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Research article

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

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ABSTRACT

The study was conducted in Alamata woreda, and carried out with the objective of studying the response of Afar sheep on body weight gain and 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). Significant ($P<0.05$) difference in final and daily live weight gain in the range of 60.42-64.67 g/d was observed in substituted Afar sheep, but control group was gain by 11g/d. Numerically among substituted group sheep substituting with different level of FBH gained more weight than the rest group, but statistically both had similar gain. The absence of statistical difference in daily body weight gain between all substituted groups indicated that the substitution at different proportions of WB and FBH had similar potential to provide nutrients to improve weight gains of the sheep. 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 enhanced final body weight and carcass quality of Afar sheep.

Keywords: Faba bean, wheat bran, carcass

INTRODUCTION

Among Africa countries, Ethiopia 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 promising to rally round the economic development of the country. (CSA, 2011). Livestock are integral components of the Ethiopian farming systems, and perform multiple functions at different levels of aggregation. At individual smallholders' level, livestock are 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. Cash income from livestock production is especially important for the poor and landless Ethiopian households, particularly women, as is also true in many other developing countries (Delgado *et al*., 1999; Thornton *et al*., 2002). For the average rural farm household with limited investment alternatives, livestock are used as store of wealth and hedge against inflation. The sub-sector does not only provide animal protein for the ever growing human population, but it also contributes in providing export commodities, such as live animal, hides and skins to earn foreign exchange to the country. With specific reference to sheep, their socio-economic importance is widely recognized.

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 in Ethiopia have crude protein (CP) levels below 7% and neutral detergent fiber (NDF) of greater than 55% (Seyoum and Zinash, 1995) which indicates poor nutritive value not capable of meeting microbial requirements (Van Soest, 1994). Besides, the steady increase in human population puts much of grazing and browsing areas under arable farming for food crop production, which further make worse the scarcity of feed resources.

Most 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 the sheep does 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).

Migongo-Bake and Hansen (1987) reported that in semi-arid and tropical ecosystems, the quality of forages decreases greatly during the dry season, leading to substantial weight loss of animals. This phenomenon requires the alleviation of nutrients deficiency in animals through implementing different feed utilization strategies as well as in order to improve the average daily gain of animals. One of the feasible methods of improving the nutritive value of fibrous feeds could be through strategic concentrate supplementation with energy and/or protein sources, which can increase the digestibility, nutrient supply and intake (Prestson and Leng, 1987). Thus, the use of other alternative and relatively cheaper sources of animal feed supplements, such agricultural and industrial byproducts should be considered. Since nowadays, the number of oil extracting and flour milling industries are expanding in the different parts of Ethiopia, the approach that seems worthy of pursuing is to use agro-industrial byproducts and other suitable feeds which are not directly consumed by human beings, but that can be fed to animals to obtain a valuable product. These include agro-industrial byproducts of flour milling such as wheat bran and faba bean hull.

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 are 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, can be used as livestock feed. However, there is scarce information on the nutritive value of this feed resource and its impacts on body weight and carcass parameters. Thus, the objective of this study was to determine the effect of faba bean hull substituting to wheat bran on live weight gain and carcass Characteristics of Afar sheep.

MATERIAL AND METHODS

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 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 are also the most crops growing in the highland of the area. About 12,685 sheep are found in the district (BoARD, 1994).

Experimental Animals and Management

Twenty-five yearling male Afar sheep with average initial body weight of 19.98$\pm$0.12 Kg (mean $\pm$ SE) were purchased from Bala market. 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.

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 0800 and 1600 hours. All animals had free access to drinking water and salt block. The experiment was conducted the body weight gain and carcass evaluation. 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

Measurements

Live weight change

Initial body weight of the experimental animals was measured at the beginning of the study after overnight fasting using spring balance. Average daily weight gain was estimated as the difference between final and initial live weight of the experimental sheep divided by the number of feeding days.

Carcass parameter

Carcass parameter was analyzed at the end of 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. Empty body weight was determined by deducting the gut content from the slaughter weight. The hot carcass weight was also measured after removing 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 11^{th} and 12^{th} ribs using square paper after cutting perpendicular to the backbone. The mean of the right and left cross sectional area were taken as a rib-eye muscle area. Carcass offal were divided as edible such as head, heart, rumen-reticulem, omasum-abomasum, small intestine, large intestine, tail, kidney, liver visceral fat, lung, trachea and testicles and non edible such as skin, penis, spleen, gut fill, blood and tongue.

RESULTS AND DISCUSSION

Body Weight Change

Substituted animals resulted in significantly higher ($P<0.05$) in daily live weight gain (ADG) than control ones shown in table 1. However, there was no significant ($P>0.05$) difference among the substituted treatments in all parameters noted. Lack of significant variation among substituted group in daily live weight gain, reflected that the substituting supplements were comparable in their potential to supply nutrients for improving the weight gains of the sheep.

The average daily weight gain of supplemented sheep in this study were comparable to the result observed by Mulu (2005) who reported 70.44 g for Wogera sheep supplemented with brewery dried grain at 300 g DM/d. Bonsi *et al.* (1996) also reported daily live weight gain of 62.9 g for Menz sheep supplemented with 169 g DM/d cotton seed cake. However, the daily weight gain in the current study for the supplemented sheep were higher than 23.78 g on

150 g/d DM WB supplemented lambs (Kaitho, 1998), and 29.2 g for Menz sheep supplemented with 156.3 g wheat bran to teff straw (Solomon *et al*., 2004).

Table 1: Body weight change, feed conversion efficiency of Afar sheep fed on grass hay and noug seed cake and substituted with different proportions of faba bean hull and wheat bran

	Treatments					
Parameters	T_1	T_2	T_3	T_4	T_5	SEM
IBW (kg)	20.00	19.96	20.04	19.96	19.92	0.12
FBW (kg)	20.99[b]	25.72[a]	25.48[a]	25.48[a]	25.74[a]	0.25
BWC (kg)	0.99[b]	5.76[a]	5.44[a]	5.52[a]	5.82[a]	0.26
ADG (g/d)	11.00[b]	63.96[a]	60.42[a]	61.29[a]	64.67[a]	2.90
FCE ADG/g feed	0.02[b]	0.09[a]	0.08[a]	0.09[a]	0.09[a]	0.004

[a,b,] =means with different superscripts in a row are significantly different ($P<0.05$); SEM = standard error of mean; ns = not significant; FCE= feed conversion efficiency; IBW = initial body weight; FBW = final body weight; BWC = body weight change, ADG = average daily body weight gain; 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.

Generally, substituted significantly enhanced growth rate of sheep. Galal *et al*. (1979) discussed that as the concentrate to roughage ratio increased in the diet, feed consumption also increased, and feed conversion improved, so the final weight and ADG also increased.

Body weight gain of (11.00 g/d) for T_1 animals indicated that a small amount of NSC supplementation resulted in alleviating the possible body weight loss of the animals. The low CP and high NDF and ADF content of the hay offered in this study is expected not to be enough to satisfy the maintenance requirement of animals. Bonsi *et al.* (1996) reported weight loss of 19.90 g/d in sheep fed teff straw sole and concluded that the low nutrient intake that occurs when low quality roughages are fed alone cannot maintain animal body weight. The same author described that sheep on the un-supplemented diet needed to mobilize energy and protein from body tissue, which might have led to the weight loss. Similarly, Kaitho (1997) indicated, because of low nitrogen, high cell wall and slow digestion and low intake of hay, animals fed on straw or hay as sole diet may not be able to maintain their nitrogen balance and growing animals could lose body weight.

Carcass Characteristics

Data on carcass characteristics are given in Table 5. 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 body weight 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 is the proportion of the body weight considered to be edible and it is an important criterion in carcass merit consideration. Dressing percentage affected by breed, age, sex and plane of nutrition pointed out by

(Devendra and Burns, 1983). The dressing percentage of sheep in the different treatments in the present study was not consistent with magnitude of differences in ADG and final body weight. Dressing percentage on empty body weight basis was actually greater (P<0.05) for T_1 than the substituted treatments. 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) of 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

^{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; 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 rib-eye area, which is an indirect estimate of body musculature or lean meat of the body, indicates the muscular development of the animal (Galal *et al.*, 1979). In this regard, higher rib-eye area for supplemented 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).

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 eating habits, what are saleable and edible proportions of the carcass offal 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 3). Live weight and nutritional status of the animals could affect the production efficiency of carcass offal reported by (Kirton *et al.*, 1972). 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 Simret (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). In the contrarily, 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	Treatments					
(g)	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 offals; 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 but there was highly significant (P<0.05) difference in penis, spleen, blood, bladder and gut fill among the substituted treatments.

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	Treatments					
(g)	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.

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 result 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 live weight change and carcass parameters of Afar sheep fed on grass hay and 45 g of NSC.

Body weight change of each sheep was estimated as the differences of final and initial body weight divided by the numbers of feeding days. Afterward, the carcass parameter was conducted.

The final body weight and average daily weight gain (ADG) recorded in Afar sheep were higher ($P<0.05$) in substituted treatments as compared to the control group. The ADG of substituted group ranged between 60.42-64.67 g/d, as well as, un-supplemented group gain weight at 11 g/d.

Generally, substituting of WB and FBH at different proportions diet improved average daily weight gain (ADG) of Afar sheep over the control group. Therefore, 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, but T_5 and T_4 are important. However based on partial budget analysis, substituting of 300 g/day FBH (T_5) could be recommended as profitable for producers with biological and economical importance.

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