World Applied Sciences Journal 4 (4): 545-553, 2008
ISSN 1818-4952

Growth Performance and Carcass Characteristics of Arsi-Bale Goats Castrated at Different Ages

[1]Tesfaye Kebede, [1]Tesfaye Lemma, [1]Hunduma Dinka, [1]Mieso Guru and [2]Amsalu Sisay

[1]Adami Tulu Agricultural Research Center, P.O. Box 35, Zeway, Ethiopia
[2]Department of Animal and Range Science, Hawassa University, P.O. Box 05, Hawassa, Ethiopia

Abstract: The study was conducted on thirty six male Arsi-Bale kids of 10.56±0.39kg initial body weight for 15 months to investigate the effects of age at castration on growth performance and carcass characteristics. The treatments were entire/intact (T1), castration at three month of age (T2), castration at six month of age (T3) and castration at nine month of age (T4). All castrated and entire goats were browsed during day time and supplemented with concentrate at 2.5% of body weight in DM per day which adjusted with changes in their body weight. Five goats from each treatment were randomly selected and slaughtered for carcass evaluation. Age at castration had no significant effect on body weight, total weight gain (TG), overall average daily gain (ADG) and linear body measurements. T1 and T4 had significantly ($P<0.05$) higher ADG (g/day) (113.73±3.53 and 108.50±5.23, respectively) than T2 (92.16±6.20) and T3 (92.16±5.72) at 9-12 months of age. There were no significant differences among treatments on most carcass or non-carcass measurements except for fat deposition, which were significantly ($P<0.05$) lower and heavier for entire as compared to castrated groups, respectively. Therefore, castration is important for better fat deposition in carcass than for body weight gain improvement as time of castration did not result in better weight gain in this study. If castration desired, early castration is recommendable as goats castrated at three months of age had better rib eye area and fat thickness than other castrated groups and intact goats.

Key words: Arsi-Bale goats · Carcass characteristics · Castration · Growth

INTRODUCTION

Small ruminant animal husbandry is the most important and usually the only living source for people inhabiting in forest regions or regions not suitable for crop cultivation and cattle production [1]. Castration of animals is a common management practice that imposes unnecessary pain and stress and may reduce performance [2]. Intact male have relatively greater muscle in the neck and forequarter than females or castrates. The presence of testicular hormones is related to greater muscle growth capacity in intact males [3]. Castration in goats has an advantage of eliminating the strong male odor present in bucks. Un-castrated and sexually mature goats are difficult to sell or they may have low market price because of their strong male taint. Castrations also affect growth and carcass composition [4]. Castrating yearling male sheep can reduce their growth capability and higher dressing percentages in castrated males than intact rams were reported [5].

Some Ethiopian farmers usually castrate their goats after maturity and fatten them for sale at premium holiday markets. However, castration at a younger age is rarely practiced, which may become necessary when superior bucks are being used for breed improvement programs since it may be more convenient for smallholders to castrate young bucks not required for breeding than to keep them from the does until they are sold. Early castration has much greater effect on carcass quality especially on marbling degree than has latter castration and male kids not required for breeding should preferably castrated at early ages, both to good quality carcass and to prevent unwanted mating. However, since the action and level of androgen differ at different ages, castration at different ages may produce different outcome. Therefore, the present study was aimed to study effect of castration at different ages on growth and carcass characteristics of Arsi-Bale goats.

Corresponding Author: Tesfaye Kebede, Adami Tulu Agricultural Research Center, P.O. Box 35, Zeway, Ethiopia

MATERIALS AND METHODS

Description of Study Area: The experiment was conducted at Adami Tulu Agricultural Research Center (ATARC), which is located 167 km south of Addis Ababa at an altitude of 1650 meter above sea level in mid rift valley. The agro-ecological zone of the area is semi arid and sub humid with acacia woodland vegetation type. The mean annual rain falls is 760mm. The mean minimum and maximum temperature are 12.6°C and 27°C, respectively. The soil type is fine, sandy loam with sand: silt: clay in the ratio of 34: 38: 18, respectively. The pH is 7.88 [6].

Experimental Animals, Their Management and Treatments: Thirty-six male Arsi-Bale kids with an average age of three months and 10.56±0.39kg body weight were purchased from local market. They were maintained in quarantine for few weeks and the kids were treated for external and internal parasites with accarcide and albendazole, respectively. One week after they have been treated, they were assigned to one of the following treatments of 9 kids each. T1=un-castrated (control), T2=castrated at an average age of 3 months, T3=castrated at an average age of 6 months and T4=castrated at an average age of 9 months. Similar management was given for all treatments and what varied among treatments was only age at castration. All kids were castrated by burdizzo.

Kids were browsed during the day time and supplemented with concentrate feed up on their return from browsing. The concentrate feed was a mixture of 49% noug cake, 50% wheat middling and 1% salt. Kids were supplemented daily on average 2.5% of their body weight. Average daily supplement were adjusted according to fortnight body weight changes of the animals. The supplement was given on group bases. Water was offered over night and they were also allowed to drink water from river during the day time while browsing.

During the experimental period (from 4/3/2005 to 3/6/2006) kids that showed abnormal symptoms such as diarrhea, loss of appetite, hair erections etc were treated after their problems were identified. Kids were weighed initially then after weekly through out the experimental periods while linear measurements and body condition score were taken fortnightly.

Carcass Evaluation: Five animals from each treatment group were randomly selected and slaughtered for carcass evaluation at the end of experimental period. The animals were slaughtered following the standard procedures of USDA [7]. The bodies were skinned; the heads and feet were removed. The carcasses were eviscerated and the internal organs and tissues were weighed. All body components such as head, feet with hooves, skin, blood, kidneys, bladder, liver with bile, heart, lungs, spleen, pancreas, penis, testicles, full and empty gut were weighed and their percentages with respect to the empty live weight of the animals were determined. Kidneys fat, heart fat, pelvic fat, scrotal fat, omental and mesenteric fat were also weighed using sensitive balance. Full live weight, empty live weight, hot carcass weight and hot dressing percentage were determined. Carcass was dissected in order to separate muscle, fat and bone tissues after 24hrs chilling at -2°C. The carcass was cut between 12^{th} and 13^{th} ribs to measure rib eye area (REA) with calibrated water proof paper. The thickness of fat along the surface of rib eye area was measured using ruler. Dressing percentage was calculated according to hot carcass weight and pre-slaughter live weight. One half of the carcass was separated in to different primal cuts (leg, lion, rack, breast and shank, and shoulder and neck). From each primal cut muscle and fat were trimmed from bone by knife and weighed separately. Finally, the amount of each tissue from each primal cut was added together with their respective to determine the proportion of muscle, bone and fat in the carcass.

Statistical Analysis: Data on body weight, body measurements, body condition score, carcass and non-carcass components were analyzed using analysis of variance procedures for a completely randomized design experiment using the General Linear Model procedures of SAS 1999-2000 [8] and Duncan's Multiple Range test was used to compare treatment means. In the analysis, except treatment, initial body weight and body measurements, all parameters were considered as dependent variables.

RESULTS AND DISCUSSION

Body Weight Changes: Mean body weight at respective ages, total weight gain (TG) and average daily gains (ADG) of Arsi-Bale male goats castrated at different ages are presented in Table 1. The mean initial weight for intact, castration at three and nine months of age were significantly ($P<0.05$) higher than those castrated at six months of ages. However, variation in initial body weight was not resulted in significant difference on total gain and over all average daily gain. Castration or age at castration had no significant effect on body weight, total gain or

Table 1: Least square mean and standard error for live weight changes by Arsi-Bale male kids castrated at different ages

Weight by months of age	Entire	Castration at 3 month	Castration at 6 month	Castration At 9 month
Body weight (kg)				
3	10.28±0.49[a]	11.28±0.29[a]	9.83±0.57[b]	10.50±0.19[a]
6	16.17±0.98[a]	16.89±0.83[a]	16.39±1.31[a]	16.28±0.66[a]
9	24.94±1.14[a]	24.44±0.98[a]	22.72±1,44[a]	24.44±0.81[a]
12	34.56±1.21[a]	32.50±0.98[a]	31.00±1.66[a]	31.89±0.95[a]
15	35.44±0.94[a]	35.11±1.03[a]	34.39±1.71[a]	34.28±0.80[a]
18	40.89±1.32[a]	40.06±1.27[a]	39.50±1.78[a]	38.94±0.76[a]
Total gain (kg)	30.61±0.96[a]	28.78±1.23[a]	29.67±1.55[a]	28.44±0.65[a]
Daily weight gain (g)				
3-6	69.28±8.13[a]	66.01±7.90[a]	77.12±9.78[a]	67.97±6.51[a]
6-9	95.24±3.71[a]	86.64±7.23[a]	80.03±5.07[a]	94.54±3.05[a]
9-12	113.73±3.53[a]	92.16±6.20[b]	92.16±5.72[b]	108.50±5.23[a]
12-15	7.19±4.13[b]	18.95±6.85[ab]	31.37±5.00[a]	24.18±4.43[a]
15-18	69.30±7.19[a]	63.32±4.18[a]	63.32±4.18[a]	61.53±2.30[a]
Overall ADG	67.48±2.12[a]	63.67±2.71[a]	65.63±3.42[a]	62.93±1.45[a]
n	9	9	9	9

Means in the same row with different letters are statistical different ($p<0.05$)

overall ADG in Arsi-Bale goats. In line with our finding, Solomon *et al*. [4] reported that castration had no significant effect on body weight or ADG in Adal goats. Similarly, Mahgoub and Lodge [9] reported that among species/sex/slaughter weight groups, castrated male and female goats had the lowest growth rate. Hopkins-Shoemaker *et al*. [2] indicated that castration of young market goats reduced growth and did not provide any distinct advantage in carcass characteristics. Likewise, Murry *et al*. [10] reported that the growth rate of entire Boer and feral backs were significantly higher than those of castrated respective. In other species of animal, Demissie *et al*. [5] stated that castration may depress the growth of young rams if they are fattened for sale immediately after castration which might be similar with current finding as intact group were better in live weight gain than the castrated once. Lee [11] also indicated that the growth rate of wither lambs was less than that of rams. Similarly, Yibrha *et al*. [12] reported that age at castration had no significant effect on body weight or average daily gain of Black-Head Somali rams.

In large ruminant, castration at either birth or weaning did not alter all growth, feedlot performance, or carcass characteristics of Angus and Charolais-sired steers [13]. In contrary to current finding, Nsoso *et al*. [14] reported significantly higher average weight in castrates (22.37±0.67 and 34.38±0.55 kg) than the entire males (14.37±0.76 and 31.22±1.27 kg) at 0-12 and 13-24 months respectively. This might be due to difference in breed type, feeding management, slaughter age/weight and methods of castration. Intact goats and those castrated at nine months of age had significantly ($P<0.05$) higher ADG than other groups at 9-12 months of ages. However, intact goats had significantly lower ADG than other treatments at 12-15 months of ages. Goats in all treatments performed better at 9-12 months of age, but rate of weight gain was reduced dramatically at 12-15 months of ages which might be partly due to shortage of feed (browses) as those three months (January, February and March) are critical dry periods where there is no green feeds available in the area. This is similar with the report of Velez *et al*. [15] who stated that animal losses weight during the dry season where both the quantity and quality of forage available are limited. Growth rate of goats in all treatments was high up to 12 months of age, but declined then after.

Linear Body Measurements: Mean heart girth (HG), height at wither (HW) and body lengths (BL) measurements for Arsi Bale male goats castrated at different ages are presented in Table 2. The initial heart girth of those goats castrated at three months of age were significantly ($P<0.05$) higher than those castrated at six months of age, while height at wither of goats castrated at three and six months of age was significantly ($P<0.05$) higher than intact kids. Castration at different ages had no significant effect on linear body measurements for Arsi-Bale goats. Inline with this report, Nsoso *et al*. [16] indicated absence of significant difference in linear body measurements among castrate and entire male goats at 14 months of age; but at 22 months of age height at

Table 2: Least square mean and standard error for linear body measurements by Arsi-Bale goats castrated at different ages

Body measurements by months of age	Entire	Castration at 3 month	Castration at 6 month	Castration at 9 month
Heart girth (cm)				
Initial	52.78±1.02^{ab}	54.00±0.67^{a}	51.22±0.91^{b}	52.56±0.38^{ab}
3-6	56.17±1.14^{a}	57.59±0.78^{a}	56.10±1.32^{a}	56.71±0.60^{a}
6-9	63.57±1.34^{a}	63.96±1.02^{a}	62.87±1.56^{a}	64.13±0.78^{a}
9-12	70.89±1.00^{a}	70.34±0.94^{a}	69.74±1.54^{a}	70.11±0.84^{a}
12-15	76.41±0.72^{a}	75.93±0.81^{a}	74.94±1.46^{a}	75.46±0.70^{a}
15-18	77.83±0.58^{a}	77.46±0.66^{a}	76.90±1.46^{a}	76.54±0.71^{a}
Final	79.67±0.82^{a}	79.78±0.95^{a}	78.89±1.40^{a}	78.78±0.78^{a}
Height at wither (cm)				
Initial	49.22±0.95^{b}	51.89±0.81^{a}	51.56 ±0.60^{a}	50.78±0.46^{ab}
3-6	54.24±0.91^{a}	55.33±0.54^{a}	54.37±0.87^{a}	53.97±0.72^{a}
6-9	62.17±1.84^{a}	62.98±0.62^{a}	60.69±1.25^{a}	61.63±1.02^{a}
9-12	68.44±0.93^{a}	68.83±0.52^{a}	67.57±1.12^{a}	68.30±0.73^{a}
12-15	73.41±0.60^{a}	73.63±0.65^{a}	72.54±1.01^{a}	72.33±0.72^{a}
15-18	75.40±0.62^{a}	75.94±0.87^{a}	74.59±0.87^{a}	74.16±0.64^{a}
Final	76.56±0.87^{a}	77.33±0.91^{a}	76.44 ± 0.93^{a}	74.78±0.91^{a}
Body length (cm)				
Initial	46.56±1.28^{a}	48.56±0.53^{a}	47.56±1.09^{a}	47.67±0.91^{a}
3-6	51.90±1.19^{a}	53.30±0.43^{a}	51.24±1.37^{a}	51.83±0.64^{a}
6-9	61.09±1.22^{a}	61.44±0.60^{a}	59.61±1.80^{a}	61.48±0.63^{a}
9-12	67.67±0.97^{a}	67.51±0.64^{a}	65.52±1.51^{a}	67.24±0.70^{a}
12-15	73.48±0.68^{a}	73.19±0.56^{a}	71.93±1.11^{a}	72.37±0.53^{a}
15-18	75.86±0.74^{a}	75.43±0.63^{a}	74.32±1.12^{a}	74.57±0.69^{a}
Final	77.67±0.87^{a}	77.89±0.77^{a}	77.00±1.30^{a}	77.67±1.11^{a}

Means in the same row with different letters are statistically different ($p<0.05$)

withers was significantly higher for castrates than entire goats. However, Nsoso *et al*. [14] reported that there were significantly higher height at withers in castrates (56.54±0.88 and 65.32±0.72cm) than the entire males (49.15±1.00 and 62.26±1.66cm) at 0-12 and 13-24 months respectively. They also stated that diagonal body length was significantly higher in castrates (51.83±0.61 and 60.2±0.49cm) than the entire males (43.03±0.69 and 54.84±1.15cm) at 0-12 and 13-24 months respectively. The same authors reported that castrates develop longer and deeper bodies and body length differed significantly among burdizzo castrated and entire goats. This might be attributed to difference in accuracy of taking linear body measurements, breed type and methodology followed. In all treatments, among body measurements, heart girth was highest followed by height at wither and lowest for body length. This indicates that Arsi-Bale goats castrated at different age had wider chest and shorter body length. However, Thiruvenkadan [17] reported that in all age groups among the body measurements, height at withers was highest followed by chest girth and body length.

There were no significant differences among treatments in body condition score except at 12-15 months of age when goats castrated at three months of age had significantly ($P<0.05$) better body condition score than the intact one (Table 3). Castrated groups had good physical appearance and attractive shine hair coats whereas intact goats were not physically attractive and had erected hair coat which gave them an appearance of malnutrition animals. As a result, castrated groups have got preference on market as compared to the intact once. Behaviorally, castrated groups were very docile and friendly to persons managing them while the intact one were disturbing by fighting and mating each other. Similarly, Devendra and McLeroy [18] reported that castrates are easier to manage than entire males.

Carcass Measurements: Mean carcass measurements in Arsi-Bale goats castrated at different ages are presented in Table 4. There was no significant difference among treatments in mean full live weight, empty live weight, hot carcass weight, dressing percentages and rib eye

Table 3: Least square mean and standard error for body condition score (BCS) by Arsi-Bale goats castrated at different ages

Body condition score by months of age	Entire	Castration at 3 month	Castration at 6 month	Castration at 9 month
Initial	2.78±0.09[a]	2.33±0.08[a]	2.22±0.09[a]	2.78±0.08[a]
3-6	2.71±0.10[a]	2.91±0.09[a]	2.75±0.16[a]	2.71±0.08[a]
6-9	3.01±0.11[a]	3.28±0.14[a]	3.12±0.21[a]	3.24±0.11[a]
9-12	3.34±0.10[a]	3.45±0.11[a]	3.33±0.18[a]	3.31±0.10[a]
12-15	3.42±0.08[b]	3.76±0.08[a]	3.63±0.17[ab]	3.53±0.08[ab]
15-18	3.75±0.07[a]	3.90±0.07[a]	3.73±0.12[a]	3.67±0.08[a]
Final	3.89±0.11[a]	3.89±0.11[a]	3.83±0.17[a]	3.72±0.09[a]

Means in the same row with different letters are statistically different ($p<0.05$)

Table 4: Least square mean and standard error for carcass traits and visceral fat deposition by Arsi-Bale goats castrated at different ages

Carcass traits	Entire	Castration at 3 month	Castration at 6 month	Castration at 9 month
n	5	5	5	5
Full live weight (kg)	41.5±2.00[a]	40.30±1.51[a]	42.0±1.76[a]	39.7±0.96[a]
Empty live weight (kg)	40.0±1.78[a]	38.80±1.34[a]	40.7±1.90[a]	37.4±0.80[a]
Hot carcass weight (kg)	19.44±0.91[a]	18.82±0.86[a]	19.32±0.89[a]	18.16±0.49[a]
Dressing percentage (%)	48.60[a]	48.51[a]	47.47[a]	48.56[a]
Fat thickness (mm)	0.98±0.05[c]	9.20±0.37[a]	8.80±1.02[a]	6.60±0.93[b]
REA (mm^2)	59.20±4.07[a]	61.00±6.24[a]	55.60±3.82[a]	51.60±5.31[a]
Heart fat (kg)	0.039±0.01[a]	0.118±0.05[a]	0.101±0.01[a]	0.089±0.02[a]
Kidney fat (kg)	0.077±0.02[c]	0.610±0.08[a]	0.771±0.12[a]	0.509±0.05[b]
Pelvic fat (kg)	0.057±0.03[b]	0.115±0.04[b]	0.210±0.04[a]	0.077±0.01[b]
Scrotal fat (kg)	0.062±0.02[b]	0.206±0.01[a]	0.248±0.02[a]	0.219±0.03[a]
O + M fat (kg)	0.288±0.04[b]	1.560±0.37[a]	1.520±0.22[a]	1.300±0.11[a]

Means in the same row with different letters are statistically different ($p<0.05$)

area (REA) which was in agreement with the report of Yibrha *et al*. [12] on Black-head Somali rams. Dressing percentage for this study varies from 47.47 to 48.6%. In contrast, Ruvuna *et al*. [19] and Arnold and Meyer [20] indicated that dressing percentage is affected by castration. Pinkerton *et al*. [21] reported that the dressing percentage in male kids varied from 45 to 52% due to various factors. Acharya [22] determined the dressing percentage between 42.7% and 55.4% depending on the slaughter age, nutrition and the race of the kids. Bhattacharyya and khan [23] stated that empty body weight or the amount of rumen and intestine contents might have affected the dressing percentage. Moreover, Tesfaye *et al*. [24] indicated that dressing percentages might be affected by organs to be included in dressed carcass as inclusion or removal of some visceral organs in hot carcass measurement might be resulted in different dressing percentages. Therefore, the lower dressing percentage in current study might be due to exclusion of some visceral organs in its determination, unlike other researchers Daskiran *et al*. [1] who included kidneys, pelvic fat and testicles in hot carcass measurements which in turn affected dressing percentages, in addition to what were mentioned. Inline with this report, Hopkins-Shoemaker *et al*. [2] stated that absence of significant differences in hot carcass weight and dressing percentages between intact and castrated Boer x Spanish goats. However, Solomon *et al*. [4] reported that castrated Adal goats had significantly higher dressing percentage than entire goats (41.6% vs. 39.5%) which were lower than current findings. This might be due to short duration of exposure to concentrate feed in previous study, slaughter weight and breed differences. Similarly, Lee [11] indicated that dressed carcass of castrated lambs were approximately 2 percentage units heavier than those of the rams. Castration at three and six months of age had significantly ($P<0.05$) higher fat thickness than castration at nine months of age and entire goats while castration at nine months had significantly ($P<0.05$) higher fat thickness than entire goats. In line with our finding, Arnold and Meyer [20] reported that castration improved carcass marbling. However, Hopkins-Shoemaker *et al*. [2] did not observe significant difference in fat thickness between intact and castrated Boer x Spanish goats. Age at castration had no significant effect on rib eye area (REA). In support of this finding,

Table 5: Means and percentages of non-carcasses components by Arsi-Bale goats castrated at different ages

Non-carcass components	Entire		Castration at 3 month		Castration at 6 month		Castration at 9 month	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
Blood	1.64^{a}	4.09^{a}	1.04^{c}	2.67^{c}	1.34^{b}	3.30^{b}	1.28^{bc}	3.42^{a}
Head	2.94^{a}	7.34^{a}	2.34^{b}	6.00^{b}	2.38^{b}	5.86^{b}	2.20^{b}	5.89^{b}
Skin	4.70^{a}	11.80^{a}	3.40^{b}	8.82^{b}	3.48^{b}	8.54^{b}	3.40^{b}	9.07^{b}
Feet	1.10^{a}	2.75^{a}	1.08^{a}	2.79^{a}	1.10^{a}	2.70^{a}	1.06^{a}	2.84^{a}
Lung and trachea	0.48^{a}	1.21^{a}	0.74^{a}	1.90^{a}	0.56^{a}	1.36^{a}	0.44^{a}	1.17^{a}
Heart	0.17^{a}	0.42^{a}	0.15^{a}	0.38^{ab}	0.15^{a}	0.36^{b}	0.14^{a}	0.38^{ab}
Liver with bile	0.74^{a}	1.85^{a}	0.62^{a}	1.60^{a}	0.68^{a}	1.64^{a}	0.76^{a}	2.04^{a}
Kidney	0.11^{a}	0.29^{a}	0.11^{a}	0.29^{a}	0.12^{a}	0.29^{a}	0.11^{a}	0.30^{a}
Spleen	0.06^{a}	0.40^{a}	0.06^{a}	0.16^{a}	0.05^{a}	0.13^{a}	0.06^{a}	0.15^{a}
Pancreas	0.05^{a}	0.12^{a}	0.14^{a}	0.35^{a}	0.06^{a}	0.15^{a}	0.06^{a}	0.15^{a}
Penis	0.04^{a}	0.11^{a}	0.02^{a}	0.06^{a}	0.08^{a}	0.19^{a}	0.03^{a}	0.08^{a}
Testis	0.29^{a}	0.73^{a}	0.03^{b}	0.09^{b}	0.03^{b}	0.08^{b}	0.04^{b}	0.12^{b}
Bladder	0.01^{b}	0.03^{b}	0.01^{b}	0.03^{b}	0.01^{b}	0.03^{b}	0.02^{a}	0.05^{a}
Full gut	7.32^{a}	18.17^{a}	5.64^{ab}	14.47^{ab}	6.02^{ab}	14.88^{ab}	4.64^{b}	12.40^{b}
Empty gut	2.36^{a}	5.94	2.78^{a}	7.16^{a}	2.64^{a}	6.52^{a}	2.36^{a}	6.31^{a}

Means in the same row with different letters are statistically different ($p<0.05$).

Hopkins-Shoemaker *et al*. [2] did not observe significant difference between intact and castrate in rib eye area. Even though there were no significant differences among treatments in REA, castration at three month of age resulted in better REA and fat thickness along the surface of REA than other treatments while castration at nine months of age had lower contents in most of the parameters studied than other castrated groups (Table 4).

Castration or age at castration had significant effect on visceral/internal fat contents except on heart fat. Castration at three and six months of age resulted in significantly ($P<0.05$) heavier kidneys fat deposition than castration at nine months of age and intact group whereas those goats castrated at nine months of age had significantly ($P<0.05$) heavier kidneys fat deposition than the intact group. Goats castrated at six months of age had significantly ($P<0.05$) higher pelvic fat content than other treatments. Similarly, Hopkins-Shoemaker *et al*. [2] observed higher kidneys and pelvic fat in castrated than intact Boer x Spanish male goats. All castrated groups had significantly ($P<0.05$) higher scrotal and omental + mesenteric (O + M) fat than intact group whereas no significant differences were observed among castrated groups in scrotal and O + M fat deposition. Solomon *et al*. [4] reported that castrated Adal goats had significantly heavier kidney and omental fat deposit than entire Adal goats, but Yibrha *et al*. [12] did not get difference in the indicated traits between castrated and entire Black-head Somali rams. In general, intact/entire goats had lower fat content than castrated groups.

Means and percentages of non-carcasses components in Arsi-Bale goats castrated at different ages are presented in Table 5. Entire/intact group had significantly ($p<0.05$) heavier free draining blood, head, skin and testis (0.96; 1.42; 2.99; 0.63 percentage points, respectively) than castrated groups while castration at six month of age resulted in heavier blood (0.63 percentage points) in carcass when compared to castration at three months of age. There were no significant differences among treatments in feet, lung and trachea, liver with bile, kidney, spleen, penis and empty gut mass in carcass of goats. Those goats castrated at nine months of age had significantly ($p<0.05$) heavier (0.02 percentage points) bladder in their carcass when compared to other treatments. Intact group had significantly ($p<0.05$) heavier (5.77 percentage points) full gut in their carcass than castration at nine months of age whereas there were no significant differences among castrated groups in full gut content. Goats castrated at six months of age had significantly ($p<0.05$) lighter (0.03 percentage points) heart in their carcass than the rest treatments.

Primal Cut Measurements: Mean carcass composition for different primal cuts in Arsi-Bale goats under different age of castration are presented in Table 6. Castration or age at castration had no significant effect on bone and muscle tissue composition of leg, loin and rack primal cuts. Intact and those castrate at three months of age had significantly ($P<0.05$) higher muscle content in shoulder and neck primal cut than other treatments. Castration at

Table 6: Least square mean and standard error for primal cuts by Arsi-Bale goats castrated at different ages

Primal cuts and their compositions	Entire	Castration at 3 month	Castration at 6 month	Castration at 9 month
Leg				
Bone (kg)	0.46±0.05[a]	0.54±0.10[a]	0.50±0.09[a]	0.52±0.09[a]
Muscle (kg)	1.92±0.13[a]	1.86±0.06[a]	1.94±0.05[a]	1.78±0.11[a]
Fat (g)	61.16±12.26[b]	198.44±49.03[a]	279.4±34.69[a]	172.42±42.63[ab]
Loin				
Bone (kg)	0.14±0.02[a]	0.12±0.02[a]	0.14±0.02[a]	0.16±0.04[a]
Muscle (kg)	0.64±0.08[a]	0.40±0.07[a]	0.68±0.21[a]	0.56±0.14[a]
Fat (g)	36.66±10.87[b]	208.00±38.31[a]	228.14±32.25[a]	231.58±28.39[a]
Rack				
Bone (kg)	0.24±0.06[a]	0.22±0.04[a]	0.16±0.04[a]	0.20±0.04[a]
Muscle (kg)	0.78±0.07[a]	0.54±0.12[a]	0.58±0.06[a]	0.58±0.14[a]
Fat (g)	41.32±7.81[b]	186.34±13.86[a]	255.92±40.51[a]	227.44±41.48[a]
Breast and shank				
Bone (kg)	0.28±0.04[a]	0.24±0.02[ab]	0.20±0.03[ab]	0.18±0.02[b]
Muscle (kg)	0.96±0.14[a]	0.76±0.09[a]	0.86±0.04[a]	0.66±0.14[a]
Fat(g)	44.26±8.22[b]	264.74±66.90[a]	251.54±26.59[a]	171.52±24.72[a]
Shoulder and neck				
Bone (kg)	0.54±0.12[a]	0.40±0.04[a]	0.34±0.04[a]	0.52±0.08[a]
Muscle (kg)	2.00±0.19[a]	1.52±0.10[a]	1.44±0.09[b]	1.46±0.10[b]
Fat (g)	116.66±24.30[a]	248.90±47.06[a]	262.04±59.70[a]	254.54±54.97[a]

Means in the same row with different letters are statistically different ($p<0.05$)

Table 7: Mean carcass composition proportion by Arsi-Bale goats castrated at different ages

	Tissue proportion (%) in carcass		
Treatments	Bone	Muscle	Fat
Entire	20.36[a]	75.97[a]	3.67[b]
Castration at 3 month	19.66[a]	66.13[b]	14.21[a]
Castration at 6 month	16.75[a]	68.45[ab]	14.80[a]
Castration at 9 month	20.57[a]	65.69[b]	13.74[a]

Means in the same column with different letters are statistically different ($p<0.05$)

nine months of age had significantly ($P<0.05$) lower bone mass in breast and shank primal cut than the rest treatments. The fat content in all primal cuts except for shoulder and neck was significantly ($P<0.05$) lower in intact goats than castrated groups while there were no significant differences among castrated groups in their fat deposit across all primal cuts. Muscle weight was highest followed by bone and lowest for fat in each primal cut for all treatments. These were all in agreement with the result of other researchers [1].

Mean carcass composition proportion (relative to hot carcass weight) in Arsi-Bale goats under different age of castration are presented in Table 7. There were no significant differences in bone proportion among treatments whereas intact group had significantly ($p<0.05$) higher muscle and lower fat proportion than castrated groups. This implies that castration affected carcass composition in addition to other factors such as breed, sex and stages of maturity [25-27]. In general, carcass composition in Arsi-Bale male goats castrated at different age with slaughter weight from 37.4-40.7kg, range from 65.69-75.97% lean (muscle), 3.67-14.8% fat and 16.75-20.57% bone. Colomer-Rocher *et al*. [28] have reported that the mean muscle content of male New Zealand Saanen goats to be about 60% and stated that this was higher than that normally found in sheep and Ruvuna *et al*. [19] have reported a lean: fat: bone ratio of 73:9:18 for 14½ month old goats which were in line with our findings. In support of current finding, Lee [11] indicated that carcass of rams tends to be leaner than those of withers and fat score distributions, based on export standard, were such that withers scored higher (fatter) than rams.

CONCLUSIONS AND RECOMMENDATION

Age at castration had no significant effect on body weight or over all average daily gain and linear body measurements except at an age of 9-15 months when significant differences observed among treatments in average daily gain. 9-12 months of age was considered as appropriate age at which optimum growth obtained from Arsi-Bale goats castrated at different ages as goats in all treatments attained better daily weight gain within this age group, but rate of weight gain was reduced dramatically from 12-15 months of ages. Castration or age at castration had no significant effect on most carcass parameters except on fat depositions and on non-carcass components. Intact/entire goats had lower fat deposition than castrated groups. Goats castrated at three months of age had higher fat thickness and rib eye area than other groups and followed by castration at six and nine months of age. Castration had significant effect on carcass composition proportion. Therefore, castration is important for better fat deposition in carcass than for body weight gain improvement as time of castration did not result in better weight gain in this study. If castration desired, early castration is recommendable as goats castrated at three months of age had better rib eye area and fat thickness than other castrated groups and intact group.

ACKNOWLEDGMENT

The authors would like to acknowledge Mr. Kassahun Kitila, Mr. Abe Barko and Mr. Osho Tibeso for their contribution in data collection. We would also like to thank Ethiopian Institute of Agricultural Research for funding the project. Our sincere gratitude goes to Adami Tulu Agricultural Research Center for facilitating logistic and other required materials during the project implementation.

REFERENCES

1. Daskiran, I., K. Askin and B. Mehmet, 2006. Slaughter and carcass characteristics of Norduz male kids raised in either intensive or pasture conditions. Pakistan J. Nutrition, 5(3): 274-277.
2. Hopkins-Shoemaker, C., S. Solaiman, C. Kerth, W. Jones and D. Bransby, 2004. Growth and carcass characteristics of castrated or intact male Boer x Spanish goats grazing marshall annual ryegrass. J. Anim. Sci., (82) suppl. 1.
3. Arnold, A.M., J.M. Peralta and M.L. Thonney, 1997. Effect of testosterone on differential muscle growth and on protein and nucleic acid concentration in muscles of growing lambs. J. Anim. Sci., 75: 1495-1503.
4. Solomon, G., I. Fletcner, K. Gizaw and Y. Yibrah, 1991. Effects of castration and supplementary feeding on growth, carcass characteristics and market value of Adal goats'. In: IAR Proceedings of the Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, pp: 159-164.
5. Demissie, T., A. Kassahun and G. Yohannes, 1989. Comparison of castrated and entire Horro male lambs for growth and fattening ability and various feeding regimes. In: IAR Proceedings of the Second National Livestock Improvement Conference, Addis Ababa, Ethiopia, pp: 74-77.
6. ATARC (Adami Tulu Agricultural Research Center), 1998. Thirty years of research experience. Oromia Agricultural Research Coordination service. Bulletin no 1.
7. USDA, 1982. Official united state standards for grades of lamb, yearling mutton and mutton carcass. Agricultural marketing service USDA, Washington, DC, 1.
8. SAS, 1999-2000. Statistical Analysis System. Institute Inc., Cary, NC, USA.
9. Mahgoub, O. and G.A. Lodge, 1998. A Comparative study on growth, body composition and carcass tissue distribution in Omani Sheep and Goats. J. Agril. Sci., 131: 329-339.
10. Murray, P.J., N.M.W. Sumarmono Pratiwi and D.G. Taylor, 2001. Growth of goats for meat production: effect of breed and castration. Asia Pacific Journal of Clinical Nutrition, 10 (suupl.).
11. Lee, G.J., 1986. Growth and carcass characteristics of ram, cryptorchid and weather Border Leicester x Merino lambs: effects of increasing carcass weight. Australian J. Experiential Agric., 26(2): 153-157.
12. Yibrah, Y., I. Fletcher, Gizaw and G. Solomon, 1991. Effect of castration on growth, fattening and market value of Black-Head Somali rams. In: IAR Proceedings of Fourth National Livestock Improvement Conference, Addis Ababa, Ethiopia, pp: 133-140.
13. Looper, M.L., Burke, J.M., Mcbeth, L.J., Krehbiel, C.R., Flores, R., Rosenkrans, Jr., C.F. and Alken, G.E., 2005. Effects of time constriction on growth, feed lot performance and carcass characteristics of Angus and Charolais-sired calves. American Society of Animal Science Southern Section meeting. J. Anim. Sci., 83: (suppl.2), 32.

14. Nsoso, S.J., B. Podisi, E. Otsogile, B.S. Mokhutshwane and B. Ahmadu, 2004b. Phenotypic characterization of indigenous Tswana goats and sheep breeds in Botswana: Continuous Traits. Tropical Animal Health and Production, 36(8): 789-800.
15. Vélez, M., J. Raudales, M.A. Esnaola and B. Murillo, 1993. Growth and carcass characteristics of lambs fed ammoniated corn straw and Gliricidia sepium or cotton-seed meal. Small Rumin. Res., 10: 209-217.
16. Nsoso, S.J., G.G. Mannathoko, T.T. Tadubana and L. Malela, 2004a. The effect of methods of castration on live weight, dressed percentage and linear body measurements on indigenous Tswana goats raised under semi-intensive management in Southeast Botswana. Livestock Research for Rural Development, 16 (2): (http://www.cipav.org.co/lrrd/lrrd16/2/nsos1602.htm).
17. Thiruvenkadan, A.K., 2005. Determination of best-fitted regression model for estimation of body weight in Kanni Adu kids under farmer's management system. Livestock Research for Rural Development, 17 (7): (http://www.cipav.org.co/lrrd17/7/thir17085.htm).
18. Devendra, C. and G.B. McLeroy, 1988. Goat and Sheep production in the Tropics. Longman Scientific and Technical Singapore, pp: 271.
19. Ruvuna, F., J.F. Taylor, M. Okeyo, M. Wanyoike and C. Ahuya, 1992. Effects of breed and castration on slaughter weight and carcass composition of goats. Small Rumin. Res., 7: 175-183.
20. Arnold, A.M. and H.H. Meyer, 1988. Effects of Gender, Time of Castration, Genotype and Feeding Regimen on Lamb Growth and Carcass Fatness. J. Anim Sci., 66: 2468-2475.
21. Pinkerton, F.N., L. Escobar, Harwell and W. Drinkwater, 1994. A survey of prevalent production and marketing practices in meat goats of southern origin. Southern Rural Development Center. Mississippi State, USA.
22. Acharya, R.M., 1988. Goat breeding and meat production. In: Goat meat production in Asia, Proceeding of Workshop, Tandojam-Pakistan, pp: 14-30.
23. Bhattacharyya, N.K. and B.U. Khan, 1988. Goat meat production in India. In: Goat meat production in Asia, Proceeding of Workshop, Tandojam-Pakistan, pp: 31-45.
24. Tesfaye, K., L. Tesfaye, T. Estifanos and G. Mieso, 2008. Effect of level of substitution of sweet potato (*Ipomoea Batatas. L*) Vines for concentrate on body weight gain and carcass characteristics of browsing Arsi-Bale goats. J. Cell Anim. Biol., 2(2): 036-042.
25. El, Karim, A.I.A. and J.B. Owen, 1987. Post-weaning growth performance, carcass characteristics and preliminary heritability estimate for some carcass traits of two types of Sudan Desert sheep on intensive feeding. J. agric. Sci. (Camb.)., 109: 531-538.
26. Snowder, G.D., H.A. Glimp and R.A. Field, 1994. Carcass characteristics and optimal slaughter weights in four breeds of sheep. J. Anim. Sci., 72: 932-937.
27. Taylor, St. C.S., J.I. Murray and M.L. Thonney, 1989. Breed and sex differences among equally mature sheep and goats. 4. Carcass muscle, fat and bone. Animal Production, 49: 385-409.
28. Colomer-Rocher, F., A.H. Kirton, G.J.K. Merer and D.M. Duganzich, 1992. Carcass composition of New Zealand Saanen goats slaughtered at different weights. Small Rumin. Res., 7: 161-173.