

Carcass Parameters and Economic Analysis of Salale Sheep Type Fed Natural Grass Hay Supplemented with Different Proportion of Wheat Bran and Noug Seed Cake Mixtures

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ABSTRACT

A study was conducted to evaluate carcass and noncarcass yield, carcass composition, and economic profitability of salale sheep type fed natural grass hay supplemented with different proportions of wheat bran and noug seed cake mixture. A randomized complete block design (RCBD) was used. The treatments were: natural pasture hay alone (T1) (control), 350gWB (T2), 117gNSC+233gWB (T3), 233gNSC+117gWB (T4), and 350gNSC (T5) with all groups offered ad libitum feeding of natural pasture hay. A total of 25, sheep were used in the experiment which yearling intact at the start of the experiment and slaughtered after 120 days of fattening. The lambs were grouped into five blocks based on their initial body weight and treatments were randomly distributed to each block of five animals. Five lambs from each treatment were randomly picked and slaughtered for carcass evaluation. The hot carcass weight and Dressing percentage on Bodyweight immediately before slaughter (BWIBS) and empty body weight (EBW) base was higher in supplemented lambs than the control group (T1). Higher hot carcass weight (14.80kg) and dressed carcass weight (58.58kg) were recorded in lambs supplemented with 117g NSC+233g WB (T3). Sheep-fed natural grass hay (T1) alone had a negative net return (-442 ETB). In conclusion, there existed a significant in Sheep supplemented with T2 (350g WB/day/head) had the highest net return (604.4 ETB) and is potentially profitable in the feeding of growing Salale sheep as compared to the other supplemented treatments.

Keywords: Carcass yield; economic profitability; Sheep; Supplement of different proportion

INTRODUCTION

In the developing countries of Africa, several production bottlenecks hamper efficient ruminant animal production. Feed scarcity as well as the high cost of feed is among the major factoring growth and carcass development (Eniolorunda et al., 2011). In Ethiopia, there are about 31.30 million sheep (CSA, 2018), playing an important role in the country's economy through foreign currency earnings from the export of live animal, meat, and leather and leather products and by their significant contribution to the livelihood of farmers by serving as a cash and animal origin protein source. However, due to several production constraints, carcass yield per sheep is rarely more than 10 kg (Berhe, 2010). Furthermore, Ethiopia's commercial

red meat industry, mainly of small ruminants, has made remarkable progress to date and shows considerable growth potential for the future (U.S. Embassies Abroad, 2017). Sheep contribute some 21% of the total ruminant livestock meat output (Ameha, 2008). While contributing significantly to meat production in Ethiopia, present production levels of sheep are far below their potential. A major cause contributing to such low meat yield is that animals are commonly slaughtered at immature body weights, 18–20 kg for sheep and 16–18 kg for goats (Ameha, 2008) [1-5].

Carcass and non-carcass components are the slaughtering results of animals (Boler and Woerner, 2017). There is a performance difference in carcass characteristic and meat quality of sheep as documented in a comparative study conducted in Ethiopian

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Received Date: June 06, 2021; Accepted Date: October 08, 2021; Published Date: October 18, 2021

Citation: Yigrem M, Seman U, Mamo M, Demlew M (2021) Carcass Parameters and Economic Analysis of Salale Sheep Type Fed Natural Grass Hay Supplemented with Different Proportion of Yigrem M, Seman U, Mamo M, Demlew M Wheat Bran and Noug Seed Cake Mixtures. J Nutr Food Sci 11:p353.

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sheep and goat. Ayelet al., (2018) reported that carcass conformation was an important indicator of commercial value since carcasses with better conformation were assumed to have advantages in higher price cut and possibly greater muscle area. On the other hand, different findings suggested that the carcass composition determined the meat yield and meat sensorial characteristics. Thus, carcass economic value is based on its conformation and composition. Researches so far conducted in Ethiopia have not produced information about how different feeding regimes could affect the composition and linear measurements of sheep carcass. The objective of this study was, therefore, to assess carcass compositions and economic profitability of salale sheep type maintained under different proportions of wheat bran and noug seed cake mixtures [6-10].

MATERIALS AND METHODS

Description of the Study Area

The experiment was conducted at GirarJarso Woreda, Salale University (on station) which is found in the North Shewa Zone of Oromia Regional State at about 114 km North of Addis Ababa. The altitude of the area is ranged between 1300-2500 meters above sea level. It is divided into three agro-ecologies, namely: highland (>2500 m.a.s.l) (15%), midland (1500-2500 m.a.s.l) (40%) and lowland (500-1500 m.a.s.l) (45%) and the area gets rainfall during both Belg (February to April) and Meher (June to September) seasons. The average annual rainfall of the area ranges from less than 840 mm to 1600 mm while the mean annual temperature varies between 15 0C to 19 0C (CSA, 2008) [11-15].

Experimental Animals and Management

Twenty-five intact yearling male growing sheep-type lambs were purchased from Degem market to experiment. The ages of the Sheep were determined by their dentition and information obtained from the owners. The animals were injected with ivermectein drugs against internal and external parasites and oxytetracycline drugs against bacterial disease. They were vaccinated against common diseases of the area (anthrax and pasteurellosis) during the quarantine period of 15 days at the experimental site. All animals were placed in individual pens equipped with a bucket and a feeding trough and identified with neck collars with tag numbers [16-18].

Experimental Design and Treatments

The experiment was conducted in a randomized complete block design (RCBD) with five treatments consisting of five sheep per treatment (Table 1). At the end of the quarantine period, the sheep were blocked into five groups (blocks) each containing five sheep based on initial body weight, which was determined as a mean of two consecutive weighings after overnight fasting. The five treatments were randomly assigned to animals in a block, which makes the number of animals/replication per treatment [19].

Table 1: Experimental treatments.

Treatments	Hay	NSC day/ animal) DM base	(g/ Wheat bran /day/ animal) on DM base	Supplement DM intake (g/d/head)
T1	Ad libitum	-	-	-
T2	Ad libitum	0	350	350
T3	Ad libitum	117	233	350
T4	Ad libitum	233	117	350
T5	Ad libitum	350	0	350

Carcass characteristics

At the end of the experiment, 15 of the experimental animals, three from each treatment were fasted of feed and water overnight, weighed, and slaughtered for carcass evaluation. On slaughtering, the animals were killed by severing the jugular vein and the carotid artery with a knife. The blood was drained into a bucket and its weight was recorded. The skin was carefully flayed to prevent fat and tissue attachments and weighed, the forelegs and the hind legs were trimmed off at the carpal and tarsal joints, respectively, and weighed. The entire gastrointestinal tract was weighed and divided into different sections, namely reticulum, rumen, omasum, and abomasums, and small and large intestines were emptied and weighed (Cezar and Sousa, 2007) [20].

The internal organs lung with trachea, heart, liver, gallbladder, bladder, kidney, spleen, and abdominal and kidney fat were removed and weighed. The weight of the penis and testis was also recorded. Immediately after dressing and evisceration, carcass weight was recorded to assess dressing percentage on slaughter weight and empty body weight (EBW) basis. Dressing percentage was calculated as the proportion of hot carcass weight to slaughter and EBW. The hot carcass weight was estimated after removing the weight of head, skin, feet, tail, thoracic, abdominal, and pelvic cavity contents as well as legs below the hook and knee joints of the animal (Cezar and Sousa, 2007).

Partial Budget Analysis

The partial budget analysis was performed to evaluate the economic advantage of the different treatments (Ehui and Ray 1992). The analysis involved the calculation of the variable costs of experimental sheep feeds and the benefits gained from the result. In the analysis, the total return (TR) was determined by calculating the difference between the selling and purchasing price of sheep in each treatment before and after the experiment. At the end of the feeding trial, the selling price of experimental sheep was estimated by three known merchants before slaughtered. The cost of feeds was computed by multiplying the actual feed intake for the whole feeding period with the prevailing prices. However, other costs like labor, housing, and veterinary service were common for all treatments and not considered. The partial budget measures profit or

losses, which are the net benefits or differences between gains and losses for the proposed change and includes calculating net return (NR), i.e., the amount of money left when total variable costs (TVC) are subtracted from the total returns (TR),

$$NR = GR - TVC$$

The change in net return (NR) was calculated as the difference between the change in total return (ΔTR) and the change in total variable cost (ΔTVC).

$$\Delta NR = \Delta GR - \Delta TVC$$

The marginal rate of return (MRR) measures the increase in net return (ΔNR) associated with each additional unit of expenditure (ΔTVC).

$$MRR = \Delta NR / \Delta TVC$$

Statistical Analysis

Data of carcass composition was analyzed using analysis of variance (ANOVA) of the general linear model procedure of SAS (2002). Treatment means that are significantly different were separated by the least significant difference (LSD).

The model for data analysis was:

$$Y_{ij} = \mu + T_i + B_j + e_{ij}$$

Where:

Y_{ij} = Response variable

μ = Overall mean

T_i = Treatment effect

B_j = Block effect

e_{ij} = Random error

RESULTS AND DISCUSSIONS

Carcass Characteristics

There was no significant difference ($p > 0.05$) observed between the control (T1) and supplemented groups in the case of all carcass characteristics (Table 2). The average values of the Slaughter Bodyweight immediately before slaughter (32.50kg), Slaughter body Weight immediately after Slaughter value(31.22kg), and empty body weight (25.12kg) were higher for sheep in 117g NSC+233g WB (T3) as compared to sheep in T1<T4<T5<T2 respectively. The dressing percentage (DP) on both Empty body weight and Slaughter Bodyweight immediately before slaughter base (BWIBS) were also higher for lambs supplemented with 117g NSC+233g WB (T3) as compared to sheep supplemented with T1<T4<T5<T2 and T1<T5<T4<T2 respectively. [21].

Table2: Carcass characteristics of Salale sheep type fed on hay basal diet and supplemented with different proportions of wheat bran and noug seed cake mixtures.

Variable	Treatments					
	T1	T2	T3	T4	T5	SEM
Slaughter Bodyweight immediately before slaughter (Kg)	26.067	32.467	32.500	31.333	32.000	1.348
Slaughter body Weight Immediately after Slaughter (Kg)	25.057	31.167	31.220	30.353	30.760	1.307
Empty Body Weight(Kg)	20.580	24.163	25.120	22.937	24.077	1.244
Hot carcass weight(Kg)	10.233	13.967	14.800	13.167	13.500	1.000
Dressing percentage	39.256	43.003	47.007	41.823	42.007	2.748
SBWIBS base(Kg)	49.723	57.777	58.583	57.203	55.843	2.266
EBW base(Kg)						

a, b, c Means within rows having different superscript are significantly different = ($P < 0.05$); SEM = standard error of mean; EBW= Empty Body Weight; SBWIBS= Slaughter Bodyweight immediately before slaughter.

The control group (T1) had lower dressing percentages. The lower dressing percentage in T1 was May due to the low digestibility of hay because of high fiber and low CP contents. The results obtained in this experiment are in agreement with the reports of Berhe M. and Testify. Y (2014) and Merhun L. et al (2016) reported that heavier empty body weight for the supplemented group than the control. The Dressing percentage values on an empty body weight basis were higher than on a Slaughter Bodyweight immediately before slaughter (BWIBS) basis, this was due to the removal of the gut content.

Edible offal components

Edible offal components of Salale sheep type lambs supplemented mixtures of noug seed cake and wheat bran at different proportions are given in Table 3. Blood, kidney, liver, heart, tongue, tails and fat, testicles, reticulo-rumen, omasum-abomasum, and small & large intestine are considered edible offals. Whereas head without tongue, skin, lung, and trachea, spleen, gallbladder, gut fill, genital organ, and feet with hooves are considered as non-edible offals.

In this study, the supplemented sheep had the higher weight of kidney, liver, heart, tongue, tails and fat, testicles, reticulo-rumen, and small & large intestine than sheep in the control treatment (T1), but blood and omasum-abomasum of T4 are lower than (T4<T1) sheep in the control treatment (T1). The higher weight of kidney, tongue, and reticulo-rumen are recorded for sheep in T5 and higher weight of liver and heart recorded for sheep in T3 and T4 respectively than sheep in T1. The result of this study is similar to that of yirga. Hirut et al (2011) reported supplemented hararghe highland sheep higher weight of liver, heart, tongue, and kidney than the control. Similarly, Tesfaye (2007) reported a positive effect of supplementation on supplemented afar sheep on the weight of liver, heart, tongue, and kidney.

The weight of tongue, liver, and tails, and fat were significantly ($p<0.05$) affected due to supplementation. Kirton et al. (1972) reported that the live weight and nutritional status of the animals can affect the production efficiency of carcass offals. However, there was no significant difference ($p>0.05$) between the control (T1) and supplemented treatments among blood, kidney, heart, Omasum-Abomasum, Reticulo-Rumen, testicle, and Small & Large Intestine. In agreement with this study, Gebretsedik. G and Kefelegn. K (2017) reported that there was no significant difference ($p>0.05$) on reticulo-rumen, small & large intestine, and omasum-abomasum between control treatments and supplemented treatments Tigray highland sheep fed urea treated wheat straw and supplemented with mixtures of wheat bran and Noug seed cake. Liver weight was significantly lower ($p<0.05$) in the control treatment (T1) compared to the supplemented treatments (T3>T2>T5>T4). The increase in liver weight might be related to the storage of reserve substances such as glycogen with supplementation. The higher weight of the liver is recorded for sheep in T3. Reported that liver weight was significantly lower ($p<0.01$) in the control treatment (T1) than the supplemented treatments for gumuz sheep and Tigray highland sheep respectively. Supplemented Sheep had significant ($p<0.001$) difference in tail and fat than the control treatments (T1). The higher weight of tails & fats is recorded for sheep in T2. This fat deposit could be attributed to the fact that supplemented sheep tend to deposit more fat in their body as compared to the non-supplemented ones. Gebretsedik G and Kefelegn K and Berhe M and Tesfy Y indicated that there was heavier tail and fat weight for supplemented Tigray highland sheep.

Table3: Edible offal components (gram) of Salale sheep type fed on hay basal diet and supplemented with different proportions of wheat bran and noug seed cake mixtures.

Edible offals	Treatments					
	T1	T2	T3	T4	T5	SEM
Blood	1012.3	1299.3	1280.3	979.7	1239.3	120.595
Kidney	69.67	82.33	83.333	79.67	86.3	8.443
Liver	279.33c	396.67a b	420.33a	313.33b c	360.00a b	22.465
Heart	124.00	137.67	144.33	169.00	164.67a	14.656
Tongue	78.00b	115.00a	106.33a b	104.33a b	131.00 a	10.217
Reticulo-Rumen	512.67	660.00	654.33	629.67	613.33	43.002
Omasum-Abomasum	204.33	225.00	230.33	185.00	240.33	45.456
Small & Large Intestine	698.3	950.0	1020.7	821.3	892.0	103.882
Testicles	215.00	333.00	320.67	333.67	268.00	53.065
Tails & Fats	365.7b	1234.7a	1010.3a	1180.0a	1106.0a	101.846

a,b,c Means within rows having different superscript are significantly different = ($P<0.05$); SEM = standard error of the mean.

Non-edible offal

Non-edible offals removed from the dressed carcass of experimental sheep are shown in Table 4. Among the non-edible offal, components the head without tongue, spleen, bladder, genital organ, and feet with hooves did not show significant ($P>0.05$) difference within the treatment groups. In agreement with the result obtained in the current study the results reported by Gebretsedik. G and Kefelegn. K (2017) shows no significant ($P>0.05$) difference in the head without tongue and genital organ weight within the treatments. Biru (2008) reported spleen, bladder, and feet weight was not significantly different in lambs fed on sweet potato tuber and haricot bean screenings in Adilo lambs. Similar results were reported by Mulugeta and Gebrehiwot (2013), who studied the effect of sesame cake supplementation on feed intake, body weight gain, feed conversion efficiency, and carcass parameters in the ration of lambs fed on wheat bran and teff straw. Head without tongue, bladder, and feet with hooves were lower for the control group (T1) than supplemented group (T2, T3, T4, and T5). But lower genital organs were recorded for T4. In addition to this, T2 resulted in a higher weight of bladder and feet with hooves than

T3, T4, and T5. The higher weight of the Head without tongue and spleen were recorded for T5 and T3 respectively. Skin, lung with the trachea, gallbladder, and gut fill of the supplemented treatments (T2, T3, T4, and T5) were significantly ($P<0.05$) higher than the control treatment, while there was no difference observed among the supplemented treatment for the above parameters, Except, lower Gut fill is recorded in T4 than supplemented treatments ($T3<T5<T2$). In contrast with the work of Simret (2005) and Matiwo who reported no significant effect of supplementation, the current study resulted in a positive effect of supplementation on the weight of Skin, lungs with the trachea, gallbladder, and gut fill.

However, in agreement with the current study results, Alemu T. (2016) reported heavier skin, lung with the trachea, gallbladder, and gut fill for supplementation than the non-supplemented gumuz sheep fed natural pasture hay and supplemented with wheat bran and Noug seed cake. Yirga. H et al (2011) and Gebretsedik . G and Kefelegn. K also reported heavier weight of Skin and lung with trachea for Hararghe highland sheep fed a basal diet of urea-treated maize Stover and Supplemented with concentrate mix and Tigray highland sheep fed urea treated wheat straw and supplemented with mixtures of wheat bran and noug seed cake.

Table4: Non-edible offfal components (gram) of Salale sheep type fed on hay basal diet and supplemented with different proportion of wheat bran and noug seed cake mixtures.

Non-edible offfal	Treatments					SEM
	T1	T2	T3	T4	T5	
Head without tongue	1570	1792	1919.7	1818	1934.7	154.81
Skin	2.267b	3.100a	3.167a	2.967a	3.467a	0.329
Lung with trachea	301.00c	437.00b	494.33a b	460.33b	579.33a	29.989
Spleen	53	88.33	98.67	82.33	96.33	18.022
Bladder	19.667	40	25.333	29.667	34	5.392
Gallbladder	4.333b	14.000a b	19.333a b	20.333a	21.667a	4.42
Gut fill	5485.0b	7004.3a b	6098.7a b	7417.0a	6652.3a b	373.846
Genital organ	72	58.33	60.67	50.67	63.67a	8.592

Feet with hooves	495.333	532.33a	545.67	526	517	23.778
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a, b, c Means within rows having different superscript are significantly different = ($P<0.05$); SEM = standard error of the mean.

Partial Budget Analysis

A partial budget analysis was conducted to assess the economic benefit of supplementation with different proportions of wheat bran and noug seed cake mixtures for Salale sheep type fed on hay basal diet (Table 5). The difference in net return was in a similar trend with their weight gain, i.e., lambs in the control group almost remain the same weight and resulted in the negative net return (-442ETB/head) and it was the lowest from all the treatments. The reasons for the negative net return might be due to the lower digestibility, nutrient intake, and average daily gain (ADG) (g/days). While supplemented group resulted in higher ADG and recorded the highest net return.

The net return from the supplemented treatments was 604.4, 527.46, 289.86, and 386.4 ETB/head for T2, T3, T4, and T5 respectively. The net return of supplemented sheep in the current study was similar to the results reported by Mulugeta and Gebrehiwot (2013) and Aschalew and Getachew (2013) which had shown good economic return in the supplemented group, for sheep fed on wheat bran and teff (*eragrostis teff*) straw and supplemented with sesame cake and sheep fed on raw, malted and heat-treated grass pea (*Lathyrussativus*) grain respectively. The marginal rate of return indicated that each additional unit of 1 ETB per sheep cost increment resulted in 1 ETB and 6.11, 3.55, 2.65, and 2.97ETB benefit for T2, T3, T4, and T5 respectively.

Table5: Partial budget analysis of Salale sheep type fed on hay basal diet and supplemented with different proportion of wheat bran and noug seed cake mixtures.

Variable	Treatments				
	T1	T2	T3	T4	T5
Number of animals	5	5	5	5	5
Purchase price of sheep (ETB/head)	1630	1600	1600	1630	1530
Total basal diet consumed (kg/head)	118.68	92.12	101.6	98.36	95.2

Total supplement consumed (kg/head)	0	42	42	42	42
Cost of the basal diet (hay) (ETB/head)	924.5	717.6	791.46	766.22	741.6
Cost of supplement (ETB/head)	0	378	406.08	433.92	462
Total feed cost (ETB/head)	924.5	1095.6	1197.54	1200.14	1203.6
Total variable cost(ETB/head)	924.5	1095.6	1197.54	1200.14	1203.6
The selling price of sheep (ETB/head)	2112.5	3300	3325	3120	3100
Total return(ETB)	482.5	1700	1725	1490	1570
Net return(ETB)	-442	604.4	527.46	289.86	386.4
Δ TVC	-	171.1	273.04	275.64	279.1
Δ NR	-	1046.4	969.46	731.86	828.4
MRR(ratio)	-	6.11	3.55	2.65	2.97

ETB =Ethiopian Birr; Δ NR = change in net return; Δ TVC = change in total variable cost; MRR = marginal rate of return.

Among the treatments, T2 (350g WB/day/head) was found to be more profitable considering the net return. The higher net return in T2 was due to the quality of protein(17.94%) and the lower ADL (1.85%) contained in T2 supplementation, which resulted in higher final body weight(32.34 kg), average daily gain (78.0 g/day/head) and feed conversion ratio (0.09g/day/head) as compared to the other treatments that had a bodyweight gain of 25.0 g/day/head, 75.0g /day/ heads, 69.0 g /day/ heads and 60.0g/day/ heads for T1, T3, T4, and T5 respectively. This indicates that lambs fed with better quality feed perform well and have higher body weight gain and are sold

at maximum price and earn a better net return. Hence, if capital is available for sheep farmers to make use of the potential of new technology, supplementation with 350g WB/day/head (T2), which resulted in the highest net return could be selected as the best supplement.

CONCLUSION

The dressing percentage (DP) was also higher for lambs supplemented with 117g NSC+233g WB (T3) as compared to sheep supplemented with T1< T4<T5<T2 respectively. The control group (T1) had a lower dressing percentage on both Empty body weight and Slaughter Bodyweight immediately before slaughter base (BWIBS). Generally, the results of this experiment indicated that supplementation of different proportion of wheat bran and noug seed cake mixtures improved feed intake partly as the result of increased digestibility due to the supply of sufficient CP and/or energy that enhanced microbial multiplication and activity, with a consequent increase in ADG and FCE.

Partial budget analysis of the present study revealed that T2 (350g WB/day/head) showed the highest net return (604.4 ETB) and marginal rate of return (6.11). Therefore, supplementation of 350g/day wheat bran (T2) improved the body weight change of sheep and correspondingly increased the net income from the sale of sheep at the end of the feeding trial. Hence, in the present study, it was concluded that supplementation of hay with 350 g/day wheat bran is biologically efficient and potentially profitable in the feeding of growing Salale sheep.

REFERENCES

1. Alemu Tarekegn. Response to Supplementing Different Proportions of Wheat Bran and Noug Seed (*Guizotia abyssinica*) Cake Mixtures on the Performance of Gumuz Sheep Fed Natural Pasture Hay in Metema District. Ethiopia. 2016; p1 -70.
2. Ameha Sebsibe. Sheep and Goat Meat Characteristics and Quality. In: AOAC (Association of Official Analytic Chemistry), 1990. Official Methods of the Analysis 15th ed. AOAC. Arlington, USA. 2008;1298p.
3. Aschalew Assefa and Getachew Anmut . Supplementation of Raw, Malted, and Heat Treated Grass Pea (*Lathyrus Sativus*) Grain on Body Weight Gain and Carcass Characteristics of Farta Sheep. Int J Soil Crop Sci. 2013;1(1):1- 6.
4. Ayele S, Urge M, Anmut G and Yusuf M. Comparative Slaughter Performance and Carcass Quality of Three Fat-Tailed Hair Sheep Supplemented Two Level of Concentrate. Trop Anim Health Prod. 2018; 51, 187-198.
5. Berhe G. (2010) Animal, and Plant Health. Directorate-Ministry of Agriculture and Rural Development of Ethiopia. Dialogue on Livestock, Food Security and Sustainability, a Side Event on the Occasion of the 22nd Session of COAG, FAO, Rome, 2010; 1.
6. Berhe, Michael&Tesfay, Yayneshet. Feed utilization, digestibility, and carcass parameters of Tigray highland sheep fed wheat straw supplemented with mixtures of wheat bran and cottonseed cake, in Tigray, Ethiopia. ABC Res Alert. 2014; 2. 10.
7. Biru K. Effects of supplementation with sweet potato tuber and haricot bean screenings on feed utilization, growth and carcass characteristics of Adilo sheep. MSc. thesis presented to the school

- of graduate studies of Alemaya University of Agriculture, Alemaya, Ethiopia. 2008; 87p.
8. Boler DD and Woerner DR. Perspective from the American Meat Science Association. *Anim Front.* 2017; 7, 8-11.
 9. Cezar MF, WH Sousa. Carcaças ovinas e caprinas: obtenção, avaliação e classificação. 147 p. Editora Agropecuária Tropical, Uberaba, Minas Gerais, Brasil, 2007.
 10. Eniolorunda OO, Apata ES and Okubanio AO (2011) Body and Carcass Measurements of Rams Fed Graded Levels of Biscuit Waste Based Diet. *Afr J Feed Sci.* 2011; 51, 333.
 11. Ehui S, Ray B. Partial budget analysis for on station and on-farm research: Method and data requirements l'analyse par budgets partiels dan la en station et en exploitation surles Systemes de production Ovis et caprines: Methode et donees. Small Ruminant research and development in Africa. FAO ILRI Addis Ababa Ethiopia, 1992.
 12. Gebretsadik, Gebremichal&Kefelegn, Kebede. Feed utilization, digestibility and carcass parameters of Tigray highland sheep fed urea treated wheat straw supplemented with mixtures of wheat bran and noug seed cake, in southern Tigray, Ethiopia. *Livestock Research for Rural Development.* 2017; 23.
 13. Hirut Y, Solomon M and Mengistu U. Effect of concentrate supplementation on live weight change and carcass characteristics of Hararghe Highland sheep fed a basal diet of urea-treated maize stover. *Livestock Research for Rural Development.* 2011; Volume 23, Article #245. Retrieved May 21, 2021.
 14. Matiws Solomon. The effect of different levels of cottonseed meal supplementation on feed intake, digestibility, live weight changes, and carcass parameters of Sidama Goats. An MSc Thesis Presented to the School of Graduate Studies Haramaya University. 2007; 53 pp.
 15. MerhunLamaro, Mengistu Urge, YosephMekasha. Effects of Supplementation with Different Levels of Wheat Bran and Noug Seed (*Guizotiaabissynica*) Cake Mixtures on Performance of Hararghe Highland Sheep Fed a Basal Diet of Maize Stover. *Am J Agric Sci.* 2016;Vol. 3, No. 3, pp. 40-47.
 16. Mulugeta F and Gebrehiwot T. Effect of sesame cake supplementation on feed intake, body weight gain, feed conversion efficiency and carcass parameters in the ration of sheep fed on wheat bran and teff (*eragrostis teff*) straw. *Momona Ethiop J Sci.* 2013; 5(1):89-106.
 17. SAS Institute, Inc. SAS course notes on Mixed Model Analysis Using SAS System. SAS Institute, Inc., Cary, NC, 2002.
 18. Simret, Betesha. Supplementation of graded levels of peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. M.Sc. A thesis presented to the school of Graduate Studies of the Alemaya University of Agriculture, Alemaya, Ethiopia. 2005; 60p.
 19. TesfayeHagos. Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: effects on feed intake, digestibility, live weight, and carcass parameters. An. MSc. A thesis presented to the School of Graduate Studies of Haramaya University, 2007; 82 pp.
 20. U.S. Embassies Abroad (2017). Ethiopia Country Commercial GuideLivestock Overview. Retrieved n 19/2019.
 21. Yirga H &Melaku S & Urge M. Effect of concentrate supplementation on live weight change and carcass characteristics of Hararghe Highland sheep fed a basal diet of urea-treated maize stover. *Livestock Research for Rural Development.* 2011; 23.