Journal of Agricultural Science; Vol. 11, No. 18; 2019
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Carcass Weight, Meat Yield and Meat Cuts From Arado, Boran, Barka, Raya Cattle Breeds in Ethiopia

Y. Y. Mummed[1] & E. C. Webb[2]

[1] School of Animal and Range Science, College of Agriculture and Environmental Science, Haramaya University, Ethiopia

[2] Department of Animal and Wild Life Sciences, University of Pretoria, South Africa

Correspondence: Yesihak Y. Mummed, School of Animal and Range Science, Haramaya University, P.O. Box 138, Dire Dawa, Ethipia. Tel: 251-09-396-0653. E-mail: yesihakyus@gmail.com

Received: May 5, 2019 Accepted: August 27, 2019 Online Published: November 15, 2019

doi:10.5539/jas.v11n18p45 URL: https://doi.org/10.5539/jas.v11n18p45

The research is financed by University of Pretoria and Haramaya University.

Abstract

This study was conducted with the objective to evaluate carcass weight, meat yield and primal meat cuts of beef from Arado, Boran, Barka, Raya and nondescript cattle breeds slaughtered at export abattoirs in Ethiopia. Data was collected from Abergelle and Melgawendo export abattoirs in 2011. The result of the study revealed that the average live weight, warm carcass weight, cold carcass weight and warm dressing percentage of cattle slaughtered at the abattoirs studied were 241.41±0.37 kg, 106.93±0.21 kg, 101.19±0.18 kg and 44.21±0.05%, respectively. Live weight, carcass weight and dressing percentage were differ ($P < 0.001$) between abattoirs, seasons and breeds of cattle slaughtered. Average meat yield and yield percentage of cattle slaughtered at Abergelle abattoir was 61.56±0.94 kg and 67.81±0.33%, respectively. Meat yield and weight of primal meat cuts were different ($P < 0.001$) between breeds of cattle. Yield percentage was significantly ($p < 0.05$) different between seasons. Retailed meat yield was significantly predicted ($R^2 = 88.1\%$) from slaughter weights, Topside (R2 = 77.86), Silverside (75.64), Knuckle (R2 = 70.13), Striploin (R2 = 70.73), Tenderloin (R2 = 61.33), Shank (R2 = 64.55) and Rumpcap (R2 = 64.48). From the study it was concluded that Boran cattle was better in dressing percentage compared to most cattle breeds in Africa while the dressing percentage and meat yield of Arado, Barka and Raya breeds were less than the percent and yield reported for other zebu cattle in Africa. A strategy should be devised to improve the carcass weight, dressing percentage and retail able meat yield from local cattle in Ethiopia.

Keywords: beef, cuts, yield

1. Introduction

Ethiopia has 59.4 million cattle (CSA, 2017) and about 33 cattle breed (EBI, 2016). However, the potential of these breeds for meat was not properly studied. Understanding the carcass traits and meat yield of a breed is a prerequisite to identify the potential of a breed for meat production. Moreover, it is important to evaluate the amount of meat that can be marketed and available as a food for the consumers. Consumers place high emphasis on food quality, and their decision on purchasing a product is mainly based on color (Marenčić et al., 2012). The pH value has a significant impact on the color, shelf life, taste, microbiological stability, yield and texture of meat and meat products and is, therefore, important for meat quality evaluation (Feiner, 2006).

Some studies were conducted at experimental station on Boran, Kereyu and Ogaden cattle carcass characteristics (Lemma et al., 2007; Mekasha et al., 2011). However, little information was available on carcass characteristics, meat yield, yield percentage and meat cut of Ethiopian cattle. The aim of this study was therefore to evaluate carcass weight, meat yield and primal meat cuts of beef from Arado, Boran, Barka, Raya and nondescript cattle breeds slaughtered at export abattoirs in Ethiopia.

2. Materials and Methods

2.1 Study Area

The study was conducted at two export abattoirs in Ethiopia, namely Abergelle and Melgawondo export abattoirs. Abergele abattoir is located in a city Mekelle which is 783 km north of Addis Ababa. The area is located at 7°13′N; 35°52′E at an altitude of 2000-2200 above sea levels. The annual temperature and rainfall ranges 11- 24 °C and 579-650 mm, respectively. Malgewondo abattoir is located in a town Wondogenet which is about 260 km south of Addis Ababa. The area is located at 7°3′N; 38°28′E at an altitude of 1800 above sea levels. The annual temperature ranges 10-29 °C and the average rainfall of the region is 1372 mm. Most cattle supplied to Abergelle abattoir supplied from mixed crop-livestock production system while Melgawedo abattoir was supplied from pastoral region of Borana.

2.2 Data Collection

Information recorded on origin of cattle, breeds, live weight and carcass weight from 22,302 cattle slaughtered from September 2010 to July 2011 at Abergelle and Melgawendo export abattoirs was used for the study.Boran, Barka, Arado, Raya and nondescript cattle breeds were slaughtered at the abattoirs. Boran cattle were slaughtered at Melgawendo abattoir while Arado, Barka, Raya and nondescript breeds slaughtered at Abegelle abattoir. In addition to carcass traits, data was collected on meat yield, yield percentage and weights of primal meat cuts from 93 carcasses of cattle slaughtered at Abergelle abattoir. This information was obtained from 23 Arado, 16 Barka, 16 Raya and 37 nondescript cattle breeds. All cattle supplied to Melgawendo abattoir were intact males while those supplied to Abergelle abattoir consisted of mix of castrated and intact bulls. The cattle slaughtered in the study abattoirs ranged in age between 3-5 years old. The age and sex of cattle slaughtered was determined based on the request of importers from importing country.

2.3 Data Analysis

Data was analyzed using the procedure of GLM of SAS (2011) software. The fixed effects of abattoir, season and breeds on carcass traits were analyzed. Factors showing significant difference at probability level of $p < 0.05$ were compared using the procedure of Tukey pairwise comparison. Standard linear model was used to estimate meat yield from live weight and carcass weight, viz. $Y = a + bx_1 + cx_2$, where y represent meat yield (kg), a, b and c are regression coefficients for fixed effect of live weight (x_1) and carcass weight (x_2). One way ANOVA was used to analyze fixed effects of breeds on meat cuts. Moreover, meat yield was estimated from meat cuts of fore and hind quarters. Dressing percentage was calculated as a ratio of carcass weight and live weight multiplied by 100 (Warriss 2000). Meat yield percentage was calculated as the ratio of kg of meat yield and cold carcass weight multiplied by 100. Season was classified in to dry (October-February) and wet (March-September).

3. Results

3.1 Live Weight, Carcass Weight and Dressing Percentages

The average live weight of cattle slaughtered was 241.41±0.37 kg. Live weight differ significantly between ($p < 0.001$) abattoirs, season and breeds of cattle. Live weight of cattle slaughtered at Melgawendo abattoir (284.02±0.92) was significantly higher ($p < 0.001$) than cattle slaughtered at Abergelle abattoir (238.16±0.27). Cattle slaughtered in the wet season had a higher ($p < 0.001$) live weight (243.05±0.35 kg) compared to those slaughtered in the dry season (238.81±0.43 kg). Boran cattle had a higher slaughter weight (284.06±0.97 kg) while Arado cattle (230.46±0.99 kg) had lower weight compared to other breeds studied. The average warm carcass weight of cattle during the study period was 106.93±0.21 kg. Warm carcass weight was significantly differ ($p < 0.001$) between abattoirs, season and breeds of cattle slaughtered. Warm carcass weight of cattle slaughtered at Melgawando abattoir (154.86±0.60 kg) was higher ($p < 0.001$) than carcass weight of cattle slaughtered at Abergelle abattoir (103.27±0.14 kg). A higher ($p < 0.001$) carcasses weight was observed in the wet season (108.12±0.20 kg) compared to the dry season (104.04±0.25 kg). Boran cattle breed (154.86±0.60 kg) had a higher carcass weight while nondescript (101.99±0.17 kg) and Arado cattle (102.12±0.61 kg) had lower weight. Barka (105.49±0.44 kg) and Raya (104.86±0.21 kg) cattle had heavier carcass weight compared to Arado cattle and nondescript breeds (Table1).

The average warm dressing percentage of cattle during the study period was 44.21±0.05%. Dressing percentage was significantly differ ($p < 0.001$) between abattoirs, season and breeds of cattle slaughtered. Cattle slaughtered at Melgawendo abattoir had a higher ($p < 0.001$) dressing percentage (54.78±0.15%) compared to cattle slaughtered at Abergelle abattoir (43.40±0.03%). A higher ($p < 0.001$) dressing percentage was observed in the wet season (44.49±0.05%) compared to the dry season (43.57±0.06%). A higher dressing percentage was observed for Boran

cattle (54.78±0.15%) while a lower dressing percentage was observed for nondescript breeds (42.84±0.04%). Arado (44.24±0.11%) and Raya (43.99±0.05%) cattle had higher dressing percentage compared to Barka (43.68±0.07%) cattle (Table 1).

Table 1. Live weight, carcass weight and dressing percentage of cattle slaughtered at Abergelle and Melgawendo abattoirs

Variable	No.	Live wt.		Warm carcass wt.		Cold carcass wt.		Warm Dressing%		Cold dressing%	
		Mean	SE	Mean	SE	Mean	SE	%	SE	%	SE
Overall	22302	241.41	0.37	106.93	0.21	101.19	0.18	44.21	0.05	42.53	0.03
Abattoir		**		**				**			
Abergelle	20720	238.16^{b}	0.27	103.27^{b}	0.14	101.19	0.13	43.40^{b}	0.03	42.53	0.03
Melgawend	1582	284.02^{a}	0.92	154.86^{a}	0.60			54.78^{a}	0.15		
Season		**		**		**		**		*	
Wet	11585	243.05^{a}	0.35	108.12^{a}	0.20	103.48	0.16	44.49^{a}	0.05	42.79^{a}	0.03
Dry	10717	238.81^{b}	0.43	104.04^{b}	0.25	100.89	0.22	43.57^{b}	0.06	42.26^{b}	0.04
Breed		**		**		**		**		*	
Arado	2115	230.46^{d}	0.99	102.12^{c}	0.61	100.08^{b}	0.60	44.24^{b}	0.11	43.36^{a}	0.11
Barka	3051	241.11^{b}	0.84	105.49^{b}	0.44	103.33^{a}	0.43	43.68^{c}	0.07	42.79^{c}	0.07
Boran	1582	284.06^{a}	0.97	154.86^{a}	0.60			54.78^{a}	0.15		
Raya	5383	238.76^{bc}	0.44	104.86^{b}	0.21	102.85^{a}	0.21	43.99^{b}	0.05	43.14^{b}	0.05
Nondescript	10171	238.56^{c}	0.35	101.99^{c}	0.17	99.91^{b}	0.16	42.84^{d}	0.04	41.96^{d}	0.04

Note. * P < 0.05, **p < 0.001, Similar letter in the same raw are not significantly different.

3.2 Meat Yield and Yield Percentage

The overall meat yield and yield percentage was 61.56±0.94 kg and 67.81±0.33%, respectively. Meat yield and yield percentage was significantly ($p < 0.05$) effected by breed of cattle slaughtered. Barka cattle had relatively higher meat yield (73.16±1.54 kg) while Arado cattle (50.28±1.48 kg) had lower yield compared to the breeds studied. Raya breed (66.17±0.46 kg) had relatively higher meat yield compared to nondescript breed (61.82±0.42 kg). The meat yield percentage between breeds studied was similar (67.35-68.38%). A higher ($p < 0.05$) meat yield percentage was observed in the wet season (68.65±0.44%) compared to the dry season (66.03±0.22%; Table 2).

Table 2. Effects of breed and season on meat yield and meat yield percentage

Variable	Meat yield (kg)		Meat yield%	
	Mean	SEM	Mean	SEM
Overall meat yield	61.56	0.94	67.81	0.33
Breed	**		ns	
Arado	50.28^{d}	1.48	67.35	0.89
Barka	73.16^{a}	1.54	68.38	0.67
Raya	66.17^{b}	0.46	67.89	0.54
Nondescript	61.82^{c}	0.42	67.82	0.47
Season	ns		*	
Dry	59.59	1.01	66.03^{b}	0.22
Wet	62.46	1.30	68.65^{a}	0.44

Note. ** p < 0.001, *p < 0.05, ns: non-significant, similar letter in the same raw are not significantly different.

3.4 The Weights of Major Primal Meat Cuts

The average meat yields from fore- and hindquarter weight were 28.05±0.50 kg and 33.50±0.48 kg, respectively. The forequarter, hindquarter and meat cuts were significantly affected ($p < 0.001$) by breeds of cattle. The forequarter and hindquarter weight of Barka breed (34.28±1.28 kg, 38.88±0.33 kg) was heavier than Raya, Arado and nondescript breeds. The fore quarter and hind quarter weight of Arado breed (22.93±0.75 kg, 27.34±0.78 kg) was the lower compared to other breeds studied. The meat cuts from the forequarters and hindquarter of Barka cattle were relatively higher ($P < 0.05$) than the Arado cattle. The weight of meat cut from

Raya cattle was relatively heavier ($P < 0.05$) than the cuts from Arado cattle except for shine and rump. All the meat cut from nondescript cattle was heavier than the meat cuts from Arado cattle except meat cuts from chuck and shine (Table 3).

Table 3. Weight of major primal meat cuts of Arado, Barka,Raya and nondescript breeds

Breed	Arado		Barka		Raya		Nondescript		Overall	
Meat cut	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Fore quarter (kg)	22.93^{c}	0.75	34.28^{a}	1.28	29.78^{b}	0.31	27.91^{b}	0.23	28.05	0.50
Brisket (kg)	3.10^{c}	0.15	5.93^{a}	0.67	4.34^{b}	0.09	4.08^{b}	0.05	4.26	0.17
Chuck (kg)	6.54^{c}	0.35	8.44^{a}	0.21	7.68^{ab}	0.19	7.26^{bc}	0.18	7.36	0.14
Shine (kg)	2.45^{b}	0.09	4.18^{a}	0.53	3.18^{b}	0.22	2.88^{b}	0.03	3.05	0.12
Neck (kg)	4.40^{b}	0.32	6.45^{a}	0.16	6.01^{a}	0.27	5.65^{a}	0.17	5.53	0.14
Blade (kg)	7.39^{b}	0.28	9.28^{a}	0.14	8.84^{a}	0.24	8.60^{a}	0.08	8.45	0.11
Hind quarter (kg)	27.34^{d}	0.78	38.88^{a}	0.33	36.39^{b}	0.30	33.90^{c}	0.23	33.50	0.48
Topside (kg)	5.07^{c}	0.19	6.79^{a}	0.12	6.29^{ab}	0.08	6.04^{b}	0.06	5.96	0.09
Silverside (kg)	5.09^{c}	0.18	6.67^{a}	0.12	6.28^{ab}	0.10	5.92^{b}	0.07	5.90	0.08
Rump (kg)	3.82^{b}	0.16	4.38^{a}	0.11	4.25^{ab}	0.15	4.46^{a}	0.11	4.25	0.07
Flank (kg)	4.57^{b}	0.22	5.99^{a}	0.37	6.38^{a}	0.20	5.92^{a}	0.07	5.71	0.12
Knuckle (kg)	3.44^{c}	0.13	4.42^{a}	0.08	4.14^{ab}	0.06	4.05^{b}	0.04	3.97	0.05
strip loin (kg)	3.58^{c}	0.18	5.61^{a}	0.14	5.00^{a}	0.11	4.47^{b}	0.11	4.54	0.10
Tenderloin (kg)	1.41^{c}	0.06	1.86^{a}	0.03	1.74^{ab}	0.03	1.62^{b}	0.03	1.63	0.03
Shank (kg)	1.22^{c}	0.05	1.65^{a}	0.03	1.52^{ab}	0.03	1.48^{b}	0.02	1.45	0.02
Rump cup (kg)	1.10^{c}	0.09	1.64^{a}	0.05	1.48^{ab}	0.02	1.40^{b}	0.05	1.43	0.03

Note. Similar letter in the same raw are not significantly different at the 5% level using the Tukey test.

All meat cuts were accurate predictor of the meat yield at highly significant level ($p < 0.001$). However, the model variances (R^2) differ between meat cuts. The accuracy of prediction (R^2) of meat yield from forequarter differs between 30.36 and 59.62%. The accuracy of prediction (R^2) of meat yield from hindquarters was between 19.72 and 77.86%. The accuracy of prediction (R^2) of meat yield from brisket and blade were 58.27% and 59.62%, respectively. The accuracy of prediction (R^2) of meat yield from topside and silverside were 77.86% and 75.64% respectively (Table 4).

Table 4. Predicting meat yield from meat cuts of cattle

Cut	Model	R^2 (%)	SE (kg)	P
Forequarter				
Brisket	Y = 42.34 + 4.62*Brisket	58.27	0.437	< .0001
Chuck	Y = 27.55 + 4.65*Chuck	47.07	0.519	< .0001
Shine	Y = 45.10 + 5.40*Shine	43.81	0.641	< .0001
Neck	Y = 41.21 + 3.68*Neck	30.36	0.584	< .0001
Blade	Y = 7.43 + 6.41*Blade	59.62	0.553	< .0001
Hind quarter				
Flank	Y = 40.32 + 3.80*Flank	19.72	0.857	< .0001
Topside	Y = 3.79 + 9.69*Topside	77.86	0.542	< .0001
Silverside	Y = 3.01 + 9.92*Silverside	75.64	0.590	< .0001
Rump	Y = 36.62 + 5.87*Rump	19.83	1.237	< .0001
Knuckle	Y = 3.64 + 14.59*Nuckle	70.13	0.998	< .0001
Striploin	Y = 25.51 + 7.99*Striploin	70.73	0.542	< .0001
Tenderloin	Y = 13.42 + 29.55*Tenderloin	61.33	2.487	< .0001
Shank	Y = 11.83 + 34.34*Shank	64.55	2.682	< .0001
Rumpcap	Y = 19.79 + 30.73*Rumpcap	64.48	3.076	< .0001

Note. Y: estimate of meat yield (kg); SE: estimated standard error of observation.

4. Discussions

The average live weight of cattle slaughtered in the abattoirs studied was comparable to the weight of Zebu (309 kg), Sanga (202 kg) and WASH (162 kg) cattle slaughtered at local abattoirs in Ghana (Teye & Sunkwa, 2010). However, live weight was lower than Nguni (324 kg) and Tuli (418 kg) cattle slaughtered in South Africa (Strydom, 2008). The higher live weights of cattle slaughtered at Melgawendo compared to Abergelle abattoir can be due to difference in breeds and body condition of cattle prior to slaughter. Cattle supplied to Melgawendo abattoir was mostly from the Boran breed. This breed was managed in pastoral and agro-pastoral production system. Moreover, a long term improvement program has been going on for the breed since 1960 (Aynalem et al., 2011). However, most cattle slaughtered at Abergelle abattoir were of the Arado, Barka, Raya and nondescript breeds but no Boran cattle. These breeds were managed in mixed crop livestock production system. The relatively higher live weight of cattle slaughtered in the wet season compared to the dry season might be due to the availability of feed and water which allowed the cattle to be finished in good body condition and higher slaughter weight. The slaughter weight differences between breeds were similarly reported in some other studies (Strydom, 2008; Teye & Sunkwa, 2010). A slaughter weight of 268 kg was reported for Boran cattle in Ethiopian similar to the present finding (Aynalem et al., 2011). Moreover, the slaughter weight of Boran cattle in the present study was comparable to the weight of Ogaden bull without supplement (297.4 kg) and the weight of Zebu cattle in Ghana (Teye & Sunkwa, 2010; Mekasha et al., 2011). The slaughter weights of Barka, Raya and Arado cattle were relatively higher than the weight of Sanga and WASHA cattle in Ghana (Teye & Sunkwa, 2010).

The average carcass weight in the present study was comparable to the carcass weight of Boran cattle (98.2-135.2 kg) managed under experimental condition in Ethiopia and Zebu breed (155.9 kg) in Ghana (Lemma et al., 2007; Teye & Sunkwa, 2010). However, it was lower than carcass weight of Ogaden cattle (163-182 kg) managed under experimental condition in Ethiopia and Nguni (181 kg) and Tuli (241 kg) cattle in South Africa (Strydom, 2008; Mekasha et al., 2011). However, it was higher than the carcass weight of WASH (74.1 kg) and Sanga cattle (95.3 kg) in Ghana (Teye & Sunkwa, 2010). The difference in carcass weights between the present study and other studies reported might be due to differences in breeds and environment.

More numbers of cattle slaughtered in the present study were nondescript breeds. According to the report from one of the abattoir, most of nondescript cattle were purchased from terminal market in the region. Cattle purchased from market could be exposed for different kinds of stress as they reached to the market after travelling long distance, most of the time through trekking. In the market places, cattle are kept in open pens. This can exposed them to the sun or cold stimuli. They might encounter some more stresses such as unfamiliar noise, environment and social regrouping. They might also be starved, dehydrated and exposed to longer periods of deprivation. This might be the reason for lower carcass weight and dressing percentage on nondescript cattle in the present study. The effect of market on the carcass traits was similarly reported by Mummed and Webb (2015).

Average warm dressing percentage of cattle slaughtered in the present study was lower than average dressing percentage of Zebu cattle (50%) slaughtered at Peshwar abattoir in Pakistan (Rahman et al., 2012). The difference in dressing percentage between abattoirs, season and breeds can be expected as there were already differences in live weigh and carcass weight between these factors. Similar to the dressing percentage of Boran cattle in the present study, Aynalem et al. (2011) has reported a dressing percentage of 55.7% for improved Boran cattle in Ethiopia. The dressing percentages of Barka, Raya and Arado cattle were comparable to the dressing percentage of N'Dama breed (42%) in West Africa and WASH breed in Ghana (SAS, 2011; Teye & Sunkwa, 2010).

The overall meat yield percentage of cattle in the present study was less than the yield reported for Nguni (72.5%) and Tuli (73%) cattle in South Africa (Strydom, 2008). The difference between breeds on meat yield was similarly reported for Angus, limousine and Wagyu cattle in Australia (Graham et al., 2009). Higher meat yield of Barka cattle compared to Arado cattle could be due to the relative heavier live weight and carcass weights of the former breed. The yield percent of cattle in the present study was comparable to Angus, limousine and Wagyu (67.7-69.9%) cattle in Australia (Graham et al., 2009). Higher percent yield in the wet season compared to the dry season can be due to the heavier live and carcass weight of cattle in the former season. A higher meat yield from hindquarter compared to forequarter was similarly reported for Piemontese and Belgian blue breeds (Biagini & Lazzaroni, 2005). The heavier fore- and hindquarter of Barka cattle compared to Raya and Arado cattle could be due to the heavier live and carcass weight of the former breed. A heavier live and carcass weights was reflected in heavier primal cuts. The difference between breeds on weight of meat cuts was similarly reported for Piemontese and Belgian Blue cattle (Biagini & Lazzaroni, 2005).

The weight of knuckles and topsides in present study were relatively lower while the weight of striploins, rumps and tenderloins were compared to the temperate and tropical cattle in Australia (Reverter et al., 2001). The weight of meat cuts from hindquarters predicted the meat yield with higher accuracy compared to the weight of meat cuts from forequarters. The weight of topsides, knuckles and striploins predicted the meat yield with higher accuracy among the weight of all meat cuts.

5. Conclusions

From the study it was concluded that the dressing percentage of Boran cattle was better while the dressing percentage of Arado, Barka and Raya breeds were comparable with some African cattle breeds. The meat yield of Arado, Barka and Raya breeds were less while the meat yield percentage and the weight of some of the prime meat cuts were comparable to the yield for most zebu cattle in tropics. Major primal meat cuts can be used to predict meat yield of cattle breeds in Ethiopia.

Reference

Aynalem, H., Workneh, A., Noah, K., Tadelle, D., & Azage, T. (2011). Breeding strategy to improve Ethiopian Boran cattle for meat and milk production. *IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 26*. Nairobi, Kenya, ILRI.

Biagini, D., & Lazzaroni, C. (2005). Carcass dissection and commercial meat yield in Piemontese and Belgian Blue double-muscled young bulls. *Livestock Production Science, 98*, 199-204. https://doi.org/10.1016/j.livprodsci.2005.05.007

CSA (Federal Democratic Republic of Ethiopia Central Statistical Agency). (2017). Livestock Characteristics (Private Peasant Holdings). *Federal Democratic Republic of Ethiopia Central Statistical Agency. Statistical Bulletin, 585*(II), 1-188.

EBI (Ethiopian Biodiversity Institute). (2016). *Ethiopian National Strategy and Plan of Action for Conservation and Utilization of Animal Genetic Resources*. Ethiopian Biodiversity Institure (EBI), Addis Ababa, Ethiopia. Retrieved from http://www.ebi.gov.et

Feiner, G. (2006). *Meat products handbook, practical science and technology*. Wood Head Publishing Limited and CRC Press LLC, Cambridge, England. https://doi.org/10.1201/9781439824245

Graham, J. F., Byron, J., Clark, A. J., Kearney, G., & 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*(6), 493-503. https://doi.org/10.1071/EA08181

Lemma, T., Geleta, T., Sisay, A., & Abebe, T. (2007). Effects of four different basal diets on the carcass composition of finishing Borana bulls. *Journal of Cell and Animal Biology, 1*(2), 015-018.

Marenčić, D., Ivanković, A., Pintić, V., Kelava, N., & Jakopović, T. (2012). Effect of the transport duration time and season on some physicochemical properties of beef meat. *ArchivTierzucht, 55*(2), 123-131. https://doi.org/10.5194/aab-55-123-2012

Mekasha, Y., Urge, M., Kurtu, M. Y., & 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*(4), 825-833.

Mummed, Y. Y., & Webb, E. C. (2015). Operation, facilities and management in public and private abattoirs in Ethiopia. *African Journal of Agricultural Research, 10*(7), 623-630. https://doi.org/10.5897/AJAR2014.9322

Rahman, A., Islam, M., Khan, S., Ahmad, S., Khattak, T. A., Rahman, A., Uddin, S., & Zeb, K. (2012). Dressing percentage and offal production of various breeds of zebu cattle slaughtered at the Peshwar abattoir. *Sarhad J. Agric., 28*(4), 655-659.

Reverter, A., Johnston, D. J., Graser, H. U., & Perry, D. (2001). Prediction of retail beef yield percentage from a number of wholesale primal cuts for use in genetic evaluation. *Proc. Assoc. Advmt. Anim. Breed. Genet., 14*. Retrieved from http://www.aaabg.org/livestocklibrary/2001/ab01112.pdf

SAS (Statistical Analysis System). (2011). *Statistical Analysis System user's guide: Statistics*. SAS Inst. Inc., Cary, NC.

Strydom, P. E. (2008). Do indigenous Southern African cattle breeds have the right genetics for commercial production of quality meat? *Meat Science, 80*, 86-93. https://doi.org/10.1016/j.meatsci.2008.04.017

Teye, G. A., & Sunkwa, W. K. (2010). Carcass characteristics of tropical beef cattle breeds (West African Shorthorn, Sanga and Zebu) in Ghana. *African Journal of Food and Agriculture Nutrition and Development, 10*(7), 2866-2883. https://doi.org/10.4314/ajfand.v10i7.59041