Comparative Evaluation of Lowland Sheep Breeds under Graded Level Supplement Feeds, Ethiopia

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Abstract

Performance of three sheep breeds in the lowland areas of western Amhara, the *Gumuz, Rutana* and *Begiet* were evaluated using three levels of concentrate (400, 500 and 600 g head^{-1} day^{-1}) having same Noug seed cake:Wheat bran ratio (75:25) under feedlot condition. The roughage was native grass hay which was offered *adlibitum*. Thirty two eight to nine old intact male sheep (12 breed^{-1}) were randomly allotted to the dietary treatments, fed for 90 days and slaughtered at an age of approximately 12 months. Breed and diet (concentrate level) significantly affected average daily gain (ADG). *Gumuz* and *Rutana* sheep breeds achieved higher average daily gain (ADG) than *Begiet*. Sheep fed on concentrate L2 (500 g head^{-1} day^{-1}) recorded significantly higher ADG than sheep fed on L1 and L3. As a result of better slaughter weight (SW) achieved higher hot carcass weight (HCW) was recorded by *Gumuz* and *Begiet* sheep breeds. Because of greater difference in proportion of non-carcass components and better HCW achieved relative to slaughter body weight, better dressing percentage (DP) was achieved by *Gumuz*. Breed and concentrate level did not improve main carcass components, edible and non- edible offal. Meat quality attributes were not influenced by breed. Among the concentrate levels L2 was optimum to improve major meat quality attributes like juiciness, flavor and over all acceptance. Sheep supplemented with concentrate L2 had the highest net return (855.06 ETB and highest MRR (14.12) compared to the other concentrate levels. Compared to other lowland breed *Gumuz* and *Rutana* sheep breeds recorded highest net return (733.42 and 531.67 ETB) and highest MRR (10.25 and 11.42 ETB), respectively. Thus, it is recommended that use of adaptive sheep breeds (*Gumuz* and *Rutana*) to that specific environment and use of concentrate level two (L2) are biologically efficient and potentially profitable in the feeding of growing lowland sheep to the area and other similar areas.

Keywords: Begiet, concentrate level, Gumuz, Rutana, sheep breed.

1. Introduction

Although there exist 29.33 million sheep population in Ethiopia CSA (2020) [1] the production and productivity is very low. The low performance of local sheep in terms of live weight (LW) gain and carcass yield is mainly due to inadequate nutrition associated with reliance on sole natural pasture, crop residues and/or stubble grazing, which are inherently low in nutrients available being subjected to great seasonal variations (Solomon et al., 2008a) [2]. 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. The present export market (to the Middle East countries) for Ethiopian live sheep and mutton is demanding animals of low land origin, weighing between 25 and 30 kg at yearling age. However, most local lambs slaughtered at this age weigh 18 to 20 kg (IAR, 1991) [3]. Thus, lack of consistent supply of the required animals at younger age has remained a major challenge for mutton and live sheep exporters.

Growth of animals at early age has strong impact on mature body weight and age at which it is

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achieved. Slow growth rate and exposure to a cycle of weight gain and loss due to fluctuations in annual cycle of feed supply is the main reason for sheep to reach higher body weight at an older age.
Thus, proper nutrition at younger age is a requirement to allow continuous growth of animals and prepare them for the finishing phase in order to achieve better growth rate and acceptable slaughter and carcass weight (McDonald et al., 2002) [4].
The major sheep breeds in North Western lowland areas of Amhara region are *Gumuz*, *Rutana and Begiet*. There is a high preference for *Gumuz*, *Rutana* and *Begiet* sheep breeds due to their adaptation to harsh environment, prolificacy, large frame and fast growth especially during the early growth stage. The preferences of these breeds may have been due to the breeds' lowland background, adaptation of the buyers to the conformation of the animals and the taste of the meat (Asfaw et al., 2011) [5]. Though there exist very large sheep population with a special merit, very few efforts were made so far in improving the production and productivity of the sheep breeds in the area. Nevertheless, available information on body weight gain and carcass yield most lowland breeds like *Gumuz*, *Rutana* and *Begiet* sheep in response to different regimes of feeding is scanty.
Some earlier study Alemu et al. (2018) [6] demonstrated that supplementation of *Gumuz* sheep with agro industrial by- products improved daily body weight gain, dressing percentage and hot carcass weight. Though, the study conducted so far generated some information, it did not produce concrete information with regard to the maximum level of concentrate required and to how the manipulation of the feeding regimes of *Gumuz* sheep will improve feed utilization and body weight gain to achieve desired carcass weight that is attractive for the export market. Information on the growth performance, carcass characteristics and sensory attributes of meat from different sheep breeds especially *Gumuz*, *Rutana* and *Begiet* when supplemented with different levels of concentrate is scarce. Therefore, the present study was designed to study the effects of genotype and different levels of concentrate supplementation on growth, carcass characteristics and meat quality of three sheep types in the low land areas of North Western Amhara.

2. Materials and methods

Description of the study area

The study was conducted at the Gende wuha Gumuz sheep open nucleus breeding scheme station which is found in West Gondar Zone of the Amhara National Regional State (ANRS), Ethiopia. The area is located between 12º 46'45.26'' N and 36º 24' 20.68''E, and at about 906 km North West of Addis Ababa and at about 158 km west of Gondar Town. The agro-ecological map of the area ILRI (2005) [7] reveals that it lies under moist kola agro-ecological zone (AEZ). The altitude of Gende wuha is about 745.4 m.a.sl. Mean annual rainfall of Gende wuha ranges from about 850 to around 1100 mm, and it receives a uni-modal rainfall [7]. The minimum annual temperature ranges between 22ºC and 28ºC. The daily maximum temperature becomes very high during the months of March to May, during which the temperature can reach as high as 43ºC. The mean annual temperature is about 31ºC [7].

Feed preparation and feeding management

Locally available mixed sward hay from Genede wuha Gumuz sheep open nucleus breeding scheme experimental station was properly harvested and used as a basal diet. Basal diet was manually chopped to the size of about 1-5 cm, thoroughly mixed and stored under shade to maintain its quality. Required amount of Noug seed cake and Wheat bran was purchased from oil extracting and milling industries and stored properly. Concentrate mix was prepared by mixing Noug seed cake and Wheat bran based on their DM content in order to maintain at least 26% CP from the two ingredients. The hay was offered *adlibitum*. The basal diet intake was adjusted every third day, whereas the daily concentrate supplements were limited to the respective treatment level in g DM day^{-1}. Water was available to the experimental animals all the time during the experiment, while supplements were offered twice a day in two equal portions at 0800 and 1600 hrs.

Experimental animals and their management

A total of 36 sheep of three genotypes; *Gumuz*, *Rutana* and *Begiet* were used for the study. Age of the animals was eight to nine months of age and the age of animals was determined directly by asking information from the owners. The lambs were ear tagged and quarantined for 21 days to get them adapted to the environment and to check their health condition. The sheep were dewormed, sprayed and vaccinated against known parasites and diseases during the quarantine period. The animals were kept under shed in individual pens of 1.2×0.8 m dimension with access to clean water and fed the experimental diet for 90 days. Experimental sheep were weighed within ten days interval in the morning before watering and feeding during the feeding trial.

Experimental design and treatments

The experiment was arranged in a completely randomized block design (RCBD) with 3x3 factorial arrangements (three genotypes and three concentrate levels). Animals within genotype were blocked according to their initial body weight and randomly assigned to one of concentrate level each consisting four animals. The three concentrate levels were 400, 500 and 600g $head^{-1}$ day^{-1}. Hay was fed *ad libitum* at 20% refusal rate. The concentrate was comprised of 74% Noug seed cake, 25% Wheat bran and 1% salt on DM basis. The concentrate was formulated at least to contain CP and energy to meet the recommendation for intensive feeding (i.e. 18% CP and 9 MJ ME/kg DM) (Flint, 2005) [8].

Feed intake and body weight measurements

Daily weights of concentrate and hay offered and refused were recorded to derive daily feed intake. All animals were weighed every 10 days before morning feeding. The initial weight (IW) and final weight (FW) were recorded twice for two consecutive days and the average was taken as a net gain. Average daily gain (ADG) was calculated as the difference between final body weight and initial body weight of the sheep divided by the number of feeding days. Total gain (TG) was calculated as the difference between final and initial weights. Feed conversion efficiency (FCE) which is the measure of feed utilization and was calculated as unit of body weight gain per unit of feed consumed.

Slaughtering procedures, carcass characteristics and meat quality

At the end of the growth trial, all experimental sheep from each feeding treatment were fasted for 12 hours overnight with free access to water (PRIMEFACT 340., 2007) [9]. The next morning, slaughter body weight (SBW) was taken immediately before the animals killed and all sheep were slaughtered to determine carcass characteristics. After flaying, weight of offal's like head, skin and feet, heart, lungs and trachea, liver with gall bladder, spleen, testis, penis, kidneys, visceral fat, reticulo-rumen, omaso-abomasum, small and large intestine were recorded.

The alimentary tracts were weighed full, and then the contents were emptied and reweighed to determine the weight of the contents by difference. Empty body weight (EBW) was calculated as slaughter weight less gut content. Hot carcass weight (HCW) was recorded immediately after slaughter and computed by excluding contents of thoracic, abdominal and pelvic cavities, head, and skin with fetlock. Dressing percentage (DP) was computed as proportion of hot carcass weight to slaughter weight (Glimour et al., 1994) [10].

The rib-eye muscle area (REA) of each animal was determined by tracing the cross sectional area of the 11^{th} and 12^{th} ribs after cutting perpendicular to the back bone rib eye area based on the recommendation of (Torell and Suveely, 2004) [11]. The left and right rib-eye muscle area was traced on a transparent water proof paper and the area was measured by using $1cm^2$ grid square having 5 by 5 dots within a grid. Fat thickness was measured at the middle upper part of rib eye area by using a graduated ruler having a sensitivity of 1 mm.

Sensory evaluation

Fresh samples of meat from each treatment from loin, ribs and leg were taken and thawed for 4 hours, cut into chops of an average of 40g and labeled for identification. Meat cubs from each cut were cooked in water at a temperature of 80°C for 60 minutes in a circulating water bath using a gas cooker as described by Fasae et al. (2010) [12]. Nine consumer panelists were used to evaluate sensory parameters of meat cuts and soup in a balanced design. They were instructed to chew on a sample and drink soup from each treatment and score it for tenderness, juiciness, flavor, connective tissue amount and overall acceptability. The panelists were score each sample on a five–point hedonic scale (Tenderness, 5=extremely tender, 1=very tough; Juiciness, 5=extremely juicy, 1=very dry; Flavor, 5=extremely intense, 1=bland; connective tissue amount, 5=none, 1=moderately abundant; Overall acceptability, 5=excellent, 1=poor) (Iwe, 2002) [13]. Panelists were eating a bit of bread and drink still water at the beginning and between samples try to make the palate conditions similar and to reduce flavor carryovers**.**

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.

According to Upton (1979) [14] procedure net income (NI) was obtained as the amount of money left when total variable costs (TVC) subtracted from the total returns (TR) of the purchasing and selling price of sheep in each treatment before and after the experiment carried on.

NI=TR-TVC

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

Δ NI=Δ TR-Δ TVC

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

MRR=Δ NI/Δ TVC

Data analysis

Statistical analysis was performed to determine the effect of genotype, supplement level and the interaction between genotype and supplement level. The data collected on feed intake, body weight change, feed conversion efficiency, carcass parameters and sensory attributes of meat was subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2003) [15] according to a 3×3 factorial arrangement with breed and diet as main effects in Randomized Complete Block Design. When the difference is significant ($p<0.05$), Tukey HSD (Tukey honestly significant difference) test was used to locate differences between the treatment means.

The statistical model was:

Yijkl=μ+Bi+Gj+Fk+(G×F) jk+E*ijkl*

where:

- Yijkl=the response variable
- μ=overall mean
- Bi=effect of block
- Gj=effect of genotype
- Fk=effect of feeding level
- (G×F) jk=interaction between genotype and feeding level
- Eijkl=random error.

3. Results and discussion

Dry matter intake

Mean daily dry matter intake (DMI) of sheep breeds (*Gumuz*, *Rutana* and *Begiet*) fed diet containing hay basal diet and supplemented with different levels of concentrate is presented in Table 1. The daily hay, supplement and total dry matter intake of different sheep breeds was not significant ($p>0.05$). This is due to the sheep breeds used are the same origin, their weight is relatively the same and animals are expected to feed on their body weight bases. Significant ($p<0.01$) difference was observed among sheep breeds used in total dry matter intake as percent of body weight. *Rutana* sheep breed recorded significantly ($p<0.01$) higher total dry matter intake as percent of body weight compared to other breeds as a result of its relative lower body weight. For indigenous *Gumuz* yearling sheep, DM intake in the range of 2.7-3.62% body weight was reported by Alemu et al. (2018) [6] when they were supplemented with different levels of concentrate, which is by far lower than the result we obtained. This is due to the differences in the amount of total dry matter intake achieved at different times. Daily total dry matter intake per unit metabolic body weight (g/kg $W^{0.75}$) was not significant ($p>0.05$) among sheep breeds.

Total daily dry matter intake of different sheep breeds supplemented with concentrate L2 and L3 was significantly ($p<0.001$) higher than sheep supplemented with L1 (Table 1). This was probably due to the addition of extra CP as a result of concentrate level increase that can stimulate efficient rumen fermentation, more passage rate and intake, which increased the basal diet intake and resulted in better total DMI [4]. Feed intake can be maximized if the feed provides all the nutrients required by appropriate rumen microbes and by the tissue of the animal.

The total DM intake as percent of body weight in the current study was significantly ($p<0.01$) different among concentrate levels. Concentrate L3 recorded significantly ($p<0.01$) higher total DM intake as percent of body weight than other levels.

Table 1. Mean daily dry matter intake of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Parameters	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B* C
Dry matter intake									
Hay DM intake (g/day)	563.55	564.95	565.82	591.19^{a}	582.17^{a}	520.97^{b}	0.9936	0.0033	0.5718
Supplement DM intake (g/day)	500.00	500.00	500.00	400.00^{c}	500.00^{b}	600.00^{a}	-	0.0000	-
Total DM intake (g/day)	1063.50	1065.00	1065.80	991.20^{b}	1082.20^{a}	1121.00^{a}	0.9934	0.0000	0.5718
DM intake (% BW)	4.31^{b}	4.63^{a}	4.19^{b}	4.22^{b}	4.24^{b}	4.68^{a}	0.0093	0.0029	0.7733
DMI (per kg $W^{0.75}$) (g/day)	36.12	37.17	61.09	43.71	44.75	45.92	0.0624	0.9810	0.7421

*a, b, c=means within rows having different superscript letters are significantly different; BW=body weight; DM=dry matter; DMI=dry matter intake; P=probability; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Concentrate L3 recorded significantly ($p<0.01$) higher total DM intake as percent of body weight than other levels. This could be due to relative lower body weight of sheep compared to daily total dry matter intake. Supplementary concentrate level markedly affect total DM intake per live body weight (Tadesse et al., 2003) [16]. Daily total dry matter intake per unit metabolic body weight (g/kg $W^{0.75}$) was not significant ($p>0.05$) among sheep fed different concentrate levels.

Body weight change and feed conversion efficiency

The body weight (BW) parameters of different sheep breeds and sheep in different concentrate levels are presented in Table 2.

Table 2. Mean initial, daily and final body weight of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Parameters	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B* C
Initial BW (kg)	20.02	18.33	22.53	20.06	20.46	20.35	0.0561	0.8805	0.2321
Final BW (kg)	24.78^{ab}	23.40^{b}	25.83^{a}	23.81^{b}	25.82^{a}	24.38^{ab}	0.0438	0.0345	0.7764
Net gain (kg)	4.76^{a}	5.07^{a}	3.30^{b}	3.75^{b}	5.36^{a}	4.03^{b}	0.0170	0.0316	0.5397
ADG (g/d)	95.17^{a}	101.50^{a}	66.00^{b}	75.00^{b}	107.17^{a}	80.50^{b}	0.0170	0.0316	0.5397
FCE	0.09^{a}	0.10^{a}	0.06^{b}	0.08^{ab}	0.10^{a}	0.07^{b}	0.0169	0.0415	0.6038

*a, b=Means within the same row not bearing a common superscript letters differ significantly; ADG=average daily body weight gain; BW=body weight; FCE: feed conversion efficiency; P= probability; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Final body weight was significantly ($p<0.05$) affected by breed and concentrate level. Associated with its highest initial body weight relatively highest final body weight was achieved by *Begiet* sheep breed. Among the concentrate levels sheep fed on L2 and L3 had significantly higher ($p<0.05$) final body weight than sheep consumed L1. This might be due to the BW gain tended to increase for the higher CP intakes as a result of increasing in concentrate level. Mulu et al. (2008) [17] noted that supplementation with high levels of protein source supplements resulted in higher final body weight (BW) than the low level of supplementation. Different sheep breeds and sheep fed on different concentrate levels significantly ($p<0.05$) affect average daily gain (ADG). *Gumuz* and *Rutana* sheep breeds achieved 1.46 and 1.77 kg extra body weight compared to Begiet by growing at an average of 29.17 and 35.5 g greater rate per day, respectively. The observed body weight gain variation between breeds could be attributed to their adaptation difference to different environment. Sheep fed on L2 recorded significantly ($p<0.05$) higher ADG than sheep fed on L1 and L3. The results of average daily body weight gain of sheep supplemented with different levels of this study were higher than those reported by Alemu et al. (2018) [6] and Fentie and

Solomon (2008) [18] which were in the range of 44.26-86.67 and 70.11-82.44 g day^{-1} for *Gumuz* sheep fed a basal diet grass hay and supplemented with 400g day^{-1} head^{-1} of Noug seed cake and Wheat bran at different proportions and for Farta sheep fed a basal diet of natural grass hay when supplemented with 300g day^{-1} head^{-1} with Noug seed cake, Wheat bran and their mixtures, respectively. This could be due to the differences in breed, concentrate level and ratio, environment and age of animals used at different times.

Feed conversion efficiency (FCE) was significant ($p<0.05$) between different sheep breeds. *Rutana* sheep breed recoded better FCE than *Gumuz* and *Begiet*. This is due to better daily body weight gain achieved than feed consumed as a result of genetic difference. Significant ($p<0.05$) difference was observed in FCE between sheep fed on different concentrate levels. The observed higher FCE in L2 may be due to higher daily body weight gain achieved than feed consumed. The current result was comparable to the FCE recorded in *Gumuz* sheep fed natural pasture hay and supplemented with 400 g day^{-1} of concentrate with a proportion of 75% Noug seed cake: 25% Wheat bran [6]. The overall trends of body weight changes of the concentrate levels across the feeding trial periods are presented in Figure 1.

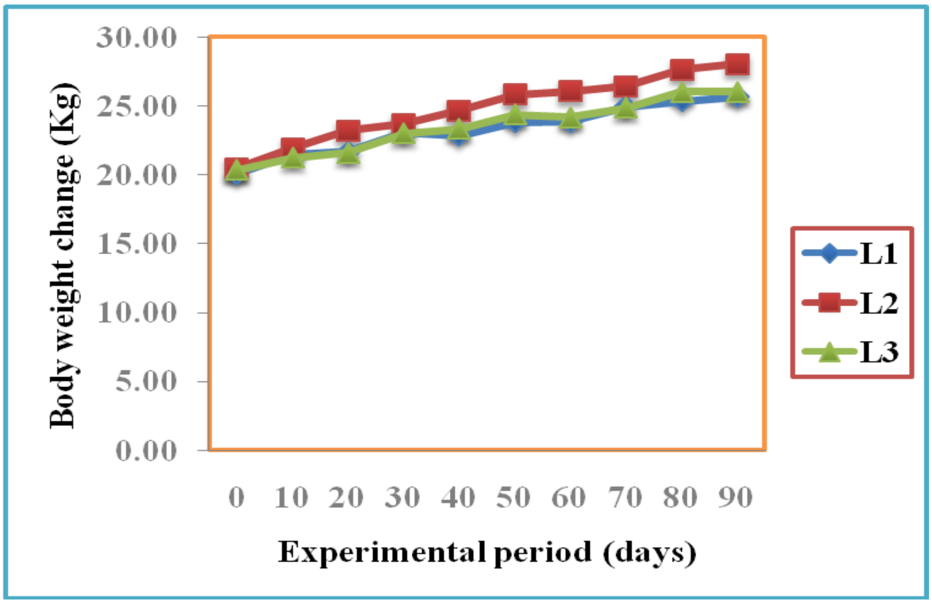

Figure 1. Body weight change over time of lowland shee breeds (*Gumuz, Rutana and Begiet*)

The exponential increase body weight change achieved in all concentrate levels with a slight over lying of L2 indicated the fact that animals assigned in each concentrate level received continual optimum nutrient required for production. Slight daily body weight gain achieved during the last ten days of experimental period was an indication of no further extending the feeding time to be effective.

Carcass parameters

The mean values of carcass characteristics of three sheep breeds (*Gumuz*, *Rutana* and *Begiet*) supplemented with different levels of concentrate in the current experiment are given in Table 3. Slaughter body weight (SW), empty body weight (EBW), hot carcass weight (HCW) and dressing percentage as a proportion of SW were significantly ($p<0.05$) affected by breed. *Begiet* breed had higher ($p<0.05$) SW and EBW than other breeds. The higher EBW achieved by this breed might be due to the lower proportion of gut content and BW increase, since EBW is the difference between SW and gut content (Jadish, 2004) [19]. As a result of better SW achieved by breeds significantly ($p<0.05$) higher HCW was recorded by *Gumuz* and *Begiet.* Dressing percentage (DP) of *Gumuz* sheep breed was significantly ($p<0.05$) higher than the rest of sheep breeds. The reason for variation in DP among genotypes in the present study was because of greater difference in proportion of non-carcass components such as gastro intestinal tract (GIT) and due to better HCW achieved relative to slaughter body weight. The dressing percentage of the current study result is within the range of the average dressing percentages (ADP) of tropical sheep (40-50%) reported by William et al. (2003) [20]. Fat thickness and rib-eye muscle area did not significantly (p>0.05) affected by genotype.

There was no any significant (p>0.05) difference observed in most of carcass parameters among sheep receiving different concentrate levels.

Table 3. Carcass characteristics of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Carcass parameters	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B*C
No. of animals slaughtered	9	9	9	9	9	9			
Slaughter BW (kg)	24.77[ab]	23.32[b]	25.24[a]	23.79	25.01	24.30	0.0416	0.6101	0.6448
Empty BW (kg)	20.24[b]	19.27[b]	22.01[a]	20.04	20.78	20.69	0.0101	0.6063	0.6347
Hot carcass weight (kg)	11.02[a]	9.76[b]	10.57[a]	10.29	11.23	10.89	0.0140	0.0899	0.5918
Dressing percentage (%)									
Slaughter BW base	44.48[a]	41.85[b]	41.88[b]	32.25	44.90	44.81	0.0192	0.0652	0.3518
Empty BW base	54.45[a]	50.65[b]	48.02[b]	51.35	54.04	52.63	0.0079	0.0831	0.2626
Fat thickness (mm)	5.67	7.61	5.39	7.28	5.83	5.56	0.3622	0.5445	0.5320
Rib-eye muscle area (cm^2)	13.45	10.89	12.01	11.4	12.67	12.23	0.0647	0.4467	0.2244

*a, b=Means within the same row not bearing a common superscript letters differ significantly; BW=body weight; P= probability; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB)

Main carcass components

Main carcass components did not significantly (p>0.05) affected by genotype and different concentrate level (Table 4).

Table 4. Main carcass components (gram) of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Main carcass components	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B*C
Fore-quarter	2032.13	1907.26	1883.72	1949.29	1770.90	2103.04	0.7355	0.2854	0.8461
Neck region	979.82	935.74	1034.15	972.00	1039.62	938.12	0.7482	0.7284	0.8280
Sternum (Brisket)	479.93	357.98	471.72	43.08	452.32	422.14	0.1575	0.9028	0.5574
Thoracic and lumbar region	812.93	709.76	834.23	781.26	809.22	775.34	0.2826	0.9050	0.5672
Rib-eye muscle	716.47	458.18	573.72	561.12	585.47	601.71	0.0851	0.9310	0.6718
Abdominal muscle	738.36	568.32	620.78	621.43	616.24	689.70	0.1043	0.5719	0.7092
Hind-quarter	2170.26	2002.82	1973.68	2107.32	1901.87	2137.48	0.5096	0.3803	0.1893
Pelvic (Rump) region	918.37	784.12	945.69	876.12	923.17	848.80	0.1919	0.7121	0.9602
Tail fat weight	262.03	167.98	221.82	194.11	217.98	240.62	0.1866	0.6444	0.8711
Ribs	916.67	786.75	912.88	877.41	895.29	842.80	0.2789	0.8361	0.4927
TMCC (Kg)	10.03	8.68	9.48	9.38	9.21	9.60	0.2445	0.8813	0.9435

*P=probability; TMCC=total main carcass components; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Edible offal components

Associated with the genetic difference among the edible offals the effect of genotype was significant (p<0.05) for testicle size and weight, while there was no any significant (p>0.05) difference exhibited in the rest of edible offals. Associated with physiologically early maturing of breeds significantly (p<0.05) higher testicle size and weight was recorded by *Gumuz* and Rutana (Table 5).

Non-edible offal components

Except gall bladder with bile most individual non-edible offals and total non-edible offals (kg) did not significantly (p>0.05) affected by genotype and different supplement levels. Significantly (p<0.05) higher gall bladder with bile was recorded by *Gumuz* and *Rutana* sheep breeds than *Begiet*. This could be due to the difference in environment they originated from and genetic difference (Table 6).

Table 5. Edible offal components (gram) of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Edible offals	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B*C
Blood	912.90	1041.90	1021.40	1091.20	927.80	957.39	0.2957	0.1576	0.7873
Heart	119.20	108.30	151.10	129.30	98.00	151.33	0.6076	0.4896	0.3995
Liver	431.60	394.80	403.00	436.20	408.91	384.26	0.6975	0.5259	0.7973
Kidney	86.30	91.40	88.40	89.30	90.22	86.78	0.5634	0.7386	0.3414
Tongue	253.60	105.00	169.90	136.10	114.67	277.81	0.4610	0.3407	0.7888
Reticulo-rumen	498.90	534.90	530.00	594.70	491.31	477.80	0.8493	0.2024	0.4847
Omaso-abomasum	279.00	318.00	279.70	272.10	378.76	243.92	0.8640	0.1648	0.8531
Hind gut	908.30	826.00	1167.80	856.30	926.72	1191.13	0.0870	0.2212	0.2869
Testicles	306.20^a	257.70^a	234.70^b	364.20	317.43	270.93	0.0137	0.1227	0.2095
Kidney fat	108.90	102.90	82.10	95.70	98.89	99.36	0.6359	0.9912	0.3324
Pelvic fat	27.80	45.40	35.80	38.10	24.33	46.62	0.2918	0.1485	0.1797
Pancreas (g)	33.33	33.20	31.70	30;00	36.26	32.56	0.9780	0.7751	0.9386
Omental & mesenteric fat (g)	209.80	114.70	153.30	182.80	150.38	143.72	0.1524	0.6738	0.9717
Total edible offals (kg)	3.89	3.72	4.11	3.95	3.75	3.95	0.4551	0.6574	0.6732
Total usable product (kg)	16.01	14.54	15.87	15.25	15.17	16.01	0.2768	0.6435	0.8915
Total usable product (%SW)	63.46	60.18	59.31	61.42	58.87	63.65	0.4225	0.5090	0.8335

*a, b=Means within the same row not bearing a common superscript letters differ significantly; P=probability; SW=slaughter weight; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Table 6. Non-edible offal components (gram) of three sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Non-edible offals	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B*C
Head without tongue (kg)	1258.40	1508.00	1167.10	1357.00	1516.10	1060.4	0.2509	0.1058	0.6797
Skin (kg)	2.10	2.14	2.28	1.92	2.21	2.39	0.6862	0.1218	0.7352
Penis (g)	195.80	70.70	207.70	94.20	183.1	196.80	0.3425	0.5518	0.1552
Feet (g)	744.60	740.00	575.70	684.70	764.60	611.00	0.1961	0.3412	0.7954
Lung with trachea (g)	436.90	402.10	371.30	430.70	387.90	398.80	0.2474	0.4691	0.5275
Spleen (g)	105.10	70.90	105.00	113.6	77.20	90.20	0.3489	0.3966	0.7991
Gall bladder with bile (g)	17.67^a	18.56^a	8.44^b	13.44	12.78	18.44	0.0131	0.2039	0.4768
Bladder (g)	62.90	57.00	33.30	60.78	45.44	47.00	0.2240	0.6281	0.5435
Total non-edible offals (kg)	5.28	5.37	4.98	5.04	5.51	5.08	0.6667	0.5085	0.8696
Gut content (kg)	3.03^a	2.57^b	1.9^c	2.65^a	2.76^a	2.09^b	0.000	0.005	0.0000

*a, b, c=Means within the same row not bearing a common superscript letters differ significantly; P=probability; SW=slaughter weight; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Meat sensory attributes

Sensory evaluation results of cooked meat of this experiment are presented in Table 7. Meat quality attributes were not significantly (p>0.05) influenced by breed. This might be due to the animals used for the experiment was with the same origin and they were managed in the same manner. Swan et al. (1998) [21] reported that breed did not affect flavor and juiciness of cooked goat Longissimus dorsal (LD) muscle. No significant (p>0.05) difference was observed between the concentrate levels with regard to meat tenderness and connective tissue amount in sheep meat. Juiciness, flavor and over all acceptance was significantly (p<0.05) higher in sheep fed concentrate L2 than sheep supplemented with L1 and L3. This could be due to higher total fat content achieved as a result of body weight improvement of animals as fat has positive relationship with juiciness and overall acceptability.

Partial budget analysis

The result of partial budget analysis was shown in Table 8. The result of partial budget analysis revealed that sheep fed on concentrate L2 and use of *Gumuz* and *Rutana* sheep breeds resulted in higher profit margin. Generally, sheep supplemented with optimum level of concentrate (L2) had a required CP intake and the use of adapted sheep breed (*Gumuz* and *Rutana*) had superior ADG as a result of this, had a higher sale price to earn higher net return. The marginal rate of return for concentrate L2 supplemented sheep was 14.12 ETB and for *Gumuz* and *Rutana* sheep breeds was 10.25 and 11.42 ETB, respectively. This indicates that to attain required BW by the use of required level of supplement feeding and by the use of adapted sheep breed, each additional unit of 1 ETB increment per sheep to purchase supplement feed resulted in a profit of 14.12 ETB for concentrate L2, 10.25 ETB for *Gumuz* and 11.42 ETB for *Rutana* sheep breed, respectively.

Table 7. Mean carcass sensory attributes of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Sensory attributes	Sheep breed (B)			Concentrate level (C)			P value		
	Gumuz	Rutana	Begiet	L1	L2	L3	B	C	B*C
Juiciness	3.92	3.94	3.84	3.74	4.15	3.81	0.8144	0.0659	0.1441
Overall tenderness	3.90	3.83	3.7	3.60	4.04	3.78	0.6296	0.1248	0.7270
Flavor intensity	3.77	3.70	3.58	3.42^b	4.11^a	3.53^b	0.6261	0.0071	0.3719
Connective tissue amount	3.96	4.02	4.02	3.84	4.29	3.87	0.9254	0.0631	0.5395
Over all acceptance	3.90	3.69	3.7	3.52^b	4.15^a	3.63^b	0.2409	0.0005	0.1902

*a, b=Means within the same row not bearing a common superscript letters differ significantly; P=probability; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

Table 8. Partial budget analysis results of lowland sheep breeds (*Gumuz*, *Rutana* and *Begiet*)

Variables	Sheep breed (B)			Concentrate level (C)		
	Gumuz	Rutana	Begiet	L1	L2	L3
Number of animals	9	9	9	9	9	9
Purchase price of sheep (ETB $head^{-1}$)	1650.00	1915,00	1824.00	1863.00	1863.00	1863.00
Total feed consumed (kg $head^{-1}$)	50.72	50.85	50.92	53.21	52.4	46.89
Total variable cost (ETB)	465.58	465.33	464.86	417.63	470.94	507.25
Gross income (ETB)	2849.00	2912	2284	2383	3189	2542
Total return (ETB)	1199.00	997	460	520	1326	679
Net return (ETB)	733.42	531.67	-4.86	102.37	855.06	171.75
MRR (ratio)	10.25	11.42	-	-	14.12	0.77

*ETB=Ethiopian Birr; MRR=marginal rate of revenue; L1=400g Supplement (75% NSC: 25% WB); L2=500g Supplement (75% NSC: 25% WB); L3=600g Supplement (75% NSC: 25% WB).

4. Conclusions

The study demonstrated the effects of genotype and levels of concentrate on growth, carcass yield and quality of selected indigenous sheep breeds at Gende wuha. Generally, the present study indicated that *Gumuz* and *Rutana* sheep breeds can achieve better daily gain than *Begiet*. This indicates due to their adaptation to the area these breeds have had a potential to achieve faster growth than *Begiet*. Concentrate level two (L2) provided optimum level of nutrient to support maintenance and growth compared to other levels and resulted in higher FCE. Among the three genotypes, *Rutana* sheep had better FCE than other breeds. As a result of better SW achieved higher HCW was recorded by *Gumuz* and *Begiet.* Because of greater difference in proportion of non-carcass components and better HCW achieved relative to slaughter body weight, better dressing percentage (DP) was achieved by *Gumuz* sheep breed. Breed and concentrate level did not improve main carcass components, edible and non- edible offals. Meat quality attributes were not influenced by breed. Among the concentrate levels L2 was optimum to improve major meat quality attributes like juiciness, flavor and over all acceptance. Moreover, it was concluded that supplementation of sheep with the required level of concentrate (L2) and the use of proper sheep breed (*Gumuz* and *Rutana) is* potentially profitable in feeding of growing lowland sheep compared to other concentrate levels and other breed and could be recommended. Hence, according to the results of this study for a better animal performance and to produce quality meat feeding of growing *Gumuz* and *Rutana* sheep and use of concentrate (L2) were biologically efficient and potentially profitable.

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