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Research article

Impact of Faba Bean *(Vicia faba L.)* Hull Substitution to Wheat Bran on Carcass Characteristics of Afar Sheep Fed Hay as Basal Diet

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ABSTRACT

The study was conducted in Alamata woreda, with the objective of studying the response of Afar sheep to carcass parameters when substituted with different proportions of wheat bran (WB) and faba bean hull (FBH) on hay and 45 g noug seed cake (NSC). The experiment was conducted by using a randomized complete block design (RCBD) with five treatments and five replications on twenty-five Afar sheep. There was lack of significant variation among substituted group in daily live weight gain (ADG)and slaughter body weight(SBW) but higher than control group when compared. There was also significance (P<0.05) differences between control and substituted group in rib eye muscle area (REMA) and was higher in substituted animals. In the current study, there was significant (P<0.05) difference observed between substituted and control group. There was no significant (P>0.05) difference among substituted group in feet and tongue but there was highly significant (P<0.05) difference in penis, spleen, blood, bladder and gut fill among the substituted treatments. The result of this study suggested that substituting at different proportions of WB and FBH generally enhance carcass quality of Afar sheep. Therefore, in this experiment WB was completely substituted by FBH in the hot carcass weight (HCW) of each substituting animals. **Copyright © WJASR, all rights reserved.**

Keywords: Carcass, faba bean, wheat bran.

1. INTRODUCTION

Among Africa countries, Ethiopia is considered to have the largest livestock population. There are huge number of cattle, sheep, goats, horse, donkeys, mules, camels, poultry and beehives in the country. This livestock sector has been contributing considerable portion to the economy of the country, and still promise to rally round the economic development of the country. (CSA, 2011). Livestock is integral components of the Ethiopian farming systems, and performs multiple functions at different levels of aggregation. At individual smallholders' level, livestock is important source of food (meat and milk), cash income, services and manure. The livestock subsector provides wide and year-round employment opportunities for surplus family labor in rural Ethiopia.

Despite the significant importance of livestock in the country, animal productivity is low due to some important constraints such as inadequate feed, wide spread disease, poor health care services, poor genetic potential of indigenous animals and insufficient knowledge on the dynamics of the different farming systems existing in the country (Yirga and Hassen, 2000). Currently, feed is the main constraint limiting livestock productivity in the country (Alemayehu, 2005). Pasture and crop residues are the main feed supply to sheep in Ethiopia and such types of feeds rarely satisfy the maintenance requirements of the animals.

Most of the dry forages provide a source of roughage, but their potential is limited by high fiber, low protein, mineral and vitamin content (Kayongo *et al*., 1993). Therefore, there is a need for supplementary feeding to meet their nutrient requirements, even for maintenance (Stobbs and Thompson, 1975). The lowest energy density at which sheep do not lose weight is between 8-10 MJ/kg DM and the minimum CP level required for maintenance is about 8% in the DM (CTA, 1991). However, the most productive animals such as rapidly growing lambs and lactating ewes need about 11% of CP for proper productive performance (CTA, 1991). These energy and protein levels are considerably higher than the average values found in natural pastures and crop residues in the tropics (CTA, 1991).

Faba bean *(Vicia faba L.*) is one of the earliest domesticated food legumes in the World, (Bond, 1976; Cubero, 1976; Witcombe, 1982).Today, faba bean is a major crop in many countries including China, Ethiopia, and Egypt, and is widely grown for human food throughout the Mediterranean region and in parts of Latin America. In Tigray Region, a total of 14,889 hectares of land were covered by different crops including maize, chickpeas, horse-beans, sorghum, barley and wheat in Raya Azebo, Alamata, Enda -Moni, Alaji and Ofla weredas using the unseasonal rains received. Faba beans are produced in large quantities throughout the year in highland of Alamata woreda. The internal part of the seed is used for human consumption and the outer cover (seed coat) is a byproduct that can be used as livestock feed. However, there is scarce information on its nutrient impact on carcass parameters. Thus, the objective of this study was to determine the effect of faba bean hull substituting to wheat bran on carcass characteristics of Afar sheep.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The experiment was conducted at Alamata district, Southern Zone of Tigray, Ethiopia. It is located 600 km North of Addis Ababa and 182 km South of Mekelle and has an elevation of 1600 meter above sea level (masl). It lies at 39^{0}35'E longitude and 12^{0}15'N latitude. The area receives a bimodal rainfall distributed between March and May for the short rainy season and between June and September for the long rainy season. The annual mean precipitation is 591 mm and mean maximum and minimum temperatures are 28 ^{0}C and 13 ^{0}C, respectively. Teff, sorghum and maize are the major crops growing in the lowland and faba bean, wheat, barley form also a significant part of the crops growing in the highland of the area. About 12,685 sheep are found in the district (BoARD, 1994).

2.2. Experimental Animals and Management

Twenty-five yearling male Afar sheep with average initial body weight of 19.98±0.12 Kg (mean ± SE) were purchased from Bala market weighing by spring balance (50 kg). The age of the animals was determined based on their dentition or information obtained from the owner. The animals were quarantined for twenty-one days and during this period; they de-wormed using Albendazole against internal and sprayed using Ivermectin against external parasites. They were also vaccinated against Anthrax, pasturollosis and sheep pox. Then experimental animals were housed in individual pens.

2.3. Experimental Design and Treatment

The experiment was conducted by using a randomized complete block design (RCBD) with five treatments and five replications. Animals were blocked based on their initial body weight (IBW) into five blocks consisting of five animals each. Treatment diets were randomly assigned to each animal in a block. All experimental animals were offered hay *ad libitum* and 45 g NSC as maintenance requirement. The hay was fed *ad libitum* allowing 20% refusal. NSC was offered in the morning with the morning meal supplement. The other supplemental feeds were offered in two equal portions twice a day at 08.00 h and 16.00 h. All animals had free access to drinking water and salt block. During the experiment body weight gain and carcass evaluation were conducted. The substitution was different proportions of WB and faba bean hull (FBH). Treatments, therefore, were:

T_1 = Hay fed *ad libitum* + 45 g NSC

T_2 = Hay fed *ad libitum* + 45 g NSC + 300 g WB + 0 g FBH

T_3 = Hay fed *ad libitum* + 45 g NSC + 200 g WB + 100 g FBH

T_4 = Hay fed *ad libitum* + 45 g NSC + 100 g WB + 200 g FBH

T_5 = Hay fed *ad libitum* + 45 g NSC + 300 g FBH + 0 g WB

2.4. Measurement

2.4.1. Carcass parameters

Carcass parameters were analyzed at the end of the study. All animals were weighed and slaughtered after overnight fasting for 12 hours. During slaughtering, the blood was collected in a container and weighed. Weight of the offal like heart, liver, kidney, tongue, reticulo-rumen, omasum, abomasums, small and large intestine, head, skin, feet, lung, trachea, spleen, gall bladder, bladder and penis were weighed and recorded. All carcass parameters weighed by digital balance immediately after slaughtering, which was so sensitive. Empty body weight was determined by deducting the gut content from the slaughter weight. The hot carcass weight was also measured after removing the skin, head, get content, and feet. Dressing percentage was calculated as a proportion of hot carcass weight to slaughter weight or empty body weight. The rib-eye muscle area of each animal was determined by tracing the cross sectional area of the 11th and 12th ribs using square paper after cutting perpendicular to the backbone. The mean of the right and left cross sectional area was taken as a rib-eye muscle area. Carcass offal were divided as edible such as head, heart, rumen-reticulum, omasum-abomasum, small intestine, large intestine, tail, kidney, liver visceral fat, lung, trachea and testicles and non-edible parts such as skin, penis, spleen, gut fill, blood and tongue.

2.5. Chemical analysis

Feed offered, refusals and feces sample were dried at 55 ^{0}C for 72 hours and ground to pass 1 mm mesh size. All samples were subjected to laboratory analysis for DM, CP and ash determination following the procedure of AOAC (1990). The ADF, NDF and ADL contents of samples were determined following the procedures of (Van Soest and Robertson, 1985). Organic matter (OM) content was calculated as 100-ash percentage. Chemical analysis was taken place in Haramaya University.

Metabolizable energy (ME) intakes were estimated from its digestible organic matter (DOM) by using the equation of (McDonald *et al*., 2002) as ME = DOMD (g/k DM) x 0.0 157, where, DOMD= Digestible organic matter per kg DM. in addition, feed conversion efficiency calculated by dividing the average body weight gain to total feeds.

3. RESULTS AND DISCUSSION

3.1. Chemical Composition of Treatment Feeds

The chemical composition of the treatment feeds is given in Table 1. The hay offered to the experimental animals in the current study contained low CP comparable to values of 6.56, 6.05, 5.64, and 7.02% reported by (Simret, 2005), (Beyene, 1976), (Getachew, 2005), (Abebaw, 2007), respectively but was higher than the values of 3.5-5.3% noted by others (Kabaija and Little, 1988; Asenakew, 2005; Jemberu, 2008; Fentie, 2007) and was lower than the value of 8.46 and 9.23% reported by (Alemu, 1981) and (Matiwos, 2007), respectively. Therefore, the CP content of the hay used in the current study, which predominantly consisted of mixed sward grass hay, was below 7.5% CP level required to satisfy the requirement of animals (Van Soest, 1982). The low CP and high NDF and ADF content could be attributed to the stage of maturity of the mixed sward from which the hay was prepared. Advance in maturity of plants is usually associated with low CP and high cell wall content (McDonald *et al.*, 2002).

The CP content of NSC in this study was lower than the values reported by (Alemu, 1981), (Beyene, 1976), (Maaza, 1981), and (Nawanyakpa *et al*., 1986) who reported 34.89, 33.77, 35.29, and 32.3% DM, respectively. However, the value was relatively comparable to the values of 30.4, 29.2, 29.5, and 29.6% reported by (Temesgen, 1995), (Bimrew, 2008), (Taddesse and Zelalem, 2003) and (Nega *et al*., 2002), respectively. The variation in the CP content of NSC used in this study and previous studies might be due to the method of processing and variety of the NSC (Solomon, 1992). The results indicated that NSC had greater ADF and NDF content than WB but lower than that of FBH. The ADF content of NSC was greater than 28.16 and 32.7% reported by (Beyene, 1976) and Nawanyakpa *et al*. (1986) respectively, and the ADL content of NSC was in line with 13.3% of (Nawanyakpa *et al.*, 1986).

Table 1. Chemical composition of experimental feeds and hay refusals.

		Chemical composition				
feeds	DM	OM	CP	NDF	ADF	ADL
	(%)	(% DM)				
Feed offered						
Hay	92.52	89.24	6.78	75.02	45.55	8.68
NSC	94.25	88.37	28.98	56.84	37.60	9.71
WB	89.33	95.26	13.13	51.22	12.95	10.56
FBH	90.94	95.94	12.78	63.07	52.20	8.69
Refusal Hay						
T1	91.99	93.42	2.92	93.42	83.95	
T2	91.88	93.51	2.48	93.51	83.88	
T3	91.48	93.46	2.33	93.46	83.92	
T4	93.10	93.90	2.63	93.00	84.01	
T5	92.89	93.12	2.33	93.12	84.00	

NSC = noug seed cake; WB = wheat bran; FBH = faba bean hull; DM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin;T_1 = hay + 45 g NSC; T_2 = T_1 + 300 g WB; T_3 = T_1 + 200 g WB + 100 g FBH; T_4 = T_1 + 100 g WB+ 200 g FBH; T_5 = T_1 + 300 g FBH.

The CP content of WB is variable. According to Lonsdale (1989), the CP content of WB varies from 13.3 to 17.0%. The result of the current study falls within this range. The CP content of WB observed in the current study was less than the value of 19.99, 19.55, 20.10, and 23.08% reported by (Alemu, 1981), (Asnakew, 2005), (Simret, 2005), and (Fentie, 2007), respectively. In addition, it was a little bit less than the results obtained by (Kaitho *et al.*, 1998), (Abate and Abate, 1991), Tesfay *et al.* (2001), and (Solomon *et al.*, 2004), who reported the CP content of WB to be 16.6, 17.2, 16.31, and 16.5%, respectively. However, it was comparable to the value of 14.53% reported by (Giri *et al.*, 2000). The differences between the results might be due to the variation in the raw material methods of milling and the prolonged storage of WB after milling.

The ADF content of WB was comparable to 12.70, 12.47, 12.36% 12.39, and 12.45% reported by (Solomon *et al.*, 2004), (Simret, 2005), (Asnakew, 2005), (Fentie, 2007), and (Jemberu, 2008), respectively but lower than 15.50 and 14.6% obtained by (Kaitho *et al.*, 1998) and (Hirut, 2008) correspondingly and higher than 9.49 and 9.46% reported by (Giri, 2000) and (Tesfay, 2007), respectively. The NDF value of the present study of WB was comparable to the value of 55.5% reported by (Hirut, 2008) and higher than the value of 44.13, 44.97, 43.83, 44.94, and 39.16% reported by (Simret, 2005), (Mulat, 2006), (Fentie, 2007), (Abebe, 2008), and (Jemberu, 2008), respectively.

FBH CP content in this study was comparable to the CP content of WB. (Jansman *et al*., 1995) noted a CP content of about 16% for FBH, which was slightly higher than the value in this study, unlike (Ermias, 2008) who noted a low CP value of 7.7% for FBH. Roughage feeds with CP content of 9.92 to 15.2%, 6.6 to 9.1% and 3 to 6.5% were classified as high, medium and low quality roughage feeds, respectively (Nsahlai *et al*., 1996). The FBH evaluated in this study could thus be classified as high quality feed with respect to their CP contents. On the other hand, similar NDF value to the result in this study was reported (Jansman *et al*., 1995). Lower CP level was noted for hay refusals as compared to the offered hay in this study. The NDF and ADF contents were conversely greater for the refusals as compared to the offered hay. All these suggest the presence of selectivity for hay fractions by the experimental animals.

3.2. Carcass Characteristics

Data on carcass characteristics are given in Table 2. Information on carcass yield is useful in comparing and determining the actual, potential and performance of meat animals. Carcasses were evaluated based upon dressing percentage on slaughter and empty body weight base, hot carcass weight, rib eye area, internal fat deposits, and edible and non-edible offal's. Sheep in the substituted treatments had greater slaughter and empty body weight, heavier carcass weight, and larger rib-eye area ($P<0.05$).

Dressing percentage on empty body weight basis was actually greater ($P<0.05$) for T_1 than the substituted treatments. That means there was higher gut content in control group than animals substituted with an extra concentrate feeds (FBH and WB). Therefore, this experiment showed that the control group spent more time for the digestion of the roughage feeds fed by the animals. In the present study the dressing percentage ranged between 41.96 and 44.31% based on slaughter weight and this result was comparable to the report of Zemicael (2007) with supplemental sesame seed (*sesame indicum*) cake, wheat bran and their mixtures on Arado sheep fed a basal diet of teff straw. Other studies (Beniam *et al.*, 1983; Devendra and Burns, 1983; Galal *et al*., 1979), also noted comparable values for different breeds of sheep.

Table 2. Carcass characteristics of Afar sheep fed on grass hay and noug seed cake and substituted with different proportions of faba bean hull and wheat bran.

Variables	Treatments					SEM
	T_1	T_2	T_3	T_4	T_5	
SBW (kg)	20.85^{b}	25.82^{a}	25.50^{a}	25.44^{a}	25.72^{a}	0.23
HCW (kg)	9.50^{c}	11.40^{a}	10.70^{b}	10.74^{b}	11.40^{a}	0.20
EBW (kg)	15.74^{d}	21.12^{a}	20.45^{bc}	20.35^{c}	20.93^{ab}	0.16
DP (%)						
SBW bases	45.56^{a}	44.14^{a}	41.96^{b}	42.21^{b}	44.31^{a}	0.47
EBW bases	60.36^{a}	53.96^{bc}	52.32^{c}	52.78^{bc}	54.45^{b}	0.74

REMA (cm^2)	7.57[b]	10.60[a]	10.89[a]	10.60[a]	10.70[a]	0.25
Other merits						
ME MJ/d	7.75[c]	10.53[ab]	10.52[ab]	10.38[b]	10.76[a]	0.09[a]
FCE ADG/g	0.02[b]	0.09[a]	0.08[a]	0.09[a]	0.09[a]	0.004

[a,b,c,d,] =means with different superscripts in a row are significantly different. (P<0.05) SBW = slaughter body weight; HCW = hot carcass weight; EBW = empty body weight; DP = dressing percentage; REMA = rib eye muscle area; SEM = standard error of mean; ME = metabolizable energy, FCE= feed conversion efficiency,T_1 = hay + 45 g NSC; $T_2 = T_1$ + 300 g WB; $T_3 = T_1$ + 200 g WB + 100 g FBH; $T_4 = T_1$ + 100 g WB + 200 g FBH; $T_5 = T_1$ + 300 g FBH.

In this study, higher rib-eye area for substituted sheep than those in control group indicated that sheep consuming different levels of the concentrate mixture were able to put relatively more lean flesh than the sheep fed hay alone. This was in agreement with other studies (Hammond and Wildeus, 1993; Mulu, 2005; Asnakew, 2005 and Zemicael, 2007).

3.3. Carcass Offal of Afar Sheep

Data on carcass offal for Afar sheep used in this study is given in Table 3 and 4. Carcass offal represents additional protein and energy sources for human consumption. In countries where certain portions of carcass offal are considered edible, this carcass offal is saleable offal that adds value to the carcass. Due to differences in test and in eating habits, what are saleable and edible proportions of the carcass in one area of a country may not be acceptable in other parts (Getahun, 2001). For instance, lung is non-edible in some places (Mulu, 2005; Matiwos, 2007) but edible in other places (Tesfay, 2007; Zemicael, 2007) the latter holds true in the present study.

The result of this study indicate that plane of nutrition can have significant effect (P<0.05) on most of the edible offal components (Table 2). Kirton *et al.* (1972) reported that live weight and nutritional status of the animals could affect the production efficiency of carcass offal. In the current study, most of the total edible offal (TEO) and total non-edible offal (TNEO) were significantly lower (P<0.05) in the control treatment compared to the substituted group. There was highly significant (P<0.05) difference among substituted in tail, visceral fat, gall bladder from edible offal. Sheep supplemented with FBH sole (T_5) had lowest blood weight (P<0.05) and (T_3) small weight gall bladder (P<0.05) as compared to supplemented group. This result agrees with that of (Simre, 2005) and (Mulu, 2005) who reported that supplementation of concentrate can have significant effect on liver, heart and kidneys. The increasing trend in liver weight with increasing supplementation level might be related to the storage of reserve substances such as glycogen as described by (Lawrence and Amedeo, 1989). On the contrary, animals fed on low quality feed use their body reserve fat to fulfill their nutrient requirement that causes decreased fat storage in their body. Mobilization of body fat during prolonged underfeeding is a well-known phenomenon. Substantial mobilization of body reserves during the dry season and at times when the animals are in negative protein and energy balance to meet their nutrient requirements was reported in sheep (Sykes, 1974).

Table 3. Edible components of Afar sheep fed on grass hay and noug seed cake and substituted with different proportions of faba bean hull and wheat bran.

Parameters (g)	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
Heart	90.00^{b}	118.00^{a}	123.00^{a}	121.00^{a}	123.00^{a}	2.70
Head	722.00^{b}	1678.00^{a}	1760.00^{a}	1686.40^{a}	1662.00^{a}	109.35
Rumen-Reticulm	420.00^{b}	618.00^{a}	626.00^{a}	618.00^{a}	622.00^{a}	4.87
Omasum-Abo	196.00^{b}	236.00^{a}	232.00^{a}	232.00^{a}	228.00^{a}	4.74
SI	332.00^{b}	412.00^{a}	410.00^{a}	410.00^{a}	408.00^{a}	3.80
LI	228.00^{b}	312.00^{a}	310.00^{a}	314.00^{a}	308.00^{a}	4.10
Tail	626.00^{d}	1212.00^{b}	1254.00^{a}	1248.00^{a}	1192.00^{c}	3.88
Kidney	48.00^{b}	58.00^{a}	60.00^{a}	55.00^{a}	56.00^{a}	1.71
Liver	185.00^{b}	210.00^{a}	212.00^{a}	208.00^{a}	206.00^{a}	3.16
V.fat	202.00^{c}	350.00^{ab}	340.00^{b}	360.00^{a}	340.00^{b}	5.09
L +T	350.00^{b}	442.00^{a}	458.00^{a}	444.00^{a}	452.00^{a}	5.39
GB	8.00^{c}	13.00^{ab}	9.00^{c}	14.00^{a}	12.00^{b}	0.54
Testicles	198.00^{b}	250.00^{a}	250.00^{a}	254.00^{a}	240.00^{a}	5.13
TEO	3605.00^{c}	5909.00^{ab}	6044.00^{a}	5964.40^{ab}	5849.00^{b}	111.88

^{a,b,c,d,} =means with different superscripts in a row are significantly different (P<0.05); GB = gall bladder; V.fat = visceral fat; L+T = lung plus trachea; SI = small intestine; LI = large intestine; TEO = total edible offal; T_1 = hay + 45 g NSC; $T_2 = T_1$ + 300 g WB; $T_3 = T_1$ + 200 g WB + 100 g FBH; $T_4 = T_1$ + 100 g WB + 200 g FBH; $T_5 = T_1$ + 300 g FBH.

There was no significant (P>0.05) difference among substituted group in feet and tongue. The existence of variation among all treatments in skin, penis, spleen, gut fill, blood and bladder and higher in substituted than control ones in non-edible offal suggested that the feed conversion efficiency of substituted group is higher.

Table 4. Non edible components of Afar sheep fed on grass hay and noug seed cake and substituted with different proportions of faba bean hull and wheat bran.

Parameters (g)	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
Skin	1230.00^{d}	2302.00^{c}	2402.00^{a}	2408.00^{a}	2320.00^{b}	4.72
Feet	398.00^{b}	466.00^{a}	456.00^{a}	464.00^{a}	462.00^{a}	3.84

Penis	48.00[c]	52.00[b]	56.00[a]	54.00[ab]	52.00[b]	1.12
Spleen	100.00[c]	120.00[b]	124.00[ab]	128.00[a]	118.00[b]	2.08
Get fill	5000.00[a]	4280.00[c]	4370.00[b]	4350.00[b]	4270.00[c]	6.90
Blood	554.00[d]	800.00[b]	820.00[ab]	840.00[a]	750.00[c]	6.79
Bladder	10.00[c]	17.00[ab]	16.00[b]	19.00[a]	18.00[ab]	0.87
Tongue	42.00[b]	56.00[a]	54.00[a]	56.00[a]	55.00[a]	2.95
NEO	7382.00[d]	8093.00[b]	8298.00[a]	8319.00[a]	8045.00[c]	10.23

[a,b,c,d,] =means with different superscripts in a row are significantly different P(<0.05), NEO = non edible offal; T_1 = hay + 45 g NSC; $T_2 = T_1$ + 300 g WB; $T_3 = T_1$ + 200 g WB + 100 g FBH; $T_4 = T_1$ + 100g WB + 200 g FBH; $T_5 = T_1$ + 300 g FBH.

4. SUMMARY AND CONCLUSION

Grazing animals in Ethiopia manage to survive mostly on poor quality feedstuffs in the form of poor quality pasture, conserved hays and crop residues. Even though natural pasture and crop residues are major livestock feeds, due to high livestock and human population pressure, the availability of natural pasture has seriously declined and practically available only on the steep slopes and cultivated land margins. Thus, keeping growing animals on such poor pasture results in under-nutrition and loss of body weight as well as need longer time to attain slaughter weight. Therefore, the present study was carried out to study the effect of FBH substitution to WB on carcass parameters of Afar sheep fed on grass hay and 45 g of NSC.

Generally, substituting of WB and FBH at different proportions diet improved carcass characteristics of Afar sheep over the control group. Therefore, in this experiment WB was completely substituted by FBH in terms of hot carcass weight and rib eye muscle area mean that T_2 is substituted by T_5 and T_3 substituted by T_4. In addition from biological point of view to attain required level of slaughter body weight within short period of fattening or growing program, sheep producer can use all the supplement types depending upon local availability of feeds, especially T_5 is very important.

5. ACKNOWLEDGMENTS

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