Response of Gumuz Sheep to Alternative Supplement Feed Ingredients, Ethiopia

Alemu Tarekegn[1], Yeshambel Mekuriaw[2*], Firew Tegegne[2]

[1]Gondar Agricultural Research Center P.o.Box 1337, Gondar, Ethiopia
[2]Bahir Dar University, college of agriculture and environmental sciences, Department of Animal Production and Technology, P.o.Box 5501, Bahir Dar, Ethiopia

Abstract
An experiment was conducted using twenty four Gumuz ram lambs with an initial body weight of 19.05±2.29 kg (mean±SD) to investigate the response to supplementations on feed intake, body weigh change and carcass characteristics of Gumuz sheep. The sheep were treated against endo- and ecto- parasites before commencing the study. The experimental design was a Randomized Complete Block Design (RCBD) with six replications. The treatments were: natural pasture hay alone (T1), natural pasture hay+ 1noug seed cake (NSC):1 wheat bran (WB) (T2), natural pasture hay + 2NSC: 1WB (T3) and natural pasture hay + 3NSC:1WB (T4). The supplements were offered at the rate of 400 g/day, which were offered twice per day at 8 a.m. and 4 p.m hours in equal portions. The feeding trial was carried out for 90 days after 15 days of adaptation period to the experimental feeds and conditions, which were then followed by carcass evaluation at the end of the study. Supplemented treatments had higher ($P<0.01$) total DMI (712.53-724.92 g/d) than the control (672.55 g/d). Supplemented sheep gained BW within the range of 44.26-86.67g/sheep/day with significantly higher ($p<0.001$) differences among the supplemented groups. Better ($p<0.001$) FCE was observed in the supplemented treatments than the control, but no significant differences ($p>0.001$) were recorded among the supplemented treatments. Sheep fed natural pasture hay alone had the lowest net return (-114.46 ETB) and had lowest ($p<0.001$) values for carcass parameters than the supplemented treatments. The possible reason might be because of the relatively less body condition which could not attract prime price in the market. The highest ($p<0.01$) dressing percentage (44.22%) as a proportion of slaughter weight was recorded in T4. Supplemented treatments had rib-eye muscle area in a range of 6.37-10.12 cm^2 and the lowest rib-eye muscle area (4.71cm^2) was recorded in the control treatment. Sheep supplemented with 3NSC:1WB (T4) had the highest net return (287.78 ETB and highest MRR (4.96) compared to the other supplemented treatments. Thus, it is recommended that supplementation of hay with 400 g/head/day concentrate mixture at 3NSC:1WB proportion is biologically efficient and potentially profitable in the feeding of growing Gumuz sheep.

Keywords Gumuz sheep, natural pasture hay, noug seed cake, wheat bran

1. Introduction

Although there are 29.33 million sheep population in Ethiopia CSA (2015) [1] the production and productivity is very low [2]. The low performance of local sheep in terms of live weight (LW) and carcass yield is mainly due to inadequate nutrition [3]. Temporally abundance of forage during short season is followed by long dry periods with feed deficit leading to a cycle of live weight gain and loss of animals. Thus, sheep often takes longer period to attain market weight, lowering its production efficiency. Considering the above facts a number of researches were conducted in the past to evaluate the effect of supplementation on the performance of different sheep breeds in Ethiopia. Noug seed cake, wheat bran and other industrial by products are among the agro-industrial by-products which were used as supplements. The

* Corresponding author: Yeshambel Mekuriaw
Email: yeshambel166@gmail.com

wheat bran and noug seed cake nutritional value is an attractive possibility for use in sheep diets, mainly for its availability year round and its quality [4].

Gumuz sheep has so far not been studied with regard to its response to different supplementation that may enhance its productivity. Though, a number of research works were under taken to evaluate the effect of different supplements on the performance of different sheep types in Ethiopia, only few researches [5] were conducted to study the effect of noug seed cake and wheat bran mixtures in sheep feeding.

In some research works conducted so far the maximum level of concentrate mixtures were limited at 350 g/head/day and also the proportions were restricted at 67NSC:33WB, 33NSC:67WB, 70NSC:30WB and 30NSC:70WB. The crude protein obtained from these levels and proportions does not meet the protein required for the growing lambs. According to ARC (1980) [6] the CP levels for growing lambs weighing from 10 to 20 kg is estimated to be from 127 to 167 gm CP/kg DM. This alarms to increase the level of concentrate and increase the part of noug seed cake in a proportion since the CP content in the noug seed cake is much higher than the CP in the wheat bran. Moreover, no attempts were made to study high level of noug seed cake and wheat bran concentrate mixtures with greater proportion options that can give high level of CP. Thus, the study was designed to come up with greater level and with 50NSC:50WB, 67NSC:33WB and 75NSC:25WB proportions to Gumuz sheep fed natural grass hay basal diet. The current study was, therefore, conducted to evaluate feed intake, live weight change and carcass characteristics of Gumuz sheep fed on natural grass hay basal diet and supplemented with different proportions of NSC and WB mixtures, to determine biologically optimum proportions of inclusion of wheat bran and noug seed cake and to estimate profitability of the feeding regimes through partial budget analysis.

2. Materials and methods

Description of the study area

The study was conducted at Gendawiha Gumuz sheep improvement station which is located between 12º 46'45.26'' N latitude and 36º24' 20.68'' E longitude, at an elevation of 745.4 m. a. sl. Mean annual rainfall ranges from about 850 to around 1100 mm, and it receives a unimodal rainfall. The mean minimum and maximum temperature of the area ranges from 19ºC up to 35ºC.

Experimental animals and their management

Twenty four growing Gumuz ram lambs having approximately six months old and with the mean body weight of 19.05±2.29 kg (mean±SD) were purchased. The animals were vaccinated against Sheep pox, Anthrax and Ovine pasteurellosis and treated against endo and ecto- parasites. Following the quarantine period, the sheep were weighed and blocked based on their initial weight into 6 blocks and each animal within each block were randomly assigned to one of the four dietary treatments. The concentrate mixtures were offered dividing in two equal portions at 8 a.m. and 4 p.m hours according to the treatment. Basal feed offered were adjusted every third day.

Experimental design and treatments

The experiment was conducted in a randomized complete block design with six replications. The dietary treatments were: natural pasture hay alone ad libitum (T1), natural pasture hay ad libitum+400 g/d (1NSC:1WB) (T2), natural pasture hay ad libitum+400 g/d (2NSC:1WB) (T3) and natural pasture hay ad libitum+400 g/d (3NSC:1WB) (T4) on DM basis.

Feed intake, body weight gain and feed conversion efficiency

The feeding trial was lasted for 90 days. For each sheep, the amounts of feed offered and refused were recorded daily and their difference is considered as daily feed intake. Body weights were taken every ten days after overnight fasting and average daily gain (ADG) was determined by regressing body weight (BW) of each animal on days of feeding. Feed conversion efficiency (FCE) was calculated as a proportion of ADG to daily feed dry matter DM intake.

Carcass parameters

At the end of the growth trial, all experimental sheep were fasted overnight, weighed and slaughtered for determination of carcass characteristics. Slaughter weight (SW) was taken immediately before the animals killed. The empty

body weight (EBW) was calculated as the difference between slaughter weight (SW) and gut content. Dressing percentage (DP) was calculated as proportion of HCW to SW. Both the right and left halves were cut between the 11th and 12th ribs perpendicular to the backbone to measure the cross- section of rib- eye area (REA) and fat thickness. The REA was measured by using mechanical polar planimeter.

Cost- benefit analysis

Cost of all variable inputs, buying and selling prices of lambs including labour cost for chopping hay were recorded to determine the net income of production. Initial price of lambs was directly taken as the purchasing price. At the end of the experiment, three experienced lamb dealers were estimated the selling price of each experimental sheep before slaughtering. Monetary values of all other variable inputs were considered at the prevailing market price.

Statistical analysis

Data from feed intake, body weight change, feed conversion efficiency and carcass parameters were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS, (2003) [7]. When the difference is significant, Tukey HSD (Tukey honestly significant difference) test was used to locate differences between the treatment means. The statistical model used for data analysis was:

$Y_{ij}=\mu+t_i+b_j+e_{ij}$,

where Y_{ij}=the observation in j^{th} block and i^{th} treatment,

μ=the overall mean

t_i=the i^{th} treatment effect

bj=the j^{th} block effect

e_{ij}=the random error.

3. Results and discussion

Dry matter and nutrient intake

The mean daily DM intake of experimental sheep is presented in Table 1. The mean daily DM intake of hay was significantly higher ($p<0.001$) in non-supplemented sheep than supplemented ones. The higher intake of hay in the control treatment might be due to the deficiency of nutrients in the hay used and the animals in the control group thrive to satisfy their nutrient requirement by increasing hay intake. The higher the composition of the NDF and ADF in feedstuffs, the lower the nutritive value of the feed and animals increase intake as far as gut fill limit further intake to satisfy their nutrient requirement [8]. The total daily DM intake was significantly ($P<0.01$) higher for supplemented sheep than for un-supplemented groups. The increased total DM intake in the present study agreed with the results of Tesfaye and Solomon (2008) [9] that reported increasing levels of concentrate supplement resulted in higher daily total DM intake by Afar rams.

Similarly, significant differences ($P<0.01$) were observed among treatments in daily dry matter intake per unit metabolic body weight (g/kg $W^{0.75}$) and total DM intake as percent of body weight. The higher proportion of Nouge seed cake substantially improved intake. And it is also in the range of reported values of Tadele et al., (2014) [10]; FAO, (2010) [11] who reported total DM intake of sheep being within the range of 58.6–82.2 g DM kg−1 W0.75. The difference in daily dry matter intake per unit metabolic body weight (g/kg W0.75) observed may be due to variations in body weight gain and efficiency of feed utilization of the experimental sheep.

Table 1. Mean daily dry matter intake of Gumuz sheep

Parameters	Treatments (mean±SE)				SL
	T1	T2	T3	T4	
Dry matter intake					
Hay DM intake (g/day)	672.6±18.3^{a}	312.5±5.9^{b}	324.9±5.2^{b}	321.6±7.6^{b}	***
Supplement DM intake (g/day)	0.00^{b}	400.00^{a}	400.00^{a}	400.00^{a}	***
Total DM intake (g/day)	672.6±18.3^{b}	712.5±5.9^{ab}	724.9±5.2^{a}	721.6±7.6^{a}	**
DM intake (% BW)	3.62±0.3^{a}	3.1±0.1^{ab}	3.0±0.2^{ab}	2.7±0.1^{b}	**
DMI (per kg $W^{0.75}$) (g/day)	74.9±4.5^{a}	67.5±2.1^{ab}	66.2±.2^{ab}	61.2±1.6^{b}	**

*a, b=means within rows having different superscript letters are significantly different at ***=p<0.001; **=p<0.01; BW=body weight; DM=dry matter; DMI=dry matter intake; SE=standard error; SL=significance level; T1=Grass hay alone (control); T2=Grass hay+400 g (50% NSC: 50% WB); T3=Grass hay+400 g (67% NSC: 33% WB); T4=Grass hay+400 g (75% NSC: 25% WB).

Figure 1 show the changes in total daily dry matter intake with time. The trend is almost similar except for the control treatment (T1) that did not show regularity in daily intake throughout the experimental period.

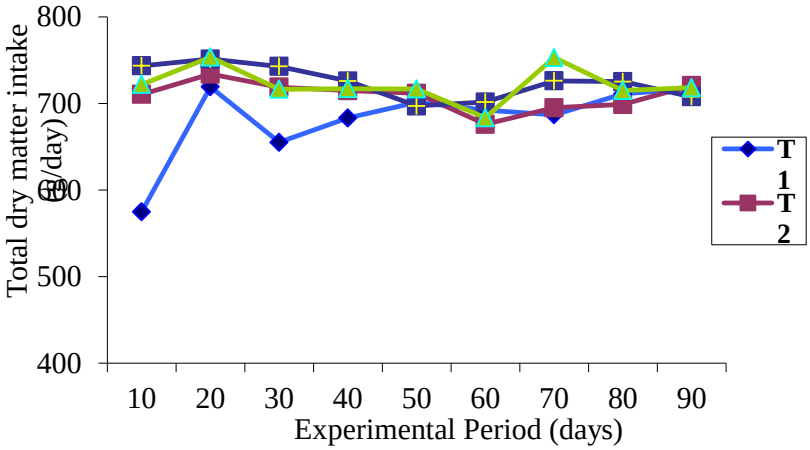

Figure 1. Daily dry matter intake of Gumuz sheep

Body weight change and feed conversion efficiency

The body weight (BW) parameters of the experimental sheep are presented in Table 2.

The supplemented treatments had significantly higher ($p<0.001$) final body weight than the control treatment. With regard to final body weight there were also highly significant ($p<0.001$) difference among the supplemented sheep. The higher ($p<0.001$) average daily BW gain was recorded for sheep in T2, T3 and T4 as compared to non- supplemented. Among the supplemented sheep, sheep in T3 and T4 had significantly higher ($p<0.001$) mean daily BW gain than sheep in T2. Different proportions of NSC to WB mixture supplementation resulted in differences in mean daily BW gain. This indicates the importance of manipulating the ratio of these ingredients for a better animal performance. The current finding revealed that as CP content increased the average daily body weight gain also increased which is in agreement with the results of Berhan and Asnakew (2015) [12], Getahun (2014) [13], Dawit and Solomon (2008) [14] and Hirut et al. (2011) [15], who reported concentrate supplementation improved daily weight gain.

Table 2. Mean initial, daily and final body weight of Gumuz Sheep.

Parameters	Treatments (mean±SE)				SL
	T1	T2	T3	T4	
Initial BW (kg)	19.27±1.1	19.37±1.1	19.15±1.1	19.18±1.0	ns
Final BW (kg)	19.30±1.7^{c}	23.13±1.1^{bc}	24.73±1.6^{ab}	26.98±1.0^{a}	***
ADG (g/d)	0.37±8.6^{c}	44.26±5.7^{b}	62.04±11.7^{ab}	86.67±8.3^{a}	***
FCE	-0.00±0.01^{b}	0.06±0.01^{a}	0.09±0.02^{a}	0.12±0.01^{a}	***

*a, b, c, Means within the same row not bearing a common superscript letters differ significantly at ***=$p<0.001$; ns=not significant at ($p>0.05$); ADG=average daily body weight gain; BW=body weight; FCE: feed conversion efficiency; SE=standard error; SL=significant level; T1=Control (Natural grass hay only); T2=Natural grass hay+400g Supplement (50%NSC: 50% WB); T3=Natural grass hay+400g Supplement (67% NSC: 33% WB); T4=Natural grass hay+400g Supplement (75% NSC: 25% WB).

Weight loss was not observed in the control treatment animals in the current study might be attributed to the quality of basal diet hay, which had better CP content and OM consequently resulted in relatively better digestibility values, which in turn maintained body weight of sheep throughout the experimental period. Feed conversion efficiency (FCE) was significantly improved ($p<0.001$) in supplemented lambs than the control. Despite the higher gains and higher DM intake of supplemented lambs, there was no significant ($p>0.001$) difference in FCE among

supplemented groups. The observed higher FCE in the supplemented groups may be due to the higher CP and energy contents of supplement mixture feeds in providing absorbed nutrients and/or by enhancing the basal diet nutrient utilization. The current result was comparable to the FCE recorded in Wogera sheep fed natural pasture hay and supplemented with graded levels of brewery dried grain (Mulu et al., 2008) [16]. Therefore, supplementation improved feed conversion efficiency due to enhanced daily body weight gain.

The overall trends of bodyweight changes across the feeding trial periods are presented in Figure 2. The linearly increase body weight change graph in the control treatment also indicated the fact that natural grass hay alone has only a potential to maintain the body weight of lambs.

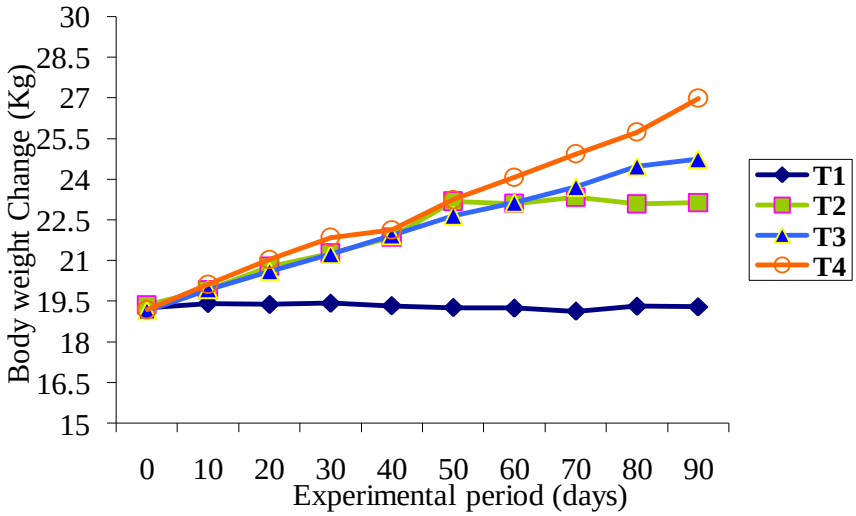

Figure 2. Body weight change over time of Gumuz sheep

Carcass Parameters

The mean values of carcass characteristics of Gumuz sheep in the current experiment are given in Table 3. The slaughter body weight (SW), empty body weight (EBW), hot carcass weight (HCW), dressing percentage as a proportion of SW, fat thickness and rib- eye muscle area were better (P<0.001) for supplemented treatments than the control treatment.

The higher EBW in the supplemented sheep might be due to the lower proportion of gut content and BW increase than the control sheep (Jadish, 2004) [17], since EBW is the difference between SW and gut content.

Table 3. Dressing percentage and carcass characteristics of Gumuz ram lambs

Carcass parameters	Treatments (mean±SE)				SL
	T1	T2	T3	T4	
No. of animals slaughtered	6	6	6	6	
Slaughter BW (kg)	18.42±1.6^{b}	22.85±1.1^{a}	24.13±1.5^{a}	26.23±1.0^{a}	***
Empty BW (kg)	13.62±1.2^{c}	18.18±0.8^{b}	19.73±1.3^{ab}	21.57±0.8^{a}	***
Hot carcass weight (kg)	6.25±0.5^{c}	9.15±0.4^{b}	10.35±0.7^{ab}	11.60±0.4^{a}	***
Dressing percentage (%)					
Slaughter BW base	33.87±0.1^{d}	40.05±0.04^{c}	42.67±0.08^{b}	44.22±0.05^{a}	***
Fat thickness (mm)	1.00±0.4^{c}	4.08±1.0^{b}	4.42±0.9^{b}	6.75±0.6^{a}	***
Rib-eye muscle area (cm^{2})	4.71±0.3^{b}	6.37±0.8^{b}	9.39±0.8^{a}	10.12±0.9^{a}	***

*a, b, c, d Means within the same row not bearing a common superscript letters differ significantly at ***=P<0.001; BW=body weight; SE=standard error; SL=significant level; T1=Control (Natural grass hay only); T2=Natural grass hay+400g Supplement (50%NSC: 50% WB); T3=Natural grass hay+400g Supplement (67% NSC: 33% WB); T4=Natural grass hay+400g Supplement (75% NSC: 25% WB).

The dressing percentage of the current study is still slightly higher than the average dressing percentages (ADP) of tropical sheep (40-50%) reported by (William et al., 2003) [18]. There was no significant ($p>0.001$) difference in SW among the supplemented sheep groups whereas, T3 and T4 performed better ($p<0.001$) in EBW and HCW than T2.

Fat Thickness and rib- eye muscle area were significantly ($p<0.001$) higher for supplemented groups as compared to the non- supplemented lambs. T4 had significantly ($p<0.001$) greater fat thickness among the supplemented treatments. Rib- eye muscle area in T3 and T4 was significantly ($p<0.001$) higher than in T2 and T1.

Partial budget analysis

The result of partial budget analysis was shown in Table 4. The result of partial budget analysis revealed that supplement with high proportion of NSC resulted in higher profit margin than supplements with low proportions of NSC.

Negative net return observed in the control treatment may be associated with unimproved body weight of sheep during the experimental period, the relatively rough hair coat and unattractive general physical appearance of animals in the control group than the supplemented sheep as a result of lower nutrient intake. Comparing with T3 and T4, sheep in T2 relatively gained lower BW as a result of lower nutrient (CP) intake that consequently resulted in lower net return. Generally, sheep which had a better CP intake had superior ADG as a result of this, had a higher sale price to earn higher net return. This result has been supported by Tekliye et al. (2018) [19], who reported the importance of supplementation in sheep for profitability of Washera sheep in Ethiopia. This result has been supported with finding of Estefanos et al. (2014) [20], who reported that supplementation enhance the economics of sheep farming. The marginal rate of return for supplemented sheep in T2, T3 and T4 was 2.22, 3.96 and 4.96 ETB, respectively. This indicates that to attain required BW by supplement feeding, each additional unit of 1 ETB increment per sheep to purchase supplement feed resulted in a profit of 2.22 ETB for T2, 3.96 ETB for T3 and 4.96 ETB for T4, respectively.

Table 4. Partial budget analysis

Variables	Treatment			
	T1	T2	T3	T4
Number of animals	6	6	6	6
Purchase price of sheep (ETB/head)	632.00	632.00	632.00	632.00
Total feed consumed (kg/ head)	60.53	64.13	65.24	64.95
Total basal diet consumed (kg/ head)	60.53	28.13	29.24	28.95
Total supplement consumed (kg/ head)	0	36	36	36
Cost of basal diet (hay) (ETB/head)	48.42	22.50	23.39	23.16
Cost of supplement (ETB/head)	0	130.93	129.26	128.47
Total feed cost (ETB/head)	48.42	153.43	152.65	151.63
Additional labor cost for hay chopping (ETB)	42.37	19.69	20.47	20.26
Total variable cost (ETB)	90.79	173.12	173.12	171.89
Gross income (ETB)	608.33	873.33	1016.67	1091.67
Total return (ETB)	-23.67	241.33	384.67	459.67
Net return (ETB)	-114.46	68.21	211.55	287.78
ΔTVC	-	82.33	82.33	81.10
ΔNI	-	182.67	326.01	402.24
MRR (ratio)	-	2.22	3.96	4.96

*ETB=Ethiopian Birr; ΔNI=change in net income; ΔTVC=change in total variable cost; MRR=marginal rate of revenue; T1=Grass hay alone (control); T2=Grass hay+400 g (50% NSC:50% WB); T3=Grass hay+400 g (67% NSC:33% WB); T4=Grass hay+400 g (75% NSC: 25% WB).

4. Conclusions

Generally, the present study indicated that supplementation of growing Gumuz ram lambs with concentrate mixtures of noug seed cake and wheat bran at different proportions had improved feed intake, body weight change and carcass parameters. Moreover, it was concluded that supplementation of hay with 400 g/day mixtures of noug seed cake and wheat bran at 75:25 proportion is biologically efficient and potentially profitable in feeding of growing Gumuz sheep compared to other proportions of supplements and could be recommended. In order to guarantee the importance of the supplementation at producers' level, undertaking on- farm demonstration using the recommended treatment (T4) used in the present study is worthwhile.

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