

Effects of Feeding Faba Bean Hull, Wheat Bran and their Mixtures on Performance of Growing Local Sheep Fed a Basal Diet of Sudan Grass Hay at Gondar Zuria, Ethiopia

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Abstract

Conventional sources of feed supplements are costly and mostly unavailable for smallholder farmers. Due to its better nutritional characteristics feeding Sudan grass hay for sheep can contribute in reducing the amount of protein source supplements and can help in improving animal performance. An experiment was conducted using twenty four male local yearling lambs with an initial body weight of 21.77 ± 1.87 kg (mean \pm SD) to investigate feed intake, digestibility, body weight change and economic benefits using local sheep fed a basal diet of Sudan grass hay supplemented with Faba bean hull, Wheat bran and their mixtures. The experiment lasted 90 days of growth and 7 days of digestibility period. The experiment was undertaken using a randomized complete block design having six blocks with four treatments (T1=Sudan grass hay ad libitum+300 g Wheat bran (WB); T2=Sudan grass hay ad libitum+200 g WB+100 g FBH; T3=Sudan grass hay ad libitum+100 g WB+200 g FBH and T4=Sudan grass hay ad libitum+300 g Faba bean hull (FBH)). Three hundred grams of treatment diets were offered daily on dry matter basis. Feed intake and body weight were measured on a daily and ten days interval basis, respectively. All the collected data on dry matter (DM) and nutrient intake, DM and nutrient digestibility, body weight changes and feed conversion efficiency (FCE) were subjected to ANOVA using General Linear Model (GLM) procedure of SAS (2003). Sudan grass hay offered had 11.75% CP, 52.12% NDF and 36.58% ADF on DM basis. Supplement feed at 300g WB (T1), 200g WB+100g FBH (T2), 100g WB+200g FBH (T3) and 300g FBH (T4) had 19.19, 17.73, 16.28 and 14.82% CP, 44.20, 51.03, 57.87 and 64.70% NDF and 12.84, 27.59, 42.35 and 57.10% ADF on DM basis, respectively. Supplementation with high protein content feeds (T1, T2 and T3) improved dry matter, organic matter and crude protein intake and apparent digestibility. Dry matter intake (925.74 - 947.38 g day⁻¹) and crude protein intake (123.46 - 131.09 g day⁻¹) were higher for T1, T2 and T3. The dry matter digestibility (75.26-79.58%) and CP digestibility coefficient (78.46-84.22%) were also higher for T1, T2 and T3. Final body weight (29.88-31.75kg) and average daily gain (98.89-107.22g) were higher for T2 and T3 but with same effect to T1. The partial budget analysis result indicated that sheep fed Sudan grass hay supplemented with 200g WB+100g FBH (T2) had the highest net return (931.62 ETB) and highest MRR (3.32) compared to the other supplemented treatments. Thus, it is recommended that supplementation of Sudan grass hay with 200g WB+100g FBH g head⁻¹ day⁻¹ (T2) is biologically efficient and potentially profitable in the feeding of growing local ram lambs.

Keywords: digestibility, faba bean hull, intake, local ram lamb, Sudan grass hay, wheat bran.

1. Introduction

Though Ethiopia has large livestock population, the contribution of the sub-sector achieved so far

has been inadequate (CSA, 2020) [1]. The low productivity of livestock is mainly because of poor feed quality and insufficient supply (FAO, 2010) [2]. The low performance of local sheep in, terms of live weight (LW) and carcass yield is mainly due to inadequate nutrition associated with reliance on sole natural pasture and crop residues, which are inherently low in nutrients available

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being subjected to great seasonal variations (Solomon et al., 2008a) [3]. Temporally abundance of forage during short season is followed by long dry periods with feed deficit leading to a cycle of live weight gain and loss of animals. To overcome the existing feed shortage in the area farmers in Sorghum growing areas of central Gondar Zone are trying to grow sorghum by increasing its seed rate not only to produce grain but equally to get Sorghum Stover to use as animal feed. However the amount of Sorghum Stover obtained is much less, low palatable and digestible and its nutritional quality is very low, which is below the maintenance requirement of animals.

To combat the livestock feed shortage, the use of highly productive and better quality forages as a feed source is recommended. Among such types of forage species, which has high potential in sorghum growing areas, is Sudan grass. The grass is native to tropical and sub-tropical Africa and many more tropical countries [2]. Trials at numerous places have demonstrated that Sudan grass promises high value for hay, especially in the semiarid regions where no perennial grass has thus far been found suited to the conditions. In this regard Gondar Agricultural Research Center has been conducted Sudan grass adaptation and has got promising results.

Sudan grass (*Sorghum bicolor* cv. Sudanese) has been gaining increasing importance in animal feed, due to its ease of cultivation, rapid establishment and growth and, mainly, the ease of handling for cutting and grazing, besides good nutritional value 12.98% CP Lima et al. (2017) [4] and of high forage production, which makes it a viable alternative to offer green forage of high nutritional value. Compared to the local feed resources (grass hay and crop residues) due to its better nutritional characteristics feeding Sudan grass hay for sheep can contribute in reducing the amount of protein source supplements and improve animal performance. However, the uses of Sudan grass hay as a basal diet in reducing amount of supplements have not been evaluated for their optimal utilization. Therefore, the objectives of the study were to evaluate feed intake, digestibility and body weight change of local yearling sheep fed Sudan grass hay as a basal diet and supplemented with faba bean hull, wheat bran and their mixtures and to estimate profitability of the feeding regimes.

2. Materials and methods

Description of the study area

The study was conducted at Gondar Zuria district capital Maksegnit; 45 km south east of the Zonal capital Gondar which is located between 12° 25' 15'' N latitude and 37° 36' 19'' E longitude, at an elevation of 2061 m.a.s.l. The area has a moist tropical climate and the monthly mean temperature ranges from 13.6°C to 32°C. Based on 10 year's (2008-2017) data, annual rainfall ranges between 641 mm and 1,678 mm (mean 1, 052 mm). Tef, sorghum and chickpea are the major crops growing in the midland and fababean, wheat and barley are also the most crops growing in the highland of the area.

Experimental feed preparation

Basal diet (Sudan grass hay) was produced by renting farmer's field and delivered freely. Sudan grass was harvested at 4 months of age and properly cured. Basal diet was manually chopped before the start of the experiment to the size of about 1-5 cm to facilitate intake and to minimize selective feeding by the experimental animals. Sudan grass hay was thoroughly mixed to reduce any variation when fed during the experiment and stored under shade to maintain its quality. Concentrate feed ingredients were purchased from the local market and delivered to farmers freely. Before the commencement of the experiment required amount of Wheat bran and Faba bean hulls were thoroughly mixed considering the level of inclusion in each treatment.

Experimental animals and their management

Twenty four yearling male local sheep with average initial body weight of 21.77±1.87kg (mean±SD) were purchased from Maksegnit market by the volunteer farmers themselves. Age of the animals was determined based on their dentition and information obtained from the owner. The animals were quarantined for 15 days and during this period; they dewormed using Albendazole against internal parasites and sprayed against external parasites. Experimental animals were housed in individual pens equipped with feeding and watering troughs.

Experimental design and treatment

The experiment was conducted by using a randomized complete block design (RCBD) with

four treatments and six replications. Animals were blocked based on their initial body weight (IBW) into six blocks consisting of four animals each. Treatment diets were randomly assigned to each animal in a block. All experimental animals were offered basal diet *ad libitum* allowing 20% refusal. Each animal within the treatment group were offered 300g of supplemental feeds daily by dividing in two equal portions at 0800 and 1600 hours according to the treatment after offering basal diet. Basal feed (Sudan grass hay) as a basic ration and water were offered *ad libitum*. Experimental diets were offered on DM basis. The supplements were different proportions of WB and FBH. Treatments, therefore, were:

T1=Sudan grass hay *ad libitum*+300 g WB

T2=Sudan grass hay *ad libitum*+200 g WB+100 g FBH

T3=Sudan grass hay *ad libitum*+100 g WB+200 g FBH

T4=Sudan grass hay *ad libitum*+300 g FBH

Growth trial

The growth trial was lasted for 90 days after being quarantined for 14 days followed by 15 days of adaptation to the experimental feed. The feed offered and refused corresponding to each treatment diet for each animal were individually recorded daily throughout the experimental period. Daily feed intake was calculated as the difference between the feeds offered and refused. Initial body weights of the animals were determined by taking the average of two consecutive weights after overnight fasting. Subsequently the body weights were taken at an interval of 10 days throughout the experimental period. Average daily body weight gain was calculated as the difference between final body weight and initial body weight of the rams divided by the number of feeding days. Feed conversion efficiency was calculated as a ratio of daily body weight gain to daily dry matter (DM) intake.

Digestibility trial

The digestibility trial was conducted following the feeding trial and lasted for 10 days.

In the digestion trial, the rams were harnessed with faecal collection bags for three days of adaptation to carrying of the bag, followed by seven days of total faeces collection per animal. The parameters studied under the digestibility were DMD, OMD, and nutrient digestibility. The

faecal output per animal was collected each morning and weighed. Twenty percent of the daily faecal excretion were sampled after thorough mixing and pooled over the experimental period. Daily collected faecal samples were then stored frozen at -10°C. After seven days of total faecal collection period, samples taken daily from each animal were thoroughly mixed and sub-sampled. Feed samples from each feed and refusals from each ram were collected daily during the 7 days of digestibility period. The feed samples were pooled per feed type and refusals per treatment were used for chemical analysis. Digestibility of nutrients was determined as the difference between nutrient intake and that recovered in the feces expressed as the proportion of nutrient intake.

Chemical analysis

Samples of feeds offered, refusal, and faeces were dried in a forced draft oven at 60°C for 72 hours to constant weight to determine partial DM content. The samples were then ground to pass through a 1 mm sieve and stored pending laboratory analysis. All the feed samples, feed refusals and faeces were analyzed for DM, ash, CP content according to the procedures (AOAC, 2000) [5]. The ash content of the sample was determined by combusting the samples at 550C for 5 h in a muffle furnace. Nitrogen (N) content was determined using the micro Kjeldahl method and the CP was calculated as $N\% \times 6.25$. Organic matter (OM) content will be calculated as the difference between DM and ash content. The neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) contents were determined according to the method suggested by Van Soest et al., (1991) [6].

Statistical analysis

The data collected on feed intake, digestibility, body weight change, and feed conversion were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2003) [7] version 9.1.3. When GLM declares significant ($p < 0.05$), least significant difference (LSD) test was used to locate differences between the treatment means.

The linear model used was: $Y_{ij} = \mu + t_i + b_j + e_{ij}$

Where Y_{ij} = the response variable (the observation in j^{th} block and i^{th} treatment)

μ = the overall mean

t_i = the treatment effect

b_j = the block effect (initial body weight effect)

e_{ij} =the random error.

Partial budget analysis

Partial budget analysis performed to evaluate the economic advantage of the different treatments by using the procedure of Upton (1979) [8]. The partial budget analysis was involved in the calculation of variable costs. The expenditures incurred on feeds calculated by taking as additions to the variable costs. The cost of the feeds was computed by multiplying the actual feed intake for the whole feeding period with the prevailing prices. At the time of feed purchasing, the prevailing price of the feeds included the transportation cost incurred to move them to the experimental site. The labor cost for chopping hay was considered as variable cost. Initial price of sheep from the market was directly taken as the purchasing price. At the end of the experiment, three experienced sheep dealers were estimated the selling price of each experimental sheep. Partial budget method measures profit or losses, which are the differences between gains and expenses for feed.

$$NI=TR-TVC$$

The change in net income (ΔNI) was calculated as the difference between changes in total return (ΔTR) and the change in total variable costs (ΔTVC), and this is to be used as a reference criterion for decision on the adoption of a new technology.

$$\Delta NI=\Delta TR-\Delta TVC$$

The marginal rate of return (MRR) that measures the increase in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC) was calculated and expressed as ratio:

$$MRR=(\Delta NI/\Delta TVC)$$

3. Results and discussion

Chemical composition of experimental feeds

The chemical composition of experimental feeds used in the feeding and digestion trials is given in Table 1. The CP content of basal diet Sudan grass hay used was characterized by relatively high CP content, indicating its good potential to support above 8% CP required satisfying the maintenance requirement of sheep (McDonald et al., 2002) [9]. Hence, the observed CP content of Sudan grass hay in the current study was above that demanded for maintenance requirements of sheep. The

higher CP content of Sudan grass hay in the current study might be attributed to inherent characteristics of the grass, good environmental condition in which the grass grown, stage of maturity at which the hay was harvested and curing process during harvesting time. The NDF, ADF and ADL contents in basal diet Sudan grass hay were 52.12, 36.58 and 3.46, respectively, which is below the values that affect feed intake and digestibility. Lima et al. (2017) [4] indicated that NDF content below 72% had no negative effect on feed intake. Nussio et al. (1998) [10] also reported that forage with ADF content around 40%, or more, shows low intake and digestibility. Forages with below 10% ADL content regarded as better the forage in feed intake and highly digestible (Mustaring et al., 2014) [11].

The CP component of the supplement feeds 300g WB, 200 g WB+100 g FBH, 100g WB+200 g FBH and 300g FBH resulted in 19.19, 17.73, 16.28 and 14.82%, respectively (Table 1). The CP content of WB observed in the current study was higher than the value 13.13% CP reported by Kefyalew et al. (2015) [12] for Afar sheep. The difference might be due to the variation in the raw material methods of milling and the prolonged storage of WB after milling. But it was comparable to 19.4 and 19.4% CP reported by Merhun et al. (2016) [13] and Yeshambel and Bimrew (2018) [14] for Hararghe Highland Sheep and Washera Sheep breeds, respectively. The NDF value of the present study of WB was lower than the value of 66.5% reported by Merhun et al. (2016) [13], but it was higher than 28.7% [14]. The ADF content of WB was higher than 11.2% ADF reported by Yeshambel and Bimrew (2018) [14].

The CP content of 200g WB+100g FBH (T2) was relatively higher than 100g WB+200g FBH (T3). This is due to the content of high CP in WB than in FBH. The observed 17.73 and 16.28% CP contents in the current study for 67% WB+33% FBH and 33% WB+67% FBH mixtures, respectively were by far higher than the CP content of 12.57, 12.75 and 12.94% for WBxFBH(3:1), WBxFBH(1:1) and WBxFBH(1:3), respectively as reported by Woretaw et al. (2021) [15]. The observed CP difference could be due to the difference in the ratio of feed ingredients during mixing the supplement feeds at different times. FBH due to its high fiber profile than WB the NDF, ADF and

ADL contents were higher in mixture having higher proportion of FBH. The CP value of FBH in the current result was relatively comparable to the values of 14.10 reported by DOPED (2017) [16] for feeding of ruminants, but higher than the value of 7.8% CP reported by Gezahegn (2018) [17]. The current NDF content was comparable 63.07% NDF content reported by Abadi et al. (2015) [18] and lower than 74.1% NDF reported by Gezahegn (2018) [17] but, it is higher than

54.3% NDF [16]. These variations might be due to differences in the variety of faba bean and the efficiency of processing methods which may or may not allow inclusion of broken and discarded faba bean. These differences might be also happened due to differences in climatic conditions such as temperature, rainfall and the soil type where the faba bean grown.

Table 1. Chemical composition (% DM) of experimental feeds

Feed item	Chemical compositions (% DM)						
	DM	OM	Ash	CP	NDF	ADF	ADL
Experimental feeds							
Sudan grass hay	91.67	91.13	12.85	11.75	52.12	36.58	3.46
T1	87.03	95.66	4.34	19.19	44.20	12.84	2.43
T2	88.15	93.68	7.18	17.73	51.03	27.59	4.46
T3	89.28	91.71	10.01	16.28	57.87	42.35	6.49
T4	90.40	89.73	12.85	14.82	64.70	57.10	8.52

*ADF=acid detergent fiber; ADL=acid detergent lignin; CP=crude protein; DM dry matter; NDF=neutral detergent fiber; OM=organic matter; T1=Sudan grass hay ad libitum+300g Wheat bran (WB); T2=Sudan grass hay ad libitum+200 g WB+100 g Faba bean hull (FBH); T3=Sudan grass hay ad libitum+100 g WB+200g FBH; T4=Sudan grass hay ad libitum+300 g FBH

Feed and nutrient intake

The mean daily DM and nutrient intake of experimental sheep is presented in Table 2. The mean daily DM intake of Sudan grass hay and total DM intake (g day⁻¹) were significantly higher ($p < 0.001$) in 200 g WB+100 g FBH (T2) and 100 g WB+200g FBH (T3) supplemented group than 300g FBH (T4) supplemented sheep, with no difference ($p > 0.05$) with 300g WB (T1). The increased hay DM intake in sheep received higher CP might have created a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis, rate and extent of digestion which resulted in better hay intake. The results are also in close agreement with [6] who reported that optimum dietary protein supplementation increased the supply of nitrogen to the rumen microbes, which is correlated with enhancement of microbial population and efficiency thereby enabling them to increase the rate of breakdown of the roughage feed in the rumen which ultimately increased feed intake. The observed increased total DM intake in the sheep raised on 300g WB (T1), 200 g WB+100 g FBH (T2) and 100g WB+200 g FBH (T3) might be due to the palatability and optimal digestibility of the supplementary feeds. The increased total DM intake in the present study agreed with the results

of Awote and Solomon (2009) [19] that reported increasing levels of concentrate supplement with better CP content resulted in higher daily total DM intake of Afar sheep fed a basal diet of urea treated tef straw. The mean total DM intake was also comparable with the range of values from 768 to 979 g day⁻¹ reported by Hirut et al. (2011) [20] for Hararghe highland sheep fed urea-treated maize straw with different level of concentrate mixtures.

There was significant ($p < 0.01$) difference in the DM intake (%BW) and DMI (per kg W^{0.75}) between the treatment groups. Significantly ($p < 0.01$) higher DM intake (%BW) and DMI (per kg W^{0.75}) were achieved at 300g WB (T1), 100g WB+200 g FBH (T3) and 300 g FBH (T4) supplemented groups. This could be due to the observed differences in body weight related with the daily total DM intake at different groups. The total DM intake as percent of body weight (2.69-3.62%) in the present study was within the range of 2.85-3.29% of BW reported by Abebe (2008) [21] and lower than that of 4.4-5.3% reported by (Awote and Solomon, 2009) [19]. The values of DM intake (70.82-74.33g/kg W^{0.75}) in the present study were in accordance with the values of 58.6-82.87 g /kg W^{0.75} reported by Fentie and Solomon (2008) [22] in Farta sheep fed natural grass hay

supplemented with noug seed (*Guizotia abyssinica*) cake, wheat bran and their mixtures. Significant ($p<0.01$) difference was detected in OM intake between the treatments. Significantly higher OM intake was observed at 300g WB (T1) and 200 g WB+100 g FBH (T2), however 200g WB+100 g FBH (T2) was similar to that of 100g WB+200 g FBH (T3) and 300 g FBH (T4). This might be due to the difference in ash content in different treatment groups. The CP intake of sheep was significantly different ($p<0.05$) among the supplemented groups. The CP intake of 300g WB (T1), 200 g WB+100 g FBH (T2) and 100 g WB+200 g FBH (T3) were significantly ($p<0.05$) higher than 300 g FBH (T4). This is because of

the increasing CP level as the proportion of WB is increased. Values of the CP intake in this study were higher than the values that ranged from 54.23 to 111.98 g day⁻¹ as reported by Alemayehu et al. (2015) [23]. This could be due to the differences in basal feed used, supplement feed ingredients and level of ingredient inclusion in supplement feeds. Regarding the fiber fraction intake significantly ($p<0.01$) higher NDF, ADF and ADL were observed at 200g WB+100 g FBH (T2), 100 g WB+200 g FBH (T3) and 300 g FBH (T4). The higher intake of fiber fractions in these groups could mainly be a contribution attributed to the fiber content of supplement especially at FBH.

Table 2. Mean daily dry matter intake of growing local ram lambs fed on Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures

Parameters	Treatments				SL
	T1	T2	T3	T4	
Dry matter intake					
Sudan grass hay DM intake (g day ⁻¹)	625.74 ^{ab}	647.38 ^a	635.09 ^a	619.35 ^b	***
Supplement DM intake (g day ⁻¹)	300.00	300.00	300.00	300.00	ns
Total DM intake (g day ⁻¹)	925.74 ^{ab}	947.38 ^a	935.09 ^a	919.35 ^b	***
DM intake (% BW)	3.13 ^a	2.98 ^b	3.13 ^a	3.22 ^a	**
DMI (per kg W ^{0.75}) (g day ⁻¹)	73.04 ^a	70.82 ^b	73.17 ^a	74.33 ^a	**
Nutrient intake					
OM intake (g day ⁻¹)	857.22 ^{ab}	871.00 ^a	845.37 ^b	847.95 ^b	**
CP intake (g day ⁻¹)	131.09 ^a	129.26 ^a	123.46 ^{ab}	117.23 ^b	*
NDF intake (g day ⁻¹)	458.74 ^b	490.50 ^{ab}	505.72 ^{ab}	516.91 ^a	**
ADF intake (g day ⁻¹)	267.42 ^b	319.58 ^a	359.36 ^a	397.85 ^a	**
ADL intake (g day ⁻¹)	28.94 ^b	35.78 ^{ab}	41.44 ^a	46.99 ^a	**

*a,b,c=means within rows having different superscript letters are significantly different at ***= $p<0.001$; **= $p<0.01$; *= $p<0.05$; ns=non-significant at ($p>0.05$); BW=body weight; DM=dry matter; DMI=dry matter intake; SL=significant level; T1=Sudan grass hay ad libitum+300 g Wheat bran (WB); T2=Sudan grass hay ad libitum+200 g WB+100 g Faba bean hull (FBH); T3=Sudan grass hay ad libitum+100g WB+200 g FBH; T4=Sudan grass hay ad libitum+300 g FBH.

A trend of total DM intake is shown in Figure 1. As the Figure illustrates the total DM intake of experimental sheep in the current study showed an increasing trend throughout the experimental period with slightly drop down at day 30. This is because due to some negligence in attendants' animal were deprived of water and ultimately they refuse to eat. The trend was shown a slight over lying between treatments in total DM intake throughout the experimental period. This associated with differences in live body weight increment of experimental animals among treatments. This might be due to differences in daily nutrient intake that can satisfy differently the daily nutrient requirement of the experimental sheep for production.

Dry matter and nutrient digestibility

Table 3 shows the DM and nutrient digestibility of growing local ram lambs fed Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures. The present study revealed that, significant differences ($p<0.05$) were observed in apparent DM and OM digestibility among the groups. Significant ($p<0.05$) apparent DM and OM digestibility was attained at 300 g WB (T1), 200 g WB+100 g FBH (T2) and 100g WB+200 g FBH (T3) than 300 g FBH (T4). Compared with 300 g FBH (T4) significantly ($p<0.001$) higher CP apparent digestibility was recorded at 300g WB (T1), 200 g WB+100g FBH (T2) and 100g WB+200 g FBH (T3). As could be observed from digestibility

figures, CP digestibility was significantly ($p < 0.001$) higher in 300g WB (T1), 200g WB+200 g FBH (T3) than 300 g FBH (T4). The variation in DM, OM and CP digestibility coefficients might be due to the differences in CP content in supplements used for the study. This is in agreement with report of [9] who noted that addition of dietary protein in the supplement has increased protein availability to rumen microbes to speed up the digestion process. However, the 300 g FBH (T4) was grouped under low

digestibility which could be due to lower CP and higher fiber content of FBH. Regarding fiber digestion significantly ($p < 0.01$) higher NDF and ADF digestibility was observed at 300 g WB (T1) and 200g WB+100 g FBH (T2). This might be due to the relatively higher CP content of supplement feeds that created a favorable rumen environment resulting in enhanced fermentation of the fibrous feeds which resulted in better NDF and ADF digestion.

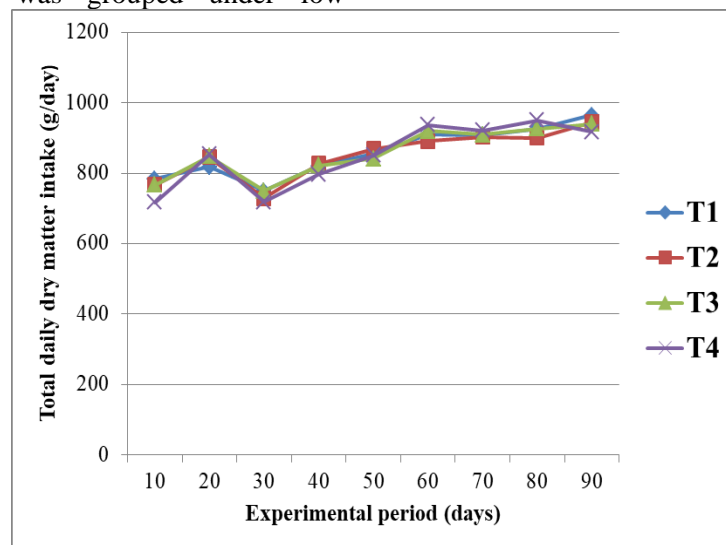


Figure 1. Dry matter intake of growing local ram lambs fed on Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures

Table 3. Mean dry matter and nutrient digestibility in growing local ram lambs fed on Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures

Digestibility (%)	Treatments				SL
	T1	T2	T3	T4	
DM	75.26 ^a	79.58 ^a	77.51 ^a	68.46 ^b	*
OM	77.16 ^a	81.72 ^a	78.54 ^a	68.9 ^b	*
CP	78.46 ^a	84.22 ^a	80.67 ^a	56.15 ^b	***
NDF	56.74 ^a	53.37 ^{ab}	49.51 ^b	44.62 ^c	**
ADF	42.81 ^a	44.59 ^a	37.83 ^b	31.22 ^c	**
Digestible nutrient intake (g day ⁻¹)					
DDMI	687.45 ^{ab}	753.92 ^a	724.78 ^a	629.38 ^b	*
DOMI	661.43 ^{ab}	711.78 ^a	663.95 ^a	584.23 ^b	*
DCPI	102.85 ^a	108.86 ^a	99.59 ^a	65.82 ^b	**
DNDFI	227.12 ^b	278.30 ^a	269.90 ^{ab}	230.64 ^c	**
DADFI	103.78 ^b	142.50 ^a	135.94 ^b	124.20 ^c	**

* a, b, c=means within rows having different superscript letters are significantly different at ***= $p < 0.001$; **= $p < 0.01$; *= $p < 0.05$; ADF=acid detergent fiber; CP=crude protein; DM=dry matter; NDF=neutral detergent fiber; OM=organic matter; SL=significance level; T1=Sudan grass hay ad libitum+300 g Wheat bran (WB); T2=Sudan grass hay ad libitum+200g WB+100 g Faba bean hull (FBH); T3=Sudan grass hay ad libitum+100g WB+200 g FBH; T4=Sudan grass hay ad libitum+300 g FBH.

Body weight change and feed conversion efficiency

The BW and FCE parameters of the experimental sheep fed the different treatment feeds are presented in Table 4. Compared with 300g FBH (T4) significantly ($p<0.001$) higher final body weight, net gain and average daily weight gain was recorded at 300g WB (T1), 200 g WB+100 g FBH (T2) and 100g WB+200 g FBH (T3). However 300 g WB (T1) had no significant ($p>0.05$) effect in improving final body weight, net gain and daily BW gain as compared to 300g FBH (T4). Supplementing same rate of faba bean

hull, wheat bran and their mixtures resulted in differences in mean final body weight, net gain and daily BW gain. This indicates the importance of manipulating different feed ingredients and the ratio of these ingredients for a better animal performance. The current finding revealed that as CP content increased in the supplement feeds the average final body weight, net gain and daily BW gain also increased which is in agreement with the results of Dawit and Solomon (2008) [24, 20] and Getahun (2014) [25] who reported concentrate supplementation with high CP profile improved all the final body weight, net gain and daily BW gain.

Table 4. Mean initial, daily and final body weight of growing local ram lambs fed on Sudan grass hay basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures

Parameters	Treatments				SL
	T1	T2	T3	T4	
Initial BW (kg)	21.45	22.10	21.43	22.11	ns
Final BW (kg)	29.55 ^{ab}	31.75 ^a	29.88 ^a	28.60 ^b	**
Net gain (kg)	8.10 ^{ab}	9.65 ^a	8.43 ^a	6.49 ^b	**
ADG (g/d)	90.00 ^{ab}	107.22 ^a	98.89 ^a	72.11 ^b	**
FCE	0.10 ^a	0.11 ^a	0.10 ^a	0.08 ^b	*

*a,b=means within rows having different superscript letters are significantly different at **= $p<0.01$; *= $p<0.05$; ns=non-significant at ($p>0.05$); ADG=average daily gain; BW=body weight; FCE=feed conversion efficiency; SL=significant level; T1=Sudan grass hay ad libitum+300 g Wheat bran (WB); T2=Sudan grass hay ad libitum+200g WB+100 g Faba bean hull (FBH); T3=Sudan grass hay ad libitum+100 g WB+200 g FBH; T4=Sudan grass hay ad libitum+300 g FBH.

Feed conversion efficiency (FCE) was significantly ($p<0.001$) improved in 300g WB (T1), 200 g WB+100 g FBH (T2) and 100 g WB p+200 g FBH (T3) when compared to 300 g FBH (T4). Despite the higher gains and higher feed DM intake attained at 300g WB (T1), 200 g WB+100 g FBH (T2) and 100 g WB+200 g FBH (T3), there was no any significant ($p>p0.05$) difference detected in FCE among these groups. The observed higher FCE in these groups may be due to the higher CP and energy contents of supplement feeds in providing absorbed nutrients and/or by enhancing the basal diet nutrient utilization. The current result was comparable to the FCE recorded in Washera lambs fed natural pasture hay and supplemented with graded levels of *Ficus thonningii* (chibha) leaves as replacement for concentrate mixture [14]. The current result was also in line with that reported the feed conversion efficiency in the supplemented treatment (0.12) by Alemu et al. (2020) [26] in Gumuz sheep. Therefore, supplementation sheep

containing high CP improved feed conversion efficiency due to enhanced daily body weight gain.

The overall trends of bodyweight changes across the feeding trial periods are presented in Figure 2. The observed increasing trend in body weight with slightly drop down at day 30 experimental period was the reflection of the lower in feed intake due to depravation of water made by animal attendants. Immediately after the situation corrected animals in all the treatment groups showed an increased in feed intake.

Partial budget analysis

The result of partial budget analysis was shown in Table 5. The result of partial budget analysis revealed that supplement with 200 g WB+100 g FBH (T2) resulted in higher profit margin than the rest of supplemented groups. Sheep supplemented with 200 g WB+100 g FBH (T2) also had the highest net return. The observed higher profit margin and net return at 200 g WB+100 g FBH

(T2) may be associated with improved in body weight of sheep during the experimental period, the relatively smooth hair coat and attractive general physical appearance of animals in T2 as a result of higher feed and nutrient intake. Generally, sheep which had a better CP and energy intake had superior ADG as a result of this, had a higher sale price to earn higher net return.

The marginal rate of return for supplemented sheep in T2 was 3.32 ETB. This indicates that to attain required BW by supplement feeding, each additional unit of 1 ETB increment per sheep to cultivate Sudan grass hay and purchase supplement feed resulted in a profit of 3.32 ETB for 200 g WB+100 g FBH (T2) supplement.

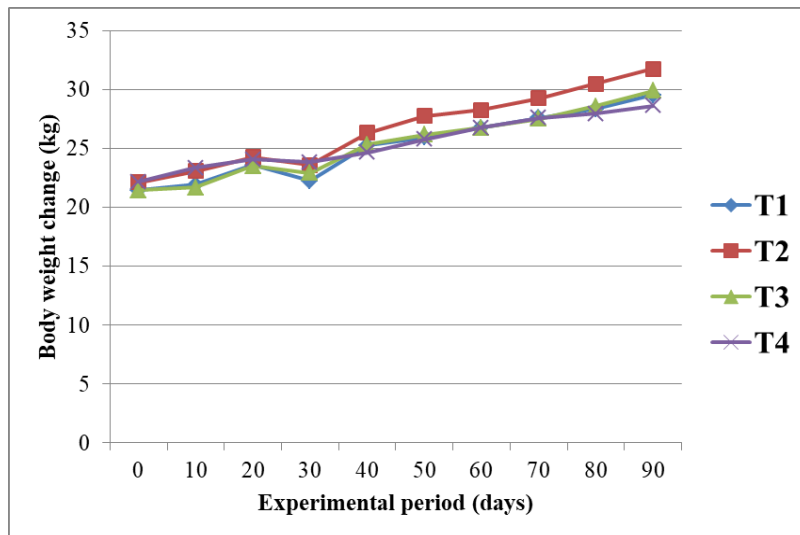


Figure 2. Body weight change over time of growing local ram lambs fed on Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures

Table 5. Partial budget analysis results of growing local ram lambs fed on Sudan grass hay as basal diet and supplemented with Faba bean hull, Wheat bran and their mixtures at G/Zuria district in the year 2020/21

Variables	Treatments			
	T1	T2	T3	T4
Number of animals	6	6	6	6
Purchase price of sheep (ETB head ⁻¹)	1540.00	1540.00	1540.00	1540.00
Total feed consumed (kg head ⁻¹)	82.74	83.31	84.15	85.26
Total variable cost (ETB)	274.96	311.71	348.80	386.24
Gross income (ETB)	2624.50	2783.33	2650.00	2460.00
Total return (ETB)	1084.50	1243.33	1110.00	920.00
Net return (ETB)	809.54	931.62	761.20	533.76
ΔTVC	-	36.75	73.84	111.28
ΔNI	-	122.08	-48.34	-275.78
MRR (ratio)	-	3.32	-0.65	-2.48

*ΔNI=change in net income; ΔTVC=change in total variable cost; ETB=Ethiopian Birr; MRR=marginal rate of revenue; T1=Sudan grass hay ad libitum+300 g Wheat bran (WB); T2=Sudan grass hay ad libitum+200 g WB+100 g Faba bean hull (FBH); T3=Sudan grass hay ad libitum+100 g WB+200 g FBH; T4=Sudan grass hay ad libitum+300 g FBH.

4. Conclusions

The result of this study indicated that CP content of Wheat bran (WB) (T1) was found relatively comparable with Wheat bran and Faba bean hull at 2:1 proportion (T2). The basal diet Sudan grass

hay has remarkable CP content with low fiber fraction that help to provide nutrient above maintenance with no effect in both feed intake and digestibility. Related with high feed intake and digestibility attained in feeding regimes that sheep supplemented with 300 g WB (T1), 200 g

WB+100 g FBH (T2) and 100g WB+200 g FBH (T3) achieved significant body weight. Though supplementation of Sudan grass hay with 300 g WB (T1) and 100 g WB+200 g FBH (T3) have the same effect in improving body weight with 200 g WB+100 g FBH (T2) they were not found profitable. Thus, it was concluded that supplementation of Sudan grass hay with 200 g WB+100 g FBH (T2) is biologically efficient and potentially profitable in feeding of growing local ram lambs compared to other supplements. Therefore, in areas where suitable for Sudan grass production and wheat bran and Faba bean hull are more accessible 200 g WB+100 g FBH (T2) can be used as an alternative and attractive supplement in sheep feeding. In order to guarantee the importance of feeding basal diet Sudan grass hay with appropriate supplement at producers' level, undertaking on- farm demonstration using the recommended treatment *Sudan grass hay ad libitum*+200 g WB+100 g FBH (T2) used in the present study is worthwhile.

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