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Research Article

Carcass composition and sensory and chemical attributes of beef from local cattle breeds in North-West Amhara Region, Ethiopia

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Abstract: *This experiment quantifies the carcass composition and the sensory and chemical attributes of beef from four local cattle breed types in selected districts of North-West Amhara, Ethiopia. Forty matured intact bulls were fattened using two treatment feeds with Diet-1 (60:40), and Diet-2 (70:30) concentrate: roughage ratio of the daily dry matter intake of the animals. Carcass data was collected from the meat of 24 slaughtered animals through direct trait measurements, using panelists, and sample proximate analysis. The GLM of SAS (version 9.0) was used to analyze the data fitting breed and treatment feeds as fixed effects. The overall mean values of Total Leg (30.09±0.50), Total loin (12.19±0.39), Total rack (8.08±0.27), Total breast and shoulder (8.27±0.26), Total Shoulder and Neck (30.06±0.78) were significantly (P<0.05) affected by the breed type that cattle from Yilmana Desna area performed the best. Besides, meat quality traits of juiciness, tenderness, and overall acceptability (P<0.05), were best for Denbecha cattle breed types. The overall moisture content of the meat (69.78±0.32) was significantly (p<0.05) different between the breeds. Overall, the examined cattle breed types have acceptable sensory and chemical qualities of meat. Future research should quantify the sensory and chemical qualities of meat from these cattle breeds under different ages, animal physiology (intact and castrated bulls), sex, and dietary supplement levels.*

Keywords: Carcass composition, Denbecha cattle, local cattle breeds, meat quality traits, Yilmana Desna cattle
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1. Introduction

Carcass composition is an important parameter in meat animal production which can be taken as an indicator of yield and quality. It is a measure of the proportion of muscle, bone and fat in the carcass. Carcass composition is affected by genetics, age, and sex of the animal, and nutritional factors that beef breeds and intact males have a higher muscle-bone ratio than dairy breeds and castrates, respectively (Irshad *et al.*, 2013).

The acceptance of food products by consumers can be measured using several characteristics such as sensory properties, nutritional values, and their impact on the health of the consumers (Bureš *et al.*, 2006). Meat quality is a general term used to describe the attributes of meat, including the eating quality, microbial quality, yields, chemical composition and conformation, the wholesomeness of meat, and environmental issues (Dagne and Ameha, 2017; Taye *et al.*, 2017; Abera *et al.*, 2022). These meat attributes are significantly influenced by genetics, and environmental and rearing factors such as diet, age, seasons, sex, and pre-slaughter animal handling practices (Dagne and Ameha, 2017; Abera *et al.*, 2022). In addition, the physical and sensory characteristics of meat, including tenderness, flavour, juiciness, colour, pH, shear force, and water-holding capacity are important meat quality parameters (Taye *et al.*, 2017; Corazzin *et al.*, 2019). These sensory attributes of meat can be checked using either trained or untrained consumer panels (Thompson, 2002). Similar to the other meat quality attributes, the organoleptic qualities of meat are highly influenced by the biological characteristics and the proteolytic activities of muscle (Taye *et al.*, 2017).

The physicochemical and sensory attributes of beef are greatly affected by several factors associated with the breed and age of the animals, rearing practices, and slaughtering and carcass handling practices (Alhidary *et al.*, 2016; Gagaoua *et al.*, 2017; Sosin-Bzducha and Puchała, 2017). Besides, the physicochemical and sensory attributes of beef and the change in its health-promoting values during storage and heat treatment are influenced by its intramuscular fat fatty acid composition (Sosin-Bzducha and Puchała, 2017). According to Thompson (2002), meat tenderness is a function of production, processing, value-adding and cooking methods used to prepare the meat for consumption in which a failure in either of the links may result in poor meat-eating qualities. Moreover, several scholars have been reporting a substantial effect of breed (Gagaoua *et al.*, 2016; Gadisa *et al.*, 2019), and finishing diets (Hwang and Joo, 2017; Yang *et al.*, 2020; Abera *et al.*, 2022) on the sensory and chemical attributes of meat from different cattle breeds worldwide. However, in North-West Amhara, where a huge cattle population with a sizeable beef potential are found, research outputs quantifying the sensory and chemical qualities of meat are limited. Hence, the objective of this study was to evaluate the carcass compositions, and sensory and chemical qualities of meat from local cattle breed types in the North-West of Amhara region, Ethiopia.

2. Materials and Methods

2.1 Description of the study areas

The study was conducted at the beef cattle farm of the College of Agriculture and Environmental Sciences, Bahir Dar University. The animals used in the experiment were purchased from four selected districts namely Yilmana Densa, Mecha and Dembecha, districts from the West Gojjam zone, and Libo-Kemkem district from South Gondar zone of the Amhara region, Ethiopia. The study districts were purposively selected due to the flourishing potential of cattle fattening activity by rural and urban dwellers and the dearth of information on carcass and meat quality characteristics of cattle breed types in the selected areas. The information regarding the geographical location, agro-ecologies, elevation, climatic conditions, land holdings, livestock population, and the human population of the study districts are presented in Table 1, and Table 2, respectively.

2.2 Experimental treatments and design

To evaluate the carcass compositions, and sensory and chemical attributes of meat from local cattle breeds in the North-west Amhara region, Ethiopia, a total of 40 matured (with two pairs of permanent incisors) intact bulls were purchased from four (10 from each) different markets namely Adet, Merawi, Dembecha, and Yifag markets, which are located in Yilmana Densa, Mecha, and Dembecha, and Libokemkem district of the Amhara region, Ethiopia, respectively. The marketplaces in each of the districts were selected on the assumption that the cattle in the district come to the markets selected, and that there could be a difference in relation to the type of animals available in each local market. The cattle breeds found distributed in the West Gojjam zone and presented to the indicated markets (Yilmana Densa, Mecha, and Dembecha) are known to be Gojjam Highland Zebu (Bos Indicus) while those cattle presented to the Yifag market are expected to be Fogera (Zenga) types (Kebede and Ayalew, 2014). However, for the Yifag market, cattle from the highlands can be presented.

Animals from each breed type were systematically (based on the initial body weight) assigned into two treatment feeds, which were levelled as treatment diet-1 comprising of 60:40 concentrate: roughage ratio of the daily dry matter intake of the experimental animal, while treatment diet-2 contained 70:30 of concentrate to roughage ratio of the animals' daily dry matter intake. The roughage feed used in this experiment was purchased grass hay harvested from a natural pasture. Whereas, the concentrate feed was formulated using 75% maize, 24% Noug seed cake, and 1% Salt mixtures.

The experimental design used in this experiment was a Randomized Complete Block Design with a factorial arrangement; four breed types with two feeding levels. The initial body weight of the experimental animals was estimated using a heart girth meter (SCHWEINE/PORCS), and it was used to block the animals into their experimental groups (two feeding levels). The feeding trial was conducted for 95 days from April to July 2021. Throughout the experimental period, animals have had free access to roughage feed and water.

2.3 Chemical analysis of the treatment feed ingredients

The proximate analysis of concentrate and roughage feeds (offered and refused) used in the experiment is presented in Table 3.

Table 1: Geographical location, altitude ranges, climate condition, and agro-ecological variations of the districts where experimental animals were purchased

Descriptors	Study districts located in the North-west of Amhara region, Ethiopia			
	Dembecha	Yilmana Densa	Mecha	Libo-Kemkem
Geographical location				
Latitude	10°32'59.99''N	11°10'-11°15'N	11°5'-11°38'N	12°39'66"-12°42'45"N
Longitude	37°28'59.99''E	37°30'-37°40'E	36°58'-37°22'E	37°26'99"-37°28'42"E
Agro-ecology (%)				
Highland	11%	24%	0%	18%
Midland	83%	64%	80%	43%
Lowland	6%	12%	20%	39%
Altitude (m a.s.l.)	1500-2999	1552-3535	1795-3268	1,800-2,000
Annual temperature (ºC)	10 -20 ºC	15 -24 ºC	17 ºC-30	19-30 ºC
Annual rainfall (mm)	1200-1600	1200-1600	820-1250	1300

Table 2: Human and livestock populations, and land area coverage (km^2) of the districts where experimental animals were purchased from in the North-West of Amhara region, Ethiopia

Districts	Land area	Human population	Cattle	Goat	Sheep	Equines	Chicken
Dembecha	971	151023	177375	11726	51820	26055	14241
Mecha	1481	375716	351844	61883	110834	39214	230286
Yilmana Densa	1018	214852	123440	11471	79217	24904	88439
Libo-Kemkem	1082	226 958	115452	36448	17939	2552	327403

Table 3: The proximate analysis of treatment diets (%) used for the fattening experiment

Feed types	DM	Ash	CP	NDF	ADF	ADL	OM
Concentrate	91.53	2.80	9.28	35.79	7.29	2.42	97.20
Hay (offered)	92.82	9.85	4.96	76.00	48.60	12.59	90.15
Hay (refusal)	92.45	11.35	3.47	80.61	54.33	15.34	88.65

Note: The values are the mean of three replicated samples, DM: Dry matter; CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; OM: Organic matter

2.4 Data types and methods of data collection

Data on carcass composition characteristics, sensory properties (juiciness, tenderness, flavour, connective tissue amount and overall acceptability), and chemical attributes (hot carcass pH, cold carcass pH, percent of moisture, percent of ash, and the percent of average protein on dry base mass protein) of meat were collected from the beef of local cattle breeds raised in the North-West of Amhara region Ethiopia. To measure the values of carcass composition characteristics and chemical attributes, and to evaluate the sensory properties of meat from the experimental animals, a total of 24 (three animals from each treatment diet) were slaughtered at the College of Agriculture and Environmental Sciences (CAES) mini abattoir, following an appropriate animal slaughtering procedures and considering the animals' welfare ethics. Animals were stunned using a pistol bolt gun and slaughtered by cutting the throat using a sharp knife.

The carcass was cut into Leg, Loin, Rack, Breast and Shoulder, Shoulder and Neck following the standard procedures and weighed separately. After that, the fat, lean, and bone parts of each part was manually and carefully separated and weighed.

2.4.1 *Sensory characteristics*

The sensory attributes of meat including juiciness, tenderness, flavour, connective tissue amount, and overall acceptability were judged based on cooked meat using selected panelists from Bahir Dar. The panelists were selected considering their interest in participating, familiarity with overall meat-eating quality, and ability to understand the scale rate used in the evaluation procedures. Before the procedure, the panelists were oriented and trained on the procedures and principles of sensory evaluation (AMSA, 2015). The evaluation rates were based on a nine-point hedonic scale as tenderness from 9 (Extremely Tender) to 1 (Extremely Tough); flavor from 9 (Extremely Intense) to 1 (None); connective tissue amount from 9 (None) to 1 (Abundant).

The procedure was, first, meat cut from the loin area of the experimental animals was chilled at 4 ºC for 24 hours and then the chilled meat was cut into nearly equal cube meat sheets and roasted with a plat at 300 ºC and given to the selected panelists to judge the sensory properties of meat. The panelists were provided with a glass of water to rinse their mouths in between the samples/tastes to avoid crossover effects.

2.4.2 *Chemical characteristics*

In addition, the chemical attributes of meat such as hot carcass pH, cold carcass pH, percent of moisture, percent of ash, and percent of average protein on dry base mass were checked following the proximate meat quality analysis protocol. The proximate meat chemical composition was carried out following the method described by the Association of Official Analytical Chemists (AOAC, 2005). Nitrogen content was determined by using the Kjeldahl method and protein was calculated as N x 6.25. Ash was determined according to the AOAC standard procedure (AOAC, 2005).

2.5 Methods of data analysis

The collected data was analyzed following the General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, version 9.0). The breed type of local beef cattle and treatment diet options were fitted as fixed factors, while the carcass compositions and sensory and chemical attributes of meat were considered dependent variables. The statistical model used is indicated below.

$$Yijk = \mu + Bi + Tj + BT\,(ij)\,k + eijk$$

Where;

Y_{ijk} = the recorded values for each evaluated quantitative traits

μ = Overall mean

B_i = the i^{th} effect of cattle breed type (i = Yilmana Densa, Mecha, Libokemkem, and Dembecha)

T_j = the j^{th} effect of treatment diets (j = Treatment diet-1, and Treatment diet-2)

$BT_{(ij)\,k}$ = the k^{th} effect of the interaction between each breed type and treatment diets

e_{ijk} = error term associated with each observation

3. Results and Discussion

3.1. Carcass composition characteristics

The observed results on carcass composition characteristics of local beef cattle breed types in North-West Amhara as affected by breed type and treatment feed are presented in Table 4. In the current study, cattle breed type had a significant (P<0.05) effect on the total leg, lean leg, total loin, bone rack, total shoulder and neck, fat loin, and bone loin measurements of local beef cattle breed types. However, cattle breed type had no significant influence on many of the carcass composition traits. Conversely, there was no significant difference between feed treatments on carcass composition traits of local beef cattle breed types in North-West Amhara. The overall least square mean (±SE) values of the total leg, lean leg, total loin, fat loin, bone loin, bone rack, and total shoulder and neck carcass traits in the current study were 30.09±0.50 kg, 21.75±0.36 kg, 12.19±0.39 kg, 3.08±0.24 kg, 2.32±0.10 kg, 0.96±0.08 kg, and 30.06±0.78 kg, respectively. Cattle breed types from Yilmana Densa district recorded the highest values of total leg (31.68±1.02 kg), lean leg (23.17±0.75 kg), total loin (13.71±0.80 kg), and total shoulder and neck (33.40±1.60 kg) carcass components than cattle breeds types brought from any other districts. Whereas, the smallest values of the abovementioned carcass components were recorded for cattle breed types brought from Mecha district. However, the highest values for the bone rack were recorded for cattle breed types from Dembecha district (1.41±0.17 kg).

Similar to the present observation, a substantial influence of breed on different carcass components has been reported by several scholars in Ethiopia and elsewhere (Pesonen *et al.*, 2012; Xie *et al.*, 2012; Avilés *et al.*, 2015; Tefera *et al.*, 2019; Musa *et al.*, 2021; Erge *et al.*, 2022). Tefera *et al.* (2019) reported a significantly (P<0.05) higher live and carcass weight for Boran cattle breeds aged 7-9 years than Arsi and Harar cattle breeds within a similar age group. Similarly, Erge *et al.* (2022) reported a significantly higher slaughter weight, and carcass weight (hot carcass weight, and chilled carcass weight) for Ogaden cattle breed compared to Arsi, Harar, and Jersey*Horro F1 crossbred bulls fed corn silage based similar finishing diet at Haramaya University, Ethiopia. Furthermore, significantly heavier carcass weight was reported for different beef cattle breeds, including Limousine (Avilés *et al.*, 2015), Angus*Holstein Friesian cows (Coleman *et al.*, 2016), and Charolais, Blonde d'Aquitaine and Limousin breeds (Pesonen *et al.*, 2012) outside of Ethiopia. However, in contrast to the present finding, a significant effect of feed treatments on carcass quality attributes of beef cattle breeds has been reported in Ethiopia (Abera *et al.*, 2022).

3.2. Sensory properties of meat

The sensory properties of meat can be judged by its tenderness, colour, juiciness, flavor, and nutritive values (Webb and O'neill, 2008). The observed values of sensory qualities of meat, from the evaluated cattle breed types, are presented in Table 5. In the present study, the breed type of cattle had a significant (P<0.05) influence on the juiciness and tenderness of the meat. Whereas, flavor, connective tissue amount, and overall acceptability of meat from local beef cattle breed types didn't show significant differences among breed types of cattle. Conversely, treatment feeds had no significant influence on the evaluated sensory qualities of meat from local beef cattle breed types in North-West Amhara. Comparable to the present finding, a significant (P<0.01) influence of breed on the juiciness of meat from Harar, Arsi, and Bale cattle breeds was reported. However, the non-significant influence of breed on the tenderness of meat in these breeds was inconsistent with the current finding (Gadisa *et al.*, 2019). In addition, a significant influence of animal types on the muscle characteristics and sensory qualities of meat was reported for eight different European beef cattle breeds (Gagaoua *et al.*, 2016).

Concerning feed treatments, a non-significant influence of rice straw and whole-crop barley (*Hordeum vulgare L.*) silage supplements on meat juiciness, tenderness, and the flavor was reported for Hanwoo (*Bos taurus coreanae*) steers fed on grass-based diets in Korea (Yang *et al.*, 2020) similar to the current results. However, inconsistent with the present observation, Gage (2021) reported a significant influence of diet on the instrumental tenderness of meat from Harar oxen aged about six years. Besides, compared to grass-fed Hanwoo and Australian beef cattle breeds, significantly (P<0.001) higher meat juiciness (8.12±0.09), tenderness (7.12±0.17), flavor (7.38±0.38), and overall palatability (7.78±0.18) was recorded from grain-fed Hanwoo beef cattle breed which is inconsistent to the present finding (Hwang and Joo, 2017). Eating characteristics is the major determinant of meat quality and is greatly influenced by tenderness, juiciness, flavor, intramuscular fat content, and the low-fat melting point of meat (Mwangi *et al.*, 2019). Meat tenderness is greatly affected by animal age, pre- and post-slaughter carcass handling, post-mortem pH decline, genetics and carcass marbling (Špehar *et al.*, 2008). While, meat flavor is varied with diet, animal sex, breed, and genetics of the animal (Arshad *et al.*, 2018). Instead, juiciness, the initial impression of moisture released on the meat surface during chewing and the degree of induced salivation (Mwangi *et al.*, 2019), is closely related to meat tenderness and hence, the more tender the meat, the more readily juices are emitted, and the juicier the meat is perceived while chewing (Dagne and Ameha, 2017). Both juiciness and tenderness are the properties that most influence meat acceptability (Muchenje *et al.*, 2009).

The overall least square mean values of meat juiciness, tenderness, and flavor investigated in the present study were higher compared to juiciness (4.92±0.31), tenderness (4.90±0.24), and flavor (5.06±0.25) of meat from Hanwoo steer fed on grass-based diet and supplemented with rice straw and concentrate mixes (Yang *et al.*, 2020). Instead, tenderness (7.08±0.08), juiciness (7.07±0.07), and flavor (7.34±0.10) of meat from Guraghe cattle aged 4-9 years slaughtered at Hosanna municipal abattoir were higher than the present investigation (Lire Gibore, 2022). Besides, Liu *et al.* (2022) reported a higher score of overall tenderness (7.54±0.27), juiciness (7.49±0.31), and flavor (6.91±0.25) of meat cut on striploin of grass-fed male Angus*Salers crossbred cattle aged about fourteen months. Besides, compared to the present results, higher values of meat juiciness (7.19±0.05), tenderness (7.21±0.06), and flavor (7.25±0.06) were reported for Harar, Arsi, and Bale cattle breeds slaughtered at public abattoirs in Ethiopia (Gadisa *et al.*, 2019). Moreover, compared to the present result, higher values of meat juiciness (8.12±0.09), tenderness (7.12±0.17), flavor (7.38±0.38), and overall palatability (7.78±0.18) was reported for grain-fed Hanwoo breed but, grass-fed animals of the same breed had recorded lower values of sensory attributes except for beef flavor (Hwang and Joo, 2017). This shows that cattle breeds investigated in the current study have less tough and juicy meat with acceptable flavor compared to the aforesaid cattle breeds in and outside Ethiopia. But, except for tenderness (6.17±0.18), which falls within the suitable range (5.50 -6.47), the juiciness (6.63±0.14), and flavor (6.34±0.14) of meat from the examined cattle breeds were outside the acceptable range, which is 4.38 - 5.60, and 5.39 - 5.93, respectively (Muchenje *et al.*, 2009).

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Table 4: Least square means (±SE) of carcass composition characteristics (kg) of local beef cattle breed types as affected by breed type and treatment feed in selected districts of North-West Amhara, Ethiopia

Traits	Overall	Local beef cattle breed types					Treatment diets			Breed * Diet
		Yilmana Densa	Mecha	Libokemkem	Dembecha	P-Value	Diet-1	Diet-2	P-value	
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE		LSM±SE	LSM±SE		
Total leg	**30.09±0.50**	**31.68±1.02^{a}**	**28.46±0.96^{b}**	**30.60±0.96^{ab}**	**29.61±1.02^{ab}**	*	**29.87±0.70**	**30.31±0.70**	ns	ns
Lean leg	21.75±0.36	23.17±0.75^{a}	20.85±0.70^{b}	21.88±0.70^{ab}	21.08±0.75^{ab}	*	21.56±0.51	21.94±0.51	ns	ns
Fat leg	3.86±0.19	4.27±0.39	3.23±0.37	4.08±0.37	3.85±0.39	ns	3.73±0.27	3.99±0.27	ns	ns
Bone leg	4.48±0.09	4.24±0.20	4.38±0.19	4.63±0.19	4.67±0.20	ns	4.58±0.14	4.38±0.14	ns	ns
Total Loin	**12.19±0.39**	**13.71±0.80^{a}**	**11.17±0.75^{b}**	**12.93±0.75^{ab}**	**10.97±0.80^{b}**	*	**12.36±0.55**	**12.03±0.55**	ns	ns
Lean Loin	7.00±0.24	7.09±0.49	6.95±0.46	7.03±0.46	6.13±0.49	ns	7.13±0.34	6.47±0.34	ns	ns
Fat Loin	3.08±0.24	3.93±0.50^{a}	1.85±0.47^{b}	3.48±0.47^{a}	3.06±0.50^{ab}	*	2.89±0.35	3.27±0.35	ns	ns
Bone Loin	2.32±0.10	2.70±0.22^{a}	2.37±0.20^{ab}	2.42±0.20^{a}	1.79±0.22^{b}	*	2.34±0.15	2.30±0.15	ns	ns
Total Rack	**8.08±0.27**	**8.44±0.55**	**7.38±0.52**	**7.67±0.52**	**8.84±0.55**	ns	**8.00±0.38**	**8.17±0.38**	ns	ns
Lean Rack	4.79±0.17	5.13±0.36	4.53±0.34	4.85±0.34	4.64±0.36	ns	4.71±0.25	4.86±0.25	ns	ns
Fat Rack	2.34±0.13	2.40±0.28	2.13±0.26	2.03±0.26	2.79±0.28	ns	2.35±0.19	2.33±0.19	ns	ns
Bone Rack	0.96±0.08	0.91±0.17^{ab}	0.72±0.16^{b}	0.78±0.16^{b}	1.41±0.17^{a}	*	0.94±0.12	0.97±0.12	ns	ns
Total Breast and Shoulder	**8.27±0.26**	**8.51±0.54**	**7.73±0.51**	**8.13±0.51**	**8.71±0.54**	ns	**8.14±0.37**	**8.40±0.37**	ns	ns
Lean Breast and Shoulder	4.50±0.12	4.64±0.40	4.23±0.38	4.63±0.38	4.51±0.40	ns	4.51±0.28	4.50±0.28	ns	ns
Fat Breast and Shoulder	2.03±0.11	2.04±0.23	1.78±0.22	1.92±0.22	2.40±0.23	ns	2.02±0.16	2.05±0.16	ns	ns
Bone Breast and Shoulder	1.73±0.07	1.84±0.15	1.72±0.14	1.58±0.14	1.80±0.15	ns	1.62±0.10	1.85±0.10	ns	ns
Total Shoulder and Neck	**30.06±0.78**	**33.40±1.60^{a}**	**28.52±1.51^{b}**	**29.22±1.51^{ab}**	**29.10±1.60^{ab}**	*	**30.56±1.10**	**29.56±1.10**	ns	ns
Lean Shoulder and Neck	21.70±0.72	24.11±1.47	20.55±1.39	21.20±1.39	20.94±1.47	ns	22.21±1.01	21.19±1.01	ns	ns
Fat Shoulder and Neck	3.77±0.26	4.30±0.53	3.43±0.50	3.60±0.50	3.74±0.53	ns	3.73±0.36	3.80±0.36	ns	ns
Bone Shoulder and Neck	4.59±0.16	4.99±0.32	4.53±0.30	4.42±0.30	4.43±0.32	ns	4.62±0.22	4.57±0.22	ns	ns

Note: a, b, c = Means within a column with different subscripts are significantly different (P<0.05), LSM = Least square means, SE = Standard error * = P<0.05, ns = none significant (P>0.05), Treatment diet-1 = 60:40 concentrate: roughage ratio of the animals' daily dry matter intake; Treatment diet-2 = 70:30 of concentrate: roughage ratio of the animals' daily dry matter intake

Table 4: Least square means (±SE) of sensory attributes of meat from fatten bulls of local beef cattle breed types in the North-West of Amhara region, Ethiopia as judged by selected panelists

Parameter	Juiciness	Tenderness	Flavor	Connective tissue amount	Overall acceptability
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	6.63±0.14	6.17±0.18	6.34±0.14	6.10±0.21	6.34±0.14
Breeds	*	*	ns	ns	*
Yilmana Densa	6.55±0.25[ab]	6.15±0.33[ab]	6.40±0.25	6.30±0.37	6.35±0.26[ab]
Mecha	6.30±0.24[b]	6.07±0.31[ab]	6.13±0.24	6.10±0.35	6.20±0.24[b]
Libokemkem	6.45±0.36[ab]	5.55±0.47[b]	6.10±0.35	5.40±0.53	5.90±0.36[b]
Dembecha	7.20±0.25[a]	6.90±0.33[a]	6.73±0.25	6.60±0.37	6.93±0.26[a]
Treatments	ns	ns	ns	ns	ns
Treatment diet-1	6.53±0.18	6.27±0.24	6.21±0.18	6.15±0.27	6.38±0.19
Treatment diet-2	6.72±0.21	6.07±0.27	6.47±0.21	6.05±0.31	6.31±0.21
Breed*treatment	ns	ns	ns	ns	ns

Note: a, b, c = Means in a column with different subscripts are significantly different (P<0.05), LSM = Least square means, SE = Standard error * = P<0.05, ns = none-significant (P>0.05), Treatment diet-1. 60:40 concentrate: roughage ratio of the animals' daily dry matter intake; Treatment diet-2. 70:30 of concentrate: roughage ratio of the animals' daily dry matter intake

3.3. Chemical attributes of meat

Meat pH value is greatly related to the biochemical process during the transformation of muscle to meat and it is the most important quality indicator of meat (Birhanu, 2019). One of the most important factors affecting the pH of meat is the pre-slaughter stress of meat animals, as stress from poor transportation facilities, rough animal handling, and temperature increment causes the animal to mobilize its' glycogen reserve before slaughter (Muchenje *et al.*, 2009). The pH of meat is considerably affecting other important sensory characteristics of meat, including tenderness, water-holding capacity, colour, flavor, and shelf-life (Knox *et al.*, 2008; Wicks *et al.*, 2019). The chemical attributes of meat observed in the proximate analysis of meat from the evaluated cattle breed types are presented in Table 6. The result showed that cattle breed types brought from Libokemekem district had recorded a significantly (P < 0.01) lower percent of moisture content (67.76±0.69) compared with cattle breed types brought from any other districts. However, both breed type and treatment feeds didn't show any significant (P>0.05) influence on other chemical attributes of meat. Consistently, a non-significant effect of breed on the initial and ultimate carcass pH was reported for Boran, Harar, and Arsi cattle breeds in Ethiopia (Birhanu *et al.*, 2019). In addition, the non-significant influence of breed on the initial and ultimate carcass pH was detected for Harar, Arsi, and Bale cattle breeds (Gadisa *et al.*, 2019). Likewise, a non-significant influence of genotype on the percent of meat ash and protein content was reported for young domestic spotted*Charolais, domestic spotted*Limousine, and domestic spotted breed of Simmental type beef cattle breeds fattened using concentrate, hay, and corn grain silage feeds, in agreement with the current results (Aleksić *et al.*, 2011).

Regarding treatment feeds, inconsistent with the present finding, a significant (P < 0.001) influence of treatment feeds on chemical attributes of meat, including crude fat, crude protein and moisture content of meat were reported for Hanwoo, American, and Australian crossbred beef cattle breeds finished on grain-fed and grass-fed bases (Hwang and Joo, 2017). But, the ash (%) of beef from these cattle breeds finished using grain-fed and grass-fed bases did not vary across breeds and treatment feeds, in agreement with the current result (Hwang and Joo, 2017). Similarly, the initial and ultimate pH and fat percent of meat from Limousine crossbred heifers fed on conventional concentrate, and concentrate-rich agro-industrial by-products based finishing diet was not varied among treatment feeds (Moreno Díaz *et al.*, 2020). However, a significant effect of treatment feeds on the percent of moisture, crude fat, and crude protein of meat was observed between Hanwoo steer fed on rice straw + concentrate, and whole-crop barley silage + concentrate feeds, which are not similar to the current results (Yang *et al.*, 2020).

The overall values of initial carcass pH (6.30±0.15) and ultimate carcass pH (5.59±0.03) of the evaluated local beef cattle breed types in the present study were almost similar to the initial carcass pH (6.36-6.40) and ultimate carcass pH (5.49-5.62) of castrated Harar oxen aged about six years fed native hay as basal diet and supplemented with maize silage at different inclusion level (Abera *et al.*, 2022). Instead, the initial and ultimate carcass pH values in this research were somewhat lower than the values of initial carcass pH (6.53±0.02), and ultimate carcass pH (5.73±0.02) of Hara, Arsi, and Bale cattle breeds slaughtered at public abattoirs in Ethiopia (Gadisa *et al.*, 2019). In addition, the initial carcass pH (6.73±0.02), and ultimate carcass pH (5.63±0.02) of Guraghe cattle aged 4-9 years slaughtered at Hosanna municipal abattoir were slightly higher than the current finding (Lire Gibore, 2022). Moreover, compared to the current finding, slightly higher values of initial carcass pH (6.72±0.034) and ultimate carcass pH (5.79±0.07) were reported for crossbred Limousine heifers finished on a concentrate rich in agro-industrial by-products (Moreno Díaz *et al.*, 2020). Furthermore, the ultimate carcass (pHu) in the present study (5.57-5.63) falls within the pHu range (5.3-5.7) reported for meat with good visual appeal and potentially good eating quality by Meat and Livestock Australia (https://www.mla.com.au/msa). This shows that beef from local cattle breeds examined in this study has an acceptable ultimate pH, which may attain desirable flavors related to cooked beef (Dagne and Ameha, 2017). Instead, the moisture (69.78±0.32) and ash (2.12±0.12) percentage of meat from the examined local beef cattle breeds were higher than the percent of moisture (61.72±1.08) and ash (0.90±0.01) of meat from Hanwoo steers fed whole-crop barley silage plus concentrate mixes (Yang *et al.*, 2020)

Another important factor, which determines meat quality and the price of beef, is marbling or the intramuscular fat content. According to Wood et al. (2008), meat quality is largely related to the fat content and fatty acid composition of muscle, which in turn depends on the nutritional status of the animal. Like other chemical characteristics of beef, cattle breed, and treatment feeds had a non-significant influence on the average fat percent of beef from local cattle breed types in North-west Amhara (Table 6). A similar non-significant influence of treatment feeds (73% concentrate-rich agro-industrial by-products) on the fat thickness over longissimus muscle and latissimus dorsi muscle of crossbred Limousine heifers has been reported (Díaz et al., 2020). However, a significant influence of maize silage on the subcutaneous fat thickness of meat has been reported for castrated Harar oxen aged ~ 6 years (Gage et al., 2022). Besides, dissimilar to our result, a significant effect of whole-crop barley silage concentrate on crude fat (%) of meat has been reported for Hanwoo steer (Yang et al., 2020). The discrepancy may be associated with the difference in initial management condition of animals, breeds, age, and types of finishing diets.

Table 5: Least square means (±SE) of proximate analysis of meat quality (%) of fattened local beef cattle breed types from selected districts in the North-West of Amhara region, Ethiopia

	Initial pH	Ultimate pH	Moisture	Ash	APDBMP	Average fat (%)
Parameters	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	6.30±0.15	5.59±0.03	69.78±0.32	2.12±0.12	81.42±1.32	8.31±0.43
Breed	ns	ns	**	ns	ns	ns
Yilmana Densa	6.44±0.24	5.63±0.05	70.19±0.62^{a}	2.51±0.24	80.64±2.55	8.98±0.89
Dembecha	6.36±0.31	5.57±0.06	70.79±0.62^{a}	2.06±0.24	81.47±2.55	8.62±1.10
Libokemekem	6.29±0.33	5.57±0.06	67.76±0.69^{b}	1.86±0.27	79.01±2.85	8.36±0.80
Mecha	6.09±0.31	5.60±0.06	70.36±0.62^{a}	2.06±0.24	84.53±2.55	7.27±0.57
Treatments	ns	ns	ns	ns	ns	ns
Treatment diet-1	6.39±0.20	5.63±0.04	69.25±0.46	2.22±0.18	80.13±1.92	7.58±0.49
Treatment diet-2	6.20±0.23	5.55±0.04	70.30±0.47	2.03±0.17	82.70±1.81	8.98±0.65
Breed*treatment	ns	ns	ns	ns	ns	ns

Note: ns = none-significant; LSM = Least square means; SE = Standard error; APDBMP = Average Protein on Dry Base Mass Protein; Treatment diet-1 = 60:40 concentrate: roughage ratio of the animals' daily intake; Treatment diet-2. 70:30 of concentrate: roughage ratio of the animals' daily dry matter intake, the initial and ultimate pH of meat are equivalent to hot, and cold carcass pH, respectively; ** = P<0.01

4. Conclusion and Recommendations

Based on the results of the study, it can be concluded that local beef cattle breed types brought from Adet market of Yilmana Densa district had the highest values of total leg, lean leg, total loin, fat loin, total shoulder and neck, and bone loin measurements. However, the highest value of bone rack was recorded for local beef cattle breed types purchased from Dembecha market of Dembecha district. Besides, animals brought from Dembecha district exhibited the highest values of meat sensory properties, including overall acceptability, juiciness, and tenderness. However, from the local beef cattle breed types, animals brought from Yifage market of Libokemkeme district was recorded with the lowest moisture content of meat. Conversely, none of the evaluated carcass compositions, sensory attributes, and chemical compositions of meat from the examined cattle breed types were variable across the treatment feeds. In general, meat from the examined cattle breed types had acceptable sensory and chemical attributes. However, further studies are needed to quantify the sensory and chemical compositions of meat from these cattle breed types under different age groups, animal physiology (intact and castrated bulls), sex, and dietary supplements.

Data availability statement

Data will be made available on request.

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Conflicts of interest

The authors declared that there is no conflict of interest.

Ethics approval

The experiment was carried out by having ethical clearance from ethical board of Bahir Dar University.

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