International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 6, Issue 5 -2019

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2019.06.05.006

Feed intake, digestibility and body weight gain of intact male borana goats supplemented with three browse species mixed with wheat bran

Sisay Kumsa, Tamirat Tasemma, Dereje Teshoma

Oromia Agriculture Research Institute, Yabello Pastoral land Dry Land Agricultural Research Center
P.O.Box 85, Southern Oromia, Borana, Ethiopia

Abstract

The experiment was conducted at Yabello Pastoral and Dry land Agriculture Research Center with the objectives to evaluate the effect of supplementation of browses species mixed with wheat bran on feed intakes, digestibility, growth performance and carcass characteristics of Borana goats fed a basal diet of native pasture hay, and to identify the economic feasibility. The experiment was conducted using Twenty five (25) intact male yearling Borana goats with an average live weight of 15.22±0.17kg (mean and standard deviation). The experimental design was randomized complete block design five treatments with five replications. Experimental goats were blocked into five blocks of five goats based on their initial body weight (BW) and randomly assigned to one of the five treatment diets within a block. Goats were acclimatized to the treatment feeds for fifteen days. The experiment consisted of 90 days of feeding trial and 10 days of digestibility trial followed by evaluation of carcass parameters at the end of the digestion trial. Five dietary supplement treatments were T1, (63:37%) wheat bran and noug seed cake +hay adlibitum T2, 50% Vechilla tortil pod + 50% of wheat bran + hay adlibitum T3,50% of Vechilla nilotica leaf + 50% of wheat bran + hay adlibitum T4,50% of Vechilla brevispica leaf + 50% of wheat bran T5,50%mixture of three browses species)+ 50% Wheat bran+ hay adlibitum. Total dry matter intake showed significant ($P<0.05$) variation between treatments, highest value in T_1 (722.92g/day), T2 (698.98 g/day), T3 (689.01g/day), T4 (658.90g/day) lowest in T5 (646.34g/day) respectively. Crude protein intake of the treatment diet was T1 (101.13g/day), T2 (88.2g/day), T3 (87.50g/day), T4 (85.94 g/day) and T5 (85.19 g/day) respectively. Digestibility of dry matter (DM) and organic matter (OM) were significantly different ($p<0.05$) where as CRUDE PROTEIN and NDF was not significant ($P>0.05$) the provision of supplement creates favorable rumen microbes for similar digestion of dry matter and fiber. Significance difference in apparent digestibility of crude protein and organic matter (DM) among the treatments were observed. The mean values of the average daily weight gains (ADWG) of supplemented goats were 76.2, 66.02, 63, 62.2 and 59.71g/day for T1, T2, T3, T4 and T5. The feed conversion efficiency was not significant ($P>0.05$) between concentrate supplement and browses species mixed with wheat bran. Partial budget analysis showed that, the highest net return (NR) was recorded high in T2 (156.39ETB/head and T4 (145.34ETB),respectively. Supplementation of browses species mixed with wheat bran resulted higher net return and marginal rate of return as compared to concentrate supplement. Generally, the present study indicated that supplementation had positive effect on performance of goat and economically viable.

Keywords: Apparent Digestibility, Borana goat, Browses, Feed Conversion Efficiency

1. Introduction

Insufficient and poor quality of feed, particularly during the dry season, is one of the most important constraints of livestock production. The availability of feed resource depends on the quantity and distribution of the rain fall and seasonality of plant growth is a reflection of the rain fall distribution (Alemayehu, 2003). Forage availability and quality are not favorable year round and hence gains made in wet season are totally or partially lost in dry season (Alemayehu, 2004). Generally, tree fodder is richer in crude protein (CRUDE PROTEIN), minerals and digestible nutrients than grasses (Devendra, 1990 and Topps, 1992). The use of tree legume fodder as supplement has improved intake, digestibility and animal performance (Norton, 1994 and Abdulrazak et al., 1996). They provide food, medicine, fodder aside from being resistant to diseases and the harsh climatic conditions (Le Houerou, 1980).

The Borana rangeland has diverse species of woody and herbaceous plants which are useful as forage (Tolera and Abebe, 2007) wich include Vechilla *brevispica*, *A. nilotica*, *A. seyal*, *A. tortil*, *Balanites aegyptiaca*, *Grewia bicolor*, *G. tembensis*, *Rhus natalensis*, *Vernonia cinerascens* and grass species *Cenchrus ciliaris*, *Chrysopogonaucheri* and *P. mezianum*. Browse species maintain their green leaves longer into the dry season (Coppock, 1994) and are known to supply better crude protein (CRUDE PROTEIN) and minerals (Devendra, 1990; Coppock, 1994). For this reason, the use of multi-purpose trees and shrubs (MPTS) as well as agro-industrial by products as alternative sustainable feed sources for ruminants is increasingly becoming important. In this regard the use of browses species has great potential. The major use of browses species is as source of crude protein.

This quality of browses most browse species is most useful during dry season when most of the range grasses and other herbaceous species dry off (Devendra, 1990). Studies have indicated that seed pods of some Vechilla species such as *Vechilla pod tortil*, *Vechilla albida* and leaves of *Vechilla nilotica*, *brevispica* leaf when offered as supplements to poor quality roughage, give live weight gains comparable with those of livestock fed seed oil cakes and Lucerne *(Medicago sativco*) (ILCA, 1988; ILCA, 1989). *Vechilla tortil* was shown to be the Vechilla species with the highest microbial degradation potential (Ngwa *et al*., 2002). *Vechilla* leaves were reported to be a valuable source of energy and protein if harvested in the early dry season or in the wet season and stored until needed. *Vechilla tortil* pods at up to 75% of the diet resulted in higher dry matter digestibility; organic matter digestibility and body weight gain (Araya *et al.*, 2003). The chemical component of *Vechilla* pod tortil in terms of crude protein and dry matter contents are 180 and 894 g/kg DM respectively. *Vechilla brevispica* leaf and *Vechilla nilotica* also contain 196, 160,824 and 980 g/kg DM crude protein and dry mater (Aster *et al*., 2012).

Therefore, Adding of different Vechilla species leaves and pods with concentrates in to animal feed base is believed to be minimized the feed shortage, improve the utilization of low quality feed resources and improve the animal performance during dry season. The nutritional value of these browses species on animal performance responses is not conducted in the area. Therefore, this study was conducted to evaluate feed intake, digestibility, and body weight gain of intact male Borana goats supplemented with three selected browses species mixed with wheat bran**.**

2. Specific objectives

To study the effect of supplementing browses species mixing with wheat bran on digestibility, feed intake and body weight gain of intact male Borana goats fed a basal diet of natural pasture hay.

To assess the economic feasibility for supplementation of browses species with wheat bran mixture

3. Materials and Methods

3.1. Study Area Description.

The experiment was conducted at Yabello Pastoral and Dry land Agriculture Research Center (YPDARC) which is located at 564 km from Addis Ababa in Southern Borana Zone of Oromia Regional State. Yabello is located at 1350- 1800 meter above sea level(m.a.s.l.) and it is located between latitude 4°30′55.81″and 5° 24′36.39″N and longitude 7° 44′14.70″and 38° 36′05.35″E. The district covers a total area of 5426km^2. Generally, the altitude of the Borana rangelands is within the range of 1000–1500m above sea level (m.a.s.l) with few hills up to 2000 m.a.s.l (Coppock 1994).

3.2. Experimental Goat and Their Management

Twenty five yearling intact male Borana goats with initial body weight (BW) 15.22 kg were bought from Yabello district. The ages of the experimental goat were estimated based on dentation. During quarantine a period of 15 days, Experimental goats were de-wormed and disinfected for internal and external parasites before the commencement of the study and individual identification (Ear tag) was given to individual. At the end of quarantine period, experimental goats were grouped into five blocks based on their initial body weight and randomly assigned to the treatment diets in a block. Experimental goats were adapted to their respective treatment for 15 days before the actual start of growth trial period. Individual pen was constructed and equipped with feeding and watering facilities.

3.3. Experimental Feed and Feeding

Hay was harvested from Yabello Research Center and used as basal diet during experimental period. Hay of natural pasture was harvested manually at optimum maturity stage/at flowering stage of growth, dried, baled and stored in hay shade *to maintain its quality*. To prevent bleaching that may happen during drying; the harvested grass was turned up frequently and dried within two to three days. Basal diets were chopped to a length of about 2-5cm to minimize wastage and selection. *Supplemental feeds used were Vechilla tortil pod, Vechilla nilotica, Vechilla brevispica, Noug cake and wheat bran.* Noug cake wheat bran adequate for the entire feeding period was purchased from Yabello town. *Vechilla brevispica leaf, Vechilla tortil pods* and *Vechilla nilotica leaf* was collected from mature plants when maturity is attained. Leaves are hand harvested by pruning the lower branches from its twigs on plastic sheet by using stick through pulling. The trimmed leaves were spread thinly on plastic sheet under shade and turn regularly to ensure uniform drying for 2-3 days and stored in plastic bag for future. The supplement diets are offered twice per day morning and evening in separate trough to that of basal diet. The amount of basal diet (on DM basis) was given and clean drinking water once per day and mineral (salt) provided free choice to each goat during the entire feeding period.

3.4. Experimental Design and Treatment Layout

The experimental animals were grouped into five blocks of five animals each based on their initial body weight that was determined by taking the averages of two consecutive weights after overnight fasting at the end of the quarantine period. Animals in a block were randomly assigned to one of the five experimental treatments. Thus, there were five animals per treatment. The basal diet natural grass hay was fed to all animals *ad libitum* and supplemental feeding was on DM basis. Supplementary treatments (T1-T5) were estimated to supply above 55 g/day CRUDE PROTEIN and body weight to achieve estimated body weight gain of 50 g per day as recommended by Ranjhan (2001) and body weight of animals.

Treatment layout

Treatment 1=37% of Noug cake + 63 % wheat bran + hay *adlibitum*
Treatment 2=50% of VPT + 50% of wheat bran + hay *adlibutum*
Treatment 3=50% of VN + 50% of wheat bran + hay *adlibutum*
Treatment 4=50% of VBL + 50% of wheat bran + hay *adlibutum*
Treatment 5=50% of MBS + 50% Wheat bran+ hay *adlibutum*

VPT=Vechilla pod tortil, VPL=Vechilla brevispica leaves, VNL=Vechilla nilotica leaves, MBS=mixture three browse species.

3.5. Feed Intake

Feed offered to experimental goat and corresponding refusals were weighed and recorded daily throughout the experimental period. Sub-samples of feeds offered and refusal were pooled across the experimental period for each animal. The composite refusal samples were pooled per treatment. Feeds and refusal samples were placed in air-tighted plastic bags and stored in an appropriate place to chemical analysis. The daily dry matter and nutrient intakes of the goats were calculated as a difference between that offered and refused. Feed conversion efficiency was estimated as a ratio of daily body weight gain per units of feed consumed daily. Daily total dry matter intake calculated as follow.

Total dry matter (DM) intake (percent body weight) =DM intake (g)/body weight*100…1

Total DM intake (metabolic body weight ($g/kgW^{0.75}$) =DM intake (g)/$BW^{0.75}$ (kg)…….....2

3. 6. Live Weight Change

The body weight of each experimental goat was measured at the beginning of the experiment and at 10 days intervals during the experimental period. At the end of feeding trial the final body weight of goats were measured. Average daily body weight gain was calculated as a difference between final and initial body weight of the goats divided by the number of experimental days. Feed conversion efficiency of the goats was determined as the proportion of daily body weight gain to the total daily dry matter (DM) intake according to Gulten et al.,(2000) as follow(equation 4).

$$ADWG = \frac{FBW - IBW}{TNFD} \quad \text{.....3}$$

Where: ADWG= Average Daily Weight Gain, IBWG= Initial Body Weight Gain and TNFD= Total Number of Feeding Days, FBW =Final Body Weight

$$FCE = DWG / TDMI \quad \text{.....4}$$

Where FCE=feed conversion, DWG=Daily weight gain, TDMI=total dry matter intakes

3.7. Digestibility Trial

At the end the feeding trial, all animals were made to adapt carrying the fecal bags for 3 days followed by total collection of faeces for 7 days. The faeces collected every day from each animal were weighed, thoroughly mixed, 10% sampled and stored in a refrigerator at -20°C. The faeces sampled for 7 days were pooled for each animal, thoroughly mixed and then 10 % sub-sampled for chemical analysis. The sub samples of the faeces were dried at 60^{o}C for 48 hrs. The dried sample of faeces were be ground pass through 1 mm sieve and stored in air tight polyethylene bag until analyzed. The apparent digestibility coefficient (DC) of nutrients is calculated by using the equation below (McDonald, 2002):

$$\text{Apparent digestibility coefficient} = \frac{(\text{Total nutrient consumed} - \text{Total nutrient in faeces}) * 100}{\text{Total nutrient}} \quad \text{---6}$$

Metabolized energy intakes of goats from experimental feeds were estimated by using the equation:

$$ME\ (MJ/kg\ DM) = DOMD * 0.016 \quad \text{.....7}$$

Where**:** DOMD=digestible organic matter

$$\text{Digestible organic matter (DOMD/g/kg DM)} = \frac{(OM \text{ in feed} - OM \text{ in faeces}) * 1000}{DM \text{ in feed}} \quad \text{.....8}$$

3.8. Feed Chemical Analysis.

Chemical analysis of feed offered and refusal in both digestibility and growth trial and faeces in digestibility trials were carried out by taking the representative sample. The sample of feed offered and refused was taken to Holleta Research Center dried in oven to constant weight of 60^{o}c for 48 hours in forced air draft oven for partial dry matter determination. The partial dried sample of feed and faeces were milled using laboratory mill to pass l mm screen. Dry matter (DM) organic matter (OM) and crude protein (CRUDE PROTEIN) of the offered and refused feeds were determined according to AOAC procedure (AOAC, 1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) in feed samples were analyzed according to Vansoest and Robertson procedure. The crude protein (CRUDE PROTEIN) content is estimated as N X 6.25.

3.9. Partial Budget Analysis

Partial budget analysis was calculated based on cost of wheat bran, Noug cake, labor cost feed, leaf collection, animal purchase and average sale price of the goat at the local market. The net return calculated from total revenue and total variable cost obtained from the sale of goat. By simple mathematical calculation, the net return obtained by subtracting change in return from total variable cost. The partial budget analyses were performed to evaluate the economic advantages of the different treatments by using the procedure of (Upton, 1979). Average market price used to find out the market values for the different treatment groups. The profit analyzed using the following equation.

$$\Delta NI = \Delta TR - \Delta VC \quad \text{.....10}$$

Where, NI = net income; TR = total return and VC = variable cost.

The marginal profit of goat fattening was calculated from the increase in change net income (ΔNI) that can be generated by each additional unit of expenditure (VC)

NR=TR-TVC……..……..11

$$MRR\ \%. = \frac{\Delta NI}{\Delta VC} * 100 \quad \text{.....11}$$ Where,

MRR=Marginal rate of return, NI=Net income, VC=Variable cost

3.10. Statistical Analysis

General linear model procedures of SAS (2002). The treatment means were separated by least significant difference (LSD). The model used for data analysis:

Model: $y_{ijk} = \mu + T_i + B_j + \varepsilon_{ijk}$

Where: Y_{ijk} = response variable; μ = overall mean;

Ti = treatment effect, Bj = block effect; ε_{ijk} = random error

4. Results and Discussion

4.1. Chemical Composition of Feed Experiment

The Chemical Composition of the feeds and experimental diet used in the present study is given in Table 1. The CRUDE PROTEIN content of the hay used in this study was not similar to the CRUDE PROTEIN content of good quality grass hay (11%) reported by McDonald (2002), and not within the range of 7.5-15.45% reported for natural pasture hay (Solomon *et al*., 2008).

Table1:Chemical composition of ingredients and experimental diets used during experimental periods (%DM basis)

Parameter	DM	OM	ADF	NDF	CRUDE PROTEIN
HAY	89.73	88.05	52.60	70.80	6.44
WB	87.03	95.66	12.84	44.20	19.19
NC	91.93	89.95	27.03	35.34	26.00
VBL	80.84	74.26	25.27	26.36	19.00
VPT	96.57	84.18	11.16	16.79	17.00
VBN	90.48	90.50	16.07	21.95	16.00
Treatment diets					
T1	89.48	92.81	19.94	39.77	21.60
T2	91.80	89.92	12.00	30.50	18.50
T3	88.20	93.08	14.46	33.08	18.00
T4	83.94	84.96	19.06	35.28	19.00
T5	88.22	89.32	15.17	32.09	18.75

DM=dry matter, OM=organic matter, ADF=acid detergent fiber, NDF=neutral detergent fiber CRUDE PROTEIN=crude protein, WB= wheat bran, NC=Noug cake, VBL*=Vechilla brevispica leaf,* VPT*=Vechilla pod tortil, MBT=mixture of browses species,* VN*=Vechilla nilotica, SEM=standard error of the mean; T1=37% of Noug cake + 63% wheat bran + hay adlibitum, T2=50% of* VPT *+ 50% of wheat bran + hay adlibitum, T 3=50% of* VN *+ 50% of wheat bran + hay adlibitum, T4=50% of* VBL *+ 50% of wheat bran + hay adlibitum, T5=50% MBS + 50% Wheat bran+ hay adlibitum.*

However, the crude protein (CRUDE PROTEIN) content of hay used in this study was higher than the CRUDE PROTEIN content of 5.6% and 4.2% reported by Getachew (2005) and Mulu (2005) respectively, but, comparable with the value of 6.56% reported by Simret (2005). The variation of crude protein content of hay may be due to nutrient content of the soil, stage of maturity, harvesting season, types grass, management of hay and climatic condition of the area.

The crude protein content of the natural pasture hay used in this study was 6.44% indicating that it has no a potential to support the maintenance requirements of goats. Hay which contains a minimum of (7%) crude protein needed to support acceptable ruminal microbial activity and the maintenance requirement of the host ruminant (Van Soest, 1994). Therefore, natural pasture hay used in the present study can categorized as poor quality and cannot fulfill the maintenance requirement of goats.

The NDF content of hay used in this study (70.8%) was less than the value of 76.75% and 75.68% and reported by Mulu (2005) and Jemberu (2002); but comparable with the value of 70.7% and 71.8% reported by Asnakew (2005) and Getachew (2005), respectively. Feeds that contain high proportion of ADF have lower availability of nutrients due to ADF being negatively correlated with feed digestibility (McDonald *et al*., 2002). The result of the chemical analysis of hay used in this study was characterized by its high DM, NDF, ADF and low CRUDE PROTEIN contents.

The crude protein content of Noug cake in current study lower than the crude protein reported by McDonald (2002), but similar with crude protein reported by Seyoum (1995) which is 23.9 and 26.8 respectively. However, it was lower than the result reported by Bhuyane *et al.* (1996) and Temesgen(1995) with values of 41.02 and 44.5% respectively. The Variation might be due to the effect of processing factory and the quality of the seed used in the factory.

The organic matter contents concentrate feeds in the present study such as wheat bran, Noug cake and concentrate mixture was 96.66, 89.95 and 92.81%, respectively. The acid detergent fiber content of wheat bran was comparable to 12.70 and 12.45% reported by Solomon *et al*. (2004 and Jemberu (2008), respectively but lower than 15.50 Hirut (2008) and higher than 9.49 reported by Giri (2000)

Dry matter, organic matter, acid detergent fiber, neutral detergent fiber and crude protein content of *Vechilla nilotica* was not comparable with the values 13.1% and 15.4% reported by Aster *et al.*, (2012) during dry and rainy season. Dry matter, organic matter, and acid detergent fiber, neutral detergent fiber, crude protein content of *Vechilla brevispica* leaves of current study was similar with the values of 19.6% reported by Aster (2012), during rainy season. *Vechilla brevispica* leaf has higher value of acid detergent fiber and lower neutral detergent fiber compare to Aster *et al*. (2012) which is 19.1 and 31.8% respectively. The dry matter, organic matter, acid detergent fiber, neutral detergent fiber and crude protein content of *Vechilla tortil* pods agreed with the values of 17.78% reported by Aster *et al*. (2012). The value of ADF and NDF of current study was higher than that value of 15.47 and 21.76% DM reported by *Aster et al*., (2012) respectively.

4.2. Dry Matter and Nutrient Intake

The mean daily dry matter and nutrient intake of the experimental goats during the feeding trial were given in table 2. There was a significant difference (P<0.001) among treatments in natural pasture hay intakes and total dry matter intakes. All supplemented treatment was readily consumed by goat without refusal. Therefore, there is no significance difference (p>0.05) on supplemented treatment. Hay of natural pasture intake and total dry mater intakes were greater (P<0.001) for T1 and T2 then T3, and values for T4 was greater than T5 (P<0.001). There is no significance difference of hay intake between T2 and T3, T5 and T4. The result of current study was indicated that the dry matter intake of hay greater for the concentrated (362.91g/day) than supplemented wheat bran mixed with browses species in which intermediate dry matter hay intake was recorded in treatment two (T_2) and three (T_3) 338.98 vs. 329.01g/day and lowest intake was observed in treatment four (T_4) and five (T_5) which was 298.90 vs. 286.34g/day respectively. This variation might be depending on voluntary feed intakes of animals. But, the amount of hay intakes reduced through the experimental period due to increased amount of supplementation after ten days interval due to the adjustment made following of their weight. Crude protein content of natural pasture hay refusal was lower than the offered hay which indicate that goats has the ability to select more nutritious part of feed. Whereas, the content of organic matter, acid detergent fiber and neutral detergent fiber higher than the offered hay. Total dry matter intake different among treatment which it followed similar trend like that of natural hay dry matter intakes intake.

Table 2: The mean daily dry matter and nutrients intake of Borana goats fed on basal diet of natural pasture hay supplemented with concentrate and browses mixture with wheat bran (g/kg of DM basis).

	Treatments						
Parameter	T_1	T_2	T_3	T_4	T_5	SEM	SL
Total hay(g/day)	362.91^{a}	338.98^{b}	329.01^{b}	298.90^{c}	286.34^{c}	6.25	***
Supplement(g/day)	360	360	360	360	360	0	ns
Total DMI (g/d)	722.91^{a}	698.98^{b}	689.01^{b}	658.90^{c}	646.34^{c}	6.25	***
Total DMI(% BW)	3.22	3.23	3.28	3.12	3.11	0.03	ns
Total DMI(g/kgW$^{0.75)}$	70.12	69.56	70.14	67.20	66.45	0.67	ns
Total OM(g/d)	653.66^{a}	622.19^{b}	624.78^{b}	569.03^{c}	573.2^{c}	7.04	***
Total CRUDE PROTEIN (g/d)	101.13^{a}	88.2^{b}	85.98^{c}	87.65^{b}	85.94^{c}	1.33	***
Total ADF (g/d)	262.67^{a}	221.50^{b}	225.11^{b}	225.23^{b}	205.23^{c}	4.10	***
Total NADF (g/d)	400.11^{a}	349.80^{b}	352.03^{b}	338.63^{b}	318.25^{c}	5.83	***
ME(MJ/day)	9.96^{ab}	9.9^{a}	9.58^{bc}	9.40^{cd}	9.29^{c}	0.06	**

*^{a,b,c,d} means different superscript in a row were significant different***=(p<0.001); ns= non significant, DMI=Dry matter intakes, BW=Body weight; OM=organic matter; CRUDE PROTEIN=crude protein, ADF=Acid detergent fiber; NDF=Neutral detergent fiber; CV=Coefficient Variation, SEM=Standard error of the Mean; STD=Standard deviation of the meanT1=37% of Noug cake + 63% wheat bran + hay adlibitum, T2=50% of VPT + 50% of wheat bran + hay adlibitum, T 3=50% of VN + 50% of wheat bran + hay adlibitum, T4=50% of VBL + 50% of wheat bran + hay adlibitum, T5=50% MBS + 50% Wheat bran+ hay adlibitum*

Therefore, total dry matter intake of goat in treatment one (T1) 722.91g/head per day found significantly higher (P<0.001) than those received browses species mixed with wheat bran. Becholie *et al*. (2005) also reported that supplementation with a protein source *(tagasaste*) increased total DM, OM and CRUDE PROTEIN intakes in lambs fed on a basal diet of grass hay. Similar finding was reported by Girma *et al*.(1994) in which sheep fed maize Stover supplemented with legumes and legumes plus concentrate mixture showed significantly higher total DM intake. Abou El-Nasr *et al.* (1994) reported that concentrate supplementation improved roughage intake, nutrient digestibility and utilization in sheep. Similarly, goat in treatment in T_4 and T_5 had the lowest total dry matter intake (658.90 vs. 646.34 g/day/head) (P<0.001) as compared goat supplemented treatment T2 and T3 (698.98 vs. 689.67g/day) this due to the amount of hay intake.

Accordingly, the values of total dry matter intake observed in this study was (646.34-722.91/day) within the range of values of 434.8-753.3g/d reported by Ermias (2008) for sheep fed a basal diet of faba bean haulms and supplemented with barley bran, linseed meal and their mixtures. The current total dry matter intake T_1 (concentrate supplement) higher than the finding of (M.M.Rahman *et al*., 2013) which was 668g/day goat supplemented palm kernel cake and higher than concentrate supplement (584g/day). Therefore, the current result summarized that browses type has a significant effect on total dry matter and nutrient intakes.

Protein intake among the different treatment groups was significantly different (p< 0.001) which could be attributed to variations in hay intake and supplement. A highest crude protein intake was observed in treatment T_1, T_2, T_4, T_3 and T_5. Among the supplemented treatments, animals on concentrate supplementation had higher (P<0.001) crude protein intake than browses leaf/pods mixed with wheat bran, while the crude protein intake of the browses with wheat bran mixture supplemented goat was similar T_2 and T_4 at (P>0.05). Ranjhan (1997) indicated that a 20 kg sheep require 85g CRUDE PROTEIN to meet its nutrient requirement for growth. According to this recommendation, CRUDE PROTEIN intake 85.98-101.113g/day of goats in all treatment is in surplus of that needed for maintenance and the target average daily gain.

The total DM intake based on percent body weight (%BW) were not significant different (P>0.05) among the supplement. The daily DM intake based on (3.11-3.28% BW) of goat in this experiment is within the range of 2.6 to 3.2% reported for Small East African goat and their crosses with Norwegian goat fed hay and supplemented with concentrate (William et al., 2013).

4.3. Apparent Dry Matter and Nutrient Digestibility

Apparent dry matter (ADM) and nutrient digestibility coefficient of Borana goats fed hay basal diet and supplemented with browses species mixed with wheat bran is presented in table 3. There is no significant difference (P>0.05) among the treatment on apparent digestibility of dry matter (DM), acid detergent fiber (ADF), neutral detergent fiber (NDF) of experimental diet. Simret (2005) confirmed that the apparent digestibility of NDF and ADF were similar between goats fed on grass hay basal diet and wheat bran-peanut cake mixture supplemented treatments. The apparent digestibility of dry matter in the current study was recorded within the ranges of (63-66). This finding lower than Arsi Bale goat feed dried mulberry leaf reported by Dereje (2014) within the value of (68.4-71.3). It may be due to the species and nutrient intakes.

Table 3. Apparent digestibility coefficient of dry matter and nutrients of Borana goat fed on concentrate and browses species mixed with wheat bran hay as basal diet.

Parameter	Treatments					SEM	SL
	T_1	T_2	T_3	T_4	T_5		
AD (%)							
ADDM	66	65	64	64	63	0.004	ns
ADOM	65[a]	65[a]	63[b]	62[b]	61[b]	0.005	***
ADADF	61	60	59	59	60	0.006	ns
ADNDF	66	65	63	65	65	0.007	ns
ADCRUDE PROTEIN	71.52[a]	67.04[ab]	65.70[b]	66.91[ab]	65.16[b]	0.47	***

*[a,b] Means with different superscripts in a row are significantly different ***=(P<0.001); AD=Apparent digestibility; ADDM = apparent digestibility dry matter; ADOM= apparent digestibility of organic matter; ADADF = apparent digestibility acid detergent fiber; ADNDF = apparent digestibility neutral detergent fiber; ADCRUDE PROTEIN = apparent digestibility crude protein intake; ST= standard deviationT1=37% of Noug cake + 63% wheat bran + hay adlibitum, T2=50% of VPT + 50% of wheat bran + hay adlibitum, T 3=50% of VN + 50% of wheat bran + hay adlibitum, T4=50% of VBL + 50% of wheat bran + hay adlibitum, T5=50% MBS + 50% Wheat bran+ hay adlibitum*

Digestibility of organic matter among the T_1 and T_2, and T_3, T_4 and T_5 were not significant (p>0.05) which is 64, 64 and 63 and T_4 and T_5 respectively. This finding also agrees with find of Abadi (*et al.*, 2015) and Weldegebriel (2014) which ranges from (57.86-62.33g/day) and 55.82-65.41g/day respectively.

The apparent digestibility of crude protein among the supplemented treatments were significant (P<0.001). Apparent digestibility of crude protein intake in treatment one was high (72%) as compare to other treatment group; it directly correlated with the intakes of crude protein. The apparent digestibility of crude protein between treatment T2 and T4, T3 and T5 were similar (67.04 vs. 66.91) and (65.7 vs. 65.16) respectively. Digestibility of crude protein in supplemented animals compared to browses species with wheat bran ones could be due to the high total crude protein intake of the supplemented goats and relatively crude protein intake of goat fed the basal diet more in treatment one. In agreement with the present study, Abebe (2006) reported that supplementation with oil seed cakes and wheat bran improved the digestibility of crude protein. So, the digestibility of a feed is influenced not only by its own composition, but also by the composition of other feeds consumed with it (McDonald *et al.*, 2002). Therefore, result of the current study suggested that feeding browses species mixed with wheat bran and concentrate mixture to be better both in feed intake and digestibility.

Generally, the basal diet used in the present study with ADF and NDF contents of 52.06 and 70.8%, respectively. It can be considered as poorly digestible grass hay. The apparent digestibility of the supplement observed in this study was the fact of improvement of digestibility of DM and nutrients which realized due to the supplemental concentrate mixture and browses species. In the current high crude protein intake may increase the digestibility of the crude fiber of the feeds. However, in the present finding values for CRUDE PROTEIN digestibility among the different treatments were very close. So, the digestibility values for DM and nutrients were relatively medium indicating the good supplemental values of the supplemented diet used in this study.

4.4. Body Weight Change and Feed Conversion Efficiency

The mean body weight (BW) and feed conversion efficiency (FCE) in table 4. There were significance difference (P < 0.05) in mean total body weight gain and average daily gain (ADG) among the treatments. Difference (DIFF) of body weight change of experimental goats are slightly greater (P<0.05) for T1 6.86kg as compared to the other treatments. There were no statistical difference (p>0.05) between treatment T_3, T_4 and T_5 which was 5.67, 5.60, 5.37kg respectively. The variation in growth rate between experimental goats could be attributed to differences intake feed of basal diet and nutritive value in the diets.

Table 4: Overall mean of body weight change, feed conversion efficiency and feed conversion ratio of Borana goats consumed natural pasture grass hay and supplemented browses species mixed with wheat bran

Parameter	Treatments					SEM	SL
	T_1	T_2	T_3	T_4	T_5		
IBW(kg)	15.60	15.80	15.40	15.50	15.40	0.08	ns
FBW(kg)	22.46^{a}	21.74^{ab}	20.07^{b}	21.00^{b}	20.77^{b}	0.22	*
DFF(kg)	6.86^{a}	5.94^{ab}	5.67^{b}	5.60^{b}	5.37^{b}	0.20	*
ADG(g/day)	76.20^{a}	66.02^{ab}	63.00^{b}	62.22^{b}	59.71^{b}	2.18	*
FCE	0.104	0.11	0.092	0.096	0.092	0.003	ns
FCR	9.54	9.18	11.67	10.97	10.98	0.40	ns

*^{a,b} means different superscript in a row were significant different *=(P<0.05; ns=not significant; SEM=standard error of the mea; SL=significance difference, IBW=initial body weight; FBW= Final body weight; DFF =difference; ADG=average daily live weight gain; APT=Vechilla pod tortil; ABL=Vechilla brevispica leaves; MBT=mixture of browses specie;, T1=37% of Noug cake + 63% wheat bran + hay adlibitum; T2=50% of APT + 50% of wheat bran + hay adlibitum; T3=50% of AN + 50% of wheat bran + hay adlibitum; T4=50% of ABL + 50% of wheat bran + hay adlibitum; T5=50% MBS + 50% Wheat bran+ hay adlibitum.*

The mean average daily weight gain of T_1 (76.20g/day) was significantly different ($p<0.05$) from all treatment this due to intake of high nutrient in experimental diet and intakes of basal diet. Abule *et al*.,(1998) reported that when supplemented with similar but different proportion of concentrate, Rift Valley goats are growing at the rate of 72 g/day which nearly almost similar with the current study. Treatment two (T2) supplements different from the other browses intake mixed with wheat bran, this due to *Vechilla tortil* has high microbial degradation. This variation due to the amount of feed intake and nutrient content of feed. Furthermore, mean of average daily body weight gain of experimental goat fed browses species mixed with wheat bran in the current experiment was comparable with growth rate between 42-65, 66.2 g/day have been estimated for local goats fed cotton seed meal in Sidama district and indigenous sheep fed a basal diet of Rhodes grass hay supplemented with concentrate (Matiwos *et al.*, 2008 and Nurfeta, 2010) respectively.

4.7. Partial Budget Analysis

The partial budget analysis of the experiment is presented in Table 9. Highest total variable cost was recorded in T1, T2, T3, T4, and T5 which (217,130.5, 128,124 and 122ETB/head respectively from decreasing order. Treatment two (T_2) has the highest net return compared to other treatments which was 156 per/head ETB. The second net return was obtained in T4 (145 ETB) and followed by T5 (142 ETB). The highest total variable cost was recorded in treatment five (T5) 95ETB/head. The result of economic analysis indicate that gross return (selling price of goat) was higher for goat fed with T1 and T2 diets which was due to the higher final body weight. But, T1 had low rate of return due to its high variable cost (feed cost). Among the browses supplementation with wheat bran, higher total return (TR) was obtained when *Vechilla* tortil pods mixed with wheat bran at (50:50) followed by T4 when three browses species mixed wheat bran (50:50). T2 supplementation resulted in good daily BW weight gain (66 g/d), ΔNR (55), highest MRR (64) and it had higher net return (157 ETB) compared to the other supplemented treatments.

T4 supplementation had also good daily weight gain (63 g/d), 44.76 changes in net return, 48.20 marginal rate of return and net return (145 ETB). Treatment five (T5) had good daily body weight change (59.71g/day), net return (142 ETB), 42 changes in net return and optimum marginal rate of return (44) compared to the other supplemented treatments. Treatment three had 111 ETB net returns, 10.96 changes in net return and 12.76 marginal rate of return and it is the lowest in economic feasibility. The change of net return and marginal rate of return indicated that per one ETB increment invested to purchase concentrate supplement to attain required BW by replacement with browses species mix with wheat bran could return 0.64, 0.12, 0.48, and 0.44 respectively. Furthermore, the MRR indicated that additional unit of 1ETB per goat cost increment resulted in 1 ETB and additional 0.64, 0.12, 0.48, 0.44ETB benefited for T2, T3, and T4 and T5 respectively.

When considering the selection of treatment based on their profit T2, T3, T4 andT5 were the best option respectively. However, T_2 was more profitable considering its MRR. Therefore, among the supplemented treatment groups, T2, T4, T5 and T3 was the best recommended option of this study.

Table 8: Partial Budget Analysis for Profitability Determination of Borana Goat

Parameters	T1	T2	T3	T4	T5
Purchased Price of Goats(ETB)	468	474	462	465	462
Number of Animals	5	5	5	5	5
Total Basal Diet Intakes(kg/ goat)	32.66	30.51	29.61	26.90	25.77
Total Consumed browses(kg/goat)	0	16.2	16.2	16.2	16.2
Total Concentrate Intake(ETB/goat)	32.4	16.2	16.2	16.2	16.2
Total Cost of Basal Diet(ETB)	54.44	50.85	49.35	44.84	42.95
Cost of other Inputs(ETB)	35	35	35	35	35
Total Cost of Concentrate(ETB)	143.09	39.67	39.57	39.83	39.38
Labor Cost Per Animals(ETB/month)	20	40	40	40	40
Total Variable Cost	217.52	130.51	128.92	124.66	122.33
Selling Price of Goat(ETB)	786.1	760.9	702.45	735	726.95
Total Return(ETB)	318.1	286.9	240.45	270	264.95
Net Return	100.58	156.39	111.53	145.34	142.62
ΔNR	-	55.81	10.96	44.76	42.05
ΔTVC	-	87.01	88.61	92.86	95.20
MRR	-	0.64	0.12	0.48	0.44

ETB= Ethiopian birr; ΔNR= change in net income; ΔTVC= change in total variable cost; MRR= marginal rate of return; NR= net return T1=37% of Noug cake + 63% wheat bran + hay adlibitum, T2=50% of APT + 50% of wheat bran + hay adlibitum, T3=50% of AN + 50% of wheat bran + hay adlibitum, T4=50% of ABL + 50% of wheat bran + hay adlibitum, T5=50% MBS + 50% Wheat bran+ hay adlibitum.

5. Conclusion and Recommendation

5.1. Conclusion

The experiment was conducted to evaluate the effect of supplementation of browses species mixed with wheat bran on feed intakes, digestibility, growth performance, carcass characteristics and to identify the economic benefit of Borana goats fed a basal diet of natural pasture hay. Twenty five intact male Borana goats with an average initial body weight (BW) of 15.17 ±0.17 kg were used for the experiment in a randomized complete block design (RCBD)with five blocks each consisting of five goats. The blocks were established based on initial body weight of the experimental goats and the goats within each block were randomly assigned to one of the five treatment diets. Four dietary treatments of browses species mixed with wheat bran and one concentrate treatment were involved; These were T1= (100%CM) wheat bran (63) and noug seed cake (37) +hay *adlibitum*, T2=50% of ATP (Vechilla tortil pod) + 50% of wheat bran + hay *adlibitum*, T3=50% of AN (Vechilla nilotica leaf) + 50% of wheat bran + hay *adlibitum*, T4=50% of ABL (*Vechilla brevispica* leaf) + 50% of wheat bran and T5=50% MBS (mixture of three browses species) + 50% Wheat bran+ hay *adlibitum.* Animals had free access to mineral and watering once a day. At the end of quarantine period, experimental goats were grouped into five blocks based on their initial body weight and randomly assigned to the treatment diets in a block. Experimental goats were adapted to their respective treatment for 15 days before the actual start of growth trial period

There were significant difference (P<0.05) among treatments in total of dry matter intakes and crude protein intake. Supplementing concentrate diet was take more natural pasture grass hay as compared to other treatment and total dry matter (DM). However, all experimental goats were consumed reasonable crude protein to fulfill the daily requirements for growth. There were no significant differences (P > 0.05) on the digestibility of DM , ADF , NDF among the experimental goats. However there was significance difference among the treatment on apparent digestibility of CRUDE PROTEIN and OM. The observed similarity among the DM and fiber digestion of the treatment indicates the supplementation create suitable rumen microbes for the digestion. The result of digestion trial of experiment indicate that browses species is as good as to concentrate diet in terms of its digestibility.

There were significant (p<0.05) differences among the dietary treatments in final body weight gain, body weight, average daily gain among the treatment. Regarding with carcass characteristics, slaughter body weight, empty body weight, hot carcass weight among the treatment diet. The rib-eye muscle area in the present study was 10.08, 9.75, 9.58, 9.95 and 9.03cm^2; SEM=0.04) for T1, T2, T3, T4 and T5 respectively.

The partial budget analysis result showed that T2 has supplementation resulted in good daily BW weight gain (66 g/d), ΔNR (55), highest MRR (64) and it had higher net return (157 ETB) compared to the other supplemented treatments. T4 supplementation had also good daily weight gain (63 g/d), 44.76 changes in net return, 48.20 marginal rate of return and net return (145 ETB). Treatment five (T5) had good daily body weight change (59.71g/day), net return (142 ETB), 42 changes in net return and optimum marginal rate of return (44) compared to the other supplemented treatments. Treatment three had 111 ETB net returns, 10.96 changes in net return and 12.76 marginal rate of return and it is the lowest in economic feasibility this is all when comparing with concentrate supplementation.

The result of present experiment indicate that supplementation of browses species with low cost of concentrate indicated good biological parameters in growing goats, and it reduce cost of production (feed cost) and increase profitability. It can be concluded that supplementation of this different browses species with wheat bran had higher effect on the total CRUDE PROTEIN intake and ADG. It was concluded that supplementation of browses species with low cost of energy source resulted in better feed intake and carcass traits in hay basal diet based feeding and supplementation of goats during dry season with locally available browses plants with the low costs of concentrate is very important to prevent goats from losing body condition during the dry season.

5.2. Recommendation.

Based on the current study, treatment T2,T4, 45 and T3 were recommended for pastoral, agro-pastoral community and any user based on the availability of these browses species. To fulfill the gap of above finding the following research will be carried out under actual pastoral and Agro-pastoralist condition

✓ Supplementations those promising plants at different level as protein and energy source under actual pastoralist's condition could be considered for further study in future.

✓ Assessing the potential and contribution of browse plant species through out of the year
Which are commonly used as dry season feed resources is important to enhance their sustainable utilization

References

Abadi Nigus, Mohammed Yusuf and Getachew Animut. 2015. Determination of digestibility of faba bean (*Vicia faba L.*) hull and wheat bran in Afar sheep. *Journal of Biology, Agriculture and Health care. Vol.5, No.1, 2015.*

Abdulrazak, S.A., Mutting, R.
W., Thorpe, W., Orskov, E.R. 1996. The effects of supplementation with *Gliricidia sepium* and *Leucaena leucocephala* forage on intake, digestion and liveweight gains of *Bos taurus* × *Bos indicus* steers offered napier grass, Journal of Anim Science., 63, 381-388.

Abebe Tafa. 2006. Supplementation with linseed (linum usitatissimum) cake, wheat bran and their mixtures on feed intake, digestibility, live weight changes, and carcass characteristics in intact male Arsi-Bale sheep. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Abera, A., Tegegne, A. and Banerjee, A.K. 2002. Slaughtering component yield characteristics of some indigenous goat types in Ethiopia. *Ethiopia Journal. Anim. Prod. 2(1):87-95.*

Abule Ebro, Amsalu Sisay and Tesfaye Alamu. 1998. Effect of level of substituting of Lablab (Dolichos lablab) for concentrate on growth rate and efficiency in post weaning goats. *In Proceeding of the 6th Annual Conference of Ethiopian Society of Animal Production*. 14-15 May 1998, Addis Ababa, Ethiopia, 264-269.

Alemayehu Mengistu, 2003. Immediate cause of the famine; the conflict dimension. Proceeding of the roundtable on drought and famine in the Pastoral Regions. Addis Ababa, Ethiopia, 23-23 December 2002. Pastoral Forum of Ethiopia.

Alemayehu Mengistu, 2004. Rangeland: Biodiversity concept, Approachs and the way forward. Addi Ababa University, Addis Ababa, Ethiopia, 80p.

Ameha Sebsibe, Casey, N.H, Van Niekerk, WA, Azage, T and Coertze, RJ. 2007. Growth performance and carcass characteristics of three Ethiopian goat breeds fed grain less diets varying in concentrate to roughage ratios. *South Africa. Journal of. Anim. Sci.* 37(4): 221-232.

AOCA (Association of Official Analytical Chemists), 1990. Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists, Washington DC.

Araya, M.R., Ngugi, R.K., Musimba, N.K.R. and Nyariki, D.M. 2003. Effects of *Vechilla tortilis* pods on Intake, Digestibility and Nutritive quality of goat diets in South-Western Eritrea. *African Journal of range and forage science* 20 (1): 59-62.

Aster Abebe, Adugna Tolera, Øystein Holanda, Tormod Ådnøya, and Lars Olav Eikad. 2012.Seasonal variation in nutritive value of some browses and grass species in Borana Rangeland, Southern Ethiopia. *Tropical and sub tropical ecosystems.*

Bhuyan, R. K., Baruah, M.C., Bora and P.C. D.1996. Effect of plane of nutrition on carcass characteristics of crossbred (Beetal X Assam local) Goat. *Dept.of Animal Nutrition, College of Veterinary Science,* Khanapara, Guwahati. Pp. 938-943.

Central Statistical Agency (CSA). 2016. Federal Democratic Republic of Ethiopia. Agricultural Sample Survey 2015/16 [2008E.C.] Volume Ii**.** Report on Livestock and Livestock Characteristics **(**Private Peasant Holdings**).**

Coppock, D.1994.The Borana plateau of southern Ethiopia: Synthesis of pastoral research development and change, 1980-91. ILCA (International Livestock Center for Africa), Addis Ababa, Ethiopia 5:150-160.

Dereje Worku.2014. Effect of Substitution of Concentrate Mix with Dried Mulberry Leaves on Feed Intake, Digestibility, Body Weight Gain and Carcass Characteristics of Arsi-Bale Goats. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Devendra, C and Burns, M.1986.feeding systems and nutrition of goat and sheep in tropics .

Devendra, C. 1990. The use of shrubs and tree fodders by ruminants. In: Shrubs and Tree Fodders for Farm Animals, C. Devendra (ed.), International Development Research Centre, IDRC-276e, Ottawa, Canada, pp: 42–60.

Getachew Assefa. 2005. Evaluation of forage yield and effect of forms of feeding of *Vechilla salignia* on intake and live weight gain of Farta sheep fed on grass hay. An MSc Thesis Haramaya, University. Haramaya, 66p..

Giri, S.S., A. Sahoo, and N.N. Pathak. 2000. Feed intake, digestibility, plane of nutrition and live weight gain by cross breed growing bulls fed on grain less diet containing different nitrogen sources. *Journal of Animal FeedScience and Technology*. 83: 195-203pp.

Gulten, K., Rad, F. and Kindir, M. 2000. Growth performance and feed conversion efficiency of Siberian Sturger juveniles (*Acipenserbaeri*) Reared in concentrate ways. *Turkeys Journal of Veterinary and Animal Science*, 24:28.

Hirut Yirga. 2008. Supplementation with concentrate mix to Hararghe highland sheep fed a basal diet of urea treated maize Stover: Effect on feed utilization, live weight change and carcass characteristics. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

ILCA (International Livestock Centre for Africa). (1989). Comparative Performance of Preweaned Calves under Simulated Pastoral Management with Vechilla, Vigna or Medicsgo as Supplement. ILCA Annual Report 1988. ILCA, Addis Ababa, Ethiopia, pp. 13-14.

ILCA (International Livestock Centre for Africa). 1988. The Use of Locally Available Feeds for Supplementing Calves in Southern Ethiopia. ILCA Annual Report 1987. ILCA, Addis Ababa, Ethiopia, pp. 6-7.

Jemberu Dessie. 2008. Effects of Supplementation of Simada Sheep with Graded levels of Concentrate cake on feed intake, Digestibility and Body weight parameters. MS.c. Thesis Haramaya University, Haramaya, Ethiopia

Le Houerou, HN. 1980. Chemical composition and nutritive value of browse in tropical West Africa. In: Le Houerou HN. Browse in Africa, the current

state of knowledge. Addis- Ababa: International Livestock Centre for Africa.

Matiwos, S., Solomon, M. and Adugna, T. 2008. The effect of different levels of cottonseed meal supplementation on feed intake, digestibility, live weight changes, and carcass parameters of Sidama goats, Livestock Science, 119, 137–44.

McDonald, P. R.A. Edward, J.F.D. Greenhalgh and G.A. Morgan. 2002. *Animal Nutrition 6th ed.* Pearson Educational Limited. Edinburgh, Great Britain. Pp 544.

Mulu, M. 2005. Effect of feeding different levels of brewery dried grain on live Weight gain and carcass characteristic of Wogera sheep fed on basal diet. MS.c. Thesis, Haramaya University, Haramaya, Ethiopia

National Research Council (NRC). 1981. *Nutrient Requirements of Goats*: Angora, Dairy, and Meat Goats in Temperate and Tropical Countries. National Academy Press. Washington, D.C.

Norton, B.W., 1994. Tree legumes as dietary supplements for ruminants. In: Gutteridge, R.C. Shelton, H.M. (Eds.), Forage Tree Legumes in Tropical Agriculture. CAB International.

Nurfeta Ajabu. 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, 42:815–824.

Ranjhan, S.K.1997. *Animal Nutrition in the Tropics. 4th edn*. Vikas publishing house Pvt. Ltd., New Delhi, India. pp. 30-57.

Ranjhan, S.k.2001.*Animal nutrition in the tropics*.4th(eds).vikas publishing housedelhi,51p.

Seyoum Bediye.1995. Evaluation of nutritive values of herbaceous legumes, Browse species and Oilseed cakes using chemical analysis, *In vitro* digestibility and Nylon bag technique. MS.c Thesis, Haramaya University, Haramaya, Ethiopia.

Shahjalal, M., A.M. Bishwas, A. Tareque and M. M. Hoki. 2000. Growth and carcass characteristics of goats given diets varying protein concentration and feeding level. *Asian- Aus. Journal. Anim. Sci.* 13: 613-618.

Simret Bistha. 2005**.** Supplementation of Graded Levels of Peanut Cake and Wheat Bran Mixture on Nutrient Utilization and Carcass Parameters of Somali Goats. M.Sc. Thesis, Haramaya university, Haramaya, Ethiopia.

Solomon Melaku and Simret Bistha. 2008. Bodyweight and carcass characteristics of Somali goats fed hay supplemented with graded levels of peanut cake and wheat bran mixture. Journal *of Trop. Anim. Health Prod*. 42, 553-560.

Solomon Melaku, K. J. Peters and Azage Tegegne. 2004. Effects of supplementation with foliages of selected multipurpose trees, their mixtures or wheat bran on feed intake, plasma enzyme activities, live weight and scrotal circumference gains of Menze sheep. Journal Livestock Production Science, Vol. 89: 2004, pp. 253-264

Tesfay Hagos. 2007. Supplementation of afar rams with graded levels of mixtures of protein and energy sources: effects on feed intake, digestibility, and live weight and carcass parameters. MSc of Haramaya University, Haramaya. Ethiopia

Tolera Adugna and Abebe Aster. 2007. Livestock production in pastoral and agro-pastoral production systems of southern Ethiopia. Livestock Research for Rural Development 19, 177. Retrieved February 11, 2008.

Access this Article in Online	
	Website: www.ijarbs.com
Quick Response Code	Subject: Agriculture
DOI:10.22192/ijarbs.2019.06.05.006	

How to cite this article:
Sisay Kumsa, Tamirat Tasemma, Dereje Teshoma. (2019). Feed intake, digestibility and body weight gain of intact male borana goats supplemented with three browse species mixed with wheat bran. Int. J. Adv. Res. Biol. Sci. 6(5): 51-64. DOI: http://dx.doi.org/10.22192/ijarbs.2019.06.05.006