



Effect of Alfalfa (*Medicago Sativa L.*) Hay Supplementation and Urea Molasses Block on Feed Intake, Digestibility, and Body Weight Change of Yearling Local Sheep Fed Grass Hay as Basal Diet

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ABSTRACT

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A study was conducted to evaluate the effect of supplementation of alfalfa (*Medicago sativa L.*) hay and urea molasses block on feed intake, digestibility, and body weight change of yearling local sheep fed with grass hay as a basal diet. The rationale for supplementation of alfalfa hay with urea molasses block 1) high-producing animals protein need cannot exclusively met from rumen microbial sources; 2) protein is the most expensive nutrient of ruminant animal feed. Twenty-four yearling intact male local sheep with a mean initial body weight of 23.9±1.9 (Mean ± SD) were used in a completely randomized block design. Treatments were 1% of live weight alfalfa hay (1A), 1.5% of live weight alfalfa hay (1.5A), 2.0% of live weight alfalfa hay (2A), and all three treatments offered with 100g/head/day of Urea-molasses-block (UMB). The control treatment was supplemented with concentrate mix at 2.0% of live weight (C). In addition, all treatments were fed grass hay ad libitum. The study period consisted of 84 days of feeding and 7 days of digestibility tests. Total dry matter intake was 1015.65, 925.41, 956.16, and 1078.13 (SE=± 19.4) for C, 1A, 1.5A, and 2A, respectively and 1A was lower than 2A and similar with 1.5A and C. Apparent crude protein digestibility and Crude protein intake of 2A was statistically similar to C. But, higher than 1A and 1.5A. Average daily gain was 109.33, 54.76, 55.36, and 63.1 (SE=± 6.13) g/day for C, 1A, 1.5A, and 2A, respectively and the values were the highest for C. The study showed that concentrate supplementation at 2% body weight resulted in greater body weight gain, crude protein intake and apparent crude protein digestibility. Additionally, the weight gain achieved at all grade levels of alfalfa plus in combination with the same amount of urea molasses block was commendable. But, considering the accessibility and cost of conventional concentrate mixture, 2% of Live Weight Alfalfa hay with 100g/head/day urea molasses block is recommended as an alternative supplement regime for better sheep performance.

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Introduction

Ethiopia is the leader in Africa for livestock resources with anticipated domestic herd size about 70.3, 95.4, and 21.5 million cattle, small ruminants, and pack animals, respectively. This country's economic growth depends heavily and continues to be supported by this sector of the livestock industry (CSA, 2021).

According to research Mlynek (2000), Ethiopia's indigenous sheep have the second-lowest average daily body weight gain of any country in Sub-Saharan Africa, at roughly 62.2g. On the other hand, the current market for Ethiopian live sheep and mutton exports (to Middle Eastern nations) needs for animals weighing between 25 and 30 kg

at yearling stage. However, the majority of local sheep slaughtered at this age weigh between 18 and 20 kg under the traditional management system (Yadete, 2014).

As a result of relying solely on locally occurring grasses, crop residues, and/or stubble grazing, which are all fundamentally deficient in nutrients, local sheep exhibit poor performance in terms of weight gain and carcass output (Melaku and Betsha, 2005; Bogale et al., 2008). These show that meat from sheep obtained from such a production systems contributes less to the per capita meat consumption (9.94 kg) in Ethiopia per annum (Teklebrhan and Urge 2013).

Supplementing with forage legumes is a sustainable strategy to increase the nutritional value of low-quality crop residues and pastures, particularly for smallholder farmers (Murphy and Colucci, 1999).

Alfalfa is a forage legume with a high yield and high nutritional value that is usually fed to ruminants as hay, silage, or both (McMahon et al., 2000). Alfalfa hay, which has the best nutritional content and produces excellent results when fed to lambs, is frequently used to supplement the crude protein of ruminants' finishing diets (Hwang et al., 2018). Alfalfa supplementation has been suggested as a way to improve weight growth, digestibility, and consumption in low-quality diets (Rong et al., 2014; Brandt and Klopfenstein, 1986).

Additionally, combining blocks and supplements will boost each one's individual benefits (Jayasuriya and Smith, 1999). Urea Molasses Multi-Nutrient Blocks (UMMB) can increase the animal's intake of feed by 25 to 30%, its ability to digest fibrous material by up to 20%, and its ability to absorb nutrients (Yami, 2007). Therefore, employing locally accessible feedstuffs indoor for shorter time periods is a profitable technique to increase animal body weight and, consequently, carcass output (Alemu, 2008).

Despite the fact that sheep's productivity was improved by high quality forage legumes supplemented with urea molasses block, Ethiopian feeding methods using these diets are rare. Hence, this study was designed to evaluate the effect of supplementation of alfalfa (*Medicago sativa* L.) hay and urea molasses block on feed intake, digestibility, and body weight change of yearling local sheep fed grass hay as basal diet.

Materials and Methods

Description of the Study Area

The study was carried out at the Sirinka Agricultural Research Centre (SARC), in Eastern Amhara Regional National State of Ethiopia. The site is found between the Latitude of 11°45'0.42"N, 39°36'52.21"E longitude approximately, and 508 kilometers northeast of Addis Abeba. The centre is located at an elevation of 1850 meters above sea level and experiences bi-modal rainfall with mean annual rainfall of 950 mm. The main rainy season, known as "Meher," runs from June to September, while the short rainy season, known as "Belg," rains from February to April (SARC, unpublished). The region's average high and low temperatures are 26°C and 13°C, respectively.

Lambs in Experiment and Management

24 male intact yearling (9-12month age) local sheep were bought with a mean initial body weight of 23.9±1.9 (Mean ± SD) from the nearby market. The sheep used in this experiment is known locally as "Tumelie." The locals in the study region thought that the sheep there were a hybrid between Wollo and Afar sheep. This sheep population was categorized as Afar sheep breed by Solomon (2008) and more recently, as rift valley sheep (Yoseph et al., 2016; GebreMichael, 2008). Individual pens with high slatted floors were employed to hold the experimental animals. Age estimation for the animals was based on their dentition and information from the owners. The individual pens used to hold the experimental animals were raised slatted floors.

Animals were isolated in the experimental area for 21 days after receiving identification ear tags. They were injected with ivermectin solution against external and internal parasites during the quarantine period. Besides, we administered pen-strep 20/20, Albendazole, and Ophthalmic ointment against microbial infection, helminths, and eye infections during the adaptation period, respectively.

They were accustomed to the pens and feed treatments for 15 days before starting the experiment. A rule of thumb would be to offer about 30g/head/day urea-molasses block (UMB) for one hour/day during the first 4 days, followed by 60g/head/day for three hours/day during the next 5 days (Jayasuriya and Smith, 1999). Thereafter, 100g/head/day of UMB was offered at 15:30hr for one hour after the animals have consumed an adequate ration in the whole experimental period. The Alfalfa hay and concentrate were offered twice per day at 11:00hr and 13:00hr in two equal portions. Chopped grass hay was given freely, along with access to clean water.

Experimental Feeds and Preparation

The experiment used grass hay that was collected from the Sirinka Agricultural Research Center's (SARC), sheep and goat breed distribution and evaluation. A concentrate mixture with formulation of [Nougseed cake (46%), wheat bran (20%), maize grain (32%), limestone (1%), and salt (1%)] were bought from Dessie Erikum, a feed mill and formulation factory. At the SARC forage multiplication site, alfalfa seed was sown at start of monsoon and harvested for hay while it was just before flowering.

The required amount of UMB/day was prepared with the proportion of molasses (40%), urea (10%), wheat Bran (25%), cement (10%), Nougcake (10%), vitamin premix (1%), salt (4%) and water with a proportion of one litre of water to 2.5kg of cement. Then, mixing, casting and molding, drying, storage, and removal of urea molasses block is carried out according to procedure of Alemu (2007).

Experimental Design and Treatments

The design of the experiment was randomized complete block design (RCBD). The experimental animals were grouped in to six blocks with four male sheep in each block based on the initial body weight.

The four treatment diets were randomly assigned to sheep in each block, which resulted in six animals per treatment, and the animals within a block had an equal chance to receive one of the four diets. The treatments were 2.0% of Live Weight Concentrate mixture + grass hay *ad libitum* (C), 1% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum* (1A), 1.5% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum* (1.5A), and 2.0% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum* (2A).

Feed Intake, Body Weight Gain and Feed Conversion Efficiency (FCE)

The daily amount of feed supplied and leftover was weighed for each animal and recorded to calculate daily feed intake as the difference between the feed supplied and leftover. Animal body weights were recorded at the start of the trial and every 14 days over the 84-day feeding period.

After overnight fast, all animals were weighed in the morning using a hanging scale with a 50 kg capacity and 200g precision. The average daily gain (ADG) was determined by dividing the difference between the animals final weight and its starting weight by the number of feeding days. To determine feed conversion efficiency (FCE), daily body weight increase was divided by daily DM consumption.

Digestibility Trial

The digestibility test was carried out following the feeding trial using the same animals. The sheep were accustomed to carry the fecal collection sack for three days. Apparent digestibility was calculated by total fecal collection after the adjustment period. Fecal output was collected and weighed daily for seven days for each animal, and a 10% subsample was taken from each animal, deep frozen at -20°C, and composited for the next seven days, from which sufficient amounts of subsamples were extracted for chemical analysis. The samples of feces were partially dried at 60°C for 72 hours in a forced draft oven, milled to pass a 1 mm screen, and were stored in an airtight polyethylene bag for analysis. A daily grab sample of feed offered and refusals from each feed and animal, respectively, was sampled throughout the 7 day digestibility testing and was composited for chemical analysis. The following equation was used to determine the apparent digestibility percentages of nutrients (McDonak et al., 2002):

$$DC (\%) = \frac{(\text{Nutrient intake} - \text{Fecal nutrient})}{\text{Nutrient intake}} \times 100$$

Chemical Analysis of Feed and Feces

Chemical analysis of the offered and refused feeds in the experiment as well as feces were subjected to laboratory determination of dry matter, organic matter, and ash according to the procedure of (Goering and Van Soest 1970). The N content of the samples were determined according to the micro-Kjeldahl method and the crude protein (CP) was calculated as N*6.25. According to the method described in Van Soest and Robertson (1985), acid detergent fiber (ADF), Neutral detergent fiber (NDF), and acid detergent lignin (ADL) were identified.

Analysis of Data

The General Linear Model Procedure of SAS (version 9.0) was employed to analyze feed intake, digestibility, and body weight change. $P \leq 0.05$ was used to declare significant differences. The Tukey HSD (Tukey honestly significant difference) test was subjected to separate treatment means. The following model was applied to analyze feed intake, digestibility, and weight change:

$$Y_{ij} = \mu + T_i + B_j + e_{ij}$$

Where;

Y_{ij} = Response variable

μ = Overall mean

T_i = feed/treatment effect

B_j = block effect

e_{ij} = effect of random error

Results

Table 1 shows the proximate composition of raw materials used. Dry matter content of grass hay, alfalfa hay and concentrate mixture were 94%, 91% and 94%, respectively. Organic matter content of feed samples ranged from 89.25% to 97.85% with concentrate mixture having the highest value while grass hay had the lowest value. Ash content of the feed samples ranged from 2.15% to 10.75% with concentrate mixture having the lowest (2.15%) while grass hay had the highest value (10.75%). Protein content of concentrate was highest with a value of 23.4% while grass hay had the lowest value (4.60%). Neutral detergent fiber content was highest in grass hay with a value of 72.21% while concentrate mixture had the lowest value (40%). Acid detergent fiber content was highest in grass hay with a value of 61.70% while concentrate mixture had the lowest value (27.66%). Acid detergent lignin content of grass hay, alfalfa hay and concentrate mixture were 12.27%, 9.67% and 5.55%, respectively.

Daily Dry Matter and Nutrient Intake

Table 2 shows experimental animals fed 2A had the highest total dry matter intake (1078.13g/day) than animals fed 1A (925.41g/day). Animals supplemented with 2A were higher in organic matter intake than 1A, while statistically similar with C and 1.5A. Crude protein intake of animals fed 2A was higher 1A and 1.5A, while statistically similar with C. Neutral detergent fiber intake ranged from 589.98g/day to 708.2g/day with animals fed 2A had the highest value.

Apparent Nutrient Digestibility

Table 3 shows dry matter digestibility of feed samples was ranged from 41.80% to 54.05% with 2A was the highest with a value of 54.05% while 1.5A was the lowest value (41.8%). Organic matter digestibility of feed samples ranged from 45.50% to 57.52% with 2A and C was higher than 1A and 1.5A. Crude protein digestibility of feed samples ranged from 67.26% to 78.61% with 2A and C was higher than 1A and 1.5A. Acid detergent fiber digestibility of C, 1A, 1.5A and 2A was 35.46%, 49.72%, 45.70% and 54.99%, respectively with 2A was higher than C, but statistically similar with other treatments. Whereas, neutral detergent fiber and acid detergent fiber digestibility were statistically similar among treatments ($P > 0.05$).

Body Weight Change and Feed Conversion Efficiency

Table 4 shows Initial and final body weights of sheep were statistically similar ($P > 0.05$) among treatments. Total live weight gain, average daily gain (ADG) ($P < 0.01$) and feed conversion efficiency ($P < 0.001$) was the highest for C as compared to the other treatments. Total live weight gain ranged from 4.6kg to 9.18kg with C was the highest with a value of 9.18kg. Average daily gain ranged from 54.76g/day to 109.33g/day C was the highest with a value of 109.33g/day. Feed conversion efficiency ranged from 0.0581 to 0.1065 with C was the highest with a value of 0.1065.

According to the observation in the current study, feed with concentrate mixture (C) showed better performance than alfalfa hay supplemented treatments which are comparable in body weight change (Figure 2).

Table 1. Raw materials and chemical composition of rations

Diet offered	% DM						
	DM (%)	OM (%)	Ash %	CP (%)	NDF (%)	ADF (%)	ADL (%)
Grass hay	94.00	89.25	10.75	4.60	72.21	61.70	12.17
Alfalfa hay	91.00	92.47	7.53	13.03	67.54	57.45	9.67
Concentrate mixture	90.00	97.85	2.15	23.40	40.00	27.66	5.55

Source: Debrebirhan Agricultural Research Center, Nutrition Laboratory Analysis Result

Table 2. Daily dry matter and nutrient intake of yearling lambs supplemented alfalfa hay with urea molasses block fed grass hay as a basal diet

	Treatments					
	C	1A	1.5A	2A	SL	SEM
Grass hay	467.96	562.53	506.3	492.6	Ns	12.84
Supplement	547.69 ^a	362.88 ^c	449.86 ^b	585.53 ^a	***	19.31
Total DM	1015.65 ^{ab}	925.41 ^b	956.16 ^{ab}	1078.13 ^a	*	19.40
Total nutrient intake						
OM	955.39 ^{ab}	831.04 ^b	860.2 ^{ab}	972.17 ^a	*	18.55
CP	151.3 ^{ab}	132.19 ^b	133.74 ^b	166.59 ^a	**	3.91
NDF	589.98 ^b	609.49 ^b	636.9 ^b	708.2 ^a	***	11.21
ADF	425.84 ^c	518.59 ^b	541.09 ^{ab}	603.17 ^a	***	15.56
ADL	84.92 ^b	99.57 ^{ab}	102.14 ^a	112.56 ^a	**	2.62

^{a,b,c} Means with in a row not bearing similar superscript are significantly different; * = P < 0.05; ** = P < 0.01; *** = P < 0.001; GH = grass hay; SL = significance level; SEM = standard error of mean; C = 2.0% of Live Weight Concentrate mix + grass hay *ad libitum*; 1A = 1% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 1.5A = 1.5% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 2A = 2.0% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*

Table 3. Apparent dry matter and nutrient digestibility of yearling lambs supplemented alfalfa hay with urea molasses block fed grass hay as a basal diet

DP (%)	Treatments					
	C	1A	1.5A	2A	SL	SEM
DM	52.11 ^{ab}	45.12 ^{bc}	41.80 ^c	54.05 ^a	**	1.57
OM	56.89 ^a	48.81 ^b	45.50 ^b	57.52 ^a	***	1.55
CP	72.02 ^{ab}	70.40 ^b	67.26 ^b	78.61 ^a	**	1.19
NDF	46.6	49.15	44.71	55.25	Ns	1.67
ADF	35.46 ^b	49.72 ^{ab}	45.70 ^{ab}	54.99 ^a	*	2.29
ADL	38.51	56.4	44.79	55.13	Ns	2.91

^{a,b,c} Means with in a row not bearing similar superscript are significantly different; * = P < 0.05; ** = P < 0.01; *** = P < 0.001; DP (%) = Apparent digestibility percentage; ADF = acid detergent fiber; ADL = acid detergent lignin; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; OM = organic matter; SL = significance level; SEM = standard error of mean; DC = digestibility coefficient; C = 2.0% of Live Weight Concentrate mix + grass hay *ad libitum*; 1A = 1% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 1.5A = 1.5% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 2A = 2.0% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*

Table 4. Body weight parameters and feed conversion efficiency

Variables	Treatments					
	C	1A	1.5A	2A	SL	SEM
IBW (kg)	23.40	23.97	24.6	23.73	Ns	0.381
FBW (kg)	32.58	28.57	29.25	29.03	Ns	0.572
TLWG (kg)	9.18 ^a	4.6 ^b	4.65 ^b	5.3 ^b	**	0.515
ADG (g/day)	109.33 ^a	54.76 ^b	55.36 ^b	63.10 ^b	**	6.126
DMI (g/day)	1015.65 ^{ab}	925.41 ^b	956.16 ^{ab}	1078.13 ^a	*	19.401
FCE [DG(g)/DMI(g)]	0.1065 ^a	0.0593 ^b	0.0581 ^b	0.0589 ^b	***	0.005

^{a,b} Means within a row not bearing similar superscript are significantly different; * = P < 0.05; ** = P < 0.01; *** = P < 0.001; ADG = average daily body weight gain; TLWG = total live weight gain; IBW = initial body weight; FBW = final body weight; FCE = Feed conversion efficiency [DG(g)/DMI(g)]; SEM = standard error of mean; SL = significance level; UMB = urea molasses block; C = 2.0% of Live Weight Concentrate mix + grass hay *ad libitum*; 1A = 1% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 1.5A = 1.5% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*; 2A = 2.0% of Live Weight Alfalfa hay + UMB (100g/head) + grass hay *ad libitum*

Discussion

Chemical Composition of Feeds

The crude protein (CP) level of grass hay used in this study was relatively low (Table 1). It revealed that it was poor quality and contained less than the 7% CP needed for microbial protein synthesis in the rumen to fulfill ruminants' minimum maintenance needs (Van Soest et al. 1991).

The crude protein content of grass hay in the present study was lower than 5.4%, 5.15%, 7.9%, 7.8%, 9.81%, 9.6% and 11% crude protein content of grass hay reported by many other previous studies (Abraham et al., 2015; Assefa et al., 2008; Gebrehiwot et al., 2017; Negussie et al., 2015; Nurfeta, 2010; Shumuye and Yayneshet, 2011; Solomon et al., 2017; Worknesh and Getachew, 2018), respectively.

Moreover, it was less than the 11% CP content of high-quality grass hay reported by (McDonald et al., 2002) and the 7.5 to 15.45% range reported for hay from natural pasture (Bogale et al., 2008; Yihalem, 2004).

The NDF, ADF, and ADL contents of grass hay in the current study were higher than the values of NDF, ADF, and ADL reported in previous studies (Abraham et al., 2015; Gebrehiwot et al., 2017). According to study, alfalfa hay (*Medicago sativa*) has CP value of 13.03 % and can satisfy the protein requirement of rapidly growing lambs as reported by (McDonald et al., 2011). It was comparable with the value of 12.9% reported by Darawish et al. (2010) and below 15%, 15.5%, 18.1%, 18.5%, 18-25% and 23% reported by (Alhidary et al., 2016; Da Silva et al., 2017; Kaito et al., 2006; Rong et al., 2014; Sun et al., 2018; Worknesh and Getachew, 2018), respectively. Whereas, it was greater than the value reported by (Abate and Melaku, 2007). NDF and ADF values of alfalfa hay were higher than the values reported by (Alhidary et al., 2016; Darawish et al., 2010; Sun et al., 2018).

Observed differences in natural pasture and alfalfa hay crude protein and fiber content might be due to variations in soil fertility, clipping stage, soil water throughout growing conditions, and general field management practices (Fekede et al., 2014).

The CP content of the concentrate mixture was lower than 28.8% stated by (Zeleke et al., 2017). Whereas, it was greater than 16.3% reported by (Amare and Girmay, 2020). This might be due to variation in the level and type of ingredients included to prepare the concentrate mixture.

Feeds that have less than 120, between 120 and 200, and more than 200 CP g/kg DM are categorized as minimal, moderate, and high protein sources, respectively by (Lonsdale, 1989). Based on this classification, grass hay and alfalfa hay in the present study are classified under low and medium protein source feeds, respectively. Whereas, the concentrate mix is classified under high protein source feed.

Daily Dry Matter and Nutrient Intake

Average daily DM intake of grass hay in the present study was lower than the 594.4g/day intake noted for grass hay for yearling central-highland sheep reported by (Gebrehiwot et al., 2017), but greater than 385.3 and

475.7g/day intake noted for Rhodes grass hay (Worknesh and Getachew, 2018). This might be due to variation in grass species, proportion of the ingredients, breed of the sheep, environment, and other management systems.

In the present study, alfalfa supplement dry matter intake (DMI) increase as degree of alfalfa hay supplementation increase and in agreement with the study on cornstalk-based diet supplemented with alfalfa hay which also improves DM intake (Wang et al., 2008). Similarly, Hunt et al. (1988) found that intake of DM linearly increased with increasing proportions of alfalfa. This might be due to variations in the level of supplementation, which is on the live weight base. Likewise, Rong et al. (2014) reported that intake of DM, OM, CP, and fiber improved with increasing levels of alfalfa in the diet.

Total crude protein intake of the experimental animals in the present study ranged from 132.19 to 166.59g/day, which were higher than 92 to 130g/day supplemented for Afar*Dorper F1 sheep fed Rhodes grass hay (Worknesh and Getachew, 2018), 81.1 to 121.6 g/day supplemented for Arsi Bale sheep breed fed with Faba bean haulms reported by (Tesfaye, 2008) and 88.2 to 106.9g/day supplemented for Bonga Sheep fed on Rhodes grass hay as basal diet (Mengistu et al., 2020).

Apparent Nutrient Digestibility

The higher apparent dry matter digestibility percentage of 2A and C might be related to the higher CP intake, which is usually associated with better DM digestibility (McDonald et al., 2011).

The crude protein digestibility values observed in this study ranged from 67.26 to 78.61%, which were consistent with the digestibility values (68.2–71.9%, 73.8%) reported by (Mitiku, 2011) and (Tesfay et al., 2018) for substitution of concentrate mix (noug seed cake and wheat bran) with dried mulberry leaf meal for Tigray lambs, lower than 73.9 to 81.8% for Bonga Sheep fed with Rhodes grass hay as basal diet (Mengistu et al., 2020) and 78.3 to 82.3% for Afar*Dorper F1 sheep fed Rhodes grass hay basal diet and supplemented with concentrate diet (Worknesh and Getachew, 2018). The observed difference might be due to variation in the breed and nutritional composition of the feed.

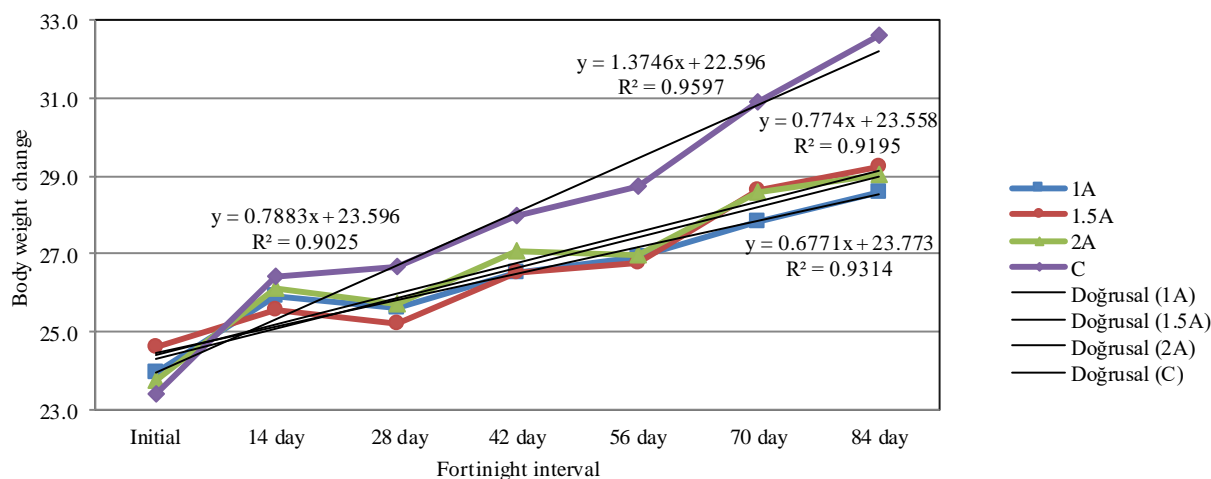


Figure 1. Trends of body weight change during experimental period of local sheep fed on grass hay and supplemented with alfalfa hay and urea molasses block

Body Weight Change and Feed Conversion Efficiency

Sheep fed alfalfa hay supplemented treatments in this study were in harmony with the replacement of grass hay/crop residue with alfalfa hay in which alfalfa hay supplementation improved total weight gain and ADG (Rong et al., 2014). The ADG of sheep fed alfalfa hay supplemented treatments were comparable with that reported for Menz and Horro lambs, but the ADG of sheep fed C was higher than ADG of Menz and Horro lambs (Mlynek, 2000).

The average daily gains of sheep fed alfalfa supplemented treatment and C in this study were higher than 44.63 and 65.1g/day for Afar × Dorper F1 sheep fed Rhodes grass hay basal diet supplemented with 286 and 300g/head/day alfalfa hay and concentrate mix, respectively (Worknesh and Getachew, 2018).

The average daily gains of sheep fed all treatment diets in the present study were lower than 138-189g/day for Small-tail Han lambs fed with different ratio of alfalfa hay and maize stover (Sun et al., 2018). Likewise, lower than 118-179g/day fed various ratios of grass hay/crop residue and alfalfa (*Medicago sativa L.*) hay in Mongolia and small-tail cross breed lamb (Rong et al., 2014).

Feed conversion efficiencies (FCE) of sheep fed alfalfa supplemented treatments in this study were similar with 0.06 for Dorper × Afar F1 sheep supplemented with alfalfa hay and lower than 0.13-0.17 for sheep fed various ratios of grass hay/crop residues and alfalfa (*Medicago sativa L.*) hay in Mongolia and small-tail sheep cross breed lamb as reported by Rong et al. (2014). But, FCE of sheep fed T4 was higher than 0.08 for Afar × Dorper F1 sheep supplemented with concentrate mix (Worknesh and Getachew, 2018).

Conclusion

The study showed that concentrate supplementation at 2% body weight resulted in greater body weight gain, crude protein intake and apparent crude protein digestibility. In addition, the growth rate of local sheep increases with add level of alfalfa hay. This result demonstrate a basic principle which is that alfalfa hay provides rumen escape protein which is the limiting factor with local grass in tropical ecosystems. Therefore, 2% of live weight alfalfa hay with 100g/head/day urea molasses block is advised as an alternative supplement regime for better sheep performance in view of the availability and expense of standard concentrate mixture. It is crucial to validate, support, and advertise the study's recommendations to farmers.

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References

- Murphy AM, Colucci PE. 1999. A tropical forage solution to poor quality ruminant diets: A review of *Lablab purpureus*, Livestock Research for Rural Development, vol. 11, no. 2, pp. 96–113.
- Abraham H, Urge M, Animut G. 2015. Effects of supplementation with air dried leaves of African wild olive (*Olea africana*), Red thorn (*Acacia lahai*) and their mixtures on performance of Tigray highland sheep fed grass hay. Glob. J. Agric. Res, 1, 1-9.
- Murphy AM, Colucci PE. 1999. A tropical forage solution to poor quality ruminant diets: A review of *Lablab purpureus*, Livestock Research for Rural Development, vol. 11, no. 2, pp. 96–113.
- Alemu Y. 2008. Short term intensive fattening of sheep and goats before slaughter for rapid improvement in weight and condition and also producer incomes. Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP). In R. C. Merkel (Ed.), Techn. Bull (Vol. 11, Issue 11, pp. 1–11).
- Alhidary IA, Abdelrahman MM, Alyemni AH, Khan RU, Al-Saiady MY, Amran RA, Alshamiry FA. 2016a. Effect of alfalfa hay on growth performance, carcass characteristics, and meat quality of growing lambs with ad libitum access to total mixed rations. Revista Brasileira de Zootecnia, 45, 302-308. <https://doi.org/10.1590/S1806-92902016000600004>
- Almaz A, Tamir B, Melaku S. 2012. Feed intake, digestibility and live weight change of lambs fed finger millet (*Eleusine coracana*) straw supplemented with atella, noug seed (*Guizotia abyssinica*) cake and their mixtures. Agricultura Tropica et Subtropica, 45(3), 105-111. <https://doi.org/10.2478/v10295-012-0018-3>
- Amare B, Girmay A. 2020. Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. Online Journal of Animal and Feed Research, 10(6), 313-320. <https://doi.org/10.51227/ojaf.2020.42>
- Assefa G, Kijora C, Kehaliew A, Bediye S, Peters KJ. 2008. Evaluation of tagasaste (*Chamaecytisus palmensis*) forage as a substitute for concentrate in diets of sheep. Livestock Science, 114(2-3), 296-304. <https://doi.org/10.1016/j.livsci.2007.05.017>
- Awgichew K. 2000. Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. <http://nbn-resolving.de/urn:nbn:de:kobv:11-10014479>
- Betsha S. 2005. Supplementation of graded levels of peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. An M. Sc Thesis Presented to the School of Graduate Studies of Alemaya University. 75p.
- Bogale S, Melaku S, Yami A. 2008. Potential use of crop residues as livestock feed resources under smallholder farmers conditions in Bale highlands of Ethiopia. Tropical and Subtropical Agroecosystems, 8(1), 107-114.
- Brandt Jr RT, Klopfenstein TJ. 1986. Evaluation of alfalfa-corn cob associative action. II. Comparative tests of alfalfa hay as a source of ruminal degradable protein. Journal of Animal Science, 63(3), 902-910. <https://doi.org/10.2527/jas1986.633902x>
- CSA (Central Statistic Authority). 2021. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey 2020/21 [2013 E.C.], Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Addis Ababa, Ethiopia. II(March), 16.

- Darawish S, Harb M. Y, Titi H. H. 2010. Effects of replacing alfalfa hay by barley straws on growth performance, carcass characteristics and nutrients digestibility for fattening Awassi lambs. *Jordan Journal of Agricultural Science*, 6, 27-40.
- Dawit A. 2007. Effect of vetch (*Vicia dasycarpa*, L.) and alfalfa (*Medicago sativa* 'hunter river') hay supplementation on feed intake, digestibility and body weight change of Arsi-Bale sheep fed a basal diet of urea treated Barley straw. An MSc Thesis presented to the school of graduate studies of Haramaya University, 86.
- Fekede F, Shiv P, Getnet A, Seyoum B, Getu K, Aemiro K, Gezahegne K. 2014. Dynamics in nutritional characteristics of natural pasture hay as affected by harvesting stage, storage method and storage duration in the cooler tropical highlands. *African Journal of Agricultural Research*, 9(43), 3233-3244. <https://doi.org/10.5897/ajar2014.8652>
- Gebrehiwot G, Negesse T, Abebe A. 2017. Effect of feeding leucaena leucocephala leaves and pods on feed intake, digestibility, body weight change and carcass characteristic of central-highland sheep fed basal diet wheat bran and natural pasture hay in Tigray, Ethiopia. *International Journal of Agriculture, Environment and Biotechnology*, 10(3), 367-376. <https://doi.org/10.5958/2230-732X.2017.00045.6>
- Gebremichael SG. 2008. Sheep resources of Ethiopia: genetic diversity and breeding strategy. Wageningen University and Research.
- Goering HK, Van Soest PJ. 1970. Forage analyses. *Agriculture Handbook* 379, 68137(402), 379.
- Haddad S. G 2000 Associative effects of supplementing barley straw diets with alfalfa hay on rumen environment and nutrient intake and digestibility for ewes. *Animal Feed Science and Technology*, 87(3-4), 163-171. [https://doi.org/10.1016/S0377-8401\(00\)00203-0](https://doi.org/10.1016/S0377-8401(00)00203-0)
- Hunt CW, Klopfenstein TJ, Britton RA. 1988. Effect of alfalfa addition to wheat straw diets on intake and digestion in beef cattle. *Nutrition reports international*.
- Hwang YH, Bakhsh A, Ismail I, Lee JG, Joo ST. 2018. Effects of intensive alfalfa feeding on meat quality and fatty acid profile of Korean native black goats. *Korean journal for food science of animal resources*, 38(5), 1092. <https://doi.org/10.5851/kosfa.2018.e42>
- Jayasuriya MCN, Smith T. 1999. Frequently asked questions on Urea-Molasses-Multinutrient Block Technology (UMMB). In IAEA working document on Guidelines for developing feed supplementation packages, Vienna, Austria. IAEA (2000).
- Kaito C, Morishita D, Matsumoto Y, Kurokawa K, Sekimizu K. 2006. Novel DNA binding protein SarZ contributes to virulence in *Staphylococcus aureus*. *Molecular microbiology*, 62(6), 1601-1617.
- Lonsdale C. 1989. Raw materials for animal feed compounders and farmers. Straights. (Book) Chalcombe Publications, Great Britain, 17-47.
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA, Wilkinson RG. 2011. *Animal Nutrition*. <https://www.bookdepository.com/Animal-Nutrition-Peter-McDonald/9781408204238>
- McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair L, Wilkinson RG. 1995. Grass and forage crops. *Animal Nutrition*, England Longman Scientific and Technical, 434, 444.
- McMahon LR, McAllister TA, Berg BP, Majak W, Acharya SN, Popp JD, Coulman BE, Wang Y, Cheng KJ. 2000. A review of the effect of forage condensed tannins on ruminal fermentation and bloat.
- Mengesha M, Tsega W. 2012. Indigenous sheep production in Ethiopia: a review. *Iranian Journal of Applied Animal Science*, 2(4), 311-318. <http://www.cabdirect.org/abstracts/20123405222.html>
- Mengistu G, Assefa G, Tilahun S. 2020. Noug Seed (*Guizotia abyssinica*) Cake Substituted with Dried Mulberry (*Morus indica*) and *Vernonia amygdalina* Mixed Leaves' Meal on Growth Performances of Bonga Sheep at Teppi, Ethiopia. *Journal of Nutrition and Metabolism*, 2020. <https://doi.org/10.1155/2020/9308761>
- Mitiku A. 2011. Substituting concentrate mix by mulberry leaves (*Morus indica* L.) in the diet of lactating Holstein cows. Mekelle University, Mekele, Ethiopia.
- Negussie F, Dawa D, Dawa D, Ababa A, Ababa A. 2015. Effect of feeding regimes on measurements of carcass dimensional and proximate composition of Blackhead Ogaden sheep. *Open Access Library Journal*, 2(06), 1. <https://doi.org/10.5829/idosi.aj.2015.4.1.94229>
- Nurfeta A. 2010. Feed intake, digestibility, nitrogen utilization, and body weight change of sheep consuming wheat straw supplemented with local agricultural and agro-industrial by-products. *Tropical animal health and production*, 42(5), 815-824. <https://doi.org/10.1007/s11250-009-9491-8>
- Rong Y, Yuan F, Johnson DA. 2014. Addition of alfalfa (*Medicago sativa* L.) to lamb diets enhances production and profits in northern China. *Livestock Research for Rural Development*, 26(224).
- Silva JCD, Vêras AC, Carvalho FRD, Ferreira MA, Souza EO. D, Barreto LG, Silva JVD. 2017. Nutritional value, performance, feeding behavior and serum biochemical profile of sheep fed with alfalfa hay replacing Bermuda grass (*Cynodon dactylon* (L.) Pers.) hay. *Chilean journal of agricultural research*, 77(4), 340-345. <https://doi.org/10.4067/S0718-58392017000400340>
- Sun L, Yin Q, Gentu G, Xue Y, Hou M, Liu L, Jia Y. 2018. Feeding forage mixtures of alfalfa hay and maize stover optimizes growth performance and carcass characteristics of lambs. *Animal Science Journal*, 89(2), 359-366. <https://doi.org/10.1111/asj.12928>
- Takele F, Getachew A. 2011. Digestion, intake and live weight changes of Horro lambs fed vetch (*Lathyrus sativus*) haulm basal diet supplemented with sole wheat bran, *Acacia alba* leaf meal or their mixture. *Pakistan Journal of Nutrition*, 10(11), 1013-1021. <https://doi.org/10.3923/pjn.2011.1013.1021>
- Van Soest PV, Robertson JB, Lewis BA. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of dairy science*, 74(10), 3583-3597.
- Worknesh S, Getachew A. 2018. Digestibility and growth performance of Dorper*F1 sheep fed Rhodes grass (*Chloris gayana*) hay supplemented with alfalfa (*Medicago sativa*), Lablab (*Lablab purpure*), *Leucaena leucocephala* and concentrate mixture. *International Journal of Livestock Production*, 9(4), 79-87. <https://doi.org/10.5897/ijlp2016.0335>
- Yami A. 2007. How to make urea molasses blocks (UMB) and feed to sheep and goats. Technical Bulletin1. Ethiopia Sheep and Goat productivity Improvement Program. RC Merkel (ed.). 10Pp.
- Zelege T, Mekonnen T, Asres Z, Liuel Y. 2017. Growth Performance of Weaned 50% F2 Boer x Central Highland Crossbred Goats Supplemented with Different Levels of Concentrate on Native Pasture.