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Feedlot performance and carcass yield of Hararghe Highland (*Bos indicus*) bulls using different concentrate feeds

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ABSTRACT. A study was conducted to evaluate the feedlot performance and carcass yield of Hararghe Highland bull using different types of concentrate feeds fed grass hay as a basal diet in eastern Ethiopia. Thirty Hararghe Highland bulls were blocked by weight and randomly allocated to one of the following six treatments. T_1 = Hay *ad libitum* + 4kg dried cafeteria leftover; T_2 = Hay *ad libitum* + 4kg wheat bran; T_3 = Hay *ad libitum* + 4 kg d^{-1} maize grain; T_4 = Hay *ad libitum* + 4kg d^{-1} mix (1:1, wheat bran to maize grain, respectively); T5 = Hay *ad libitum* + 4kg scrambled whole groundnut; T6 = Hay *ad libitum* + 4kg d^{-1} mix (equal proportion of maize grain, wheat bran, dried cafeteria leftover and scrambled whole groundnut. Bulls were fed for 90 days and slaughtered for carcass yield studies. Bulls fed on T6 and T3 had highest ($p < 0.05$) finished weight and ADG than did in T2, T5 and T1. Similarly, better ($p < 0.05$) gain to feed ratio was noted on bulls fed T6 and T3 than rest of treatments. Carcass yield on slaughter weight was also improved in T6 and T3 consistent to feedlot performance traits. Bulls supplemented with T6 and T3 had highest carcass yield than T2, T5, T1 and T4. Therefore, this study suggested that Hararghe Highland bull has potent for feedlot industry using strategic supplementation.

Keywords: concentrate; carcass yield; feedlot; Hararghe Highland bull.

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Introduction

By 2050, the human population will grow to over 9 billion people, and in the same time frame, global meat consumption is projected to increase by 73% (Food and Agriculture Organization of the United Nations [FAO], 2011). In the developing world meat consumption is rapidly increased to meet the sharp demand of meat in Asian, pacific and African continents. More specifically, Ethiopia is one of the fastest growing countries and registered two digit economic growths since the last two decades in the world. This creates a great shift of demand from crop to animal products as a result of increasing urbanization and improvement in the livelihood of the people in the country. In order to meet the meat demands of the ever-growing Ethiopian human population with annual growth rate of 2.4% and expected to reach about 149.3 million by the year 2040 (FAO, 2005). This scenario creates a better and huge market opportunity for the livestock producer's animal protein in the country particularly for livestock producers such as for small-scale and commercial fattening schemes in the country.

Feedlot industry in Ethiopia is a great potential because of abundant and availability of large number of livestock species used for fattening (Tsegay & Mengistu, 2013). Among the other livestock, beef cattle were highly demanded by the feedlot farming industry in the country. Moreover, the availability of feed resources such as roughages and agro-industrial wastes makes it suitable for fattening industry (Tsegay & Mengistu, 2013).

However, fattening in Ethiopia is mainly practiced in traditional way by small holder farmers except very rare commercial farms. For example, in traditional mixed crop-livestock farming practice of the highland parts of Ethiopia demands male cattle to mainly serve as draught animals (Behnke, 2010). Draught oxen are normally released for beef when they retired from work. However, in rare cases male cattle that are considered as extra of the household farm power requirement are channeled to finishing or fattening diets at a younger age and being sold as beef. In the highlands, cattle are mainly raised under low-input management conditions where feed shortage is encountered for considerable time of the year. Therefore, the average finished weight and carcass yield of tropical cattle breeds are low according to previous reports (Nega et al., 2003; Shirima et al., 2016). Hence, in Ethiopia meat production even not enough for domestic consumption as compared to developing and developed countries; the per capital consumption is lowered 9.9 kg year^{-1} as compared to developed nations which is 120 kg. Average daily protein consumption is 53 g than developed 102 g, which is below the recommended safe level for adult 58 g (FAO, 2007; World Health Organization [WHO], 2007). This might be because feeder animals are fattened on low nutrient content of commonly available animals' feeds such as has been ascribed to be the major factor that compromises beef production of tropical cattle breeds. Moreover, almost all fattening trails conducted on fattening performance of animals are focused on restricted feeding and in many cases feeder cattle are fed below finishing requirements in Ethiopia.

Hence, among other options improvement of fattening performance of feeder cattle through proper feeding of indigenous animal using concentrate supplementation is crucial in order to achieve the desired yield. The tropical breeds of Hararghe Highland produced a promising daily gain which is about one kg day^{-1} as noted in the present study this is in favor the previous many reports dictated that performance of indigenous animals is lowered. Hence indigenous animals must be feed up to their requirements to exploit their genetic potential and obtain better finished weight and carcass yield. Therefore, Supplementation with differential proportion of agro-industrial by-products up on the animal requirement is among the alternatives to be due attention before we look to other options like crossbreeding of indigenous animals and deterioration of genetic diversity. Therefore, this study was conducted to evaluate the feedlot performance and carcass yield of Hararghe Highland bull using different types of concentrate feeds fed grass hay as a basal diet in eastern Ethiopia.

Material and methods

Study site

The study was conducted at Haramaya University beef fattening unit. It is located at 9.0°N and 42.0°E and 515 km east of Addis Ababa, Ethiopia. The site is situated at an altitude of 1950 m. a.s.l., and has an average temperature of 16°C and mean annual rainfall of 790 mm (Mishra, Kidan, Kibret, Assen, & Eshetu, 2004).

Animals and management

A total of 30 Hararghe Highland bull were used for the feedlot trail. All bulls were obtained from the farm. Bulls were weighed individually and tagged with plastic identification tag. Bulls were ranked by BW, and those weighing greater than two standard deviations from the means body weight were excluded from the study. The remaining bulls were stratified by body weight into five blocks. The animals were treated against external and internal parasites and acclimated for 21 days of adaptation period for the test feed before commencement of the experiment. The feedlot experiment lasted for 90 days.

Design and treatments

The experiment was conducted as a completely randomized block design with in which the main treatments were type of concentrate feed and hay as a source of roughage (Table 1). The bulls were assigned in to five block based on their body weight. Bull within each block was equally allocated among one of the six dietary treatments according to their body weight. All bulls received hay basal diets and fresh water on an *adlib* for the entire experiment.

Measurements

Feed offered and refused were measured daily to determine feed intake. Body weight of the bulls was measured using a stationary weighing bridge. The ADG of bull was determined by dividing weight gain by the number of days on feed. The gain-to-feed ratio was calculated as kilograms of body weight gained per kilogram of DM ingested. All the bulls were sloughed and hot carcass weight (HCW) was computed by excluding the contents of thoracic, abdominal and pelvic cavity, head, skin, and the limbs. Dressing percentage or carcass yield (DP) was calculated as a ratio of hot carcass weight to slaughter weight. The cross sectional area of loin-eye muscle at the 11th and 12th ribs of slaughtered bull was traced from each side on transparency paper after cutting perpendicular to the backbone and measured by tracing the transparency paper on graph papers. The average of the right and left cross sectional area was considered as a rib-eye muscle area.

Chemical analysis of feeds

Feed samples were analyzed for dry matter (DM), ash, ether extract (EE) and crude protein (CP) according to the procedures of Association Official Analytical Chemists (AOAC, 1980). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of each sample were also analyzed, according to the procedure described by Van Soest and Robertson (1995).

Data analysis

Data on feedlot performance and carcass were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 2003). The differences among treatment means was tested using Tukeys' studentized range (HSD) test. The model used for data analysis was:

$$Y_{ij} = \mu + T_i + B_j + \varepsilon_{ij}$$

where:
Y_{ij} = response variable;
μ = overall mean;
Ti = treatment effect;
B_j = block effect;
ε_{ij} = random error.

Results

Chemical composition of feeds

The chemical composition of feeds is given in Table 2. Among the different concentrate feeds higher value of crude protein (CP) was obtained in Ground Whole Groundnut (GN) than maize grain (MG), Cafteria Lefet over (CL) and wheat bran (WB). Moreover, higher value of fat is recorded on GN than wheat bran (WB). However, higher ADL values were noted in hay and CL.

Dry matter and nutrient intake

Hay dry matter intake of bulls (HDMI) was similar ($p > 0.05$) across the treatment groups. However, concentrate dry matter intake (CDMI) and total dry matter intake (TDMI) were affected by treatment groups. The CDMI of Bulls in T6 was highest ($p < 0.001$) than did in T5 and T2, respectively. However, similar CDMI intake was noted in T6, T1, T3, T2 and T4 (Table 3). Likewise, TDMI were highest ($p < 0.001$) in T6 > T4 > T3 > T1 > T2 as compared to T5. Daily nutrient intake was also affected by treatment groups. Accordingly, bulls in T5 had lowest ($p < 0.001$) organic matter intake than did in T6 > T4 > T3 > T1 > T2. Conversely, highest crude protein (CP) and ether extract (EE) intake were recorded in bulls fed T5 than rest of treatment groups.

Table1. Treatment layout of the experiment.

Treatments	Concentrate type (Kg)	Hay
Treatment one (T1	Shed dried cafeteria left over (4kg)	*Ad libtum*
Treatment two (T2)	Wheat bran (4 kg)	*Ad libtum*
Treatment three (T3)	Maize grain (4 kg)	*Ad libtum*
Treatment four (T4)	Mix of two concentrate ingredients (4kg)	*Ad libtum*
Treatment five (T5)	Scrambled whole groundnut (4kg)	*Ad libtum*
Treatment six (T6)	Mix of all four concentrate ingredients (4kg)	*Ad libtum*

T_4 = Hay *ad libitum* + 4 kg d^{-1} mix (1:1, wheat bran to maize grain, respectively); T6 = Hay *ad libitum* + 4kg d^{-1} mix (equal proportion of maize grain, wheat bran, dried cafeteria leftover and scrambled whole groundnut); clean drinking water was freely available; salt was added as one percent of the concentrate offer.

Table 2. Chemical composition of feed ingredients.

Feed items	On DM bases, %						
	DM	Ash	CP	EE	NDF	ADF	ADL
Hay	94.2	9.4	5.5	2.1	75.8	46.2	8.3
Dried cafeteria leftover	92.2	3.0	11.8	7.6	23.5	4.0	2.9
Wheat bran	93.1	3.8	15.2	4.8	43.0	9.5	1.9
Ground maize grain	88.9	2.2	7.1	5.3	27.9	3.9	0.5
Ground whole ground nut	90.6	2.5	49.0	40.0	16.4	7.2	0.98

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CP = Crude Protein; DM = Dry Matter; EE = Ether Extracts; NDF = Neutral Detergent Fiber.

Table 3. Daily dry matter and nutrient intake of *Hararghe Highland* bull.

Intake (kg day^{-1})	Treatment feeds							
	T_1	T_2	T_3	T_4	T_5	T6	SEM	P
HDM	6.24	6.25	6.25	6.25	6.27	6.24	0..01	0.98
CDM	3.83^{ab}	3.75^{b}	3.77^{ab}	3.84^{ab}	3.2^{c}	3.87^{a}	0.04	.001
TDM	10.08^{a}	10.00^{a}	10.03^{a}	10.10^{a}	9.49^{b}	10.11^{a}	0.04	.001
DMI (%BW)	4.62	4.56	4.61	4.66	4.34	4.64	0.07	0.88
			NI (kg day^{-1})					
OM	9.37^{ab}	9.27^{b}	9.36^{ab}	9.40^{a}	8.82^{c}	9.41^{a}	0.04	.001
CP	0.79^{d}	0.91^{c}	0.61^{e}	0.77^{d}	1.92^{a}	1.14^{b}	0.08	.001
EE	0.42^{c}	0.31^{d}	0.33^{d}	0.32^{d}	1.42^{a}	0.68^{b}	0.07	.001
NDF	5.63^{d}	6.35^{a}	5.79^{c}	6.10^{b}	5.28^{e}	5.80^{c}	0.06	.001
ADF	3.03^{c}	3.24^{a}	3.03^{c}	3.14^{b}	3.13^{b}	3.12b	0.01	.001

$^{a-e}$mean values in a row having different superscripts differ significantly; SEM = standard error of the mean; DMI = dry matter intake; BW = body weight; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; CDM = concentrate dry matter intake; HDM = hay dry matter intake; TDMI = total dry matter intake; NI = nutrient intake; T_1 = Hay *ad libitum* + 4kg dried cafeteria leftover ; T_2 = Hay *ad libitum* + 4kg wheat bran; T_3 = Hay *ad libitum* + 4 kg d^{-1} maize grain; T_4 = Hay *ad libitum* + 4kg d^{-1} mix (1:1, wheat bran to maize grain, respectively); T5 = Hay *ad libitum* + 4kg scrambled whole groundnut; T6 = Hay *ad libitum* + 4kg d^{-1} mix (equal proportion of maize grain, wheat bran, dried cafeteria leftover and scrambled whole groundnut).

Feedlot performance and carcass yield of Highland bull

Feedlot performance of Hararghe highland bull such as final body weight (FBW), ADG and FCE were affected by treatment feeds. Bulls fed on T6 and T3 recorded highest ($p < 0.05$) finished weight and ADG than did in T2, T5 and T1. Similarly, highest ($p < 0.05$) feed conversion efficiency was detected on bulls fed T6 and T3 as compared to T2, T5, T1 and T4 (Table 4).

Carcass yield (CY) on slaughter weight is given in Table 4. Carcass yield (CY) on slaughter weight were also affected in consistent with feedlot performance traits. Bulls fed on T6 and T3 had highest carcass yield than T2, T5, T1 and T4.

Loin eye area is the most useful technique used to indicate the amount muscle obtained from the total carcass of meat animals. The loin eye area of Hararghe Highland Zebu bull ranges from 70.to 75.5 cm^2. Similarly, comparable *Longismuss* muscle area was noted for Ogaden bulls in the eastern part of Ethiopia (Yoseph et al., 2011). However, large *Longismus* muscle area (83.4 cm^2) was obtained in temperate breeds than did in the present study (Casas et al., 2010).

Discussion

Bulls fed on concentrate mix of T6 and T3 had improved feedlot performance and carcass yield of the cattle. However, lower results of the parameters measured for the animals that received the T5, possibly was due to the high EE content (14.8%) ingested in the feed.

The finished weight of Hararghe Highland bull is ranged between 313.0-339.5 kg. It is higher than the previous reports of Ethiopian breeds (Nega et al., 2003; Yoseph et al., 2011). Likewise, the finished weight of Hararge Highland also higher as compared to Tanzanian indigenous breeds (Shirima et al., 2016). However, very high figure was noted in temperate breeds than did in the present study (Casas et al., 2010). This might be due to temperate breeds are improved breeds and kept on better management conditions than the tropical local breeds.

Table 4. Feedlot performance and carcass yield of *Hararghe Highland* Bull.

Parameters	Treatments						SEM	P
	T_1	T_2	T_3	T_4	T_5	T6		
IBW(kg)	219.6	219.8	219.6	219.6	219.6	219.8	3.63	1.00
FBW (kg)	328.6^{b}	313.0^{d}	338.6^{a}	335.0^{ab}	322.0^{bc}	339.5^{a}	5.25	0.04
ADG (kg d^{-1})	1.21^{b}	1.03^{d}	1.32^{a}	1.28^{ab}	1.13^{bc}	1.33^{a}	0.05	0.01
FCE	0.12^{b}	0.10^{c}	0.13^{a}	0.12^{b}	0.11^{bc}	0.13^{a}	0.04	0.03
HCW(kg)	155.1^{b}	132.0^{c}	164.4^{a}	160.3^{ab}	142.9^{bc}	165.4^{a}	3.34	0.009
CY (kg)	47.1^{b}	42.2^{c}	48.7^{a}	47.8^{a}	44.3^{bc}	48.5^{a}	0.52	<.0001
Loin eye area (cm^2)	70.4	71.3	72.6	73.0	72.5	75.5	3.10	0.06

$^{a,-d}$mean values in a row having different superscripts differ significantly; SEM = Standard error of the mean; ADG = average daily gain; CY = Carcass yield; FCE = feed conversion efficiency; HCW = hot carcass weight; IBW = initial body weight; FBW = final body weight; T_1 = Hay *ad libitum* + 4kg dried cafeteria leftover ; T_2 = Hay *ad libitum* + 4kg wheat bran; T_3 = Hay *ad libitum* + 4 kg d^{-1} maize grain; T_4 = Hay *ad libitum* + 4kg d^{-1} mix (1:1, wheat bran to maize grain, respectively); T5 = Hay *ad libitum* + 4kg scrambled whole groundnut; T6 = Hay *ad libitum* + 4kg d^{-1} mix (equal proportion of maize grain, wheat bran, dried cafeteria leftover and scrambled whole groundnut).

In this feedlot study better gain was achieved as compared to previous reports where in almost all studies conducted in Ethiopian local cattle breeds and some tropics is reported less than one kg day^{-1} (Yoseph et al., 2011) and 0.47 and 0.61 kg day^{-1} (Osuji & Capper, 1992), respectively reported for Zebu oxen. Moreover, it was higher than 0.74 kg day^{-1} reported for matured Zebu bulls fed teff straw and supplemented with poultry litter and noug seed cake (Nega et al., 2003). Furthermore, Nega et al. (2003) also reported lower ADG 0.44-0.57 kg day^{-1} for Arsi cattle than Hararghe Highland Zebu. Similarly, Jepsen and Creek (1976) noted lower average daily gain 0.55 to 0.61 and 0.78 to 0.89 kg day^{-1} for Arsi and Boran, respectively under feedlot conditions. Moreover, The Ethiopian Boran breeds with an estimated age of 6 and 8 years old gain 0.65 and 0.65 kg per day, respectively under pasture grazing management (Mohammed & Hailu, 2015). Moreover, the obtained results in this study were higher than with the report of Haile, Joshi, Ayalew, Tegegne, and Singh (2009) which showed the daily body weight gain of Ethiopian Boran was estimated 0.44 kg at low input management. The difference in weight gain might be attributed to difference in quantity, quality of the supplements, basal diet feed, and the physiological and genetic potential of the feeder animals. However, a comparable report of weight gain (0.96 kg) of Ethiopian Boran breed was obtained under feedlot management (unpublished). However, the average daily gain of Hararghe Highland is tended to be comparable with temperate breeds (1.3 kg) (Casas et al., 2010). This showed that the animals were fed up to their potential during the feedlot experiment.

The carcass weight harvested from this study ranged from 155.1 to 165.4 kg. This figure is consistent with the topical average from 155 to 237 kg (Tsegay & Mengisitu, 2013). The carcass yield of Hararghe Highland bull was higher than the carcass weights noted in previous Ethiopian indigenous genotype as reported by, Yoseph et al. (2011), this might be difference in climate, breed type, the level of fattening and the feeding regimes. However, the figure obtained in the current study is lowered as compared to temperate carcass yield (Adams et al., 1982; Chambaz et al., 2003; Wheeler et al., 2004; Wheeler et al., 2005; Yong et al., 2007; Asizua et al., 2009 and Casas et al., 2010).

Dressing percent is an important measurement in meat animals it indicates the amount of carcass in relation to the live weight of animals. It has been demonstrated that carcass traits including dressing percentage are influenced by several factors such as plane of nutrition, sex and age of the animals (Devendra & Burns, 1983; Tsegay et al., 2013). The amount of dressing percentage or carcass yield in the present study is in line with the tropical yields (Rage et al., 2006; Kemp et al., 2007). The carcass value of Hararghe Highland bull was comparable to the previous Ethiopian local breeds (Jepsen & Creek, 1976; Nega et al., 2003; Mohammed & Hailu, 2015). However, lower carcass yield was obtained as compared to temperate average (Casas et al., 2010).

Conclusion

Bulls fed on combination of all concentrate feeds (T6) and maize grain (T3) had highest finished weight and average daily gain. Consistent to feedlot performance traits. Carcass yield of Hararghe Highland was improved using all concentrate mix or maize grain as compared to bulls on other treatment groups. Therefore, this study suggested that Hararghe Highland bull has the potential for feedlot industry using strategic supplementation to produce red meat.

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