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Carcass Traits, Meat Yield and Primal Meat Cuts from Arsi, Harar, Ogaden and F1 Jersey*Horro Crossbred Bulls Fed Corn Silage Based Similar Finishing Diet

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Abstract

This study was conducted with the objective to determine carcass traits, meat yield, and primal meat cuts of Arsi, Harar, Jersey*Horro crossbred, and Ogaden cattle breeds at Haramaya University, Ethiopia. A total of 12 bulls of four cattle breeds (3 Arsi, 3 Harar, 3 F1 Jersey*Horro crossbred and 3 Ogaden) with almost similar ages were randomly assigned to four treatments in a completely randomised design (CRD). Data on carcass traits, meat yield, and primal meat cuts were analyzed using the General Linear Model (GLM) of the Statistical Analysis Software (SAS) 9.4 version. The overall averages of live body weight, hot carcass weight, chilled carcass weight, dressing percentages based on hot carcass weight, and rib eye area of experimental cattle breeds were 215.58 kg, 102.93 kg, 99.56 kg, 47.61%, and 8.13 inch^2, respectively. The hot carcass weight and chilled carcass weight of the Ogaden (136.57; 133.30 kg, resp.) breed were higher ($p < 0.01$) compared to other experimental cattle breeds. Dressing percentages based on hot carcass weight were higher ($p < 0.05$) for the Ogaden (49.61%) and Arsi (49.82%) cattle breeds compared to Harar and Jersey*Horro crossbred (45.73%, 45.27%, resp.) cattle breeds. The average meat yield and proportion of meat yield of cattle breeds were 77.52 kg and 77.46%, respectively. With a linear regression coefficient of prediction (R^2) ranging from 52.26% to 93.58%, primal meat cuts significantly ($p < 0.01$) predicted meat yield. In conclusion, the breed of cattle had a significant ($p < 0.05$) influence on live body weight, hot and chilled carcass weight, dressing percentage, rib eye area, subcutaneous fat thickness, meat yield, and the weights of most primal meat cuts. The Ogaden cattle breed had a higher and better meat yield, carcass traits, and most primal meat cuts compared to other experimental cattle breeds. Furthermore, the inclusion of corn silage in the diet of fattening bulls improved the carcass and meat yield. Therefore, the performance of Ogaden cattle compared to other and previous studies suggests the possibility of using this breed for export purposes in addition to Borana and Harar cattle breeds in the future.

Keywords

Meat Yield, Carcass Traits, Primal Meat Cuts, Cattle Breeds, Corn Silage

1. Introduction

Ethiopia has a huge number of cattle populations, with an estimated 70 million cattle [1] and 33 different cattle breeds [2]. Meat production has enormous potential, but per capita meat consumption and carcass weight per head of cattle are both low. Indigenous cattle had an average carcass weight of 135 kg, which was lower than the African average of 146 kg [3]. Ethiopia has one of the world's lowest per capita meat consumption rates, at 8 kg, with beef accounting for around 5.3 kg [3] [4]. The carcass classification method is used to estimate meat yield, primal meat cuts, and determine the palatability of saleable meat. Meat firms are marketing separate primal meat cuts to improve the price of primal meat cuts in developed countries [5]. Meat yield and composition are the main determinants of carcass price, which influences the price of primal meat cuts [6]. Meat animals with higher genetic potential produced more meat yield, which was associated with a higher proportion of the high price of primal meat cuts, which clearly indicates a benefit to both the producer and the processer. Payment based on meat yield and primal meat cuts is a promising development for rapid genetic improvement for meat yield [7] [8].

In Ethiopia, there is a high demand for meat and meat products both for domestic and international markets. To fulfill this rising demand for meat, the carcass traits, meat yield, and primal meat cutting potential of cattle breeds should be well evaluated for producers and consumers. Some authors conducted research activities on carcass traits, meat yield, and primal meat cut of a few cattle breeds in different cattle production and management systems in Ethiopia, such as on live weight change and carcass traits of Ogaden bulls grazing native pasture [9]; on change in body weight in yearling Arsi bulls fed on different feeding rations [10]; and on carcass and meat characteristics of Harar, Borana, and Arsi cattle breeds with different age groups under different production systems in Ethiopia [11]. Moreover, similar parameters were evaluated for Borana, Barka, Arado, and Raya cattle slaughtered in export abattoirs in Ethiopia [3]. Last but not least, [12] also reported carcass and meat characteristics of Boran, Arsi, Friesian* local crossbred, and Harar cattle breeds supplemented with a similar amount of concentrate. Finishing beef cattle with corn silage was widely practiced in countries with a developed beef sector. However, the effect of finishing cattle breeds used for beef production with corn silage and concentrate supplement on carcass traits, meat yield, and primal meat cuts was not evaluated in Ethiopia.

The significant effects of breeds on carcass traits and meat yield were reported by different researchers [3] [11] [13] [14]. Moreover, the effect of age on meat yield and cuts was similarly reported for different breeds of cattle in Ethiopia [11] [12]. The slaughter of bulls younger than 3 years of age managed under different production systems yielded lower carcass and meat yields [11]. The supplementation of concentrate for 3 months before slaughter improved the carcass and meat yield of pure local and crossbred cattle [12]. A study conducted on the perception of stakeholders on determinants of the quality of beef [15] revealed that most stakeholders know the importance of young bulls in producing quality beef; however, they feel that local cattle would not yield a higher amount of carcass when slaughtered at a younger age than 4 years of age. To compromise the quality of beef from a younger age with acceptable carcass weight, it was found important to evaluate the effect of finishing bulls from different breeds for about 24 months with corn silage and concentrate. Furthermore, no research on meat yield and primal meat cuts from F1 Jersey*Horro crossbred, and Ogaden cattle breeds finishing on corn silage-based rations has been conducted in Ethiopia. Therefore, the objective of this study was to determine the carcass traits, meat yield, and primal meat cuts of Arsi, Harar, Jersey*Horro crossbred, and Ogaden cattle breeds.

2. Materials and Methods

2.1. A Brief Description of the Research Area

Experimental bulls were finished and slaughtered at the Haramaya University (HU) beef cattle farm and abattoir, respectively. Haramaya University is situated 512 km from the capital city, Addis Ababa, Ethiopia. The research area is situated at 420 30'E longitude, 90 20'N latitude, and 2043 m.a.s.l. elevation. With an average annual rainfall of 780 mm, the research area's average annual minimum and maximum temperatures were 12.6˚C and 28.5˚C, respectively.

2.2. Experimental Cattle Breeds and Treatments

A total of 12 bulls of four cattle breeds (3 Arsi, 3 Harar, 3 Ogaden, and 3 F1 Jersey*Horro crossbred bulls) of nearly similar age (2 to 2.5 years old and a pair of permanent teeth) were slaughtered after being fattened for 90 days using corn silage and concentrate as supplements. The experimental cattle breeds were randomly assigned in a breed factor treatments arrangement in completely randomised design (CRD). The diet was composed of concentrate (48%) and roughage (52%). Corn silage consisted of 20% of the total ration [28]. Corn silage (20%)

and grass hay (32%) were used as roughage. The concentrate ration was composed of 27.8% ground noug cake, 34.78% wheat bran, 33.14% maize grain, 1.7% salt, 1.7% limestone, and 0.88% ruminant premix based on requirements for fattening beef cattle. A similar diet was offered for experimental cattle breeds. However, the amount of diet per head of cattle breed/day was calculated and offered based on 3% of the live body weight of experimental cattle breeds and the amount of total feed offer was adjusted based on change in live body weight once every two weeks.

2.3. Determination of Meat Yield, Carcass and Non-Carcass Characteristics

The experimental bulls were slaughtered following the abattoir procedure at Haramaya University after fasting for 12 hours. Data on the slaughter weight was taken before slaughter. After bleeding, the carcass and non-carcass components (such as head, skin, feet, full alimentary/viscera tract, liver, spleen, kidneys, genitals, lung, and trachea; omental, kidneys, heart, and pelvic fats) were harvested and weighed using a sensitive balance. Hot carcass weight (HCW) was taken at 1 h after slaughter and the carcasses were chilled at 4˚C for 24 h. The chilled carcass weight (CCW) was determined 24 hours after the animal was slaughtered. The fraction of the difference between HCW and CCW to HCW was then used to compute the carcass chilling loss/shrinkage loss. Empty body weight (EBW) was computed by deducting the weight of gut contents from the slaughter live body weight. The dressing percentage of experimental bulls was calculated by multiplying the proportion of carcass weight to slaughter live body weight by 100 [16]. The yield percentage was computed as the ratio of kg of meat yield to chilled carcass weight multiplied by 100.

The rib eye area (REA), often known as the eye muscle area, is an objective measurement used to predict muscle content. REA was measured after drawing the eye muscle at the 12/13th rib position with a digital planimeter or plastic grid (AS-234e model number) rated in inches square. Fat thickness is used to estimate the amount of subcutaneous fat on the carcass, and it was measured using a scientific ruler rated in millimeters at the 12th rib, 11 cm from the spinal cord on the carcass. The subcutaneous fat thickness was measured with three duplicate readings, and the average of the three readings was considered the value for the subcutaneous fat thickness.

2.4. Determination of Primal Meat Cuts

The primal meat cut was measured according to the American primal meat cutting criteria. The carcasses were split into half right and lift sides along the axis of balance, then the right-side carcasses were separated into fore (anterior portion) and hind (posterior portion) quarters of the carcass between the 12th and 13th rib using a meat saw. Based on the USA's primal meat cut system, the fore and hindquarters of beef carcasses were partitioned into primal meat slices. The beef carcass on the forequarter was separated into chuck, brisket, rib, plate, and shank, whereas the beef carcass on the hind quarter was splited into flank, tender loin, sir loin, top sir lion, bottom sir loin, and round. The weights of fore and hindquarters primal meat cuts were taken using a sensitive balance. The weights of bone and meat (lean meat + fat) were taken using sensitive balance after the primal cuts were deboned into bone and meat (lean meat + fat). The proportion of each primal meat cut was computed by multiplying the weights of primal meat cuts by two, then dividing by the total chilled carcass weight and multiplying by 100. The percentage of meat yield was computed as meat yield per chilled carcass weight and multiplied by 100.

2.5. Statistical Analysis

The General Linear Model (GLM) of Statistical Analysis Software 9.4 versions [17] was used to analyze the data. One way or factor analysis of variance (ANOVA) was used to analyze the fixed effect of cattle breed on all dependent variables. The significant differences among treatments were tested at $p < 0.05$, and for a significant effect of treatment, multiple comparisons of treatments were further done for least square mean separation using the Tukey test. The linear regression was used for the prediction of the change in meat yield as a result of changes in live body weight, body condition score, carcass weight, rib eye area, and primal meat cuts. A Pearson correlation was conducted among the most suitable dependent variables of meat yield, some carcass traits, and primal meat cut variables. The breed of cattle as an independent variable was included in the model to determine the main effect of cattle breed on all dependent variables. Therefore, the first model used for this study is indicated below.

$$Y_{ik} = \mu + A_i + e_{ik}$$

whereas,

Y_{ik} = Response or dependent variable,

μ = Overall mean,

A_i = Cattle Breed effect (i = 4 breeds, or 3 pure indigenous cattle breeds and 1 crossbreed),

e_{ik} = random error.

The linear regression equation model used to predict the relationships between the changes in meat yield as a result of a change in live body weight and body condition score, as well as the model used to predict the change in meat yield as a result of a change in carcass weight and rib eye area is indicated as following.

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

whereas,

Y_i = Dependent variable (Meat yield),

α = Intercept point,

X_1 and X_2 = Live body weight and body condition score variables,

β_1 and β_2 = regression slopes of live body weight and body condition score,

ε = Residual error.

The linear regression equation model used to predict the relationships between the changes in meat yield as a result of a change in primal meat cuts is indicated below.

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$$

whereas,

Y_i = Dependent variable (Meat yield),

α = Intercept point,

X_1, X_2 … and X_n = Rib eye area and primal meat cuts variables,

β_1, β_2 … and β_n = regression slopes of rib eye area and primal meat cuts,

ε = Residual error.

3. Results and Discussion

3.1. Slaughter Weight and Carcass Traits

The slaughter weight and carcass characteristics of Arsi, Harar, Jersey*Horro crossbred, and Ogaden cattle breeds finished under similar feeding conditions are presented in Table 1. Cattle breed had a significant ($p < 0.05$) influence on live body weight, hot carcass weight, chilled carcass weight, dressing percentage based on hot and chilled carcass weight, and rib eye area. The overall mean slaughter live weight for Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds was 215.58 ± 12.21 kg. The slaughter weight of the Ogaden (275.00 ± 11.06 kg) breed was higher ($p < 0.001$) than the other experimental cattle breeds. The slaughter weight of the Harar (216.00 ± 8.00 kg) breed was higher ($p < 0.001$) than the Arsi (172.67 ± 5.21 kg) cattle breed, but there was a non-significant (p >

Table 1. Slaughter weight and carcass characteristics (LSmeans ± SE) of Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Traits	Cattle Breeds				Overall mean	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Slaughter weight (kg)	172.67 ± 5.21^c	216.00 ± 8.00^b	198.67 ± 15.34^{bc}	275.00 ± 11.06^a	215.58 ± 12.21	0.0008
Hot carcass weight (kg)	85.97 ± 2.66^b	98.93 ± 5.74^b	90.25 ± 8.93^b	136.57 ± 7.28^a	102.93 ± 6.64	0.0023
Chilled carcass weight (kg)	83.10 ± 2.87^b	95.03 ± 5.11^b	86.82 ± 9.00^b	133.30 ± 7.52^a	99.56 ± 6.63	0.0023
Dressing percentage (%)based on hot carcass weight	49.82 ± 1.37^a	45.73 ± 1.11^b	45.27 ± 1.17^b	49.61 ± 0.77^a	47.61 ± 0.80	0.0354
Dressing percentage (%) based on chilled carcass weight	48.15 ± 1.33^a	43.94 ± 0.84^b	43.51 ± 1.36^b	48.41 ± 0.86^a	46.01 ± 0.84	0.0241
Chilling/shrinkage loss (%)	3.36 ± 0.43	3.89 ± 0.50	3.90 ± 0.51	2.43 ± 0.41	3.39 ± 0.27	0.1629
Rib eye area (inch^2)	6.07± 0.03^b	9.03 ± 0.12^a	7.87 ± 1.03^{ab}	9.53 ± 0.55^a	8.13 ± 0.47	0.0134

*Means with different superscript letters within each row are significantly different at $p < 0.05$. SE is an abbreviation of standard error.

0.05) difference in slaughter live weight between the Harar and Jersey*Horro crossbred cattle breeds. In the present study, the average hot and chilled carcass weights of cattle breeds were 102.93 ± 6.64 and 99.56 ± 6.63 kg, respectively, which was comparable to the average carcass weight (106.93 kg) of Boran, Arado, Raya, and Barka cattle breeds [3]. Hot carcass weight and chilled carcass weight from the Ogaden (136.57 ± 7.29; 133.30 ± 7.52 kg, resp.) breed were heavier ($p < 0.01$) than the other experimental cattle breeds, but there was a non-significant ($p > 0.05$) difference in hot and chilled carcass weight among the Arsi, Jersey*Horro crossbred, and Harar cattle breeds.

The average hot carcass weight of the Ogaden cattle breed (136.57 ± 7.29 kg) observed in the current study was lower than the carcass weight of matured Ogaden bulls supplemented with a 50:50 hay to agro-industrial by-products mix ratio [9] and the carcass weight (154.86 kg) for the Borana cattle breed slaughtered at an abattoir [3]. The difference in carcass weight could be due to variations in the age and management of bulls. However, it was slightly comparable to the carcass weight of Borana bulls (98.2 - 135.2 kg) managed on-station [18]. [19] confirmed that the Ogaden and Borana cattle breeds had some similar physical traits. The heavier live and carcass weight of the Ogaden cattle breed compared to other experimental breeds might be related to the best growth genetic potential and improvement of the Ogaden cattle breed through selection at Haramaya University since 1990 [19]. The milk from the cows of the Ogaden breed on the experimental station was solely reserved for calves as milking was not practiced. In agreement with the results of this study, [3] reported that cattle breed had a significant influence on live and hot carcass weight. In contrast to the results of this study, [11] and [12] reported that cattle breeds had no significant influence on live weight and carcass weight for less than three years of age. However, cattle breeds had a significant influence on the slaughter live weight and the hot and chilled carcass weight of cattle breeds for the 7 - 9 year age group [11].

The hot carcass weights observed for Arsi (85.97 ± 2.66 kg) and Harar (98.93 ± 5.74 kg) cattle breeds in the present study were higher than the carcass weights observed for Arsi (69.6 kg) and Harar (85 kg) cattle breeds for less than 3 years of age group for the same breed [11], for Arsi (82 kg) and Harar (81.3 kg) cattle breeds in the earlier study ([12]. The breed under this experiment didn't replace any of the milk teeth, and they quit younger than the bulls reported in the previous studies. The difference in carcass weight might be related to the use of corn silage as the basal diet. The live weight and hot carcass weight obtained for Jersey*Horro crossbred (198.67 ± 15.34, 90.25 ± 8.93 kg, resp.) in this study were higher than those of Friesian*local crossbred (186.2, 86.5 kg, resp.) for a similar age group reported by [12], which might be related to either the genetics of the breeds or the use of corn silage as a basal diet in this study. [3] [11] [12] and [14] also suggested that the variations in carcass weights among cattle breeds could be due to the differences between breeds and environments.

The overall mean dressing percentages based on hot and chilled carcass weights were 47.61% and 46.01%, respectively. The dressing percentages based on hot carcass weight and chilled carcass weight for Ogaden and Arsi cattle breeds were higher ($p < 0.05$) than for Harar and Jersey*Horro crossbred cattle breeds. [3] also reported that a cattle breed had a significant influence on dressing percentage. The dressing percentage observed in this study for the Ogaden (49.61%) breed was lower than the value for the Ogaden (57.3%) cattle breed supplemented with a 50:50 hay to agro-industrial by-products mix ratio [9], for Borana breed (54.78%) slaughtered at an modern abattoir [3]. Similarly, a 55.7% dressing percentage was reported for Borana cattle in Ethiopia, which was due to the long term improvement strategy of the breed [20]. A higher dressing percentage of Ogaden bulls could be explained by the fact that the bulls have been managed on-station at Haramaya University since 1990. The dressing percentages obtained in this study for Arsi (49.82%) and Harar (45.73%) were comparable with the results of Aris (51.6%) and Harar (46.4%) cattle breeds for the same breed and age group [11], and for Aris (51.1%) and Harar (48.3%) breeds of similar age group [12].

Similarly, the dressing percentage obtained for Jersey*Horro crossbred (45.27%) was comparable to the result of Friesian*local crossbred (46.6%) for the same age group [12]. However, the dressing percentage obtained for Arsi (49.82%) cattle breed in the present study was lower than the dressing percentage for yearling Arsi (56.4% to 59.6%) bulls supplemented with different proportion of concentrate and *ad libtum* grass hay for 238 days [10], and Kereyu bulls (56.3%) with two years old fed different dietary ration for 168 days [21], the variation in dressing percentage might be related to the difference in duration of finishing period, type and amount of rations.

The proportion of chilling/shrinkage loss of carcass was not significantly ($p > 0.05$) influenced by the breed of cattle. Even though there was a non-significant difference, the chilling loss was lower ($p > 0.05$) for the Ogaden (2.43%) cattle breed compared to other experimental cattle breeds, which might be related to the higher thickness of subcutaneous fat. [12] also reported that the shrinkage loss of carcass was not significantly influenced by the breed of cattle. The percentages of chilling loss observed in this study were lower than the values of Arsi (6.4%) and Harar (4.7%) cattle breeds for the same breed and age group [12].

The overall mean rib eye area of experimental cattle breeds was 8.13 ± 0.47 inch square. The average rib eye areas of the Harar (9.03 ± 0.12 inch^2) and Ogaden (9.53 ± 0.55 inch^2) cattle breeds were higher ($p < 0.05$) than the Arsi (6.07 ± 0.03 inch^2) cattle breed. The rib eye areas of the Jersey*Horro crossbred (7.87 ± 1.03 inch^2) breed were not significantly ($p > 0.05$) different from the other experimental cattle breeds. In line with the results of the current study, cattle breeds had a significant influence on rib eye area [11], while [12] did not obtain a significant influence of breeds and age groups. The rib eye areas of cattle breeds obtained in the present study were higher than the rib eye areas of Arsi (5.60 inch^2), Friesian*local crossbred (5.28 inch^2) and Harar (6.05 inch^2) cattle breeds of the earlier results of finding [12], and Harar cattle breed (6.06 inch^2) [11], but lower than the rib eye area of Arsi (7.28 inch^2) cattle breed for the same breed and age group [11]. The average rib eye area of the Ogaden (9.53 ± 0.55 inch^2) breed observed in this study was higher ($p < 0.05$) than the result for Ogaden (7.09 inch^2) bulls of earlier findings [9]. The variation in rib eye area might be related to the difference in body condition, age, the use of corn silage as a basal diet, and the amount of concentrate supplementation for Ogaden bulls. [9] also suggested that supplementation of Ogaden bulls with a 50:50 agro-industrial by-products mix to hay ratio improved hot carcass weight.

3.2. Weight of Non-Carcass Characteristics

The breed of cattle had a significant influence on the weights of hide, heart, liver, gastro-intestinal tract, empty body weight, feet, and lung with trachea traits (Table 2). The hide weight of the Ogaden (22.33 ± 1.9 kg) cattle breed was heavier ($P < 0.05$) than that of the Arsi (16.10 ± 0.9 kg) and Jersey*Horro crossbred (16.97 ± 0.8 kg) cattle breeds, but not significantly ($P > 0.05$) different from that of the Harar (18.17 ± 1.5 kg) cattle breed. The heart weight of the Ogaden (0.93 ± 0.01 kg) cattle breed was higher ($P < 0.05$) than the Arsi (0.67 ± 0.1 kg) and Harar (0.67 ± 0.01 kg) cattle breeds, but not significantly ($P > 0.05$) different from the heart weight of the Jersey*Horro crossbred (0.83 ± 0.01 kg) cattle breed. The Ogaden cattle breed had a heavier ($P < 0.001$) liver weight (3.77 ± 0.01 kg) than Arsi (2.67 ± 0.01 kg), Harar (2.73 ± 0.1 kg) and Jersey*Horro crossbred (2.80 ± 0.1 kg) cattle breeds.

Table 2. Weight of non-carcass characteristics (LSmeans ± SE) of Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Non-carcass traits	Cattle Breeds				Overall mean ± SE	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Heart (kg)	0.67 ± 0.1^b	0.67 ± 0.01^b	0.83 ± 0.01^{ab}	0.93 ± 0.01^a	0.78 ± 0.01	0.0173
Kidneys (kg)	0.40 ± 0.1	0.53 ± 0.1	0.43 ± 0.01	0.70 ± 0.1	0.52 ± 0.1	0.1594
Liver (kg)	2.67 ± 0.01^b	2.73 ± 0.1^b	2.80 ± 0.1^b	3.77 ± 0.01^a	2.99 ± 0.1	<.0001
Spleen (kg)	0.50 ± 0.1	0.63 ± 0.01	0.63 ± 0.01	0.57 ± 0.01	0.58 ± 0.01	0.1388
Head with tong (kg)	10.60 ± 0.5	11.07 ± 0.7	11.47 ± 0.6	13.50 ± 1.0	11.66 ± 0.05	0.0868
Blood (kg)	5.53 ± 0.5	5.77 ± 0.1	6.17 ± 0.1	6.70 ± 0.4	6.04 ± 0.2	0.1199
Hide (kg)	16.10 ± 0.9^b	18.17 ± 1.5^{ab}	16.97 ± 0.8^b	22.33 ± 1.9^a	18.39 ± 0.9	0.0459
GIT (Gastro-Intestinal tract) (kg)	34.53 ± 2.4^c	45.17 ± 1.2^b	42.67 ± 2.9^b	52.37 ± 1.7^a	43.68 ± 2.1	0.0026
Empty body weight (kg)	172.67 ± 7.2^c	216.00 ± 8.9^b	198.67 ± 15.2^{bc}	275.00 ± 11.7^a	171.90 ± 10.6	0.0036
Lung & trachea (kg)	2.40 ± 0.1^b	2.93 ± 0.3^{ab}	2.77 ± 0.1^b	3.67 ± 0.3^a	2.94 ± 0.2	0.0273
Genitals with scrotal fat (kg)	1.33 ± 0.1	1.43 ± 0.1	1.47 ± 0.01	1.77 ± 0.1	1.50 ± 0.1	0.1143
Feet (kg)	4.00 ± 0.1^b	4.30 ± 0.1^b	4.57 ± 0.3^b	5.97 ± 0.2^a	4.71 ± 0.2	0.0004

*Means with different superscript letters within each row are significantly different at $p < 0.05$. SE is standard error.

The weights of the full gastro-intestinal tract, empty body weight, and feet of the Ogaden cattle breed were also higher (P < 0.01) than those of other experimental cattle breeds. The weight of the full gastro-intestinal tract of the Arsi (34.53 ± 2.4 kg) cattle breed was lower (p < 0.01) than that of the Harar (45.17 ± 1.2 kg) and Jersey*Horro crossbred (42.67 ± 2.9 kg) cattle breeds. The empty body weight of the Arsi (172.67 ± 7.2 kg) cattle breed was also lower (P < 0.01) than the Harar (216.00 ± 8.9 kg) cattle breed. The weight of lung with trachea from Ogaden (3.67 ± 0.3 kg) breed was higher (p < 0.05) than the Arsi (2.40 ± 0.1 kg) and Jersey*Horro crossbred (2.77 ± 0.1 kg) cattle breeds. The weights of most of the non-carcass traits were heavier for the Ogaden cattle breed, which might be related to the good live body conformation and condition of the Ogaden cattle breed.

In agreement with the results of the present study, [12] observed that cattle breeds had a significant influence on edible and non-edible offals of non-carcass characteristics. The authors also obtained the edible and non-edible traits were higher for the Borana cattle breed, intermediate for the Harar and Friesian*local crossbred, and lower for the Arsi cattle breed. The weights of the head with tong, blood, kidneys, spleen, and genitals with scrotal fat were not significantly (p > 0.05) different among experimental cattle breeds. Even though it was not fully in line with the results of this study, some authors also reported that there were non-significant differences in the weights of edible non-carcass components of yearling Arsi bulls fed different dietary rations [10] and the weights of non-edible organs of two-year old Kereyu bulls supplemented with different dietary rations [21] and yearling Kereyu bulls fed different feeding rations [22].

3.3. Subcutaneous Fat Thickness and Fat Composition of Organs

Cattle breeds had a significant influence on subcutaneous fat thickness, weights of heart fat and kidney fat (**Table 3**). The average subcutaneous fat thickness observed in the present study was 3.0 ± 0.19 mm. The thickness of subcutaneous fat was higher (p < 0.01) for Ogaden (3.75 ± 0.14 mm) compared to the Arsi

Table 3. Thickness of subcutaneous fat and fat composition of organs (LSmeans ± SE) from Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Fat traits	Cattle Breeds				Overall mean ± SE	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Subcu. Fat thickness (mm)	2.25 ± 0.01^{c}	3.17 ± 0.08^{ab}	2.83 ± 0.42^{bc}	3.75 ± 0.14^{a}	3.00 ± 0.19	0.0092
Kidneys fat (kg)	0.73 ± 0.03^{b}	0.92 ± 0.19^{b}	1.00 ± 0.12^{b}	1.40 ± 0.06^{a}	1.01 ± 0.09	0.0211
Heart fat (kg)	0.22 ± 0.02^{c}	0.27 ± 0.03^{bc}	0.32 ± 0.02^{ab}	0.38 ± 0.04^{a}	0.30 ± 0.02	0.0228
Pelvic fat (kg)	1.13 ± 0.07	1.00 ± 0.01	1.03 ± 0.12	1.20 ± 0.10	1.09 ± 0.05	0.4970
Omental fat (kg)	1.10 ± 0.06	1.23 ± 0.19	1.23 ± 0.03	1.85 ± 0.43	1.35 ± 0.13	0.1861

*Means with different superscript letters within each row are significantly different at p < 0.05. SE is standard error.

(2.25 ± 0.01 mm) and Jersey*Horro crossbred (2.83 ± 0.42 mm) cattle breeds, but it was not significantly different from the Harar (3.17 ± 0.08 mm) cattle breed. The weight of kidney fat was heavier ($p < 0.05$) for the Ogaden (1.40 ± 0.06 kg) cattle breed compared to other experimental cattle breeds. Similarly, the weight of heart fat was heavier ($P < 0.05$) for the Ogaden (0.38 ± 0.04 kg) cattle breed compared to the Arsi (0.22 ± 0.02 kg) and Harar (0.27 ± 0.03 kg) cattle breeds, but not significantly different from the Jersey*Horro crossbred (0.32 ± 0.02 kg) cattle breed. In line with the results of this study, [23] reported that the Borana cattle breed had a higher weight of kidney fat than the Kereyu cattle breed. In contrast to the results of the present study, some studies reported that the breed of cattle did not significantly influence the fat characteristics of Arsi and Harar cattle breeds for less than 3 years of age [11] [12]. The weights of heart fat and kidney fat obtained in this study were higher than the weights of heart fat and kidney fat for Arsi (0.16, 0.13 kg, resp.) and Harar (0.13, 0.11 kg, resp.) for the same breed and age group fattened in different production systems [11]. The variations in the weights of fat traits might be related to the difference in the design of the experiment, fattening and production systems of bulls before slaughter.

The average thickness of subcutaneous fat for the Ogaden (3.75 ± 0.14 mm) cattle breed obtained in the present study was similar to the average subcutaneous fat thickness of Borana (3.75 mm) and Kereyu bulls (3.75 mm) [24]. However, the averages of subcutaneous fat thickness for Arsi (2.25 mm), Harar (3.17 mm), Jersey*Horro crossbred (2.83 mm) and Ogaden (3.75 mm) cattle breeds obtained in this study were lower than the fat thickness of Arsi (6.25 mm) and Harar (4.25 mm) cattle breeds from the previous results of finding [12], and the fat thickness of Arsi (4.75 mm) and Harar (4.75 mm) cattle breeds for the same age group [11]. The variation in the amount of fat deposition might be related to the difference in feeding practices before slaughter.

3.4. Meat Yield

The breed of cattle had a significant influence on the total amount of meat yield and the meat yield from fore and hind-quarters (**Table 4**). The overall mean of

Table 4. Meat yield (LSmeans ± SE) of Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Meat yield traits	Cattle Breeds				Overall mean ± SE	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Meat yield from fore-quarter (kg)	34.49 ± 1.98^{b}	37.91 ± 2.40^{b}	34.49 ± 3.05^{b}	56.53 ± 2.72^{a}	40.86 ± 2.97	0.0008
Meat yield from hind-quarter (kg)	28.31 ± 0.81^{b}	35.06 ± 2.90^{b}	32.09 ± 4.30^{b}	51.17 ± 2.16^{a}	36.66 ± 2.89	0.0021
Total meat yield (kg)	62.80 ± 2.72^{b}	72.97 ± 4.75^{b}	66.59 ± 6.93^{b}	107.70 ± 4.58^{a}	77.52 ± 5.77	0.0008
Total meat yield (%)	75.52 ± 0.71^{b}	76.69 ± 0.93^{b}	76.69 ± 0.34^{b}	80.93 ± 1.2^{a}	77.46 ± 0.72	0.0095

*Means with different superscript letters within each row are significantly different at $p < 0.05$. SE is standard error. Meat yield embraces both lean meat and fat.

meat yield and proportion of meat yield of experimental cattle breeds were 77.52 ± 5.77 kg and 77.46%, respectively. The total amount of meat yield was higher ($p < 0.01$) for the Ogaden (107.70 ± 4.58 kg) cattle breed compared to the Arsi (62.80 ± 2.72 kg), Harar (72.97 ± 4.75 kg) and Jersey*Horro crossbred (66.59 ± 6.93 kg) cattle breeds. Similarly, the proportion of meat yield and meat yield from fore and hind-quarters were higher ($p < 0.01$) for the Ogaden cattle breed compared to other experimental cattle breeds; a higher meat yield from the Ogaden cattle breed might be due to the relatively heavier live weight and carcass weights of the Ogaden cattle breed. However, there was a non-significant ($p > 0.05$) difference in total amount and proportion of meat yield, as well as meat yield from fore and hind-quarters among Arsi, Harar, and Jersey*Horro crossbred cattle breeds. It indicates the Ogaden cattle breed has good meat yield genetic potential to improve or boost meat production. [9] also suggested that supplementation of Ogaden bulls with an agro-industrial by-products mix with hay can improve the growth and carcass weight of Ogaden bulls.

In agreement with the meat yield results of the present study, some previous studies confirmed that the breed of cattle had a significant influence on the amount of meat yield and yield percentage of cattle breeds [3] [11] [12] [24]. In this study, the proportion of meat yield obtained from Ogaden (80.93%) cattle breed was higher than the proportions obtained from Arsi (78.1%), Borana (77.0%), Harar (77.2%), and Friesian*local crossbred (72.8%) cattle breeds in previous results [12], whereas the proportions of meat yield obtained from Arsi (75.52%), Harar (76.69%), and Jersey*Horro crossbred (76.69%) cattle breeds obtained in the present study were comparable with the proportions of similar age groups of cattle breeds in previous results [12].

The average proportion of meat yield (77.52%) obtained from cattle breeds in the present study was also higher than the percentage of meat yield from Barka (67.81%) cattle breed [3], Arsi (50.86%), Borana (30%), and Harar (18.72%) cattle breeds of less than 3 years of age [11], which were slaughtered by purchasing from mixed-crop livestock and ranch systems without fattening. The variation in percentage of meat yield might be related to the body condition, slaughter weight, and carcass weight of bulls, which was mediated by feeding condition before slaughter. In the present study, concentrate was supplemented in addition to corn silage, while in the previous study; bulls were slaughtered from respective production systems without being supplemented. [11] also justified that the low percentages of meat yield from previous study were probably the influence of the environment, overall management, and genetic differences between cattle breeds.

3.5. Primal Meat Cut Yields

The breed of cattle had a significant influence on the weights of chuck, shank, tender loin, sir loin, top sir loin, and bottom sir loin primal meat cuts (**Table 5**). The overall mean weights of the fore and hind quarters of primal meat cuts were

Table 5. The weight of primal meat cuts (LSmeans ± SE) from Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Weights of primal meat cut (kg)	Cattle Breeds				Overall mean ± SE	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Chuck	24.26 ± 1.98[b]	24.24 ± 0.77[b]	22.86 ± 1.99[b]	39.87 ± 1.92[a]	27.81 ± 2.23	0.0004
Rib	8.93 ± 0.22	11.03 ± 1.47	9.03 ± 1.00	11.87 ± 0.76	10.22 ± 0.56	0.1577
Plate	3.70 ± 0.35	5.37 ± 0.67	4.17 ± 0.24	5.50 ± 0.70	4.68 ± 0.32	0.1064
Brisket	4.23 ± 0.59	4.23 ± 0.48	4.43 ± 0.29	5.57 ± 85	4.62 ± 0.30	0.3769
Shank	6.53 ± 0.57[b]	6.33 ± 0.24[b]	6.33 ± 0.79[b]	10.33 ± 0.13[a]	7.38 ± 0.56	0.0011
Total Fore-quarter	47.66 ± 2.52[b]	51.21 ± 2.20[b]	46.83 ± 4.03[b]	73.13 ± 3.53[a]	54.71 ± 3.51	0.0011
Tender loin	2.73 ± 0.49[b]	4.29 ± 0.55[b]	4.20 ± 0.69[b]	7.07 ± 0.47[a]	4.57 ± 0.53	0.0038
Sir loin	6.77 ± 0.21[b]	7.72 ± 0.46[b]	6.63 ± 0.89[b]	10.47 ± 0.18[a]	7.90 ± 0.51	0.0026
Top sir loin	5.13 ± 0.47[b]	6.87 ± 0.07[b]	6.67 ± 1.35[b]	10.10 ± 0.98[a]	7.19 ± 0.66	0.021
Bottom sir loin	5.00 ± 0.12[b]	5.98 ± 0.59[b]	6.20 ± 0.90[b]	8.87 ± 0.24[a]	6.51 ± 0.49	0.0063
Flank	3.73 ± 0.13	4.80 ± 0.90	4.60 ± 0.53	6.13 ± 0.13	4.82 ± 0.34	0.0699
Round	12.07 ± 0.18	14.20 ± 3.10	11.66 ± 2.14	18.20 ± 2.36	14.03 ± 1.23	0.2227
Total Hind-quarter	35.44 ± 0.53[b]	43.86 ± 2.94[b]	39.96 ± 5.20[b]	60.83 ± 3.76[a]	45.02 ± 3.26	0.0047

*Means with different superscript letters within each row are significantly different at $p < 0.05$. SE is standard error.

54.71 ± 3.51 and 45.02 ± 3.26 kg, respectively. The average weights of chuck, shank, tender loin, sir loin, top sir loin, and bottom sir loin primal meat cuts were 27.8, 7.38, 4.57, 7.90, 7.19, and 6.51 kg, respectively. The Ogaden cattle breed had a heavier ($p < 0.05$) weight of fore and hind quarters, chuck, shank, tender loin, sir loin, top sir loin, and bottom sir loin primal meat cuts compared to other experimental cattle breeds in the present study, which might be related to relatively heavier live weight and carcass weight, better body condition, and conformation of the Ogaden cattle breed. A heavier primal meat cut was attained from heavier live body weight and carcass weight [3]. However, there was a non-significant difference in primal meat cuts between Arsi, Harar, and Jersey*Horro crossbred cattle breeds in the present study. In line with the results of this study, some studies indicated that the breed of cattle had a significant influence on the yields or weights of some primal meat cuts [3] [11] [12] [25]. The overall mean weight of sir lion (7.90 ± 0.51 kg) obtained in the present study was higher than the weights of sir lion from Aris (3.82 kg), Borana (4.4 kg), Friesian*local crossbred (5.76 kg) and Harar (3.5 kg) cattle breeds of the same age group reported by [12], which might be related to the difference in feeding corn silage as the basal diet in the present study.

The overall proportions of the fore and hind quarters of primal meat cuts were 55.09% and 45.05%, respectively. The percentages of primal meat cuts were not significantly ($p > 0.05$) different between cattle breeds, except for the proportion of chuck primal meat cuts. The proportions of chuck primal meat cut from Ogaden (29.94%) and Arsi (29.11%) cattle breeds were higher ($p < 0.05$) than the Harar (25.57%) cattle breed. The proportion of chuck primal meat cut from Ogaden (29.94%) was also higher ($p < 0.05$) than the Jersey*Horro crossbred (26.43%) cattle breed (Table 6). In line with this result, [12] reported that breeds of cattle were not significantly different in percentages of primal meat cuts, except for chuck primal cut for the same breed and age group of cattle. The overall percentages of chuck, rib, and round primal meat cuts in the present study were 27.76, 10.42, and 14.03 percent, respectively, which account for the highest proportions of primal meat cuts. The proportions of chuck, rib, and round primal meat cuts from Arsi (29.11%, 10.78%, 12.07%, resp.) and Harar (25.57%, 11.51%, and 14.20%, resp.) cattle breeds were lower than the percentages of chuck and round primal meat cuts from Arsi (31.38%, 18.2%, resp.) and Harar (32.1%, 19%, resp.) cattle breeds for the same breed and age [11]. However, the proportions of rib primal cut obtained in the present study were higher than the percentages of rib primal meat cut from Arsi (7.74%) and Harar (7.87%) cattle breeds for the same breed and age [11].

3.6. Meat Yield Prediction Using Linear Regression

The linear regression prediction equations of meat yield (Y) from live body weight, body condition, carcass weight, rib eye area, and primal meat cuts are indicated in Table 7. Live body weight, body condition, carcass weight, and rib eye area were all significant ($P < 0.01$) and accurate predictors of meat yield, with coefficients

Table 6. The proportion of primal meat cuts from Arsi, Harar, Jersey*Horro crossbred and Ogaden cattle breeds.

Proportion of primal meat cut (%)	Cattle Breeds				Overall mean ± SE	P-value
	Arsi	Harar	Jersey*Horro	Ogaden		
	Mean ± SE					
Chuck	29.11 ± 1.45^{ac}	25.57 ± 0.6^{b}	26.43 ± 0.52^{bc}	29.94 ± 0.28^{a}	27.76 ± 0.65	0.0176
Rib	10.78 ± 0.55	11.51 ± 1.02	10.48 ± 0.87	8.92 ± 0.46	10.42 ± 0.43	0.1825
Plate	4.49 ± 0.58	5.76 ± 1.06	4.85 ± 0.25	4.13 ± 0.47	4.81 ± 0.34	0.3959
Brisket	5.06 ± 0.59	4.43 ± 0.32	5.16 ± 0.32	4.13 ± 0.43	4.70 ± 0.22	0.3254
Shank	7.83 ± 0.44	6.68 ± 0.22	7.26 ± 0.17	7.82 ± 0.56	7.40 ± 0.22	0.1878
Total Fore-quarter	57.28 ± 1.11	53.95 ± 0.76	54.18 ± 1.61	54.93 ± 1.00	55.09 ± 0.63	0.2398
Tender loin	3.31 ± 0.61	4.58 ± 0.76	4.93 ± 0.86	5.31 ± 0.25	4.53 ± 0.36	0.2407
Sir loin	8.16 ± 0.19	8.12 ± 0.14	7.59 ± 0.27	7.90 ± 0.43	7.94 ± 0.14	0.4849
Top sir loin	6.15 ± 0.37	7.26 ± 0.37	7.56 ± 0.89	7.55 ± 0.43	7.13 ± 0.29	0.3035
Bottom sir loin	6.03 ± 0.28	6.30 ± 0.52	7.15 ± 0.69	6.68 ± 0.23	6.54 ± 0.24	0.4095
Flank	4.50 ± 0.12	5.11 ± 1.06	5.31 ± 0.29	4.62 ± 0.22	4.89 ± 0.26	0.7078
Round	14.57 ± 0.71	14.71 ± 2.72	13.25 ± 1.52	13.58 ± 1.15	14.03 ± 0.75	0.9064
Total Hind-quarter	42.72 ± 1.11	46.09 ± 0.74	45.78 ± 1.57	45.63 ± 0.94	45.05 ± 0.63	0.2036

*Means with different superscript letters within each row are significantly different at $p < 0.05$. SE is standard error.

Table 7. Linear regression prediction of meat yield (*Y*) from live body weight, body condition score, rib eye area, and primal meat cuts.

Linear regression prediction equations	R^2 (%)	MSE	P-value
Y = −21.57456 + 0.45963 (live body weight)	94.51	4.91	<0.0001
Y = −32.56511 + 17.97226 (Body condition score)	62.91	12.77	0.0021
Y (Optimal prediction) = −14.39766+ 0.51570 (Final weight) −3.14510 (Body condition)	93.93	4.93	<0.0001
Y = −3.47467+ 0.78685 (Carcass weight)	82.02	8.89	<0.0001
Y = 4.41111 + 8.99740 (Rib eye area)	54.58	14.13	0.0061
Y (Optimal prediction) = −8.72339 +0.68572 (Carcass weight) + 1.92714 (Rib eye area)	79.42	9.09	0.0003
Y = 8.46065 + 2.63818 (loin)	89.88	6.67	<0.0001
Y = 8.01348+ 2.49946 (Chuck)	93.58	5.31	<0.0001
Y = 5.98972 + 9.68740 (Shank)	87.51	7.41	<0.0001
Y = 24.97508 + 3.74438 (Round)	63.56	12.66	0.0019
Y = 12.79511 + 14.01875 (Brisket)	53.8	14.25	0.0066
Y = 19.12819+ 12.12183 (Flank)	52.26	14.49	0.0079
Y = 1.57425 + 7.43303 (Rib)	52.8	14.41	0.0074
Y = 37.81688+ 8.47647 (Plate)	22.55	18.45	0.1188
Y (Optimal prediction) = −6.07768 + 0.88940 (Chuck) + 1.06245 (Loin) + 1.25760 (Shank) + 0.52862 (Round) + 1.40446 (Rib)	99.64 = Adjusted R^2	1.19	<0.0001

* *Y* is an estimation of meat yield (lean meat + fat). Adjusted R^2 is used as the coefficient of prediction for optimal prediction of meat yield from significant explanatory variables. R^2 is the linear regression coefficient of prediction. SEM is an abbreviation for the standard error of mean.

of determination (R^2) of 94.51%, 62.91%, 82.02%, and 54.58%, respectively. The optimal adjusted coefficient of prediction (R^2) of meat yield from both live body weight and body condition was 93.93%, which is the highest and most significant ($P < 0.001$) coefficient of prediction (R^2) of meat yield. The accurate predictor ($R^2 = 94.51\%$) of meat yield from live body weight obtained in the present study was higher than the coefficient of prediction ($R^2 = 70.66\%$) of meat yield from live body weight of an earlier result of finding [11] and the coefficient of prediction ($R^2 = 89.56\%$) of meat yield from live body weight of the previous result of finding [12]. The authors also confirmed that meat yield was accurately predicted from live body weight.

The linear regression prediction coefficient (R^2) of meat yield from carcass weight ($R^2 = 82.02\%$) obtained in the present study was higher than the prediction coefficient for carcass weight ($R^2 = 74.75\%$) in the model alone [11]. However, the prediction coefficient (R^2) of meat yield from both carcass weight and rib eye area ($R^2 = 79.42\%$) obtained in this study was lower than the prediction coefficient for both carcass weight and rib eye area ($R^2 = 84.75\%$) results of a previous study [11]. The slight variation might be due to the use of an adjusted prediction coefficient for optimal prediction coefficient in the present study; the unadjusted prediction coefficient for estimation of meat yield from both carcass weight and rib eye area was 83.75 percent, which was comparable to the prediction coefficient (R^2 = 84.75%) reported by [11]. The optimal linear regression equation of meat yield (y) from carcass weight and rib eye area was formulated as $Y = -8.72339 + 0.68572$ (carcass weight) + 1.92714 (rib eye area) with a highly significant ($p < 0.01$) prediction coefficient (R^2) of 79.42%. The results of the optimal prediction coefficient indicate that meat yield was accurately and significantly ($p < 001$) estimated from carcass weight and rib eye area.

Meat yield was significantly ($P < 0.01$) predicted from primal meat cuts with a linear regression coefficient of prediction (R^2) of 52.26 up to 93.58%, except for plate primal cut in the present study. Out of primal meat cuts, chuck, lion, and shank were the most accurate and significantly ($P < 0.01$) highest (93.58%, 89.88%, and 87.51%) predictors of meat yield in the present study, respectively. The significant ($p < 0.01$) and accurate prediction (52.26% up to 93.58%) of meat yield from primal meat cuts obtained in this study was slightly comparable with the range of coefficient of prediction (R^2 = 65.99% up to 91.97%) of meat yield from primal meat cuts reported by [11]. It was, however, greater than the coefficient of prediction (R^2) of meat yield from primal cuts, which ranged between 19.72% and 77.86% of previous results [3], as well as the coefficient of prediction (R^2) of meat yield from primal cuts, which ranged between 32.86% and 84.08% of previous results [12]. The optimal linear regression prediction equation model (Y) for meat yield from primal meat cuts with an accurate and significant ($P < 0.001$) coefficient of prediction (adjusted R^2 = 99.64%) is generated as $Y = -6.07768 + 0.88940$ (Chuck) + 1.06245 (Loin) + 1.25760 (Shank) + 0.52862 (Round) + 1.40446 (Rib). [3] also confirmed that meat yield was accurately and significantly ($p < 0.001$) predicted for all primal meat cuts.

3.7. Pearson Correlation between Meat Yield and Certain Carcass Characteristics

A Pearson correlation coefficient among meat yield, live body weight, and some carcass traits is presented in **Table 8**. Meat yield was a strong positive and significantly ($p < 0.01$) correlated with live weight (r = 0.9722), hot carcass weight (r = 0.9056), rib eye area (r = 0.7388) and fat thickness (r = 0.8749). There was also a strong positive and significant ($p < 0.001$) correlation of live body weight with hot carcass weight (r = 0.8869), rib eye area (r = 0.8547) and fat thickness (r = 0.9455). Hot carcass weight was a strong positive and significantly ($p < 0.01$) correlated with rib eye area (r = 0.7356) and fat thickness (r = 0.8489). There was also a strong positive and significantly ($p < 0.001$) correlated with rib eye area and fat thickness (r = 0.9671) in the present study. In agreement with the correlation results of this finding, there was a strong positive and significant ($p < 0.001$) correlation among meat yield, live body weight, and carcass weight of previous findings [11] [25]. The authors also obtained a positive and significant

Table 8. Pearson correlation among meat yield, live body weight, and some carcass traits.

	Meat Yield	Live weight	Hot Carcass weight	Dressing percentage	REA	Fat Thickness
Meat Yield	1	0.9722 <0.0001	0.9056 <0.0001	0.3615 0.2482	0.7388 0.0061	0.8749 0.0002
Live weight		1	0.8869 0.0001	0.1831 0.5689	0.8547 0.0004	0.9455 <0.0001
Hot Carcass weight			1	0.4813 0.1132	0.7356 0.0064	0.8489 0.0005
Dressing percentage				1	−0.0495 0.8785	0.1151 0.7218
REA					1	0.9671 <0.0001
Fat Thickness						1

*REA is an abbreviation for rib-eye area.

($p < 0.01$) correlation among carcass weight, rib eye area, and subcutaneous fat thickness. Similarly, [12] also confirmed that there was a positive and significant ($p < 0.01$) correlation among meat yield, rib eye area, and subcutaneous fat thickness. As expected, meat yield, rib eye area, and fat thickness were strongly associated with live body weight and carcass weight. [26] and [27] also confirmed that most carcass traits increased, as carcass weight increased.

Dressing percentage was positively and non-significantly ($p > 0.05$) correlated with meat yield, live weight, carcass weight, and fat thickness, but it was negatively and non-significantly ($p > 0.05$) correlated with rib eye area ($r = -0.0495$) in the present study. In partial agreement with the results of this finding, dressing percentage was also positively and non-significantly ($p > 0.05$) correlated with meat yield, live weight, carcass weight, and fat thickness. However, dressing percentage was negatively and non-significantly ($p > 0.05$) correlated with kidney fat ($r = -0.020$), but it was also positively and non-significantly ($p > 0.05$) correlated with rib eye area ($r = 0.140$) of the earlier results of the finding [11]. Understanding the relationship among live body weight, carcass traits, and meat yield helps in deciding a price for carcass traits that better reflects the value of the carcass in terms of meat yield [25].

4. Conclusion and Recommendation

The results of this study confirmed that the breed of cattle had a significant ($p < 0.05$) influence on slaughter weight, hot and chilled carcass weight, dressing percentage, rib eye area, subcutaneous fat thickness, weights of heart fat and kidney fat, meat yield, and weights of most of the primal meat cuts. The Ogaden cattle breed had better meat yield, carcass traits, and most of the primal meat cutting potential compared to other experimental cattle breeds. The weights of the carcass and meat characteristics in the present study were better than those reported for similar breeds in the previous study. Meat yield was accurately and significantly ($P < 0.01$) predicted from live body weight, body condition, rib eye area, and most of the primal meat cuts. In conclusion, the breed of cattle had a significant ($p < 0.05$) influence on carcass traits, meat yield, and some primal meat cuts. Furthermore, the inclusion of corn silage in the diet of fattening bulls improved the carcass and meat yield. Therefore, the performance of Ogaden cattle compared to other and previous studies suggests the possibility of using this breed for export purposes in addition to Boran and Harar cattle breeds in the future.

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Conflicts of Interest

The authors declared that there is no conflict of interest between authors and organizations regarding this paper.

References

[1] CSA (Central Statistical Authority) (2021) Agricultural Sample Survey 2020/21 (2013 E.C). Report on Livestock and Livestock Characteristics. Volume II, Statistical Bulletin 589, Central Statistical Authority, Addis Ababa, 13.

[2] EBI (Ethiopian Biodiversity Institute) (2016) Ethiopian National Strategy and Plan of Action for Conservation and Utilization of Animal Genetic Resources. Ethiopian Biodiversity Institute (EBI), Addis Ababa. http://www.ebi.gov.et

[3] Mummed, Y.Y. and Webb, E.C. (2019) Carcass Weight, Meat Yield and Meat Cuts from Arado, Boran, Barka, Raya Cattle Breeds in Ethiopia. *Journal of Agricultural Science*, **11**, 45-51. https://doi.org/10.5539/jas.v11n18p45

[4] Betru, S. and Kawashima, H. (2009) Pattern and Determinants of Meat Consumption in Urban and Rural Ethiopia. *Livestock Research for Rural Development*, **21**, Article No. 143.

[5] Joo, S.T., Kim, G.D., Hwang, Y.H. and Ryu, Y.C. (2013) Control of Fresh Meat Quality through Manipulation of Muscle Fiber Characteristics. *Meat Science*, **95**, 828-836. https://doi.org/10.1016/j.meatsci.2013.04.044

[6] Drennan, M.J., McGee, M. and Keane, M.G. (2008) The Value of Muscular and Skeletal Scores in the Live Animal and Carcass Classification Scores as Indicators of Carcass Composition in Cattle. *Animal*, **2**, 752-760. https://doi.org/10.1017/S1751731108001754

[7] Connolly, S.M., Cromie, A.R., Sleator, R.D. and Berry, D.P. (2019) Predicted Carcass Meat Yield and Primal Cut Yields in Cattle Divergent in Genetic Merit for a Terminal Index. *Translational Animal Science*, **3**, 1-13. https://doi.org/10.1093/tas/txy129

[8] Naserkheil, M., Lee, D., Chung, K., Park, M.N. and Mehrban, H. (2021) Estimation of Genetic Correlations of Primal Cut Yields with Carcass Traits in Hanwoo Beef Cattle. *Animals*, **11**, Article No. 3102. https://doi.org/10.3390/ani11113102

[9] Mekasha, Y., Urge, M., Kurtu, M.Y. and Bayissa, M. (2011) Effect of Strategic Supplementation with Different Proportion of Agro-Industrial By-Products and Grass Hay on Body Weight Change and Carcass Characteristics of Tropical Ogaden Bull (Bosindicus) Grazing Native Pasture. *African Journal of Agricultural Research*, **6**, 825-833.

[10] Aman, G., Tesfaye A., Mieso G., Ashebir W. and Genet, D. (2019) Evaluation of Different Feeding Options for Yearling Arsi Bulls to Attain Export Market Weight. *Journal of Biology, Agriculture and Health*, **9**, 1-5.

[11] Tefera, T.D., Mummed, Y.Y., Kurtu, M.Y., Letta, M.U., Quine, T.G. and Vipham, J.L. (2019) Effect of Age and Breeds of Cattle on Carcass and Meat Characteristics of Arsi, Boran and Harar Cattle in Ethiopia. *Open Journal of Animal Sciences*, **9**, 367-383. https://doi.org/10.4236/ojas.2019.93030

[12] Musa, A.A., Mummed, Y.Y., Kurtu, M.Y., Temesgen, M. and O'Quinn T.G. (2021). Carcass and Meat Characteristics of Bulls from Arsi, Boran, Harar and Holstein Frisian Crosses Cattle Breeds Finished under Similar Level of Concentrate Supplementation. *Open Journal of Animal Sciences*, **11**, 11-30. https://doi.org/10.4236/ojas.2021.111002

[13] Prado, R.M., Prado, I.N., Marques, J.A., Rotta, P.P., Visentainer, J.V., Silva, R.R. and Souza, N.E. (2009) Meat Quality of the Longissimus Muscle of Bulls and Steers (1/2 Nellore vs. 1/2 Simmental) Finished in Feedlot. *Journal of Animal and Feed Sciences*, **18**, 221-230. https://doi.org/10.22358/jafs/66386/2009

[14] Rotta, P.P., Prado, I.N., Prado, R.M., Moletta, J.L., Silva, R.R. and Perotto, D. (2009) Carcass Characteristics and Chemical Composition of the Longissimus Muscle of Nellore, Caracu and Holstein-Friesian Bulls Finished in a Feedlot. *Asian-Australasian Journal of Animal Sciences*, **22**, 598-604. https://doi.org/10.5713/ajas.2009.80538

[15] Gadisa, B., Yesihak, Y. and Yousuf, M. (2019) Evaluation of Eating Quality in Sensory Panelist and Instrumental Tenderness of Beef from Harar, Arsi and Bale Cattle Breeds in Oromia, Ethiopia. *International Journal of Agricultural Science and Food Technology*, **5**, 35-42.

[16] Chulayo, A.Y. (2015) The Effects of Distance, Lairage Duration and Animal-Related Factors on Pre-Slaughter Stress Indicators, Carcass Characteristics, Nanostructure and Technological Properties of Beef. M.Sc. Thesis, University of Fort Hare, South Africa.

[17] SAS Institute Inc. (2018) Statistical Analysis Software. Users' Guide Statistics Version 9.4. SAS Institute Inc., Cary.

[18] Lemma, T., Geleta, T., Sisay, A. and Abebe, T. (2007) Effects of Four Different Basal Diets on the Carcass Composition of Finishing Borana Bulls. *Journal of Cell and Animal Biology*, **1**, 15-18.

[19] Getinet. M., Workneh, A. and Hegde, P.B. (2009) Growth and Reproductive Performance of Ogaden Cattle at Haramaya University, Ethiopia. *Ethiopian Journal of Animal Production*, **9**, 13-38.

[20] Aynalem, H., Workneh, A., Noah, K., Tadelle, D. and Azage, T. (2011) Breeding Strategy to Improve Ethiopian Boran Cattle for Meat and Milk Production. *Improving Productivity and Market Success of Ethiopian Farmers Project* (*IPMS*), *Working Paper No.* 26, International Livestock Research Institute (ILRI), Addis Ababa.

[21] Tesfaye, A.T., Girma, D., Mieso, G., Ashebir, W., Amen, G., Frehowit, M. and Tesfaye, A.A. (2018) Evaluation of Different Dietary Rations for Growth Performance and Carcass Characteristics of Two Years Old Kereyu Bulls for Export/Local Market Weight. *Basic Research Journal of Agricultural Science and Review*, **6**, 49-56.

[22] Worku, A., Alemu, T., Gurru, M., Gudeto, A., Messele, F. and Dadi, G. (2019) Evaluation of Different Feeding Options on Growth Response and Carcass Characteristic of Yearling Kereyu-Bulls to Attain Local/Export Market Weight. *International Journal of Agricultural Science and Food Technology*, **5**, 50-53.

[23] Negash, M., Lemma, T., Dadi, H., Feyera, T., Woldu, T., Alemu, T. and Shilima, B. (2008) Comparison of Body Weight Gain Performance and Carcass Characteristics of the Two Ethiopian Cattle Breeds under Natural Pasture Grazing Management. *Livestock Research for Rural Development*, **20**, Article No. 117.

[24] Graham, J.F., Byron, J., Clark, A.J., Kearney, G. and Orchard, B. (2009) Effect of Post-Weaning Growth and Bulls Selected for Extremes in Retail Beef Yield and Intramuscular Fat on Progeny Live weight and Carcass Traits. *Animal Production Science*, **49**, 493-503. https://doi.org/10.1071/EA08181

[25] Seo, H.-W., Van Ba, H., Seong, P.-N., Kim, Y.-S., Kang, S.-M., Cho, S.H., *et al.* (2021) Relationship between Body Size Traits and Carcass Traits with Primal Cuts Yields in Hanwoo Steers. *Animal Bioscience*, **34**, 127-133. https://doi.org/10.5713/ajas.19.0809

[26] Tait, R.G., Wilson, D.E. and Rouse, G.H. (2005) Prediction of Retail Product and Trimmable Fat Yields from the Four Primal Cuts in Beef Cattle Using Ultrasound or Carcass Data. *Journal of Animal Science*, **83**, 1353-1360. https://doi.org/10.2527/2005.8361353x

[27] Greiner, S.P., Rouse, G.H., Wilson, D.E., Cundiff, L.V. and Wheeler, T.L. (2003) Prediction of Retail Product Weight and Percentage Using Ultrasound and Carcass Measurements in Beef Cattle. *Journal of Animal Science*, **81**, 1736-1742. https://doi.org/10.2527/2003.8171736x

[28] Habte, A., Ashenafi, M., Berhan, T., Getnet A. and Fekede, F. (2020) Effect of Maize Silage and Concentrates Fed Separately or as Total Mixed Ration (TMR) on Milk Yield of Jersey Cows. *Livestock Research for Rural Development*, **32**, 1-8.