. The ANOVA model used for data analysis was:

$$Y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$$

Where: Y_{ij} is response variable in i^{th} treatment and j^{th} block, μ is the overall mean, α_i is the i^{th} treatment effect, β_j is the j^{th} block effect and e_{ij} is random errors.

Table 1: Chemical composition of treatment feeds

Composition	Vetch haulm	Wheat bran	*Acacia albida* leaf meal
DM (g/kg)	923.00	930.00	895.00
OM (g/kg DM)	893.00	946.00	899.00
CP (g/kg DM)	6.54	16.00	19.45
NDF (g/kg DM)	654.00	612.00	648.00
ADF (g/kg DM)	477.00	444.00	449.00
ADL (g/kg DM)	102.00	98.00	105.00
Total tannin (g/kg)	1.10	0.30	18.70

ADF: Acid Detergent Fiber; ADL: Acid Detergent Lignin; CP: Crude Protein; DM: Dry Matter; NDF: Neutral Detergent Fiber; OM: Organic Matter

Table 2: Apparent nutrient digestibility coefficient of nutrient in Horro lambs fed *L. sativus* haulm supplemented with wheat bran, *A. albida* leaf meal or their mixtures (values are means±SEM)

Apparent digestibility coefficient	Treatments T1	T2	T3	T4	T5	SEM
DMD	0.55	0.57	0.59	0.57	0.57	0.214
OMD	0.53^{c}	0.60^{ab}	0.61^{a}	0.60^{ab}	0.57^{bc}	0.101
CPD	0.23^{c}	0.46^{ab}	0.52^{a}	0.51^{ab}	0.42^{b}	0.325
NDFD	0.47	0.48	0.51	0.50	0.44	0.327
ADFD	0.46	0.50	0.51	0.47	0.47	0.220

^{abc}Values within a row with different superscripts differ significantly (p<0.05); ADFD: Acid Detergent Fiber Digestibility; CPD: Crude Protein Digestibility; DMD: Dry Matter Digestibility; NDFD: Neutral Detergent Fiber Digestibility; OMD: Organic Matter Digestibility; SEM: Standard Error of the Mean; T1: *ad libitum L. sativus* haulm; T2: *ad libitum L. sativus* haulm + 300 g DM wheat bran; T3: *ad libitum L. sativus* haulm + 200 and 100 g DM wheat bran and *A. albida* leaf meal mixture; T4: *ad libitum L. sativus* haulm + 100 and 200 g DM wheat bran and *A. albida* leaf meal mixture; T5: *ad libitum L. sativus* haulm + 300 g DM *A. albida* leaf meal

RESULTS

Chemical composition of treatment feeds: Chemical composition of the feeds used in the present study is presented in Table 1. The content of NDF, ADF and ADL seems similar in all of the three feed ingredients. *Acacia albida* leaf meal contained higher CP and tannin than the other treatment feeds. Compared to the supplements feeds VH contains lower CP (6.54%) and relatively higher NDF (65.4%) and ADF (47.7) fractions.

Feed and nutrient digestibility: Apparent DM, NDF and ADF digestibility were not significantly affected (p>0.05) by treatments (Table 2). Treatment effect was significant (p<0.05) for OM and CP digestibility. Digestibility of OM was greater (p<0.05) for T3 as compared to T1 and T5. The non-supplemented animals had lower CP digestibility as compared to the supplemented groups. However, among the supplemented groups there was no significant difference (p>0.05) in CP digestibility except between T3 and T5 (p<0.05).

Feed intake: All animals had a complete consumption of the supplemented *A. albida* leaf meal and/or wheat bran offered to them. Supplementation resulted in significantly higher (p<0.05) total DM intake, but did not have a significant effect (p>0.05) on the intake of the basal diet (Table 3). Substitution ratio was similar among treatments (p>0.05) obviously due to similar intake of the basal diet among treatments. Like that of the total DM intake, total nutrient and digestible nutrient intakes were generally greater (p<0.05) for the supplemented animals compared to the ones fed vetch haulm alone. Intake of CP in supplemented groups was around 10% of the total DM intake. Moreover, metabolizable energy (MJ/day) of the supplemented treatments were significantly improved (p<0.05) compared to non-supplemented group.

Table 3: Nutrient and digestible nutrient intake (g/day) and Substitution Ratio (SR) of Horro lambs fed *L. sativus* haulm supplemented with wheat bran, *A. albida* leaf meal or their mixtures (values are means±SEM)

Nutrient intake	Treatments T1	T2	T3	T4	T5	SEM
TDM	598^{c}	851^{b}	914^{a}	906^{ab}	850^{b}	19.4
HDM	598	551	614	606	550	19.4
OM	534^{d}	775^{bc}	823^{a}	816^{ab}	761^{c}	17.3
CP	38.9^{c}	84.0^{b}	91.6^{a}	94.5^{a}	94.3^{a}	1.43
NDF	391^{c}	544^{b}	589^{a}	587^{a}	555^{ab}	12.7
ADF	285^{c}	396^{b}	447^{a}	423^{ab}	397^{b}	9.26
ADL	60.9^{c}	85.6^{b}	92.8^{a}	92.6^{a}	87.6^{ab}	1.99
ME (MJ/day)	3.78^{b}	6.24^{a}	6.68^{a}	6.04^{a}	5.88^{a}	0.378
SR		0.16	-0.06	-0.03	0.16	0.074
Digestible nutrient intake						
DDM	289^{b}	465^{a}	494^{a}	459^{a}	459^{a}	28.3
DOM	236^{b}	390^{a}	417^{a}	377^{a}	367^{a}	23.6
DCP	7.8^{b}	42.7^{a}	45.2^{a}	44.2^{a}	38.1^{a}	3.09
DNDF	149^{b}	231^{a}	254^{a}	238^{a}	205^{ab}	20.0
DADF	112^{c}	196^{a}	192^{a}	164^{ab}	149^{bc}	13.8

^{abc}Values within a row with different superscripts differ significantly (p<0.05); ADF: Acid Detergent Fiber; ADL: Acid Detergent Lignin; CP: Crude Protein; DADF: Digestible Acid Detergent Fiber; DCP: Digestible Crude Protein; DDM: Digestible Dry Matter; DNDF: Digestible Neutral Detergent Fiber; DOM: Digestible Organic Matter; HDM: Haulm Dry Matter; NDF: Neutral Detergent Fiber; OM: Organic Matter; SEM: Standard Error of the Mean; TDM: Total Dry Matter; T1: *ad libitum L. sativus* haulm; T2: *ad libitum L. sativus* haulm + 300 g DM wheat bran; T3: *ad libitum L. sativus* haulm + 200 and 100 g DM wheat bran and *A. albida* leaf meal mixture; T4: *ad libitum L. sativus* haulm + 100 and 200 g DM wheat bran and *A. albida* leaf meal mixture; T5: *ad libitum L. sativus* haulm + 300 g DM *A. albida* leaf meal

Live weight changes and feed conversion efficiency: Initial body weights of lambs were similar (p>0.05) among treatments (Table 4). Supplementation significantly improved (p<0.05) final body weight, total gain, average daily gain and feed conversion efficiency. Despite the medium CP content of the VH used in this study compared to cereal straws, animals on the haulm diet were unable to maintain body weight when fed alone. Final weight, total and average daily gains were greater (p<0.05) for T3 than T5, but was similar among T2, T3 and T4 as well as T2, T4 and T5.

Table 4: Growth performance and feed conversion efficiency in Horro lambs fed *L. sativus* haulm supplemented with wheat bran, *A. albida* leaf meal or their mixtures (values are means±SEM)

	Treatments					
Parameters	T1	T2	T3	T4	T5	SEM
IW (kg)	22.90	23.00	23.00	23.20	23.20	0.250
FW (kg)	19.40^{c}	26.30^{ab}	27.40^{a}	26.80^{ab}	25.60^{b}	0.520
Total gain (kg)	-3.44^{c}	3.32^{ab}	4.44^{a}	3.35^{ab}	2.36^{b}	0.411
ADG (g/day)	-40.90^{c}	39.50^{ab}	52.90^{a}	42.40^{ab}	28.10^{b}	4.890
ADG (g/kgW$^{0.75}$)	-3.95^{c}	3.85^{ab}	5.07^{a}	4.02^{ab}	2.22^{b}	0.514
FCE (g gain/g intake)	-0.07^{c}	0.05^{ab}	0.06^{a}	0.05^{ab}	0.03^{b}	0.007

^{abc}Values within a row with different superscripts differ significantly (p<0.05); ADG: Average Daily Gain; FCE: Feed Conversion Efficiency; FW: Final Live Weight; IW: Initial Live Weight; W$^{0.75}$: metabolic body weight; SEM: Standard Error of the Mean; T1: *ad libitum L. sativus* haulm; T2: *ad libitum L. sativus* haulm + 300 g DM wheat bran; T3: *ad libitum L. sativus* haulm + 200 and 100 g DM wheat bran and *A. albida* leaf meal mixture; T4: *ad libitum L. sativus* haulm + 100 and 200 g DM wheat bran and *A. albida* leaf meal mixture; T5: *ad libitum L. sativus* haulm + 300 g DM *A. albida* leaf meal

DISCUSSION

Chemical composition of treatment feeds: Since the feeds used in the current study are either matured or dried under sun, their DM content is expectedly high (Table 1). Moreover, their fiber fractions, NDF, ADF and ADL, compositions were not deviate largely. Though crop residues are expected to have relatedly more fiber fraction, the browse, *A. albida* leaf meal used in this study contains a bit elevated fiber fractions than expected for most browse plants. As a result, this may limit its comparative supplementary feeding value as feeds of high fiber contents limit intake and digestion (Van Soest, 1994). Many studies noted less than 550 g/kg NDF and 370 g/kg ADF for different acacia species (Asfaw *et al*., 2006; Jimenez-Ferrer *et al*., 2007; Mahala and Fadel Elseed, 2007; Mukandiwa *et al*., 2010). Such variation in fiber content may partly stem from differences in stage of plant maturity at the time of leaf harvesting. However, the tannin content in the meal is by far below the limit that cause bind to protein in most cases and sometimes with fibers digestibility. Probably, this may act as beneficiary effect of tannin to function as protecting protein degradation in the rumen (Dynes and Schlink, 2002).

The CP content of the haulm was considered to be medium though it was lower than 109.9 g/kg reported by (Likawent *et al*., 2004) but within a range of 54 to 124 g/kg (Tesfaye, 1999; Savadogo *et al*., 2000; Likawent *et al*., 2004) for haulms of other pulse crops such as haricot bean, lentil, chick pea, cowpea and groundnut. Such difference could attribute to differences related to species and/or variety, agronomic practices and soil fertility. The 65 g/kg CP in the current result was fairly comparable to the 70 g/kg CP (Ibrahim and Tibin, 2003) that affect rumen condition for efficient utilization of feeds. Moreover, it is comparable with the 60 g/kg CP reported for urea treated wheat straw (Getahun, 2006), an indication for VH to be used as potential replacer to urea treated wheat straw. The CP content of *A. albida* leaf is high. Thus, the leaf from this browse plant can be considered as good and cheap source of plant protein supplement to support animal performance, provided that the anti-nutritional factors in the plant is not limiting. The current CP value of *A. albida* is within the range of 171-197 g/kg reported (Gohl, 1981) for the leaf of the same browse plant and 206.3 and 195 g/kg for seeds and pulp of *A. albida* (Hassan *et al*., 2007).

Feed and nutrient digestibility: Inclusion of different forms of supplement resulted in significant improvement in CP and OM digestibility but not affect significantly the digestibility of the fiber fraction. Digestibility of CP and OM were significantly improved for T3 as compared to T1 and T5. The non-supplemented animals had lower CP and OM digestibility as compared to the supplemented groups. However, among the supplemented groups there was no significant difference in CP digestibility except between T3 and T5. Lower OM and CP digestibility for non-supplemented animals in the present study may presumably be justified by the lower level of CP intake that might have limited nitrogen supply to rumen microorganisms to support optimum digestion activity (Ibrahim and Tibin, 2003). Similar to the current results supplementation of hay or straw based diets did not improve digestibility of fiber but impact CP digestibility (Mulu, 2005; Simret, 2005; Kusmartono, 2007). It is generally expected for supplementation to improve digestibility of DM and nutrients. However, results of supplementation on digestibility of DM and nutrients reported by various researchers appear to lack consistency (Ngamsaeng and Wanapar, 2005; Lamidi *et al*., 2006; Berhan and Getachew, 2009). The relatively greater digestibility of OM and CP when the two supplements were fed in mixture than alone in the current study is inline with Nouala *et al*. (2006) who reported that replacing commercial concentrate with 25-50% *Moringa oleifera* leaf resulted in higher *in vitro* DM digestibility.

Haddad and Husein (2003) indicated that DM, OM and CP digestibility will increase with increase in energy density of the diet. Though the metabolizable energy intake (MJ/day) among the supplemented groups were not significantly different, the relatively higher metabolizable energy intake (Table 3) in T3 than T5 (6.68 vs 5.88) might probable be an attribute for the significant difference in OM and CP digestibility

coefficient between the two treatments (Table 2). The same reason of low energy intake when vetch was fed alone than for the supplemented animals in the present study may justify the low OM and CP digestibility observed for animals fed the non-supplemented diet.
High CP intake has been generally associated with more nutrient digestibility. For instance, Chobang *et al.* (2009) indicated that increasing the level of CP in total ration improved CP intake and enhanced CP digestibility. However, DM and CP digestibility appeared not to be linearly related with CP intake in the present study which may probably be in part due to the increased level of tannin concentration as the level of *A. Albida* leaf meal inclusion in the diet increases which might have suppressive effect on CP digestibility (Igwebuike *et al.*, 2008). Relatedly, Kamalak *et al.* (2004) also indicated a negative relationship between tannin content and digestibility of most nutrients.

Feed intake: The significantly improved total DM and nutrient intake in the supplemented group is presumably justified by the above limit of CP intake (7%) affect rumen condition for efficient utilization of feeds (Ibrahim and Tibin, 2003). In the present study intake of CP in the supplemented treatments were about 10% of the total DM intakes. Therefore, the significant improvement in intake and digestion of most of the nutrients in the current study of the supplemented group can be justified by the relatively better intake and digestibility of CP. The lack of significant differences in digestibility and intake of total or digestible nutrients between T2 and T5 suggests that *A. albida* leaf can at least be a good substitute to wheat bran if available and price is feasible.
The average daily DM intake of the VH in the present study was comparable with the 581 g/day intake reported for chickpea but was lower than the 632 and 839 g/day intake noted for lentil and vetch reported by Likawent *et al.* (2004) for yearling Menz lambs. These intake differences were also reflected on animal performance. Likawent *et al.* (2004) noted a positive daily weight gain even for the comparable intake of chickpea as opposed to the negative body weight gain observed in the present study, which may be partly due to variation in DM and/or nutrient intake and digestibility and feed conversion efficiency of the breeds. On the other hand intake of total DM for the non-supplemented group in the current study was relatively greater than the 477 g/day intake of hay (Mulu, 2005) and the 567 g/day urea treated wheat straw (Getahun, 2006) used as basal diet for sheep which indicated that VH has greater and/or comparable feeding value with grass or urea treated wheat straw.
Horro lambs generally respond positively for supplementation and as such the level of supplementation and intakes of DM and nutrients have been linearly correlated (Tesfaye *et al.*, 2002; Gemeda *et al.*, 2003; Zewdu *et al.*, 2006). In this study similar amount of supplement to supplemented treatments was employed and the level used was sufficient enough to positively impact intake, digestibility and/or animal performance. Supplemented groups of this study had by far greater than the 274-522 g/day DM intake reported by Melese *et al.* (2002) for the same breed of lambs supplemented with improved forage and/or concentrate. Similar to the present findings, Ibrahim and Tibin (2003) indicated that replacing pods of *A. albida* at 0, 15, 30 and 45% for sorghum gain in total mixed ration resulted in significant improvement in daily feed intake. Berhan and Getachew (2009) indicated a significant improvement in total DM, OM and CP intake when hay basal diet was supplemented with different forms of *A. saligna*. Navas-Camacho *et al.* (1993) indicated that inclusion of tree legumes up to 10% of the total ration as protein supplement increased total DM intake than at 34% level. In agreement with this, the 10.9% intake of *A. albida* leaf meal (T3) resulted in higher ($p<0.05$) total DM and OM intakes than when *A. albida* accounted 35.3% (T5) of the total DM intake. The decline in total DM intake at high level of *A. albida* leaf meal inclusion may be due to high tannin intake with the leaf meal and its possible concomitant impact on nutrient digestibility and/or on rumen ecosystem.

Live weight changes and feed conversion efficiency: Different forms of supplement significantly improve final body weight, total gain, average daily gain and feed conversion efficiency of the lambs in the present study. Despite the medium CP content of the VH used in this study compared to cereal straws, animals on the haulm diet were unable to maintain body weight when fed alone. The CP level in VH was expected not to bring such body weight loss as it is close to the limiting CP level of 7% required for optimum ruminal microbial synthesis (Ibrahim and Tibin, 2003). However, the high fiber content, low CP digestibility associated with the low intake of metabolizable energy (Kitho, 1997) for animals on haulm alone might presumably have caused losses in body weight. However, death was not occurred for lambs fed the VH alone. Likawent *et al.* (2004) reported a daily weight gain of 26 g/day when Menz ram lambs were fed sole *L. sativus* haulm, contrary to the result of the current study that showed haulm of *L. sativus* not to satisfy the maintenance requirement of the lambs. However, weight loss when lambs fed unsupplemented crop residues and natural grass hay has been noted before (Mulu, 2005; Simret, 2005; Getahun, 2006; Berhan and Getachew, 2009).
Final weight, total and average daily gains were significantly improved for T3 than T5, but was similar among T2, T3 and T4 as well as T2, T4 and T5. This

was somewhat in accordance with differences in digestibility and/or intake of DM, OM and/or nutrients observed in this study. The tendency for decrease in average daily gain with increase in the level of *A. albida* leaf meal was in agreement with the report of Ibrahim and Tibin (2003) when pods of *A. albida* was used at increasing replacement levels (0, 15, 30 and 45%) for sorghum bran. Rubanza *et al.* (2007) also indicated a better growth performance when meals of *A. nilotica*, *A. polyacantha* and *L. leucocephala* were supplemented in combination with other concentrate for goats in support of the results of the current finding. Typical to the current result for T5, Mukandiwa *et al.* (2010) reported a daily weight gain of 28 g/day when range grazing goats were supplemented with leaf of *A. angustissima* mixed with pear millet. Similarly, Asfaw *et al.* (2006) reported for Arsi sheep that supplementation of 30% of total DM mixture of *A. angustissima* leaf resulted in a gain of 46 g/day.

The result of the current finding outlined that *A. albida* leaf meal as either a sole supplement or in mixture with wheat bran to be comparable to supplementary value of improved fodders for sheep. Takele *et al.* (2006) reported a daily weight gain of 24 g/day for Horro lambs supplemented with 272 g/day of wilted *L. pallida* leaf for *Chloris gayana* basal diet which is similar to current finding. Moreover, Getahun (2006) reported a gain of 29.2 g/day when 300 g *L. leucocephala* leaf was supplemented for wheat straw which is very consistent with the current value for T5. Solomon *et al.* (2004) reported a daily live weight gain of 21.6 to 36.3 g/day when Menz ewes were fed teff straw basal diet supplemented with different multi-purpose trees which is in agreement with the result of the current study. Therefore, it can be said that *A. albida* leaf has comparable feeding value with other indigenous and some improved tree legumes.

Moreover, the trends of weight change in experimental lambs (Fig. 1) can indicate how lambs were respond to different treatment diets in the feeding period. It can be easily observed from the graph that unsupplemented animals were able to maintain body weight only for the first two weeks thereafter sharp decline followed while the supplement groups showed increases in body weight through most of the feeding period. Supplemented groups under different treatments showed more or less similar trend in body weight change throughout the experimental period. Furthermore, association between average daily gain and CP digestibility (Fig. 2) can partly explain impact of CP digestibility in influencing weight gain. A significant correlation ($r = 0.82$, $p<0.05$) was observed between CP digestibility and average daily weight gain of the experimental lambs. Higher CP digestibility of the feed is obviously associated with enhanced ruminal nitrogen supply for microbial protein synthesis. This concomitantly may have direct and indirect impact on

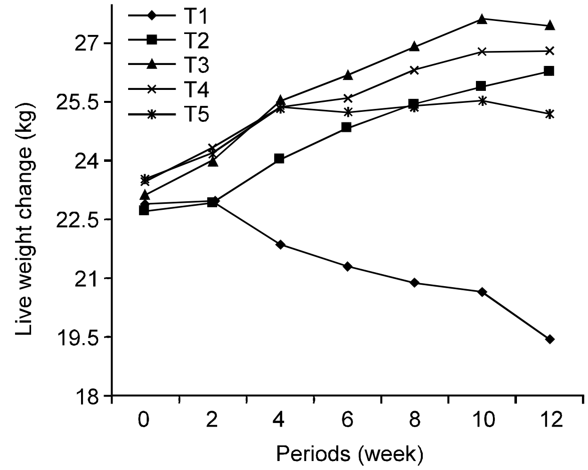

Fig. 1: Trends of body weight change in Horro lambs fed *L. sativus* haulm supplemented with wheat bran, *A. albida* leaf meal or their mixtures. (T1: *ad libitum L. sativus* haulm; T2: *ad libitum L. sativus* haulm + 300 g DM wheat bran; T3: *ad libitum L. sativus* haulm + 200 and 100 g DM wheat bran and *A. albida* leaf meal mixture; T4: *ad libitum L. sativus* haulm + 100 and 200 g DM wheat bran and *A. albida* leaf meal mixture; T5: *ad libitum L. sativus* haulm + 300 g DM *A. albida* leaf meal)

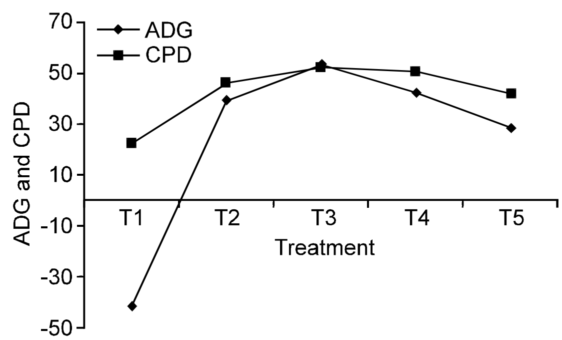

Fig. 2: Association of crude protein digestibility (CPD, %) and average daily weight gain (ADG, g/day) of lambs fed L. sativus supplemented with wheat bran, *A. albida* leaf meal or their mixture. (T1: *ad libitum L. sativus* haulm; T2: *ad libitum L. sativus* haulm + 300 g DM wheat bran; T3: *ad libitum L. sativus* haulm + 200 and 100 g DM wheat bran and *A. albida* leaf meal mixture; T4: *ad libitum L. sativus* haulm + 100 and 200 g DM wheat bran and *A. albida* leaf meal mixture; T5: *ad libitum L. sativus* haulm + 300 g DM *A. albida* leaf meal)

nutrient digestion and availability to the animal. As such differences in performance observed in this study may mainly stem from variation in CP digestibility.

Conclusion: Results of the present study suggested that *A. albida* leaf meal and wheat bran supplemented to vetch haulm at 300 g DM level daily supported similar degree of animal performance. Similar amount of supplement of wheat bran and *A. albida* leaf meal when supplemented in mixture might have better impact on feed and nutrient intakes, digestibility and growth performance of animals than supplementing the sole *A. albida* leaf meal or wheat bran.

Thus, it can be concluded that supplementation of wheat bran, *A. albida* leaf meal and their mixture to vetch haulm can be employed to enhance performance of growing lambs and based on the feeding regimen employed in this study, the 2:1 ratio of wheat bran:*A. albida* leaf meal supplement of T3 would be recommended due to its relatively better impact on nutrient utilization, animal performance and carcass yield.

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