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Carcass and non-carcass characteristics of Tigray highland lambs fed mulberry (*Morus alba*) leaf meal at different supplementation levels

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Abstract

The study was carried out to evaluate the effect of mulberry (*Morus alba*) leaf meal levels on growth performance and carcass characteristics of Tigray highland lambs. The experiment consisted of five treatments; and conducted in a randomized complete block design using thirty intact yearlings Tigray highland male lambs. The experimental diets were 300g concentrate mix alone, 225g concentrate mix + 86.55g mulberry leaf, 150g concentrate mix + 173.1g mulberry leaf, 75g concentrate mix + 259.7g mulberry leaf and 346.2g mulberry leaf alone with barley straw ad libitum to all treatments. The mix was prepared from Noug seed cake and wheat bran at ratio of 1:2, respectively. Higher weights of total edible offal component, empty body weight, rib eye muscle area and slaughter weight were observed as a result of high level of mulberry leaf meal supplementation than the sole concentrate mix treatment. On the other hand, the dressing percentage on slaughter weight base as well as empty body weight base and hot carcass weight showed less difference ($p>0.05$) between sole mulberry leaf meal and sole concentrate mix treatments. The result of the present study indicated that substitution of mulberry leaf meal for concentrate mix can be used effectively without affecting the results of growth parameters as well as edible or non edible offal components that can be achieved by sole concentrate supplementation. Hence, the finding revealed that feeding mulberry leaf meal alone to Tigray highland lambs could substitute the costly and even less accessible commercial concentrate mix to resource poor farmers and could result in reasonably better performance of lambs.

Keywords: Carcass, Edible offal, Mulberry, Non edible offal.

INTRODUCTION

In areas where livestock are closely integrated with crop production, crop residues are considered as valuable sources of ruminant feeds. The tendency of increased acreage of cropping land is always at the expenses of decreased available grazing lands, thus boost the importance of crop residues as animal feed resources. However, crop residues are of generally low in nutritive value and are fibrous having low digestible organic matter (OM) per kg dry matter (DM)) and low crude protein (CP) content [3, 15]. The increasing pressure on land and the growing demand for livestock products makes it crucial to ensure the effective use of feed resources, including crop residues and other agro-industrial by-products. With the increasing need of human population for animal products, there is a need of matching feed resources available with animal nutrient requirements. Thus, supplementation of crop residues with agro-industrial by-products and/or plant protein sources will alleviate CP deficiency in fibrous feeds [36].

The commercial protein supplements are however, inaccessible and if any too expensive for the small scale farmers. Different studies indicated that mulberry is well comparable with leguminous multipurpose trees and concentrates as a feed for ruminants [8, 33, 31, 22, 23]. Habib *et al.* [18] evaluated the chemical composition of dried mulberry leaves and reported that it has comparable nutrient composition with that of commercial concentrates diets. However, the information on the feeding value of mulberry foliage and its concomitant effect on feed intake and carcass characteristics of lambs in Ethiopia are scanty and need further documentation. To this end FAO [13] suggested that the urgent need of the farmers for high quality feed for ruminants in developing countries can be achievable through intensive utilization of multipurpose trees and shrubs as they have better nutritional quality nearly equivalent to grain based concentrates.

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According to Shayo [35], leaves of multipurpose trees like mulberry are highly digestible; contain high concentration of CP and minerals, and low cell wall contents. This important characteristic of the mulberry is a key attribute that makes it worthy of investigation as feed alternative for ruminants. Therefore, this study was carried out with the objective of investigating the effect of partial or full substitution of mulberry leaf meal for concentrate mix on performance and carcass characteristics of yearling Tigray highland lambs fed barley straw basal diet.

MATERIALS AND METHODS

Experimental animals, experimental design and treatments

Thirty intact yearlings Tigray highland male lambs with initial body weights of 17.8±0.95 kg (mean ± SD) having relatively similar body condition were used for the study. The lambs were quarantined, drenched against internal parasites, sprayed for ecto-parasites and vaccinated for anthrax as well as ovine pasturolosis. The supplements were offered in two equal portions at 08:00 and 16:00 hours daily while the water and mineral salt licks were accessed freely to all lambs.

A complete randomized blocked design with five treatments of six animals each was employed and lambs were blocked on the basis of their initial body weight (overnight fasting) and the five treatments were randomly assigned to animals in the block. Lambs were housed in concrete floor that penned individually. The lambs were allocated to the diet groups where concentrate mix was progressively replaced by mulberry leaf meal from 0% to 100% at iso-nitrogenous level.

Table 1: Chemical composition of feeds used for the experiment

Experimental feeds		Chemical composition (%DM)							
	DM (%)	OM	Ash	CP	NDF	ADF	ADL	EE	CF
Barley straw	96.0	92.5	7.5	4.0	78.6	49.6	8.6	1.3	57.6
Concentrate mix	90.2	92.3	7.66	22.0	35.2	20.2	3.39	7.16	13.3
Mulberry leaf meal	91.8	84.3	15.7	18.5	38.0	22.3	4.19	4.15	14.2

DM: Dry matter; OM: Organic matter; CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; EE: Ether Extract; CF: Crude fiber

The treatments were 300g concentrate mix alone, 225g concentrate mix + 86.55g mulberry leaf, 150g concentrate mix + 173.1g mulberry leaf, 75g concentrate mix + 259.7g mulberry leaf and 346.2g mulberry leaf alone with barley straw *ad libitum* to all treatments. The concentrate mix contained noug seed cake (NSC) and wheat bran (WB) at ratio of 1:2. Feeds offered to experimental lambs and corresponding refusals were weighed and recorded daily throughout the experimental period to determine daily feed intake of experimental lambs.

Chemical analysis of feed offer and refusals

Chemical compositions of the feed and refusal samples were determined at Holeta Agricultural Research Center, animal nutrition laboratory, Ethiopia. Samples of dried feeds and refusals were dried overnight at 105 °C in a forced draft oven for determination of total dry matter content. Ash content was determined by combusting samples at 550 °C overnight and organic matter (OM) content was calculated by difference (OM=100-ash content). Nitrogen (N) content was determined using the Kjeldahl method (AOAC, 1990)[5] and crude protein (CP) was calculated as N×6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the procedures of Van Soest and Robertson [37].

Carcass evaluation

At the end of feeding trial, all experimental lambs were slaughtered after overnight fasting for evaluation of carcass parameters. Empty body weight was calculated as slaughter weight less gut content. Hot carcass weight was estimated after removing weight of the head, skin, thoracic, abdominal and pelvic cavity contents, and the limbs. Dressing percentage was calculated as a ratio of hot carcass weight and slaughter weight or empty body weight basis. The rib eye muscle area is determined by measuring area of the *Longissimus dorsi* muscle exposed by cutting the carcass between the 12th and 13th ribs [29].

Statistical analysis

Data from the experiment were subjected to the analysis of variance (ANOVA) in a randomized complete block design using the general linear model procedure of SAS [34]. Individual differences between means were tested using Tukey HSD test. In all the comparisons, the level of significance was set at $\alpha = 0.05$.

RESULTS

Live weight change and feed conversion efficiency

Average daily gain (ADG) was significantly ($p < 0.05$) higher at 150CM: 173MLM than the other treatments (Table 2). Lambs fed from 150CM: 173MLM to 346MLM (treatments with higher proportion of mulberry leaf meal) gained 1.3 – 1.5 kg extra body weight compared to those fed 300CM (sole concentrate mix) by growing at an average of 9.2 to 13.9 g greater rate per day. However, difference in feed conversion efficiency among treatments except 150CM: 173MLM, which showed significantly ($p < 0.05$) higher feed conversion efficiency than the 300CM and 225CM: 87MLM, was not significant ($p > 0.05$) though 75 CM: 260MLM and 346MLM supplemented lambs relatively tended to have better feed conversion efficiency than lambs supplemented with 300CM and 225CM: 87MLM. In general, all the experimental sheep showed good growth performances throughout the experimental period.

Table 2: Growth performance parameters of Tigray highland lambs supplemented with different levels of dried mulberry leaf meal and concentrate mix

Growth parameters	Treatments						
	300 CM	225CM: 87MLM	150 CM: 173 MLM	75 CM: 260 MLM	346MLM	SEM	SL
Initial body weight (kg)	17.5	17.8	17.8	17.8	18	0.59	0.94
Final body weight (kg)	23.2[b]	23.6[b]	24.7[a]	24.6[a]	24.5[a]	0.42	0.005
Slaughter weight (kg)	23.0[b]	23.5[b]	24.5[a]	24.4[a]	24.3[a]	0.39	<.0001
Average daily gain (g/day)	63.0[b]	64.8[ab]	76.9[a]	75.0[ab]	72.2[ab]	4.28	0.012
Feed conversion efficiency (g gain/g fed)	0.075[b]	0.075[b]	0.089[a]	0.085[ab]	0.079[ab]	0.005	0.042

[ab]Means with different superscript letters in a row differ significantly.
CM: concentrate mix; MLM: mulberry leaf meal; 300CM: *ad libitum* barley straw + 300g concentrate mix;
225CM:87 MLM: *ad libitum* barley straw + 225g concentrate mix + 86.55g mulberry leaf meal;
150 CM:173MLM: *ad libitum* barley straw + 150g concentrate mix + 173.1g mulberry leaf meal;
75 CM:260MLM: *ad libitum* barley straw + 75g concentrate mix + 259.7g mulberry leaf meal;
346MLM: *ad libitum* barley straw +346.2g mulberry leaf meal; SEM: standard error of the mean;
SL: significant level

Effect on main carcass traits

The slaughters weight, empty body weight and rib eye muscle area indicated higher ($p<0.05$) in the sole mulberry leaf meal supplemented groups than those supplemented with concentrate mix alone. Moreover, hot carcass weight indicated significantly ($p<0.05$) higher in 150CM: 173MLM than 300CM and 225CM: 87MLM. Nevertheless there was less difference among 150CM: 173MLM, 75 CM: 260MLM and 346MLM for hot carcass weight and rib eye muscle area. 150CM: 173MLM had higher ($p<0.05$) dressing percentage on slaughter weight base as well as empty body weight base than 300CM and 225CM: 87MLM. However, it had less difference with 75CM: 260MLM and 346MLM. At higher proportion of mulberry leaf meal, the carcass parameters resulted better.

Table 3: Carcass characteristics of Tigray highland lambs supplemented with different levels of dried mulberry leaf meal and concentrate mix

Carcass weight	Treatments						
	300 CM	225CM: 87MLM	150 CM: 173 MLM	75 CM: 260 MLM	346MLM	SEM	SL
EBW (kg)	19.3[b]	19.8[b]	20.7[a]	20.5[a]	20.5[a]	0.36	<.0001
HCW (kg)	10.6[b]	10.9[b]	11.8[a]	11.5[ab]	11.5[ab]	0.32	0.0003
DP (EBW basis)	54.8[b]	55.1[b]	56.8[a]	56.1[ab]	56.4[ab]	0.65	0.0047
DP (SBW basis)	46.1[b]	46.4[b]	48.0[a]	47.1[ab]	47.4[ab]	0.65	0.0087
Rib eye muscle area cm2	9.0[b]	9.3[b]	9.9[a]	9.8[a]	9.6[a]	0.18	<.0001

[ab]Means with different superscript letters in a row differ significantly.
CM: concentrate mix; MLM: mulberry leaf meal; 300CM: *ad libitum* barley straw + 300g concentrate mix;
225CM:87 MLM: *ad libitum* barley straw + 225g concentrate mix + 86.55g mulberry leaf meal;
150 CM:173MLM: *ad libitum* barley straw + 150g concentrate mix + 173.1g mulberry leaf meal;
75 CM:260MLM: *ad libitum* barley straw + 75g concentrate mix + 259.7g mulberry leaf meal;
346MLM: *ad libitum* barley straw +346.2g mulberry leaf meal; SEM: standard error of the mean;
SL: significant level; SBW: slaughter body weight; EBW: empty body weight; HCW: hot carcass weight; DP dressing percentage

Effect on Edible offal components

According to table 4, 150CM: 173MLM, 75 CM: 260MLM and 346MLM indicated higher ($p<0.05$) empty gut, heart, tail, total visceral fat and TEOW than 300CM and 225CM: 87MLM. However, the above parameters showed less difference between 300CM and 225CM: 87MLM. Similarly, less difference was observed among 150CM: 173MLM, 75 CM: 260MLM and 346MLM for the mentioned parameters.

Table 4: Response to supplementation with partial or full substituted concentrate mix with mulberry leaves on edible offal of Tigray highland lambs

Parameters	Treatments						
	300CM	225CM: 87MLM	150 CM: 173 MLM	75 CM: 260 MLM	346MLM	SEM	SL
Empty gut	1.57[b]	1.58[b]	1.66[a]	1.68[a]	1.67[a]	0.029	0.0009
Head with tongue	2.006	1.952	2.003	2.005	1.984	0.031	0.4307
Kidney	0.070[ab]	0.069[b]	0.076[a]	0.074[ab]	0.074[ab]	0.002	0.0219
Liver with bile	0.340[bc]	0.338[c]	0.348[abc]	0.353[ab]	0.359[a]	0.005	0.0013
Testis	0.256	0.254	0.248	0.258	0.262	0.008	0.5489
Heart	0.095[b]	0.095[b]	0.101[a]	0.102[a]	0.102[a]	0.002	0.0005
Tail	0.514[b]	0.511[b]	0.536[a]	0.545[a]	0.536[a]	0.010	0.0086
Total visceral fat*	0.308[b]	0.303[b]	0.331[a]	0.322[a]	0.321[a]	0.002	0.0007
TEOW	5.15[b]	5.10[b]	5.30[a]	5.31[a]	5.31[a]	0.041	0.0002

[a-c]Means in the same row with different superscript differ significantly.
CM: concentrate mix; MLM: mulberry leaf meal; 300CM: *ad libitum* barley straw + 300g concentrate mix;
225CM:87 MLM: *ad libitum* barley straw + 225g concentrate mix + 86.55g mulberry leaf meal;
150 CM:173MLM: *ad libitum* barley straw + 150g concentrate mix + 173.1g mulberry leaf meal;
75 CM:260MLM: *ad libitum* barley straw + 75g concentrate mix + 259.7g mulberry leaf meal;
346MLM: *ad libitum* barley straw +346.2g mulberry leaf meal; SEM: standard error of the mean;
SL: significant level; TEOW: Total edible offal weight

Effect on non-edible offal components

The values of gut contents, skin and legs, esophagus, urinary bladder and TNEOW indicated less (p>0.05) difference between sole mulberry leaf meal and sole concentrate mix. However, the values of spleen increased with increased proportion of mulberry leaf meal in the diet.

Table 5: Response to supplementation with partial or full substituted concentrate mix with mulberry leaves on non edible offal components of Tigray highland lambs

Parameters	Treatments						
	300CM	225CM: 87MLM	150CM: 173 MLM	75 CM: 260 MLM	346MLM	SEM	SL
Gut contents	3.652^{b}	3.85^{ab}	3.805^{ab}	3.900^{a}	3.843^{ab}	0.084	0.0098
Skin and legs	2.492^{b}	2.483^{b}	2.520^{ab}	2.555^{a}	2.507^{ab}	0.031	0.0257
Blood	0.693	0.684	0.707	0.714	0.713	0.010	0.127
Penis	0.054	0.055	0.057	0.060	0.056	0.002	0.115
Esophagus	0.034^{ab}	0.032^{b}	0.036^{ab}	0.037^{a}	0.036^{ab}	0.001	0.0039
Lung with trachea	0.261	0.245	0.270	0.269	0.255	0.021	0.231
Spleen	0.027^{b}	0.027^{b}	0.030^{a}	0.031^{a}	0.031^{a}	0.001	<.0001
Urinary bladder	0.025^{ab}	0.024^{b}	0.025^{ab}	0.027^{a}	0.026^{ab}	0.001	0.0346
TNEOW	7.24^{b}	7.36^{b}	7.45^{ab}	7.59^{a}	7.47^{ab}	0.093	<.0001

$^{a\text{-}b}$Means in the same row with different superscript differ significantly.
CM: concentrate mix; MLM: mulberry leaf meal; 300CM: *ad libitum* barley straw + 300g concentrate mix;
225CM:87 MLM: *ad libitum* barley straw + 225g concentrate mix + 86.55g mulberry leaf meal;
150 CM:173MLM: *ad libitum* barley straw + 150g concentrate mix + 173.1g mulberry leaf meal;
75 CM:260MLM: *ad libitum* barley straw + 75g concentrate mix + 259.7g mulberry leaf meal;
346MLM: *ad libitum* barley straw +346.2g mulberry leaf meal; SEM: standard error of the mean;
SL: significant level; TNEOW: Total non edible offal weight

DISCUSSIONS

Body weight gain

The final weight and average daily gain were significantly (p<0.05) improved when concentrate was partially or fully substituted by mulberry leaf meal in the current study. Rubanza*et al*. [32] also indicated a better growth performance when meals of forage trees like *A. nilotica, A. polyacantha* and *L. leucocephala* were supplemented in combination with other concentrate diets for goats that is in support of the current finding. However, contrary to the present study, insignificant results for final body weight, average daily gain and feed conversion efficiency were reported in all treatments by Dereje [10] for Arsi-bale goats when supplemented with inclusion of different levels of dried mulberry leaf in concentrate mix consisted of wheat bran and noug seed cake.

The 150CM: 173MLM composition showed slightly higher value for all body weight measurement parameters. This might be resulted due to the additive effect of mulberry and might be depicted better when 150CM: 173MLM composition of concentrate with mulberry leaf meal is supplemented. In agreement with the present result, Benavides [7] in the study of mulberry as sheep feed noted the presence of an additive effect of mulberry rather than a substitution effect. Likewise, Miller *et al*. [26] suggested supplementation of growing goats with a high energy ration in combination with mulberry during the finishing period to induce better performance than the sole concentrate supplement.

The average daily weight gain obtained in the present study was in the range of 38.0-101 g/day reported by González and Milera [16] and Benavides [7] in weaned goats supplemented with various levels (0, 0.5, 1.5 and 2.5% BW) of mulberry forage to *ad libitum* consumption of Guinea grass (*Panicum maximum*) and for Black belly sheep that consumed King Grass and supplemented with concentrate containing 0, 0.5, 1 and 1.5% of BW of mulberry leaf, respectively. Moreover, the average daily weight gain of lambs in the present experiment was higher than average daily gain of 55 g reported by Liu *et al*. [21] for growing sheep of the Huzhou breed supplemented with 240 gair dried mulberry leaves. Desta*et al*. [11] also noted similar figures (60.93 -70.74g) of average daily gain for Abergelle rams supplemented with mulberry leaves. Nevertheless, higher average daily gain of 121-125 g/day by Miller *et al*. [26] and 80 g and 90 g by Martin *et al*. [24] were reported for weaned goats consumed Pangola grass hay *ad libitum* and supplemented with three levels (0, 50 and 100%) of dried mulberry leaves in combination with a commercial goat ration, respectively. Cuong*et al*. [9] also noted that the potential of fresh mulberry leaves replaced cottonseed meal in the diets of growing cattle with no reduction in live weight gain and feed conversion rate.

In line with the present finding, diets supplemented with mulberry leaves have been reported to lead in increased body weight gains in growing lambs [8] and growing goats[16]. Moreover, Ba *et al*. [6] also reported that milk production increased with the increased levels of mulberry offered to goats. Similarly, Ba *et al*. [6] also noted that mulberry foliage silage could be safely used as the sole feed for growing goats. Benavides [8] also observed no difference in milk yield among groups of grazing dairy cattle supplemented with either concentrate or mulberry leaves. Replacing the mulberry for soybean meal in diets for dairy cows did not affect milk yield or quality [31]. All these authors emphasized the potential of mulberry to replace the costly concentrate diets to resource poor farmers.

Carcass characteristics

The significantly higher carcass traits in 150CM: 173MLM compared with 300CM (sole concentrate mix) obtained in the current finding might be due to higher feed conversion efficiency and average body weight gain. Carcass weight, dressing percentage and rib eye muscle area were greater for animals supplemented with 150CM: 173MLM than those supplemented with higher proportion of concentrate mix groups. This is in line with the average body weight gain and feed conversion efficiency obtained in the current study. The slaughter weight and empty body weight resulted higher (p<0.05) in sole mulberry leaf meal as compared to the whole concentrate mix. This justifies the potential of mulberry leaf meal to replace partially or fully to the commercial concentrate mixture.

The higher values of dressing percentage based on empty body weight than dressing percentage based on slaughter weight base might be due to the influence of digesta on dressing percentage. Dressing percentage based on empty body weight (54.4-56.8 %) obtained in this study was comparable to 53-56.3% [1], 53-57% [12] and 55.7-56.4% [19]. However, Neamn [28] and Zemichael [38] reported lower results of dressing percentage based on empty body weight 48.6-50% and 47-53%, respectively than the current study.

The dressing percentage based on slaughter weight base in the current study ranged between 46.1-48.0%, which seemed in agreement with the 47.3-48.6% for Tigray highland sheep [4]. Nevertheless, lower results on dressing percentages of 32-38%, 38-39.6%, 39.5-43.4% and 36-38.4% on slaughter weight basis than the current study were reported by Neamn [28] and Gebretinsae [14] for local sheep, Zemichael [38] for Arado sheep and Mulu [27] for Wogera sheep, respectively. Generally, the variations in carcass traits in this study and other results of previous studies might be due to variations in age and breed of sheep, and quantity and quality of basal and supplement feeds used during the experiment. In agreement with this, McDonald *et al*. [25] noted that, nutrition, age, sex, genetics, season and other related factors affect the growth and carcass traits of animals.

Rib eye muscle area is an indicator of muscling and amount of lean meat in the carcass. The rib eye muscle area in the current study was in the range of 9.0-9.9 cm^2 that is comparable with 8.6-9.5, 6.3-9.2 and 8.2-10.4 cm^2 reported by Abebe [1], Amare *et al*. [4] and Emebet [12] for supplemented groups of Black Head Ogaden sheep, Tigray Highland sheep and Arsi-Bale sheep, respectively. Lower values of rib eye muscle area than the present study were reported by Desta *et al*. [11] (8.43-8.98 cm^2), Guesh [17] (6.7-7.3 cm^2), Neamn [28] (4.5-6.5), Hagos [19] (5.7-6.4 cm^2) and Hirut [20] (7-8.4 cm^2) for yearling intact male Abergelle sheep, Black Head Ogaden sheep, local sheep, Tigray Highland sheep and Hararghe Highland sheep, respectively. However, rib eye muscle area in the current study was lower than the values of 13-19.5 and 11.5-12.75cm^2 reported by Mulu [27] and Zemichael [38] for supplemented groups of Wogera sheep and Arado sheep, respectively. The differences in rib eye muscle area reported by various authors might be due to variations in the amount and quality of supplements and variations in sheep breeds used for the experiment. Rib eye muscle area is affected by the weight and muscularity of the live animal [29] and it is increased with carcass weight [30] and this report conforms to the result of the current finding.

The total edible offal as well as the total visceral fat deposition indicated higher in the higher proportion of mulberry leaf supplemented lambs than the higher proportion of concentrate supplemented groups. This idea is confirmed by Araba *et al*. [2] who noted that fat deposition followed the trend of gain as faster gaining animals deposited more fat. Therefore, the result of the present study indicated that substitution of mulberry leaf meal for concentrate mix can be used effectively without affecting the result of growth performance, carcass parameters, edible or non edible offal components that can be achieved by sole concentrate supplementation.

CONCLUSION

Base on the above findings with 18.5% CP, the mulberry leaf meal can be considered as a medium protein feeds. As it is easily available in the locality of the farmers in the study area, the plant can substitute other commercial protein supplements which are too expensive and not affordable by low income farmers as well. The slaughter weight and empty weight resulted higher in sole mulberry leaf meal as compared to the whole concentrate mix. The result of the present study indicated that substitution of mulberry leaf meal for concentrate mix can be used effectively without affecting the result of edible or non edible offal components that can be achieved by sole concentrate supplementation.

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REFERENCES

1. Gemechu A. Effect of supplementation with graded levels of concentrate mix on feed intake, digestibility, body weight change, carcass parameters and economic benefit of Arsi-Bale sheep fed a basal diet of urea treated barley straw. Thesis presented to Haramaya University, Ethiopia. 2011;74p.
2. Araba A, Bas P, Kabbai A, Moran RP. Performance, carcass characteristics and meat quality of Timahdite-breed lambs finished on pasture or on hay and concentrate. In: Papachristou, T.G., Parissi, Z.M. and BenSalem, H. (eds.), Nutritional and foraging ecology of sheep and goats. Ciheam, Nagref, Zaragoza. 2009; 465-469.
3. Tolera A. Feed resources and feeding management: a manual for feedlot operators and development workers. Ethiopia; 2008.
4. Amare D, Solomon M, Gebreyohannes B. Supplementation of isonitrogenous oil seed cakes in cactus (*Opuntiaficus-indica*)–tef straw (*Eragrostis tef*) based feeding of Tigray Highland sheep. Animal Feed Science and Technology. 2009; 148:214-226.
5. Association of Official Analytical Chemist (AOAC). Official Method of Analysis. 12th ed. Washington DC (USA): Association of Official Analytical Chemist, 1990.
6. Ba NX, Giang VD,Ngoan LD. Ensiling of mulberry foliage (Morusalba) and the nutritive value of mulberry foliage silage for goats in central Vietnam. Livestock Research for Rural Development. 2005; 17(15).
7. Benavides J. Utilization of mulberry in animal production systems (part 1/3); 2001. http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGAP/FRG/MULBERRY/Benavid.tx
8. Benavides JE. Utilization of Mulberry in Animal Production Systems, In: Sanchez (ed.), Mulberry for Animal Production, *Proceeding of Electronic Conference*, 2000.
9. Cuong Chi VU, Pham M, Cuong P, Hung C. The Nutritive Value of Mulberry Leaf (*Morus alba*) and Effects of Partly Replacement of Cotton Seed with Fresh Mulberry Leaf in Rations on Performance of Growing Cattle in the North of Vietnam. Proceedings of AHAT/BSAS International Conference: Integrating Livestock-Crop Systems to Meet the Challenges of Globalization, Khonkaen, Thailand, 2005.
10. DerejeWorku. Effect of Substitution of Concentrate Mix with Dried Mulberry Leaves on Feed Intake, Digestibility, Body Weight Gain and Carcass Characteristics of Arsi-Bale Goats. Thesis presented to Haramaya University, Haramaya, Ethiopia, 2015.
11. Desta T, Yadav RK, Teferi A. Substitution of dried mulberry (*Morus indica* L.) leaf meal for concentrate mix on feed intake, digestibility, body weight gain and carcass characteristics of Abergelle sheep. International Journal of Livestock Production. 2017; 8(4):48-56. DOI: 10.5897/IJLP2016.0346
12. Legesse E. Supplementation of Black Head Ogaden Sheep Fed Haricot Bean (*Phaseolus vulgaris*) Haulms with Mixtures of Wheat Bran and Brewers Dried Grain: Effects on Feed Utilization, Live Weight Gain and Carcass Parameters. Thesis Presented to the School of Graduate Studies, Haramaya University, Ethiopia, 2008.
13. Food and Agriculture Organization of the United Nations (FAO). Animal production based on crop residues: China's experiences. FAO Animal Production and Health Paper. 2002; 149:39.
14. Mezgebo G. Effects of Supplementing dried branches of *Acacia senegal* and cactus cladodes on feed intake, digestibility, body weight gain and carcass characteristics of local male sheep fed barley straw. Thesis

presented to the School of Graduate Studies of Haramaya University, Ethiopia. 2011; 73p.
15. Gizaw S, Tegegne A, Gebremedhin B, Hoekstra D. Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement. Improving Productivity and Market Success (IPMS) of Ethiopian farmers project working paper 23. International Livestock Research Institute (ILRI), Nairobi, Kenya, 2010.
16. Gonzalez E, Milera M. Mulberry in livestock feeding systems in Cuba: Forage quality and goat growth. Livestock Feeding Systems in Cuba, 2000.
17. Fisaha G. Comparison of supplementing urea molasses and urea Atella blocks on feed intake, digestibility, body weight change and carcass characteristics of male Black Head Ogaden sheep fed natural pasture hay. Thesis presented to the School of Graduate Studies of Haramaya University, Ethiopa, 2011; 70p.
18. Habib G, Khan NA, Sultan A, Ali M. Nutritive value of common tree leaves for livestock in the semi-arid and arid range lands of Northern Pakistan. Livestock Science. 2016; 184:64-70.
19. Abreha H. Effects of supplementation with air dried leaves of African wild olive (Olea africana), red thorn (*Acacia lahai*) and their mixtures on performance of Tigray highland sheep fed grass hay. Thesis presented to the School of Graduate Studies of Haramaya University, Ethiopa, 2011; 104p.
20. Yirga H. Supplementation with concentrate mix to Hararghe highland sheep fed a basal diet of urea-treated maize stover: Effect on feed utilization, live weight change and carcass characteristics. Thesis Presented to School of Graduate Studies of Haramaya University, Ethiopa, 2008; 93p.
21. Liu JX, Yao J, Yan B, Yu JQ, Shi ZQ. Effects of mulberry leaves to replace rapeseed meal on performance of sheep feeding on ammoniated rice straw diet. Small Ruminant Research. 2001; 39:131-136.
22. Kabi F, Bareeba FB. Herbage biomass production and nutritive value of mulberry (*Morus alba*) and *Calliandra calothyrsus* harvested at different cutting frequencies. Animal Feed Science and Technology. 2008;140:178-190.
23. Kandylis K, Hadjigeorgiou I, Harizanis P. The nutritive value of mulberry leaves (*Morus alba*) as a feed supplement for sheep. Trop. Anim. Prod. 2009; 41:17-24.
24. Martin GJ, Gertrudis P, Yolai N, Yuvan C, Maykelis D, Ojeda F, *et al*. Behavior of mulberry (*Morus alba*) and its impact on the animal production and the breeding of silkworms in Cuba. Cuban J. Agric. Sci. 2014; 48:73-78.
25. McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA, Wilkinson RG. Animal Nutrition. 7th ed. Prentice hall publishing, Harlow, England. 2010; 247-473.
26. Miller D, McDonald D, Asiedu F. The effect of mulberry leaf meal on the growth performance of weaner goats in Jamaica. CARDI Review. 2005;5:5-11.
27. Moges M. Effect of feeding different levels of breweries’ dried grain on live weight and carcass characteristics of Wogera sheep fed on hay basal diet. Thesis presented to school of graduate studies, Haramaya University, Ethiopa, 2005; 56p.
28. Gebresilassie N. Effect of supplementation with dried leaves of *Acacia Albida*, *Acacia seyal* and their mixture on feed intake, digestibility, live weight gain and carcass characteristics of local sheep fed barley straw as basal diet. Thesis presented to the School of Graduate Studies of Haramaya University, Ethiopia, 2011; 79p.
29. O’RourkeB, Russell R, Buege D. Lamb carcass evaluation. UW-Madison, Department of Animal Sciences, 2004.
30. Park GB, Moon SS, Ko YD, Ha JK, Lee JG, Chang HH, *et al*. Influence of slaughter weight and sex on yield and quality grades of Hanwoo (Korean native cattle) carcasses. J. Anim. Sci. 2002; 80:129-136.
31. Pham KC, Nguyen TT, Vu CC. Effect of replacement of soybean with mulberry leaves in diets on performance of lactating cows. Proceedings MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources, Halong Bay, Vietnam, 2007. http://www.mekarn.org/prohan/trung.htm
32. Rubanza CDK, Shem MN, Bakengesa SS, lchinohe T, Fujihara T. Effect of *Acacianilotica*, *A. polyacantha and Leucaena liucocephala* leaf meal supplementation on performance of small east African goat fed native pasture hay basal forages. Small Ruminant Research. 2007;70:165-173.
33. Sanchez MD. World distribution and utilization of mulberry and its potential for animal feeding. FAO Animal Production and Health Paper 147, Rome, Italy. 2002; pp.345.
34. Statistical Analysis System (SAS)**.** SAS/STAT Guide to personal computers, version 9.2. Statistical Analysis System Institute Inc., NC, USA, 2008.
35. ShayoCM. Browse leaves and pods as ruminant feed in central Tanzania (thesis). Swedish University of Agricultural Sciences, Sweden, 1998.
36. Solomon M. Evaluation of selected multi-purpose trees as feed supplements in tef (*Eragrostis tef*) straw based feeding of Menze sheep. Ph.D Thesis, Humboldt University, Berlin, Germany. 2001; 210 pp.
37. Van Soest PJ, Robertson BJ, BA Lewis.Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science.1991; 74:3583-3597.
38. Gebresilassie Z. The effect of supplementation with sesame seed (*Sesame indicum*) cake, wheat bran, and their mixtures on feed utilization and live weight gain of Arado sheep. Thesis Presented to School of Graduate Studies Haramaya University, Ethiopia. 2007; 71p.