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FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF INDIGENOUS CATTLE BREEDS IN THE AMHARA REGION OF ETHIOPIA

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ABSTRACT: Evaluating the feedlot potential and carcass traits of beef cattle breeds is crucial for identifying breeds suited to meat production and for guiding fattening enterprises. This study was conducted to assess the performance of cattle breeds sourced from selected districts in northwest Amhara, Ethiopia, under controlled feeding conditions. A total of 40 mature (2 pairs of permanent incisors intact bulls were purchased from four purposively selected local markets: Adet (Yilmana Densa), Merawi (Mecha), Dembecha (Dembecha), and Yifag (Libokemkem). The animals were transported to the Bahir Dar University beef farm and randomly allocated to two feeding treatments: 60:40 and 70:30 ratios of concentrate:roughage (Treatments 1 and 2, respectively) of the animals' daily dry matter intake. The experiment was conducted over 95 days via a randomized complete block design (RCBD) with a factorial arrangement. Data collected included body weight, morphological traits, carcass yield, and edible and non-edible offal, analyzed using the general linear model (GLM) procedure of SAS 9.0. Breed significantly influenced initial and final body weights ($P < 0.01$), slaughter weight, hot and cold carcass weights, weight-to-bone thickness ratio, and the weights of tail, head, and skin ($P < 0.05$). Cattle from Yilmana Densa consistently outperformed others, with a mean slaughter weight of 339.35±10.90 kg, hot carcass weight of 196.49±6.50 kg, and cold carcass weight of 193.51±6.07 kg. In contrast, feeding treatments had no significant effect on the evaluated traits. Overall, indigenous cattle breeds in northwest Amhara exhibited promising feedlot potential and acceptable carcass yields. Further studies incorporating meat quality parameters, age effects, and alternative dietary supplements are recommended to optimize production and market value.

Keywords: Beef, Carcass characteristics, Carcass weight, Local cattle breeds, Yilmana Densa.

INTRODUCTION

Ethiopia possesses the largest livestock population in Africa, with an estimated 70 million cattle, 52.5 million goats, 42.9 million sheep, 57 million poultry, 8.1 million camels, 2.1 million horses, 10.8 million donkeys, 0.38 million mules, and 6.99 million beehives (CSA, 2021). Among the national cattle herd, indigenous breeds account for 97.4%, while hybrid and exotic breeds represent only 2.3% and 0.31%, respectively.

The livestock sector is a cornerstone of Ethiopia's economy (Alemneh and Getabalew, 2019; Abebe et al., 2022; Aragie and Thurlow, 2024), contributing about 16.5% to the national gross domestic product (GDP), 35.6% of the agricultural GDP, 15% of export earnings, and 30% of agricultural employment (Eshetu & Abraham, 2016). Beyond its economic contribution, livestock provides households with food (milk, meat, and blood), hides, draft power, wealth accumulation, and a form of insurance against shocks (Dinku, 2019). Cattle also hold important cultural and social value, particularly among pastoralist and agro-pastoralist communities.

In Ethiopia, cattle are managed for multiple purposes, including meat, milk, and draft power. Unlike countries with specialized beef breeds, Ethiopia does not maintain cattle exclusively bred for beef production (Alemneh and Getabalew, 2019). Instead, beef is often sourced from old oxen that have already served for draft purposes, which limits both yield and quality. Despite this practice, indigenous cattle possess untapped potential for beef production, yet their growth performance and carcass quality remain poorly characterized. Efforts to improve the beef potential of local breeds have been minimal (Tucho et al., 2021), with most research and development programs focusing on dairy traits. This lack of attention has slowed progress in developing efficient beef production systems. Even though there are no specialized beef cattle breeds, in Ethiopia, approximately 1.2% of the total cattle population is raised exclusively for meat (CSA, 2021).

Cattle fattening is a newly emerging business sector in Ethiopia due to its sizable role in creating employment opportunities and income generation for urban and peri-urban inhabitants (Ayalew et al., 2018; Belayneh et al., 2021; Erge et al., 2022; Lire Gibore, 2022). Despite this growth, it faces numerous challenges, including limited genetic

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improvement programs, scarcity of quality feed resources, high disease burden, weak livestock policies, and socioeconomic constraints (Abebe et al., 2022; Milikias & Gebre, 2024; Wendimu et al., 2023). Nevertheless, several indigenous cattle breeds such as Harar, Arsi, and Bale (Gadisa et al., 2019), Ogaden (Mekuriaw et al., 2009), and Boran, Arsi, and Harar (Tefera et al., 2019) are recognized for their superior meat yield and carcass quality.

Northwest Amhara also harbors a diverse range of cattle breeds with potential for beef production. However, their fattening performance and carcass traits remain poorly characterized, particularly under the mixed crop–livestock production system. Understanding the growth potential and carcass characteristics of these cattle is essential for breed selection, improved management practices, and the development of a sustainable beef industry.

Therefore, this study was conducted to evaluate the feedlot performance and carcass characteristics of cattle breeds purchased from selected districts in northwest Amhara, Ethiopia, under a natural pasture hay-based diet.

MATERIALS AND METHODS

Descriptions of the study area

The study was conducted at the beef cattle farm of the College of Agriculture and Environmental Sciences, Zenzelima campus, Bahir Dar University in Bahir Dar town. The animals were maintained in a slatted-floor barn throughout the experiment. The animals used in the experiment were sourced from four selected districts located in the northwest Amhara region, namely, the Yilmana Densa, Mecha, and Dembecha districts from the West Gojjam zone and the Libokemkem district from the South Gondar zone of the Amhara region. The study districts were purposively selected because of the flourishing potential of cattle fattening activity by rural and peri-urban dwellers, and the dearth of information in the selected areas. Information on the geographical location, agro-ecologies, elevation, and climatic conditions, as well as the land area, livestock population, and human population of the study districts, is presented in Table 1.

Table 1 - Geographical location, altitude ranges, climate conditions, agro-ecology, and human and livestock population of the study districts from which the experimental animals were sourced.

Descriptors	Name of the districts where the experimental animals were sourced			
	Dembecha	Yilmana Densa	Mecha	Libokemkem
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%	Absent	18%
Midland	83%	64%	Absent	43%
Lowland	6%	12%	Absent	39%
Altitude (m.a.s.l.)	1500-2999	1552-3535	1795-3268	1,800-2,000
Annual T° (°C)	10 °C-20 °C	15 °C -24 °C	17 °C-30 °C	19°C-30°C
Annual rainfall (mm)	1200-1600	1200-1600	820-1250	1300
Land area	971.29	1018.11	159,898	1081.57
Human population	151,023	214,852	375,716:	226, 958
Cattle	177375	123,440	351,844	115452
Goat	11726	11,471	61,883	36448
Sheep	51820	79,217	110,834	17939
Equines	26055	24,904	39,214	2,552
Chicken	14241	88,439	230,286	327403

The sources of the information are each district's Agriculture Development Offices.

Experimental design, treatments and animal management

A total of 40 mature (2 pairs of permanent incisors) intact bulls were purchased from four (10 from each) different local markets, namely, Adet, Merawi, Dembecha, and Yifag markets located at Yilmana Densa, Mecha, and Dembecha districts of West Gojjam zone and Libokemkem district of South Gondar zone of the Amhara region, Ethiopia, respectively. The marketplaces in each of the districts were selected based on the assumption that the cattle in each district would be presented to the mentioned markets and that there could be differences in relation to the type of animals available in each marketplace. The cattle breeds 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), whereas those cattle presented to the Yifag market are expected to be Fogera cattle (Zenga) (Kebede & Ayalew, 2014). After purchase, the animals were ear-tagged and brought to the College of Agriculture and Environmental Sciences (CAES) animal experimental site for the experiment. At the experimental site, the animals were allowed access to feed and water *ad libitum* and some amount of concentrated feed for 15 days during the acclimatization period. The animals were then systematically (based on initial weight) assigned to two treatment feeds, which were classified as Treatment-1, comprising a 60:40 concentrate-to-roughage ratio of the daily dry matter intake of the experimental animal, whereas Treatment-2 included a 70:30 concentrate-to-roughage ratio of the daily dry matter intake. The daily dry matter intake was calculated on the basis of the assumption that cattle can consume 3% of their body weight. The dry matter (DM) percentages of the roughage and concentrate feeds used in the experiment were considered to be 92.82% and 91.53%, respectively. The roughage feed used in this experiment was purchased from grass hay harvested from a natural pasture at the 50% blooming stage. The concentrated feed was formulated with 75% maize, 24% *noug* seed (*Guizotia abyssinica*) cake, and a 1% salt mixture. The experimental design used in this experiment was a randomized complete block design (RCBD) with a factorial arrangement. The initial body weights of the experimental animals were estimated via a heart girth meter (SCHWEINE/PORCS), which was used to block the animals into experimental groups. The feeding trial was conducted for 95 days from April to July 2021. Throughout the experimental period, the animals had free access to roughage feed and water.

Chemical analysis of the treatment feed ingredients

The proximate analysis of the concentrate and roughage feeds (offered and refused) used in the experiment is presented in Table 2.

Table 2 - Proximate analysis of the treatment feed used to evaluate the beef performance of cattle breeds purchased from four selected districts of northwestern Amhara, Ethiopia

Types of feed	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

The samples were taken in triplicate, and the means were taken; DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; OM = organic matter.

Data types and methods of data collection

Data on morphological traits such as initial body weight (IBW), final body weight (FBW), total body weight gain (TBWG), daily body weight gain (DBWG), slaughter weight (SW), carcass characteristics (total hot carcass weight, cold carcass weight, and dressing percentage), and measurements of different edible and nonedible offal components of the experimental animals were collected. Morphological measurements were taken on thirteen traits of the experimental animals at the beginning and end of the feeding experiment, following the trait definition and reference points indicated by ICAR (2017) for conformation recording of beef cattle breeds (Table 3). Similarly, the IBW and FBW of the experimental animals were measured at the beginning and end of the experiment, respectively, while the slaughter weight was measured immediately before the slaughtering of fattened animals. To measure the carcass characteristics (total hot carcass weight) and edible and non-edible characteristics of the evaluated cattle breeds, a total of 24 (three animals from each treatment) were slaughtered at the College of Agriculture and Environmental Sciences mini abattoir following appropriate animal slaughtering procedures and considering animal welfare ethics at the end of the experiment. The animals were stunned via a pistol bolt and slaughtered by cutting the throat via a sharp knife. The weights of the live animals and their morphological traits were measured via a girth meter (SCHWEINE/PORCS), whereas carcass and offal weight measurements were taken via a ground scale and a Salter balance, respectively. The carcass weights of the left and right carcasses were determined by splitting via a saw, and the weights were summed to determine the total carcass weight. The carcass was maintained in a chilling room at 2–4 °C, and the cold carcass weight was measured after 24 hours of chilling. Carcass weight and offal measurements were taken just after slaughter.

Table 3 - Definitions and reference points of linear body measurements (cm) and body weights (kg) recorded for experimental local beef cattle breeds in northwestern Amhara, Ethiopia.

Trait's name	The trait definition, and reference points considered to measure the traits
Body weight	Body weight as measured by heart girth
Body length	Length from shoulder to pins
Back length	Length from shoulder to hips
Thurl width	Distance between thurls
Body depth	Distance between top of back and bottom of barrel at the deepest point; independent of stature
Chest depth	Distance between top of back just behind shoulder and bottom of barrel behind the front leg
Flank depth	Distance between top of back just before hips and bottom of barrel just before the rear leg
Length of rump	Distance from hips to pins
Height at withers	Measured from top of the back in between the shoulders to the ground
Height at rump	Measured from the top of the back in between the hips to the ground
Width at hips	Distance between the hips
Width at pins	Distance between the pins
Back width	Width of the back behind the shoulders
Thickness of bone	Thickness of the canon bone in the forelegs

Source: ICAR (2017)

In addition, data on total body weight gain (Negash et al., 2008; Gage et al., 2022), average daily body weight gain (Gage et al., 2022), weight–bone thickness ratio (Musa et al., 2021), and dressing percentage (Erge et al., 2022; Gage et al., 2022; Mummed & Webb, 2019) were derived following the procedures used by previous scholars. The ratio was calculated as follows: Ratio = $\frac{\text{Final body Weight}}{\text{Bone thickness}}$ (Musa et al., 2021)

Data analysis

The general linear model (GLM) procedures of the Statistical Analysis System (SAS, version 9.0) were used for data analysis. The feed treatment options and breeds of local beef cattle were fitted as fixed factors, whereas body weight, morphological measurements, and carcass and offal characteristics of the evaluated cattle breeds were considered response variables for the analysis. The statistical model used to analyze quantitative data collected from the investigated cattle breeds was as follows: $Y_{ijk} = \mu + B_i + T_j + BT_{(ij)k} + e_{ijk}$

Where: Y_{ijk} = the recorded values for each quantitative response variable (live body weight, morphological traits, and carcass and offal characteristics) for the evaluated cattle breeds in the i^{th} breed, j^{th} treatment feed, and their interaction effects; μ = the overall mean; B_i = the i^{th} cattle breed (i = cattle breed from Yilmana Densa, Mecha, Libokemkem, and Dembecha districts); T_j = the j^{th} treatment feed (j = treatment-1, and treatment-2); $BT_{(ij)k}$ = the k^{th} effect of the interaction between cattle breed and treatment feed; e_{ijk} = error term associated with each observation

RESULTS AND DISCUSSION

Body weight and morphological traits

Table 4 shows the overall values of the least square means (LSM±SE) of the initial and final live body weights, average daily weight gain, final measurement of morphological traits, and final body weight-to-bone thickness ratio of the evaluated cattle breeds. As indicated in Table 4, the breed of cattle had a significant influence on the initial and final body weights (P<0.01) and ratio (final body weight to the thickness of bone) (P<0.05) of the evaluated cattle breeds. However, breed had no significant influence on any of the evaluated morphological measurements or the body weight gain of cattle breeds. Accordingly, from the evaluated cattle breeds, the cattle breed brought from Mecha had the lowest initial (265.20±8.56 kg) and final (359.60±10.99 kg) live body weight compared with other cattle breeds. The highest initial (310.10±8.56 kg) and final (416.70±10.99 kg) live body weights were recorded for cattle breeds from Yilmana Densa district. In addition, cattle breeds from Yilmana Densa presented the highest ratio (23.67±0.87). The variation in the initial and final live body weights and ratios among the evaluated cattle breeds may be due to the differences in muscling ability and agroecology, and/or management dissimilarities of cattle at a younger age before the intervention of the experiment among the sample districts. Conversely, treatment had no significant influence on the body weight and morphological traits of the evaluated cattle breeds. This might be because the nutrient density of diet-2 was beyond the digesting ability of the animals to make use of the nutrients in it, which in turn indicates that there is an optimum roughage concentrate mix in livestock feed (Richardson et al., 2011).

The effects of breed on the initial and final live body weights of different beef cattle breeds have been reported by different scholars in Ethiopia and elsewhere. For example, Xie et al. (2012) reported a significant effect of breed on the initial live body weight of beef cattle breeds, as the Limousin and Simmental breeds had heavier initial body weights than did the Luxi, Jinnan, and Qinchuan cattle breeds in China under village-based management conditions in Liaoning Province, North China, which is consistent with the present findings. Similarly, Pesonen et al. (2012) reported a significantly greater initial body weight for Limousin (325 kg) bulls than for Aberdeen Angus (285 kg) and Angus x Limousin crossbred bulls (276 kg); however, the initial body weight did not differ from the final live body weight, which is not in line with the current results. In addition, similar to the present observation, Pesonen et al. (2012) reported a non-significant effect of breed on daily weight gain (gd^{-1}) for the aforementioned beef cattle breeds. Furthermore, Tefera et al. (2019) reported a significant effect of breed on the live body weight of 7–9-year-old Arsi, Boran, and Harar cattle breeds, as the highest value was recorded for Boran (433.00±39.27 kg), followed by Arsi (192.00±9.17 kg) and Harar (155.75±43.84 kg) cattle breeds.

Similar to the present findings, a non-significant (P>0.05) influence of treatment feeds on the final body weight, live body weight change, and average daily gain of two-year-old Kereyu bulls was reported at the Adami Tulu Agricultural Research Center (Tesfaye et al., 2018). In addition, Gudeto et al. (2019) reported a non-significant influence of dietary rations on final body weight and total and average daily weight gain of yearling Arsi bulls analyzed at 60 days, 120 days, and 238 days of the fattening period at the Adami Tulu Agricultural Research Center. Furthermore, a non-significant influence of feeding treatment on final body weight was reported for local intact oxen aged approximately 5 years in Wolaita, southern Ethiopia (Bassa et al., 2016). However, inconsistent with the present results, a significant effect of supplementation with different concentrate feeds at various proportions on the final body weight and total body weight gain of beef cattle breeds has been reported in Ethiopia and elsewhere. For instance, Gebremariam (2019) reported a significant effect of treatment feeds on the final body weight and average daily gain of Hararghe highland bulls fed grass hay as a basal diet in Eastern Ethiopia. Similarly, different from the current observations, a significant influence of varying inclusion levels of groundnut haulms and maize offal on the final weight, weight change, and average daily gain of Bunaji bulls aged 2.5-3 years has been reported in Nigeria, as the highest values of these traits were recorded for treatment feeds containing 20% groundnut haulms: 80% maize offal ratio (Goska et al., 2017).

The overall values of initial body weight (291.25±4.28 kg) and final body weight (389.68±5.49 kg) of cattle breeds in the present study were greater than the values of initial body weight (149±6.36 kg) and final body weight (274.8±7.2 kg) reported for two-year-old Kereyu bulls (Tesfaye et al., 2018). Similarly, the values of initial body weight (249.13±4.15 kg) and final body weight (306.23±5.22 kg) recorded for local intact oxen aged approximately 5 years in Wolaita, southern Ethiopia, were lower than the current observations (Bassa et al., 2016). In addition, compared with the current findings, lower initial body weights (194.03±8.84 kg), final body weights (264.72±19.49 kg), and total body weight gains (70.69±16.86 kg) have been reported for Baggara bulls fed different roughage diets supplemented with molasses in Sudan (Adam et al., 2016). This implies that cattle breeds evaluated in the present study had better fattening performance in a feedlot operation.

Carcass weights and dressing percentages

The overall values of the LSM±SE of fasting body weight, hot carcass weight, and cold carcass weight for the evaluated cattle breeds were 319.88±5.30 kg, 181.65±3.16 kg, and 178.67±2.95 kg, respectively, and breed had a significant ($P<0.05$) effect on all of these traits (Table 5). However, breed had a non-significant ($P>0.05$) influence on the dressing percentage of the evaluated cattle breeds. Accordingly, cattle breeds from Yilmana Densa presented the highest fasting body weight (339.35±10.90 kg), total hot carcass weight (196.49±6.50 kg), and total cold carcass weight (193.51±6.07 kg) measurements. In contrast, cattle breeds from Dembecha presented the smallest values of fasting body weight (303.38±10.28 kg) and hot carcass weight (171.27±6.13 kg) compared with the other cattle breeds. Conversely, treatment had no significant ($P>0.05$) effect on the fasting body weight, total hot or cold carcass weight, or dressing percentage of the examined cattle breeds.

Consistent with the current findings, a significant ($P<0.001$) influence of breed on warm carcass weight and cold carcass weight was reported between the Arado, Boran, Barka, and Raya cattle breeds in Ethiopia (Mummed & Webb, 2019). Similarly, Erge et al. (2022) reported a significant (at least $P<0.001$) influence of breed on slaughter weight, hot carcass weight, and cold carcass weight for Arsi, Harar, Jersey x Horro F1, and Ogaden cattle breeds fed a corn silage-based finishing diet in Ethiopia. In addition, a significant influence of breed on slaughter/fasting weight was reported for Limousine and Retinta bulls (Avilés et al., 2015). In contrast, Musa et al. (2021) reported a non-significant influence of breed on slaughter weight, hot carcass weight, and cold carcass weight for Arsi, Borana, Harar, and Harar x HF crossbred cattle breeds in Ethiopia. Furthermore, in agreement with the present observations, a non-significant influence of breed on dressing percentage has been reported for Arsi, Boran, and Harar (Tefera et al., 2019), and Arsi, Boran, Harar and Harar x HF (Musa et al., 2021) cattle breeds in Ethiopia. However, in contrast to the current observations, a significant influence of breed on the dressing percentage of different beef cattle breeds has been reported in the literature (Pesonen et al., 2012; Xie et al., 2012; Mummed and Webb, 2019; Coleman et al., 2016; Erge et al., 2022). In contrast to these observations, a significant influence of different feeding regimes using different feed ingredients at various proportions on carcass weights and dressing percentages of beef cattle breeds has been reported around the world (Irshad et al., 2013; Clinquart et al., 2022). For example, a significant effect of replacing hay with maize silage at various rates on the carcass weights and dressing percentages of Harar cattle was reported in Ethiopia (Gage et al., 2022).

Similarly, the carcass yield and hot carcass weight of Hararghe Highland bulls fed grass hay as a basal diet were significantly (at least $P<0.01$) influenced by supplementation with different concentrate feeds, and the highest values of these carcass traits were observed for treatment feeds prepared with 4 kg d^{-1} maize grain and 4 kg d^{-1} mixtures of maize grain, wheat bran, dried cafeteria leftover and scrambled whole groundnut in equal proportions (Gebremariam, 2019). In addition, a considerable effect of the feeding system on slaughter weight was reported for Limousine and Retinta beef cattle breeds kept under feedlot conditions (Avilés et al., 2015).

The overall values of fasting weight and total hot and cold carcass weight in the present study were higher than the values reported for draught cattle raised for beef in Eastern Ethiopia, which were 247.93±5.27 kg, 90.98±2.11 kg, and 89.16±10.94 kg, respectively (Senbeta & Megersa, 2019). In addition, compared with the present findings, smaller overall values of hot carcass weight (106.93±0.21 kg) and cold carcass weight (101.19±0.18 kg) were reported for Arado, Barka, Boran, Raya, and nondescript cattle breeds slaughtered at Abergelle and Melgawendo abattoirs (Mummed & Webb, 2019). Moreover, the values of slaughter weight (179.1±1.0 kg), hot carcass weight (86.8±3.5 kg), and cold carcass weight (82.7±3.4 kg) reported for the Arsi, Boran, Harar, and Harar x HF cattle breeds (Musa et al., 2021) were lower than the current findings. Furthermore, compared with the present findings, smaller values of slaughter weight (215.58±12.21 kg), hot carcass weight (102.93±6.64 kg), and cold carcass weight (99.56±6.63 kg) were reported for the Arsi, Harar, Jersey x Horro, and Ogaden cattle breeds fed a corn silage-based finishing diet (Erge et al., 2022). These findings indicate that cattle breeds considered in the present study have better beef potential than other Ethiopian cattle breeds do.

Table 4 - Least square means (LSM±SE) of initial body weight, final body weight, total body weight (kg), and final morphological measurements (cm) of mature (with 2 pairs of permanent incisors) local intact bulls affected by breed and treatment feeds in selected districts of Northwest Amhara, Ethiopia

		Cattle Breeds					Treatment Feeds			
Parameters	Overall	Sig.	Yilmana Densa	Mecha	Libokemkem	Dembecha	Sig.	Treatment-1	Treatment-2	Feed*Breed
Initial body weight	291.25±4.28	**	310.10±8.56^{a}	265.20±8.56^{b}	297.00±8.56^{a}	292.70±8.56^{a}	ns	291.10±6.05	291.40±6.05	ns
Final body weight	389.68±5.49	**	416.70±10.99^{a}	359.60±10.99^{b}	394.90±10.99^{a}	387.50±10.99^{ab}	ns	393.85±7.77	385.50±7.77	ns
Total body weight gain	98.43±5.30	ns	106.60±10.60	94.40±10.60	97.90±10.60	94.80±10.60	ns	102.75±7.49	94.10±7.49	ns
Daily body weight gain	1.036±0.056	ns	1.122±0.112	0.994±0.112	1.031±0.112	0.998±0.112	ns	1.082±0.079	0.990±0.079	ns
Body length	91.73±0.92	ns	90.80±1.83	90.70±1.83	92.60±0.83	92.80±1.83	ns	91.90±1.30	91.55±1.30	ns
Back length	67.63±0.97	ns	66.70±1.95	69.70±1.95	66.60±1.95	67.50±1.95	ns	67.85±1.38	67.40±1.38	*
Thurl width	34.33±0.52	ns	36.10±1.05	34.10±1.05	33.80±1.05	33.30±1.05	ns	34.10±0.74	34.55±0.74	ns
Body depth	72.58±0.70	ns	73.20±1.39	74.40±1.39	71.00±1.39	71.70±1.39	ns	72.15±0.98	73.00±0.98	ns
Chest depth	63.33±0.35	ns	62.70±0.71	63.70±0.71	63.00±0.71	63.90±0.71	ns	63.20±0.50	63.45±0.50	ns
Flank depth	55.63±0.55	ns	55.00±1.10	56.60±1.10	56.00±1.10	54.90±1.10	ns	55.15±0.78	56.10±0.78	ns
Length of rump	38.53±0.42	ns	38.40±0.83	38.20±0.83	38.70±0.83	38.80±0.83	ns	37.90±0.59	39.15±0.59	ns
Height at withers	127.15±0.37	ns	128.40±0.74	127.10±0.74	126.70±0.74	126.40±0.74	ns	126.85±0.53	127.45±0.53	ns
Height at rump	123.75±0.49	ns	124.20±0.98	124.20±0.98	123.50±0.98	123.10±0.98	ns	123.60±0.69	123.90±0.69	ns
Width at hips	32.20±0.71	ns	34.20±1.41	32.60±1.41	30.90±1.41	31.10±1.41	ns	31.35±1.00	33.05±1.00	ns
Width at pins	17.68±0.36	ns	18.30±0.72	16.60±0.72	18.00±0.72	17.80±0.72	ns	17.55±0.51	17.80±0.51	ns
Back width	25.65±0.61	ns	25.50±1.22	24.50±1.22	26.00±1.22	26.60±1.22	ns	25.80±0.86	25.50±0.86	ns
Thickness of bone	17.88±0.23	ns	17.70±0.45	17.80±0.45	18.20±0.45	17.80±0.45	ns	17.60±0.32	18.15±0.32	ns
Ratio	21.93±0.43	*	23.67±0.87^{a}	20.37±0.87^{b}	21.84±0.87^{ab}	21.86±0.87^{ab}	ns	22.44±0.61	21.42±0.61	ns

$^{a, b, c}$ = Means within a column with different subscripts are significantly different (P<0.05), Sig = Significant, ns = non-significant, * = P<0.05; ** = P<0.01, Treatment-1 = 60:40 concentrate: roughage ratio of the animals' daily dry matter intake; Treatment-2 = 70:30 of concentrate: roughage ratio of the animals' daily dry matter intake

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Table 5 - Least square means (±SE) of carcass weights (kg), dressing percentage (%), and rib eye area (mm2) of local beef cattle breeds as affected by breed and treatment feeds in northwest Amhara, Ethiopia

Parameter	FsBWt	THCWt	TCCWt	REA	DP
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	319.88±5.30	181.65±3.16	178.67±2.95	263.92±8.47	56.77±0.42
Cattle Breeds	*	*	*	ns	ns
Yilmana Densa	339.35±10.90[a]	196.49±6.50[a]	193.51±6.07[a]	284.08±17.86	57.98±0.86
Mecha	303.38±10.28[b]	171.27±6.13[b]	168.53±5.72[b]	261.00±15.97	56.48±0.82
Libokemkem	318.40±10.28[ab]	181.10±6.13[ab]	178.13±5.72[ab]	260.0±15.97	56.85±0.82
Dembecha	318.40±10.90[ab]	177.74±6.50[ab]	174.51±6.07[b]	250.58±17.86	55.78±0.87
Treatment Feeds	ns	ns	ns	ns	ns
Treatment-1	322.49±7.49	182.64±4.47	179.50±4.17	274.38±11.98	56.62±0.59
Treatment-2	317.28±7.49	180.66±4.47	177.84±4.17	253.46±11.98	56.92±0.59
Breed*Feed	ns	ns	ns	ns	ns

[a, b, c] = Means in a column with different letters are significant, FsBWt = Fasting body weight, THCWt = Total hot carcass weight, TCCWt = Total cold carcass weight, REA = Rib eye area, DP= Dressing percentage, LSM =Least square means, SE = Standard error, * = P<0.05, ns = non-significant (P>0.05), Treatment-1 = 60:40, and Treatment-2 = 70:30 concentrate: roughage ratio of the animals' daily dry matter intake, respectively

Edible and non-edible offal characteristics

The results of edible and non-edible offal characteristics of the evaluated cattle breeds as affected by breed and treatment feeds are presented in Table 6. Except for tail weight and head and skin weight, the cattle breed had no significant effect on the non-edible carcass characteristics of the evaluated cattle breeds. Similarly, treatment feed had no significant effect on the offal carcass measurements of the evaluated cattle breeds. Similar to the present findings, Musa et al. (2021) reported a non-significant effect of breed on scrotal fat, kidney fat, heart fat, and omental fat for Arsi, Boran, Harar, and Harar x HF crossbred beef cattle breeds in Ethiopia; however, the author reported a significant (P<0.05) influence of breed on the pelvic fat of the evaluated cattle breeds. In addition, a non-significant influence of breed on the weight of the kidney, spleen, and head was reported for Ethiopian cattle breeds, including the Arsi, Harar, Jersey x Horro F1, and Ogaden cattle breeds (Erge et al., 2022), which is consistent with the present findings. In addition, unlike heart fat and omental fat, the weights of kidney fat and pelvic fat of the Arsi, Boran, and Harar cattle breeds were not significantly affected by breed (Tefera et al., 2019). In contrast to the present observations, Erge et al. (2022) reported a significant influence of breed on the weight of the heart, liver, hide, gastrointestinal tract (GIT), empty gut, lung and trachea, and feet of the Arsi, Harar, Jersey x Horro F1 crossbred, and Ogaden cattle breeds. Likewise, inconsistent with the present findings, a significant influence of breed on offal characteristics, including pelvic fat, scrotal fat, kidney fat, and rib eye area, was reported for Borana and Kereyu cattle breeds managed under natural pasture grazing conditions in Ethiopia (Mohammed et al., 2008).

Regarding the treatment feeds, similar to the present findings, a non-significant influence of soybean meal replacement by Crambe crushed at varying levels (0–15%) in the concentrate supplement on carcass characteristics, including liver, pelvic fat, leg length, total meat, loin characteristics, carcass fat thickness, and preslaughter and carcass weights of Nellore cows finished on pasture (*Brachiaria humidicola*), was reported in Brazil (Souza et al., 2015). Additionally, similar to the present findings, the feeding of different dietary rations to Kereyu bulls aged two years did not significantly affect the characteristics of the edible and nonedible organs or carcass, such as the tail, skin, feet, lungs, pancreas, bladder, penis, full gut, empty gut, small and large intestine, tongue, hump, and head, of the evaluated bulls in Ethiopia (Tesfaye et al., 2018). Moreover, a non-significant effect of different roughage sources on the non-edible organs or carcass, including the tail, lung and trachea; the spleen; the heart; the pancreas; the liver; the genitalia; and the empty intestine, has been reported for Baggara bulls in Sudan (Adam et al., 2016).

Instead, unlike the present observations, a significant (P<0.05) effect of dietary changes on the loin eye area of Hararghe Highland bulls (Gebremariam, 2019) and the total edible offal of Harar oxen (Gage et al., 2022) has been reported in Ethiopia. In addition, inconsistent with the present finding, a substantial (P<0.05) effect of treatment feeds on the percentage of nonedible offal components was reported for Aceh cattle fed with forage and concentrate at different levels in Indonesia, as the highest percentage of nonedible offal was recorded for the treatment groups allotted to 15 kg of forage and 2 kg of commercial concentrate (Koesmara et al., 2019). Similarly, noncarcass characteristics, including the heart and liver of Nellore steers, were strongly associated with the feed efficiency of the experimental animals, different from the present findings (Nascimento et al., 2016). Furthermore, a significant (at least P<0.05) influence of treatment feeds on noncarcass characteristics such as head, skin with a tail, hooves, gut fill, plunk, and empty body weight was reported for short horn zebu bulls grazing on natural pastures and supplemented with crude protein at varying levels in Uganda, as the highest values of these traits were recorded for animals supplemented with a formulated ration containing 110 CP kg^{-1} of dry matter and 130 CP kg^{-1} of dry matter compared with the other inclusion levels of crude protein (Nantongo et al., 2021).

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Table 6 - Least square means (±SE) of edible and nonedible offal characteristics (kg) of local beef cattle breeds affected by breed and treatment feeds in selected districts of northwest Amhara, Ethiopia

Parameter	Tail	HS	Head	FH	Tongue	LT	Heart	HF	Pancreas	Kidney	KF
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	1.15±0.05	14.22±0.29	29.73±0.85	6.57±0.24	1.12±0.07	4.09±0.19	1.0±0.04	0.56±0.05	0.89±0.05	0.61±0.02	3.80±0.27
Cattle Breeds	*	*	ns	ns	ns	ns	ns	ns	ns	*	ns
Yilmana Densa	1.45±0.10^{a}	15.82±0.60^{a}	30.63±1.79	7.10±0.50	1.23±0.16	4.38±0.40	1.18±0.09	0.58±0.10	0.89±0.10	0.72±0.05^{a}	4.28±0.57
Mecha	1.17±0.09^{b}	13.37±0.54^{b}	29.02±1.60	6.25±0.45	1.03±0.14	3.92±0.35	0.95±0.08	0.50±0.09	0.83±0.09	0.58±0.04^{b}	3.43±0.51
Libokemkem	1.00±0.09^{b}	13.80±0.54^{b}	29.17±1.60	6.17±0.45	1.05±0.14	3.88±0.35	1.02±0.08	0.62±0.09	0.90±0.09	0.52±0.04^{b}	3.58±0.51
Dembecha	0.98±0.10^{b}	13.91±0.60^{b}	30.08±1.79	6.77±0.50	1.18±0.16	4.18±0.40	1.18±0.09	0.55±0.10	0.93±0.10	0.62±0.05^{ab}	3.92±0.57
Treatment Feeds	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Treatment-1	1.16±0.07	14.18±0.40	29.13±1.20	6.75±0.33	1.23±0.10	3.95±0.27	1.08±0.06	0.62±0.07	0.86±0.06	0.62±0.03	4.25±0.38
Treatment-2	1.14±0.07	14.27±0.40	30.33±1.20	6.39±0.33	1.02±0.10	4.23±0.27	1.08±0.06	0.50±0.07	0.91±0.06	0.60±0.03	3.36±0.38
Breed*Feed	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	ns

Table 6 - Continued

Parameter	Bladder	L+B	PF	SI	LI	OF	Hump	Testicle	Penis	SF	FG	EG
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	0.34±0.03	4.69±0.14	1.26±0.10	11.19±0.62	7.36±0.74	5.54±0.38	6.5±0.45	0.50±0.03	0.53±0.03	1.84±0.11	35.13±1.49	9.28±0.34
Cattle Breeds	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Yilmana Densa	0.39±0.05	4.81±0.30	1.34±0.20	11.80±1.31	6.93±1.55	5.66±0.81	7.21±0.96	0.53±0.06	0.59±0.05	2.03±0.23	34.91±3.15	9.53±0.72
Mecha	0.32±0.05	4.72±0.26	0.93±0.18	10.95±1.17	8.03±1.39	4.52±0.72	6.03±0.86	0.48±0.05	0.52±0.05	1.87±0.21	32.70±2.81	8.45±0.64
Libokemkem	0.37±0.05	4.38±0.26	1.32±0.18	10.98±1.17	6.77±1.39	6.15±0.72	6.58±0.86	0.48±0.05	0.52±0.05	1.83±0.21	36.22±2.81	9.20±0.64
Dembecha	0.28±0.05	4.87±0.30	1.44±0.20	11.03±1.31	7.72±1.55	5.83±0.81	6.47±0.96	0.48±0.06	0.48±0.05	1.63±0.23	36.68±3.15	9.94±0.72
Treatment Feeds	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Treatment-1	0.32±0.04	4.70±0.20	1.37±0.13	11.88±0.88	6.75±1.04	6.13±0.54	7.20±0.64	0.52±0.04	0.54±0.04	1.78±0.16	35.12±2.11	9.48±0.48
Treatment-2	0.36±0.04	4.68±0.20	1.15±0.13	10.50±0.88	7.97±1.04	4.95±0.54	5.95±0.64	0.48±0.04	0.51±0.04	1.90±0.16	35.13±2.11	9.08±0.48
Breed*Feed	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Note: - a, b, c = Means in a column with different subscripts are significantly different (P<0.05), T = Tail, HS = Head and skin, H = Hide, FH = Feet with hooves, Tg = Tongue, LT = Lung and Trachea, Hr = Heart, HF = Heart fat, P = Pancreas, K = Kidney, KF = Kidney fat, B = Bladder, L+B = Liver + Bile, PF = Pelvic fat, SI = Small Intestine, LI = Large Intestine, OF = Omental fat, Hp = Hump, Ts = Testicle, Pn = Penis, SF = Scrotal fat, FG = Full gut, EG = Empty gut, LSM = Least square means, SE = standard error, ns = none –significant (P>0.05), * = P<0.05, Treatment-1. 60:40 concentrate: roughage ratio of the animals' daily dry matter intake; Treatment-2. 70:30 of concentrate: roughage ratio of the animals' daily dry matter intake

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The overall values of heart (1.0±0.04 kg), liver and bile (4.69±0.14 kg), kidney (0.61±0.02 kg), and lung and trachea (4.09±0.19 kg) weights obtained in the present study were lower than the values of heart (1.19 kg), kidney (0.72 kg), liver (5.32 kg), and lung (5.21 kg) weights reported for Charolais x Nelore steers fed ground corn in Santa Maria, Brazil (Freitas et al., 2019). Similarly, the values of the kidney (1.61±0.04 kg), liver (7.53±0.12 kg), heart (2.52±0.05 kg), and pancreas (0.56±0.08 kg) of pure Holstein calves were greater than the values reported in the present study (Rezagholivand et al., 2021). The overall value of the rib eye area (263.92±8.47 mm^2) of the evaluated cattle breeds was lower than the value recorded for Nguni heifers aged 24 months (4412.30±978.89 mm^2) fed pasture-based grazing and 10% cactus diets (Nyambali et al., 2022). In addition, compared with the present findings, a greater value of the rib eye area (5.791±2.34 $inch^2$) was reported for Arsi, Borana, HF-cross, and Harar bulls in Ethiopia (Musa et al., 2021). However, Musa et al. (2021) reported lower values of scrotal fat (0.52±0.04 kg), kidney fat (0.57±0.04 kg), pelvic fat (0.29±0.02 kg), omental fat (0.88±0.07 kg), and heart fat (0.53±0.03 kg) for Arsi, Borana, HF-cross, and Harar bulls than the present findings. Similarly, compared with the present findings, lower values of kidney fat (1.01±0.09 kg), heart fat (0.30±0.02 kg), omental fat (1.35±0.13 kg), and pelvic fat (1.09±0.05 kg) were reported for the Arsi, Harar, Jersey x Horro, and Ogaden cattle breeds (Erge et al., 2022).

CONCLUSION

The study demonstrated that beef cattle breeds from northwest Amhara exhibit promising feedlot performance and carcass yield when finished under controlled feeding conditions. Significant differences were observed among breeds, with Yilmana Densa cattle outperforming others in slaughter weight, hot carcass weight, and cold carcass weight, highlighting their superior beef production potential. In contrast, dietary treatment (60:40 vs. 70:30 concentrate: roughage ratios) did not significantly influence growth or carcass traits, indicating that breed factors contributed more strongly than feed ratio in this context. The non-significant effect between the treatment diets indicates that there is an optimum roughage: concentrate ratio. Overall, indigenous cattle breeds in the region can provide acceptable meat yield under smallholder and commercial fattening systems, but their full potential remains underexplored. Further investigations are required to exhaustively quantify the feedlot potential and carcass yield and quality of these cattle breeds under different age groups with varying dietary supplements.

DECLARATIONS

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Ethics approval and consent to participate

The authors complied with the ARRIVE guidelines and or the Interdisciplinary Principles and Guidelines for the Use of Animals in Research, Testing, and Education by the New York Academy of Sciences, Ad Hoc Animal Research Committee. The proposal was presented and approved by the Research and Post-graduate Vice Dean's Office of the College of Agriculture and Environmental Sciences of Bahir Dar University.

Consent for publication

All authors agree to the publication of this manuscript.

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors Contributions

F.Tegegne and M.Taye contributed to the development of the concept note, animal selection, experimental animal follow-up, data analysis, reviewed and finalized the manuscript; D.Kebede, M.Getaneh, and E.Admasu contributed to animal selection, experimental animal follow-up, data collection, data analysis, drafted the manuscript; B.Asmare, H.Tamrat, N.Beyero, and A.Tassew contributed to the development of the concept notes, formulation of the rations, experimental animal follow-up, reviewed and approved the manuscript.

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Competing interests

The authors declare that they have no competing interests.

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