Feedlot Comparative Fattening, Nutrient Utilization and Profitability Evaluation of Intact and Castrated Washera Sheep

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Abstract: A study was conducted to evaluate the feedlot performance of intact and castrated Washera sheep under Low (300 g/day) and High (450 g/day dry matter (DM)) levels of concentrate mix supplementation. The concentrate mix contained 68 and 32% of wheat bran and noug seed cake, respectively. Twenty four sheep (12 intact and 12 castrated) with age range of 9-10 months and initial weight of 24.1±1.8 kg (mean ± SD) were used. A randomized complete block design in a 2x2 factorial treatment arrangement (2 sex category and 2 concentrate levels) was employed. The study period lasted for 90 days of fattening and 7 days of digestibility. Basal hay was fed ad libitum at a rate of 20% refusal. Total DM (871 vs 738), organic matter (OM) (789 vs 666), and crude protein (CP) (134 vs 104 g/d) intakes were significantly higher ($p<0.01$) for sheep at the High than the Low level of supplement. Similarly, High level of supplementation resulted in higher apparent DM, OM and CP digestibility than the Low level. Intake and digestibility were not affected by castration. Intact sheep had higher average daily gain (ADG) (58.5 vs 45.5 g/d) and feed conversion efficiency (0.071 vs 0.058) than castrated sheep. Intact sheep supplemented with High level of concentrate supplementation fetched the highest net return (798.15 Birr/head) followed by intact sheep supplemented with Low level (692.72 Birr/head). In conclusion, the result shows that fattening of intact sheep with High level of concentrate supplementation improved nutrients utilization and average daily gain, and increased net income.

Keywords: *Castrated, Feed conversion efficiency, Feed intake, Intact, Partial budget, Sheep*

Introduction

Ethiopia harbours a huge and genetically diversified sheep population that are considered as an important asset for the present and future livelihoods of the large rural poor farmers in terms of financial income, food and non-food products, and socio-economic and cultural functions (Asresu *et al.*, 2013), and to the national economy in the form of live animal, meat and processed and semi-processed skin and leather export (Adane and Girma, 2008; AGP-Livestock Market Development Project, 2013). However, the present production level of sheep from the widely practiced subsistent type of production systems is far below their potential. As a result, meat production is estimated at about 3.5 kg per sheep per year in the population and 10 kg per sheep slaughtered, which are very low when compared with those in neighboring countries having small ruminant population of 50-75% less than Ethiopia (Amha, 2008). One of the major constraints for such low productivity of sheep is lack of good quality and enough feed (CSA, 2015). As the study by Tesfaye *et al.* (2011) indicated, sheep responds very well to a better feeding system. Therefore, the current production system demands interventions in feeding strategy to enhance animal productivity and help realize the increasing demand both for domestic consumption and for the highly competitive export market.

Castration is an important on-farm management practice for sheep husbandry in Ethiopia. The prominent reasons for castration were reducing aggression and sexual activity, easier and safer handling, management flexibility to finish lambs to meet market specifications under variable seasonal conditions, and more importantly for the production of improved quality meat and weight development (Alemu, 2008a; SSGWG, 2013). In Ethiopia, there are niche markets for animals that are castrated and fattened to very high weight and condition. Such animals fetch higher market prices during public and religious holydays and festivals. Yenesew *et al.* (2013) reported that castrated sheep having bigger body size with prominent fat tail and attractive coat color are selected for holyday and festival celebrations in North-western Ethiopia. Moreover, for highland mixed crop-livestock farmers, castrating and fattening one or more sheep for holidays home consumption is considered as a sign of prestige.

Although castrating sheep and fattening for economic and social values in North-western Ethiopia is a very long traditional activity of the society (Mengistie *et al.*, 2010; Yenesew *et al.*, 2013), no

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comparative performance evaluation study between intact and castrated Washera sheep under different feeding regime is available to recommend for the extension programs. Therefore, the present study was designed to fill this gap with the objective of evaluating the difference in nutrient utilization and fattening performance of intact and castrated Washera sheep kept under feedlot condition.

Materials and Methods

The Study Area

The study was conducted at Burie campus of Debre Markos University, which is situated at a latitude of 10°42' North and 37°4' East longitude and an altitude of 2091 meters above sea level. The area features a semi-humid climate with relatively cool temperatures. The average minimum and maximum annual temperature of the area are 14°C and 24°C, respectively. It has uni-modal rainfall pattern with annual precipitation range of 1000-1500 mm, the bulk of which occurs from May to September (IPMS, 2007).

Experimental Animals and Management

A total of 24 male Washera sheep of about 8-10 months of age were purchased from the local market and used for the experiment. The age of the animals was estimated by the pattern of eruption of the incisor teeth (Solomon and Kassahun, 2009) and the information obtained from the owners. In the experimental site the sheep were quarantined for 21 days in order to observe their health condition and vaccinated for sheep pox and injected with 20% oxy-tetracycline for treatment of Pasteurellosis. Ivermectin was injected as a broad spectrum treatment against internal and external parasites. They were also de-warmed with Albendazole mainly against the adult stages of internal parasites. During the 3rd week of the quarantine period, twelve of the twenty four rams were selected randomly based on their weight, and castrated using Burdizzo clamp method. Then all animals were left for grazing for about 45 days as recommended by Awet and Solomon (2009) to permit the castrated animals recover from the stress of castration.

After recovery period, the sheep within castrated and intact were blocked into six groups of two sheep each based on their initial weights and randomly assigned to treatments (six animals per treatment) and randomly assigned to a well-ventilated individual pens equipped with watering and feeding troughs. The sheep were acclimated to the pen environment and experimental condition for about two weeks, which was followed by 7 days of digestibility trial and 90 days of fattening/feeding trial.

Experimental Design and Treatments

The experiment was arranged in a randomized complete block design with 2x2 factorial arrangements (two sex categories (castrated and intact sheep) and two concentrate levels). The experiment feeds consisted of mixed sward natural pasture hay as a basal diet and concentrate mix as a supplement. The hay was manually chopped to about 2.5 cm size and fed *ad lib* ensuring a refusal of 20% with the amount of offer adjusted once every 3rd day. Animals were supplemented with either Low (300 g DM/day/head) or High (450 g DM/day/head) level of concentrate mix. The concentrate diet was introduced gradually over the two weeks of acclimation period until the total daily offer reached at the end of the acclimation period.

The levels of concentrate were set on the basis of recommended levels used in earlier works to evaluate fattening potential of Washera sheep (Tesfaye *et al*., 2011). The concentrate mix was composed of 68% wheat bran (WB) and 32% noug seed cake (NSC), formulated to have about 22% CP to fulfill the nutrient requirements of growing lambs based on the recommendations of Kearl (1982). The concentrate was offered twice a day in two equal portions at 0800 and 1600 hours. Clean water and salt lick were available all the time throughout the experimental period.

Digestibility Trial

All animals were harnessed with faecal collection bags for three days of adaptation followed by 7 days faeces collection period. During collection period, feces voided into the bags were emptied into a container, weighed and recorded for each animal separately, thoroughly mixed and a sub-sample of 10% was taken daily and bulked across the experimental period and stored in a refrigerator at -20°C. At the end of the experiment, the bulked samples from each animal were thawed, thoroughly mixed, and sufficient amount of sub-sample from each were taken and partially dried at 60°C for 72 hours, ground to pass 1 mm screen and stored pending chemical analysis. The feed offered and refused to each animal were weighed and recorded daily. Daily feed intake of the experimental animals was calculated on DM bases as the difference between the feeds DM offered and refused. Feed samples from the offer (hay and concentrate) and hay refusals per animal were taken daily and pooled, thoroughly mixed and sub-sampled for chemical analysis. The apparent digestibility of DM and nutrients were determined as a difference of intake and fecal output divided by intake multiplied by 100.

Growth Trial

The growth study lasted 90 days following the digestibility trial. When the growth trial commenced, the initial body weight (IBW) of each animal was taken after overnight fasting. The amount of concentrate and hay offered and refused were recorded daily throughout the study period using digital balance having a sensitivity of 0.02 kg. The metabolize energy (ME) intake of experimental animals (MJ/kg DM) was estimated from its digestible organic matter (DOM) by using the equation ME = DOM x 0.0157 (McDonald *et*

al., 2002). Where: DOM = Digestible organic matter per kg DM.

All animals were weighed at an interval of 10 days after overnight feed withdrawal and before the daily feeding, using hanging scale graduated in 0.2 kg interval. Total weight gain (TWG) was calculated as the difference between final and initial weights. Average daily weight gain (ADG) was determined by regressing body weight against time. Feed conversion efficiency (FCE) of the animal was determined as the proportion of daily weight gain to the daily DM intake.

Profitability Analysis

Partial budget analysis was conducted to determine profitability differences of fattening intact and castrated Washera sheep under the two levels of concentrate supplementation, considering total variable costs (TVC) (Purchase price of sheep, total feed cost, and castration cost). The selling price of each animal was estimated by three experienced individuals involved in sheep trading in the area. The difference in average selling and purchase price of each animal was taken as total return (TR). Profitability was determined using net income (NI), calculated as NI = TR – TVC, since there was no change in NI (ΔNI) and change in TVC (ΔTVC) to calculate the marginal rate of return.

Chemical Analysis

Chemical analysis of samples was done in Haramaya University Animal nutrition laboratory. Representative samples of feeds (basal hay and concentrates), hay refusals, and feces were dried at 60°C for 72 hours. The dried samples were ground using laboratory mill to pass through 1 mm screen and stored for subsequent analyses of dry matter (DM), crude protein (CP), ash (AOAC, 1990), acid detergent fiber (ADF), neutral detergent fiber (NDF) and acid detergent lignin (ADL) (Van Soest and Robertson, 1985). The CP was calculated as N*6.25.

Statistical Analysis

Data was analyzed using the general linear model GLM procedure of SAS (SAS, 2003). Adjusted Tukey test was used to locate the significant differences between means when F-test declare significance at $p<0.05$. The statistical model used was: $Y_{ijkl} = \mu + B_i + S_j + C_k + (S\times C)_{jk} + Eijkl$. Where: Y_{ijkl} = the response variable; μ = overall mean; B_i = effect of block; S_j = effect of sex; C_k = effect of concentrate level; $(S\times C)_{jk}$ = interaction between sex of sheep and concentrate level, and E_{ijkl} = random error. Since interaction between sex and supplement level for all attributes evaluated were not statistically significant ($p>0.05$), only means for main factors were presented and discussed.

Results

Chemical Composition of the Experimental Feeds

The chemical composition of feeds and hay refusals is shown in Table 1. The relatively good CP concentration and high fiber fraction contents of hay indicated a moderate to high stage of maturity at harvest that can categorize the hay as medium quality. The higher CP and OM, and the lower fiber fraction contents of the concentrate mixture used revealed its high nutritional value to supplement roughages. The lower CP and highest fiber fraction contents of hay refusals as compared to the offer reflect the selective consumption of animals towards the more nutritious part of the basal hay.

Table 1. Chemical composition (% for DM and % DM for others) of experimental feeds and hay refusals

Experimental feeds	DM	OM	Ash	CP	NDF	ADF	ADL
Hay	92.1	90.0	10.0	7.9	72.2	46.5	10.1
Wheat bran (WB)	90.8	89.7	10.3	18.0	44.1	14.4	8.1
Noug seed cake (NSC)	92.2	91.9	8.1	31.8	34.9	28.2	10.9
Concentrate mix	90.9	91.7	8.3	21.6	41.0	15.5	8.7
Hay refusal							
Low – Intact	92.0	92.3	7.7	3.6	75.5	51.2	12.6
Low – Castrate	91.8	92.4	7.6	4.7	74.3	52.1	13.1
High – Intact	91.9	92.2	7.8	4.7	75.6	52.0	14.8
High – Castrate	91.7	91.5	8.5	4.9	75.2	52.2	12.7

DM= Dry matter; OM= Organic matter; CP= Crude protein; NDF= Neutral detergent fiber; ADF= Acid detergent fiber; ADL= Acid detergent lignin; Concentrate mix= 32% NSC + 68% WB; Low= Hay ad libitum + 300 g/d Concentrate mix; High= Hay ad libitum + 450 g/d Concentrate mix; Intact= Uncastrated sheep; Castrate= Castrate sheep.

Dry Matter and Nutrient Intakes

The concentrate was consumed without refusal and hay dry matter intake was not statistically different at both sex and levels of supplementation (Table 2), as a result the daily total DM intake was greater ($p<0.001$) in sheep supplemented with high level of concentrate than the low level. Similarly, total OM, CP, NDF and ME intakes were significantly higher ($p<0.01$) for the sheep consumed high level of supplement. However, ADF intakes were not statistically different between supplement levels.

Dry Matter and Nutrient Digestibility

There was significant variations between supplement levels in apparent DM, OM, and CP digestibility, but digestibility of NDF and ADF were unaffected by

supplement levels (Table 3). The higher digestibility of DM and nutrients in the high supplement level compared to the low level may be a consequence of higher supply of dietary CP in the former group.

Table 2. Dry matter and nutrient intakes of intact and castrate Washera sheep fed grass hay basal diet supplemented with two levels of concentrate mix

Parameters	Sex category (S)			Concentrate mix level (C)			SEM
	Intact	Castrate	p-value	Low	High	p-value	
DM intake							
Hay (g/d)	449	410	0.129	438	421	0.50	17.2
Concentrate (g/d)	375	375	--	300	450	--	--
Total DM (g/d)	824	785	0.129	738[b]	871[a]	<.001	17.2
DM (% BW)	3.02	3.0	0.307	2.8[b]	3.2[a]	<.001	0.05
DM (g/kg $W^{0.75}$)	69	67	0.195	63[b]	73[a]	<.001	1.12
Nutrient intake							
OM (g/d)	745	710	0.131	666[b]	789[a]	<.001	15.5
CP (g/d)	121	117	0.076	104[b]	134[a]	<.001	1.43
NDF (g/d)	474	447	0.139	436[b]	485[a]	0.014	12.4
ADF (g/d)	261	242	0.109	244	259	0.20	7.91
ME (MJ/d)	7.72	7.17	0.087	6.75[b]	8.14[a]	<.001	0.21

[a,b]Means with different superscript letter within sex category and diet in the same row differ significantly (p<0.05). Concentrate mix= 32% Noug seed cake + 68% wheat bran; Low= 300 g/d concentrate mix; High= 450 g/d concentrate mix; SEM= Standard error of mean; DM= Dry matter; OM= Organic matter; CP= Crude protein; NDF= Neutral detergent fiber; ADF= Acid detergent fiber; ME= Metabolizable energy.

Table 3. Apparent digestibility (%) of dry matter and nutrients of intact and castrate Washera sheep fed grass hay basal diet supplemented with two levels of concentrate mix

Parameters	Sex category (S)			Concentrate mix level (C)			SEM
	Intact	Castrate	p-value	Low	High	p-value	
DM	64.3	63.5	0.677	61.8[b]	66.0[a]	0.043	1.33
OM	66.4	65.6	0.684	63.9[b]	68.1[a]	0.034	1.27
CP	84.7	84.7	0.990	83.6[b]	85.9[a]	0.043	0.75
NDF	59.0	56.5	0.278	56.5	59.0	0.286	1.58
ADF	46.4	43.0	0.271	44.3	45.1	0.786	2.08

[a,b]Means with different superscript letter within sex category and diet in the same row differ significantly (p<0.05). Concentrate mix= 32% Noug seed cake + 68% wheat bran; Low= 300 g/d concentrate mix; High= 450 g/d concentrate mix; SEM= Standard error of mean; DM= Dry matter; OM= Organic matter; CP= Crude protein; NDF= Neutral detergent fiber; ADF= Acid detergent fiber.

Table 4. Body weight and feed conversion efficiency of intact and castrated Washera sheep fed grass hay basal diet supplemented with two levels of concentrate mix

Parameters	Sex category (S)			Concentrate mix level (C)			SEM
	Intact	Castrate	p-value	Low	High	p-value	
IBW (kg)	24.1	24.1	0.974	24.1	24.1	0.898	0.36
FBW (kg)	29.4[a]	28.2[b]	0.009	28.1[b]	29.5[a]	0.002	0.27
TWG (kg)	5.3[a]	4.1[b]	0.010	4.0[b]	5.4[a]	0.003	0.27
ADG (g/d)	58.5[a]	45.5[b]	0.010	44.4[b]	59.5[a]	0.003	2.99
FCE	0.071[a]	0.058[b]	0.035	0.060	0.068	0.178	0.004

[a,b]Means with different superscript letter within sex category and diet in the same row differ significantly (p<0.05). Concentrate mix= 32% Noug seed cake + 68% wheat bran; Low= 300 g/d concentrate mix; High= 450 g/d concentrate mix; SEM= Standard error of mean; IBW= Initial body weight; FBW= Final body weight; TWG= Total weight gain; ADG= Average daily gain; FCE= Feed conversion efficiency.

Body Weight and Feed Conversion Efficiency

Final body weight (FBW), total weight gain (TWG) and average daily gain (ADG) were significantly affected by sex and supplement level (p<0.05; Table 4). Intact sheep and those supplemented with high level of concentrate gained 1.2 and 1.4 kg more weight, respectively than their counterparts. Intact sheep, regardless of supplement level, attained higher FBW, TWG, ADG and FCE than castrates.

Profitability Analysis

The profitability analysis results indicated that fattening intact Washera sheep supplemented with high level of concentrate brought the highest net income followed

by intact sheep supplemented with low level of concentrate. Castrates supplemented with both levels of concentrate are less profitable than the intact at both level of supplementation (Table 5).

Table 5. Profitability of intact and castrated Washera sheep fed grass hay basal diet supplemented with two level of concentrate mix

Parameters	Concentrate mix level			
	Low		High	
	Intact	Castrate	Intact	Castrate
Purchase price of lambs (Birr/head)	938.00	933.00	923.00	930.00
Total Hay consumed (kg/head)	42.4	37.4	37.5	33.0
Total concentrate consumed (kg)	27.0	27.0	40.5	40.5
Cost for hay (Birr/head)	119.57	105.47	105.75	93.06
Cost for concentrate (Birr/head)	100.71	100.71	151.1	151.1
Total feed cost (Birr/head)	220.28	206.18	256.85	244.16
Castration cost (Birr/head)	0.00	6.00	0.00	6.00
Total Variable cost (TVC) (Birr/head)	1158.28	1145.18	1179.85	1180.16
Gross income (Birr/head)	1851.00	1792.00	1978.00	1865.00
Total return (TR) (Birr/head)	913.00	859.00	1055.00	935.00
Net return (NI) (Birr/head)	692.72	646.82	798.15	684.84

Concentrate mix= 32% Noug seed cake + 68% wheat bran; Low= 300 g/d concentrate mix; High= 450 g/d concentrate mix.

Discussion

Chemical Composition of the Experimental Feeds

Generally, the nutrient compositions of the experimental feeds were within the range for Ethiopian feeds (Seyoum *et al*., 2007). The moderate level of CP of the native grass hay can satisfy the maintenance requirement, and proper rumen function in ruminants (Van Soest, 1994). Moreover, the CP content of the concentrate mix (21.6% of DM) is in the range of the CP contents of quality feed for optimal growth (>15% CP) of sheep in warm climates (Salah *et al*., 2014).

Dry Matter and Nutrient Intakes

The daily DM intake as percent of body weight was within the range of 2.6 to 3.3% reported for growing sheep weighing 25 kg with a daily live body weight gain of 25-100 g/day (Kearl, 1982). According to Ranjhan (2004) the average daily protein and energy requirement for maintenance of sheep weighing 30 kg are 36 g CP and 4.02 MJ ME. The sheep in the present study consumed 104-134 g/day CP and 6.75-8.14 MJ/day ME, which are higher than the requirement for maintenance. Thus, concentrate supplementation at higher level provide opportunity for intake of more nutritionally dense and digestible feeds. In this regard, Van Soest (1994) noted that higher level of supplementation increases the supply of nitrogen to the rumen microbes thereby increasing microbial population and efficiency, the rate of fermentation of digesta and feed intake. In accordance with the present study, Getahun (2014) reported higher feed intake at high level of supplementation for Afar and Black Head Ogaden sheep. Unlike the supplement level, castration of sheep did not significantly impacted DM and nutrient intake, possibly due to the late age of castration and subsequent shorter feeding period, which did not, brought significant physiological change. The present finding is in agreement with the result obtained by Awet and Solomon (2009) who reported increased dry matter intake with increasing level of supplement, but not due to castration of Afar sheep.

Dry Matter and Nutrient Digestibility

According to David (2007) feed with DM digestibility of less than 55% is considered as poor quality and will not maintain body weight, whereas feed having digestibility exceeding 65% is categorized as high quality. This shows that both levels of supplements used in this study could provide nutrients sufficient to allow growth of the animals. The higher DM and nutrient digestibility with the high level of supplement obtained in the present study could be a consequence of the higher CP intake. Supplementation of poor quality forage with good protein feed increases the availability of nitrogen in the rumen, thereby improving the rate of degradation and utilization of the feed (McDonald *et al*., 2010). The absence of difference in digestibility of nutrients between the sex groups imply that castration as in the condition of the present study, such as age and feeding practice, does not have significant effect on nutrient digestibility.

Body Weight and Feed Conversion Efficiency

The higher ADG in high than low level concentrate supplemented group is due to the differences in intake and digestibility of nutrients. In agreement with the present finding, other studies noted significant improvement in daily weight gain and final body weight of indigenous sheep at high level of supplementation (Tesfaye *et al*., 2011; Getahun, 2014). This is in line with the fact that supplements result in improved animal performance possibly by providing essential nutrients for rumen microorganisms, enhancing the microbial activities in the rumen, and through availing more nutrients for the animal (Van Soest, 1994).

The higher weight gain observed for intact sheep than castrates at similar amounts of dry matter intake demonstrated difference in feed utilization efficiency among the groups. This could be attributed to the effect of testosterone hormone which is known to increase the efficiency of dietary nutrient utilization, through enhancing feed intake and FCE (Ismail, 2006). The lower FCE in castrated sheep could also be due to the expected higher body fat to lean ratio for castrated than intact sheep, which requires higher energy cost to deposit a kg of body fat than a kg of lean tissue (Amha, 2008). Lower FCE is recorded in animals with high fat content as a result of greater use of nutrients for maintenance of body tissues and metabolism and productive outputs (Guenter and Campbell, 1995). In the study conducted by Mahgoub *et al.* (1998) it was confirmed that castrated sheep had significantly higher carcass and non-carcass fat contents than ram lambs. These authors also noted that ram lambs grew faster from birth and reached predetermined slaughter weights of 18 and 28 kg in 13 and 25 days earlier than wither lambs, respectively. In another study, Cloete *et al.* (2012) indicated that Dorper ram lambs grew faster than castrates and twice as fast as ewes under feedlot management conditions.

Profitability

Fattening sheep involves intensive feeding to attain slaughter weight with adequate finish in feedlots so as to improve carcass yield for domestic consumption/ export and to directly increase producer's income (Alemu, 2008b). The higher net income for intact sheep in the present study is mainly due to the high body weight gain and feed utilization efficiency which improved performance and their sale values than castrate sheep at both levels of supplementation. The present finding showed that fattening intact Washera sheep in feedlot management condition is more suitable for meat production as they had better weight gain, FCE, and profitability than castrated sheep. Similarly, Hanrahan (2010) noted that leaving male lambs entire increases lamb performance, profit margin per male lamb, produces leaner carcasses and does not affect meat eating quality.

Conclusion

The present study highlighted that intact Washera sheep had higher average daily gain than castrates presumably due to higher feed conversion efficiency. Moreover, high level of concentrate supplement resulted to greater growth rate than the low level. Partial budget analysis showed that fattening intact Washera sheep by supplementing 450 g/day concentrate mix resulted in higher net income followed by intact sheep supplemented with 300 g/day concentrate mix. Therefore, under the current study condition fattening of intact Washera sheep with high level of supplementation is recommended to attain better animal performance and maximum profit.

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Conflict of Interests

The authors declare that they have no competing interests.

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