International Scholars Journals

International Journal of Agricultural Sciences ISSN 2167-0447 Vol. 10 (4), pp. 001-009, April, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of strategic supplementation with different proportion of agro-industrial by-products and grass hay on body weight change

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Accepted 20 February, 2020

The effect of supplementation with agro-industrial by-products and hay on body weight change and carcass characteristics of Ogaden bulls grazing natural pasture was investigated at Haramaya University beef farm. Eighteen uniform and healthy Ogaden bulls with initial mean body weight of 258.5±41.5 kg were selected from the University farm and randomly assigned to one of the three treatments. Treatment 1 (T1; Control) constituted grazing natural pasture alone, while treatments 2 and 3 constituted grazing natural pasture supplemented with agro industrial by-products and hay at a ratio of 25:75 and 50:50, respectively. Average daily body weight gain was highest (P < 0.05) for bulls in T3 (0.65±0.05 kg), while no difference was observed between bulls in T2 (0.47±0.05) and T1 (0.39±0.05). Mean body condition score was highest (P < 0.05) for bulls in T3 and T2 compared to bulls in T1. Feeding period influenced (P < 0.05) body weight change and body condition score , where bulls in the final period were heavier and had better body condition score than the preceding periods Feeding Ogaden bulls with T3 and T2 improved (P < 0.05) empty body and hot carcass weights compared to grazing alone (T1). Dressing percentage was slightly higher for bulls in T3 and T2 compared to bulls in T1. Thus, it could be concluded that supplementation with T3 would be a better feeding strategy to improve the performance of Ogaden bulls under tropical environment.

Key words: Body weight, body condition score, carcass and non-carcass components, supplementation, Ogaden bulls.

INTRODUCTION

The Ogaden cattle is one of the tropical cattle breeds (*Bos indicus*) widely distributed in eastern and south eastern part of Ethiopia. The breed has been evolved in arid and semi arid agro- ecological setup, but later on distributed and adapted to the wide agro-ecological zones. Because of its multi-purpose role, the Ogaden cattle has been used for milk, beef, draft power, farm yard manure and income generation. Even though this is generally true, it has been evident that this genotype has better market compared to other cattle breeds in the country and fetches premium prices both at domestic and foreign markets (Fekadu and Alemu, 2000; Personal communication). Such a scenario created an opportunity for small-scale cattle-fattening schemes in eastern part of the country in general and in Hararghe highlands in particular. However, the potential of this genotype for beef production has not been well explored. In spite of this, poor nutrition that is attributed to low nutrient content of commonly available animals' feeds has been ascribed to be the major factor that compromises beef production of tropical cattle breeds.

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Natural pasture and crop residues are the dominant feed types for livestock in tropics and sub-tropics. However, the availability of natural pasture is dictated to fluctuate due to seasonality of rainfall so that feed stuff derived from thereof is abundant during the rainy season and inadequate during the dry season. Thus, wet season feed resources including natural pasture are limited to supporting optimum animal performance mainly because of its low DM content (Gebre-Egziabher and Mullugeta, 1995). Consequently, reduced animal performances through body weight and body condition loss as well as reduced carcass composition are common in grazing animals (Lamond, 1970).

Supplementation of low quality feed resources with nutritious ones is among the strategies followed to prevent weight loss and improve animal performance. Supplementation of wet season feeds with feeds containing high DM could also increase its dry matter intake and thereby ameliorate animal productivity. Agro-industrial by-products including flour mill and oil-seed cakes are an alternative feed that contain high nutritive value. Several studies have shown that supplementation with wheat bran or wheat middlings and noug seed cake or peanut cake have improved body weight gain and carcass characteristics of cattle fed crop residues or grazing natural pasture (Azage and Mukassa- Mugerewa, 1995; Tesfaye et al., 2002; Osuji and Capper, 1992). It is therefore, accentuated to search for supplementation strategies that would enhance dry matter and nutrient intakes of tropical feed resources and thereby ameliorates the performance of cattle. Supplementation with differential proportion of agro-industrial by-products to hay ratio could be among the alternatives to be looked into in this regard.

However, information is non-existent to show the response of Ogaden cattle breed to strategic supplementation with different proportions of agro-industrial by-product and hay. Besides, similar to other tropical breeds, there is lack of information on body weight change pattern and carcass characteristics of Ogaden genotype. Since these traits are influenced, among other factors, by differences in breed (Tesfaye et al., 2000), it is utmost important to generate pertinent information for this breed that would assist in the global breed documentation endeavor. The current study was, therefore, designed to investigate the effect of strategic supplementation with agro-industrial by-products and hay on body weight change and carcass characteristics of tropical Ogaden bulls.

MATERIALS AND METHODS

Study site

The study was conducted from June to October, 2002 at Haramaya University beef farm (9.0°N and 42.0°E), located at 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 et al., 2004).

Animals and management

Eighteen uniform and healthy Ogaden bulls (indigenous Zebu type) with an initial average body weight of (Mean±SE) 258.5±9.8 kg were selected from the University beef farm and randomly assigned to the three different dietary treatments for equal mean body weight and standard error. After randomization, there was no difference ($P > 0.05$) in initial body weight and body condition score among the animals assigned into the different treatments. The animals were allowed to graze on natural pasture (dominated by *Hypernia rufa* spp.) altogether, during the daytime, for 7 h per day. During the night, animals were housed in individual pen in an open shed. The animals were provided with clean water three times a day (at 8:00 am, 12:00 am and 04:00 pm).

Dietary treatments

Treatments encompassed either grazing natural pasture alone (Control; Treatment 1; T1) or grazing natural pasture and supplemented with agro industrial by-products mix and hay at a ratio of 25:75 (Treatment 2; T2) or grazing natural pasture and supplemented with agro industrial by-products mix and hay at a ratio of 50:50 (Treatment 3; T3). Grazing was done during the daytime while supplementing was done during the night in individual feeding trough. The total amount of supplement was calculated at 1% of the body weight on dry matter basis and adjustment was made weekly. Concentrate was made from agro-industrial by-products, including wheat bran, wheat short, groundnut cake and table salt and manually mixed at 39, 25, 35 and 1% of the total mix, respectively. The animals were treated against external and internal parasites and underwent three weeks of adaptation period for feed before commencement of the feeding experiment. The experiment lasted 12 weeks (4 periods, each with 3 weeks).

Feed sampling and processing

Representative feed samples were collected from the offer once per week and pooled by feed type for the entire experimental period. After thorough mixing, the pooled samples were sub-sampled and dried at 60°C to constant weight for chemical analysis. Both air dried and oven dried feed samples were finely ground to pass through 1 mm mesh size and stored in an air tight plastic bags pending chemical analysis. Dry matter (DM) content of the feed was monitored by drying representative feed samples in a forced draft oven at 105°C overnight.

Measurements

Body weight and body condition score

Body weight of the animals was measured weekly using a stationary weighing bridge, while body condition score was assessed in a scale 1 to 9 (1=Emaciated and 9=Obese) by the same technician according to the procedure described by Nicholson and Butterworth (1986).

Evaluation of carcass and non-carcass components

At the end of the actual experimental period, 9 Ogaden bulls (3 bulls from each treatment) were selected randomly for carcass evaluation. The animals were deprived of feed and water overnight

Table 1. Chemical composition of feed stuff.

Variable		Feed type			
		Native grass hay	Wheat bran	Wheat short	Groundnut cake
Dry Matter (DM) (%)		91.4	89.8	90.5	91.2
% DM	Ash (%)	9.2	4.6	4.9	5.0
	Organic matter (%)	90.7	95.3	95.0	94.9
	Crude protein (%)	8.9	19.7	19.3	46.5
	True IVOMD (%)	66.6	83.2	84.8	90.2
	Nutrient detergent fiber (%)	76.8	44.5	49.1	27.1
	Acid detergent fiber (%)	42.5	12.1	9.9	12.0
	Lignin (%)	5.9	2.1	1.9	3.3
	Gross energy (MJ/Kg DM)	18.8	21.2	20.5	23.4

before the slaughter. Pre-slaughter body weight was taken before slaughter, and weight of skin, legs and head was measured right after slaughter and skinning. Weight of non-carcass edible organs such as heart, liver, intestine were also measured and recorded. The entire alimentary tract was removed and weighed before and after emptying the contents. The carcass was split into 2 halves and the weight of each was taken. The area under the loin, rib eye muscle area, was traced by tracing the cross sectional area of the 11th and 12th ribs after cutting perpendicular to the back bone with tracing paper, and the area was calculated using digital planimeter. The average of the right and left cross sectional area was considered as a rib-eye muscle area. The right half of the carcass was kept in deep freezer (-10°C) overnight and de-boned into lean meat, fat and bone components. Dressing percentage was calculated as the proportion of hot carcass to slaughter weight.

Chemical analysis of feeds

Feed samples were analyzed for dry matter, organic matter and ash content according to AOAC (1990). Nitrogen content of the feed was determined using Kjeldhal procedure and the energy content via bomb calorimetry. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed as suggested by Van Soest et al. (1991). *In vitro* organic matter digestibility (IVOMD) was analyzed following the procedures of Tilley and Terry (1963).

Statistical data analysis

Data on body weight and body condition score were stratified into dietary treatments, feeding period (each with 4 weeks) and their interaction and analyzed in a mixed procedure of SAS with repeated measure analysis (SAS, 1999). Data on carcass and non-carcass components, however, were analyzed using the General Linear Model (GLM) procedure of SAS. Initial body weight was modeled as a linear covariate for the analysis of body weight and carcass characteristics. The contrast statement of SAS was employed for comparisons among treatment groups.

RESULTS

Chemical composition of feeds

Crude protein content of groundnut cake (46.5%) was the highest while it was moderate for wheat bran (19.7%) and wheat short (19.3%) and lowest for native grass hay (8.9%) (Table 1). Conversely, grass hay had the highest NDF (76.8%) while wheat bran (44.5%) and wheat short (49.1%) had moderate and groundnut cake had the least (27.1%). Grass hay contained higher ash (9.2%) compared to the agro industrial by-products used in this study. However, groundnut cake had the highest true *in vitro* organic matter digestibility (IVOMD; 90.2%) followed by wheat short (84.8%) and wheat bran (83.2%) while grass hay had the lowest (66.6%).

Body weight change and body condition score

The pattern of body weight change and body condition score of indigenous Ogaden bulls subjected to differential level of nutritional supplementation (hay to concentrate ratio) is presented in Table 2. The mean body weight was highest ($P < 0.05$) for Ogaden bulls in T3 (304.5±4.3) while no difference ($P > 0.05$) was noted for bulls in T2 (288±4.3) and T1 (277.8±4.3). The total and average daily body weight gain (ADg) of Ogaden bulls was positive for all treatments. However, it was highest ($P < 0.05$) for bulls in T3 (total body weight gain = 74.5±6.4 kg; ADg = 0.65±0.05 kg/day) and least for bulls in T1 (total body weight gain = 44.5±6.4; ADg = 0.39±0.05 kg/day). There was no difference ($P > 0.05$) in total body weight change and ADg between bulls in T2 and T1. Feeding period has significantly influenced body weight of Ogaden bulls, where bulls gained body weight with advancing feeding period, eventhough the interaction between body weight and feeding period was not significant (Table 2; Figure 1). Consequently, bulls in the final period of feeding (Period IV) had the highest ($P < 0.05$) body weight, while those in period III had better ($P < 0.05$) body weight than bulls in periods I and II.

The mean body condition score of Ogaden bulls was the highest ($P < 0.05$) for bulls in T3 and T2 compared to bulls in the control (T1). Similar to body weight, body condition score of Ogaden bulls was improved over the

Table 2. Effect of supplementation of different levels of concentrate to hay ratio on body weight change and body condition score of Ogaden bulls grazing native pasture.

Variable	Treatment (Mean ±SE)			Period mean
	T1	T2	T3	
Body weight (kg)				
Period I	263.9±8.3	276.8±8.3	281.5±8.3	274.2±5.6^{A}
Period II	264.5±8.3	282.0±8.3	293.7±8.3	280.1±4.8^{AB}
Period III	285.42±8.3	285.6±8.3	313.8±8.3	294.9±4.8^{B}
Period IV	297.7±8.3	307.7±8.3	329.2±8.3	311.6±4.8^{C}
Treatment mean	277.8±4.3^{a}	288.0±4.3^{a}	304.5±4.3^{b}	
Total body weight gain	44.5±6.4 ^{a}	53.7±6.4 ^{a}	74.5±6.4 ^{b}	
Average daily body weight gain	0.39±0.05 ^{a}	0.47±0.05^{a}	0.65±0.05^{b}	
Body condition score				
Period I	5.1±0.12	5.5±0.13	5.5±0.12	5.4±0.07^{A}
Period II	5.1±0.12	5.5±0.12	5.5±0.12	5.4±0.07^{B}
Period III	5.6±0.14	5.7±0.14	5.9±0.14	5.7±0.08^{C}
Period IV	6.3±0.18	6.5±0.18	6.4±0.18	6.4±0.10^{C}
Mean	5.5±0.07^{a}	5.8±0.07 ^{b}	5.8±0.07 ^{b}	

*Means with different superscript small letters across the same rows are significantly different (P < 0.05); Means with different superscript capital letters across the same columns are significantly different (P < 0.05); Period= Feeding period which lasted 3 weeks for each period; T1= Grazing natural pasture alone (Control); T2= Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 25:75; T3= Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 50:50.

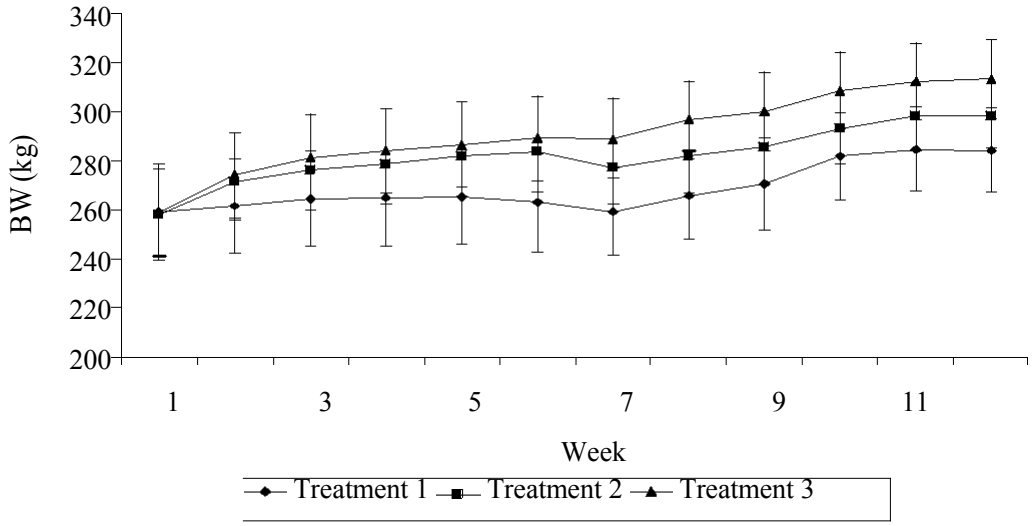

Figure 1. Body weight change (Mean ±SEM) pattern of Ogaden bulls supplemented with differential level of agro industrial by-products to hay ratio based on grazing native pasture. T1 =grazing natural pasture alone (Control); T2 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 25: 75; T3 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 50:50. BW = Body Weight).

feeding period where bulls in the final period of feeding (Period IV) had the highest (P < 0.05) body condition score, while bulls in periods I and II had similar (P > 0.05).

Carcass characteristics

Carcass characteristics and carcass components of Ogaden bulls exposed to different levels of

Table 3. Effect of supplementation with different levels of agro industrial by-products to hay ratio on carcass characteristics of Ogaden bulls grazing native tropical pasture.

Variables	Treatment (Mean ±SE)			Contrast			
	T1	T2	T3	T1 Vs T2	T1 Vs T3	T2 Vs T3	T1 Vs T2+T3
Pre-slaughter weight (kg)	297.4±7.3	302.7±7.2	318.2±7.2	ns	ns	ns	ns
Empty body weight (kg)	246.9±4.3	261.3±4.2	272.4±4.2	P=0.06	**	ns	*
Hot carcass weight (kg)	163.2±3.1	171.6±3.0	182.5±3.0	ns	**	P=0.054	*
Dressing percentage (%)							
Slaughter weight basis	54.7±0.77	56.4±0.75	57.3±0.75	ns	P= 0.06	ns	P= 0.07
Empty weight basis	65.9±1.0	65.5±1.0	66.9±1.0	ns	ns	ns	ns
Rib-eye-muscle area (cm^2)	69.5±4.6	73.1±4.2	70.9±4.3	ns	ns	ns	ns

* = P < 0.05; ** = P < 0.01; T = Treatment; ns = Not significant; T1 = Grazing natural pasture alone (Control); T2 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 25:75; T3 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 50:50.

Table 4. Effect of supplementation with different levels of agro industrial by-products to hay ratio on carcass components of tropical Ogaden bulls grazing native tropical pasture.

Variables	Treatment (Mean ±SE)		
	1	2	3
Lean meat (g/kg cold carcass)	628±11	670±8.8	665±12
Fat (g/kg cold carcass)	32±8.3	33±6.5	60±9.4
Bone (g/kg cold carcass)	197±6	180±5.8	176±8.4
Lean meat + fat : Bone ratio	3.7±0.25	4.0±0.25	3.5±0.25
Lean meat: Bone ratio	3.5±0.21	3.8±0.20	3.3±0.21
Fat: Bone ratio	0.23±0.05	0.20±0.05	0.25±0.05
Lean: Fat ratio	16.6±3.26	19.7±3.19	14.0±3.21
Rib eye area (cm^2)	69.5±4.6	73.1±4.2	70.9±4.3

T1 = grazing muscles natural pasture alone (Control); T2 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 25: 75; T3 = Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 50:50.

supplementation are presented in Tables 3 and 4. Supplementing Ogaden bulls with differential levels of hay to concentrate ratio (T3 and T2) improved (P < 0.05) empty body weight (T3 = 272.4±4.2; T2 = 261.3±4.2) and hot carcass weight (T3 = 182.5±3.0; T2 = 171.6± 3.0) compared to the control (T1). Supplementation with T3 and T2 also slightly improved (P= 0.07 to 0.06) dressing percentage expressed on slaughtered body weight basis (T3 = 57.3±0.75; T2 = 56.4±0.75). Similarly, bulls in T3 had slightly higher weight of lean meat and fat than bulls in T2 and T1.

Non-carcass characteristics

Non-carcass characteristics of Ogaden bulls supplemented with differential levels of hay to concentrate ratio is presented in Table 5. Unlike carcass characteristics, supplementation with

Table 5. Effect of supplementation with different levels of agro industrial by-products to hay ratio on non-carcass components of Ogaden bulls.

Variables	Treatment (Mean ±SE)		
	T1	T2	T3
Edible components (kg)			
Liver with gall bladder	4.95±0.21	5.18±0.21	5.33±0.21
Kidneys	0.65±0.07	0.67±0.06	0.67±0.06
Heart	1.51±0.09	1.39±0.07	1.59±0.07
Empty gut	18.2±0.91	17.4±0.89	17.9±0.89
Reticulo-rumen	6.89±0.39	6.89±0.38	7.40±0.39
Abomasum	1.63±0.31	1.65±0.30	1.60±0.28
Omassum	1.78±0.20	1.83±0.19	1.85±0.19
Small intestine	4.81±0.20	3.92±0.19	4.2±0.19
Large intestine	3.16±0.22	3.10±0.21	2.92±0.21
Esophagus	0.39±0.05	0.40±0.04	0.46±0.04
Diaghram	1.02±0.16	0.91±0.13	1.06±0.13
Tail	0.91±0.04	0.94±0.04	1.0±0.04
TECC	26.8±1.25	26.6±1.01	27.7±1.01
Non-edible components (kg)			
Skin	24.7±1.43	23.4±1.4	25.4±1.4
Lungs and trachea	2.57±0.16	2.32±0.16	2.99±0.13
Head	14.8±0.4	14.2±0.4	15.89±0.4
Feet	5.98±0.3	5.56±0.3	6.25±0.3
Spleen	0.85±0.10	0.87±0.09	0.94±0.09
Testicles	0.59±0.04	0.60±0.04	0.73±0.04
Penis	0.76±0.09	0.68±0.08	0.82±0.08
Urinary bladder	0.17±0.02	0.16±0.02	0.19±0.02
Internal fat	4.83±0.61	5.15±0.60	6.77±0.60
TNECC	53.3±3.10	53.0±3.14	59.5±2.4

T1=grazing natural pasture alone (Control); T2=Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 25:75; T3=Grazing natural pasture and supplemented with agro industrial by-products and hay at a ratio of 50:50; TECC=Total edible carcass component; TNECC=Total non-edible carcass component.

differential levels of hay to concentrate ratio did not bring substantial change ($P > 0.05$) on edible and non-edible non-carcass components. However, bulls in T3 diet had slightly higher weight of liver and heart than in other treatments. Similarly, bulls in T3 diet had slightly higher weights of skin, lungs and trachea, head, legs, spleen, testes and urinary bladder than bulls in the control (T1) and T2. The weights of rumen, kidney, and fats of linguini, intestine and scrotum were to some extent higher for bulls in T3 than bulls in the control (T1).

DISCUSSION

Chemical composition of feed staff

The crude protein content of native grass hay in the present experiment was lower than 9.9% reported by Wondwossen and Solomon (2010) and 11% reported by McDonald (2002). However, it was higher than 5.1% reported by Mekasha et al. (2007), 6.1% reported by Khalilli (1993) and 4.2% reported by Mullu (2005). The difference in crude protein composition across the different studies might be attributed to differences in stage of maturity at harvest and other environmental factors (Adugna and Sundstol, 2000). However, the present value is higher than a threshold required for optimum functioning of rumen microorganisms (Whiteman, 1980). The fiber fraction and mineral composition of native grass hay was in agreement with the earlier reports (Mekasha et al., 2007). As expected, the CP content of wheat bran and wheat middlings were similar but groundnut cake had the highest. While the present CP composition of wheat bran was comparable to the values reported by Mekasha et al. (2007), it was slightly higher than 16.3 to 16.8% reported by other

researchers (Hirut, 2008; Tesfaye, 2007; Solomon et al., 2004). Similarly, the NDF and ADF constituent of wheat bran used in the present experiment were comparable to the values reported earlier (Mekasha et al., 2007); however, it is slightly lower than the values reported by Hirut (2008) . The CP content of groundnut cake was lower than 62.5% reported by Hirut (2008) but comparable to other findings (Mekasha et al., 2007). The fiber fraction of groundnut cake, however, was in agreement with previous works (Hirut, 2008; Mekasha et al., 2007). Differences in chemical composition of the ingredients used for concentrate mix might be related to differences in variety of the raw materials used, processing methods employed and laboratory chemical analysis procedures.

Body weight change and body condition score

Supplementing Ogaden bulls with T3 increased the ADg by 66% compared to un-supplemented group (T1). This is attributed to the higher nutrients contained in the supplement as shown in Table 1. Improving feed quality through improvement in its protein content and digestibility results in improved body weight gain (Abi-Saab et al., 1997). The lack of difference ($P > 0.05$) in ADg between bulls in T2 and the control implies that the level of concentrate mix included in the supplement was low to support higher gain. Consequently, the amount of nutrients available at small intestine for bulls in both treatments might be similar irrespective of the differences in dietary treatments and expected feed intake (Solomon and Simret, 2008).

Since this study was commenced at the beginning of the rainy season, it was expected that the dry matter content of the natural pasture was low but improved through time as the pasture matured. Thus, even though it was difficult to accurately measure total feed intake under grazing experiment, the present increment in average body weight over the feeding period might be due to improvement in dry matter composition of the pasture.

The total body weight change and ADg of bulls for T3, in the present study, was higher than 69.1 and 0.47 kg, respectively, reported for Zebu oxen grazing natural pasture and supplemented with higher level of wheat bran (Tesfaye et al., 2002). The present ADg for bulls in T3 was also higher than 0.614 kg/day reported for drought oxen fed teff straw and supplemented with wheat bran, wheat middlings and cotton seed cake (Osuji and Capper, 1992). However, it was lower than 0.740 kg/day reported for matured Zebu bulls fed teff straw and supplemented with poultry litter and noug seed cake (Preston and Leng, 1986). The difference in weight gain might be attributed to difference in quantity and quality of the supplements and the basal diet feed, and the physiological and genetic potential of the animals concerned. However, inspite of the absence of supplement in T1, the Ogaden bulls not only maintained their initial body weight but also gained 0.39 ± 0.05 kg (mean±S.E.) body weight per day during the experimental period. The fact that the experimental period covered long rainy season (June- September) might have favored the Ogaden bulls to graze nutritionally better natural pasture. This is corroborated by the earlier works that confirm that nutritional quality of the natural pasture is higher during the rainy season than in dry season (Zinash et al., 1995). This is augmented by Fekadu and Alemu (2000) who reported that the rainy season feeds contain higher crude protein (11.6%) and higher digestibility (IVDMD = 70.3%) compared to dry season feeds. This implies that bulls in the control treatment might have consumed better nutrients from the natural pasture and gained body weight during this period. The finding could be explained by the physiological phenomenon, known as compensatory growth, where the loss in body weight during the dry season is compensated for during the rainy season when the quantity and quality of the feed are improved. However, the average daily body weight gained by bulls in the control was far lower than bulls supplemented with higher level of concentrate to hay ratio (T3) implying that supplementation with better nutrients is indispensable to exploit the genetic potential of the animals and thereby achieve higher body weight under tropical environment. Similarly, Gebre-Egziabher and Mullugeta (1995) demonstrated that although wet season grazing pastures are better than dry season pastures, supplementation is important for better performance both in dry and wet seasons.

Since body condition score is an excellent indicator of the nutritional status of the animals and is an indirect reflection of the body reserve, the highest body condition score obtained for bulls in T3 reveals that these animals were in a better nutritional status and had better body reserve. Body condition scoring is a useful management tool for distinguishing differences in nutritional need of ruminants in the herd.

Carcass and non-carcass characteristics

Similar to body weight and body condition score, some of the carcass components (empty and hot carcass weights) of Ogaden bulls were influenced by the present dietary treatments imposition where bulls in a better plane of nutrition (T3 and T2) were superior compared to the control (T1). The finding was in agreement with Fadol and Babiker (2010) who reported higher hot and cold carcass weight for Sudanese Zebu bulls fed *ad libitum* diet compared to the restricted group. Matiwos (2007) has also reported improved carcass yield due to nutritional supplementation (Matiwos, 2007). 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 and Burns, 1983).

On the other hand, this study could not find strong differences in some of the carcass and non-carcass parameters due to the current dietary treatment imposition (Tables 3 to 5). Similarly, Sebsibe et al. (2007) and Knoblich et al. (1997) could not find difference in carcass parameters due to difference in feeding regime employed. Lack of difference in carcass components (carcass bone, muscle to bone ratio, muscle to fat ratio) and rib-eye muscle area has also been reported in cattle (Fadol and Babiker, 2010) and small ruminants (Solomon and Simret, 2008; Chestnut, 1994). Tesfaye et al. (2002) reported that there was no difference in dressing percentage in zebu oxen fed tef straw and supplemented with different levels of wheat bran. Fadol and Babiker (2010) investigated the effect of feedlot regimen on performance and carcass characteristics of Sudan Baggara Zebu cattle and reported that there was no difference in dressing percentage and rib muscle (longissismus dorsi) area between bulls fed *ad libitum* and intermittently restricted group. The lack of significance difference for some carcass traits observed in the current study might be attributed to the better quality of the pasture at the time of the experiment. The lack of difference for bone is that it is a tissue which develops early in all animal species and does not depend on nutrition and sex at older ages (Solomon and Simret, 2008).

On the other hand, the mean dressing percentage (slaughter weight basis) recorded for Ogaden bulls in the present study was 56% (ranging from 54.7% in Control to 57.3% in T3). This value was superior compared to the dressing percentage of 52.5% reported for Sudan Baggara Zebu bulls maintained under *ad libitum* feeding management (Fadol and Babiker, 2010; Talib and Ahmed, 2008). It was also higher than 54% reported for Boran bulls (Thorpe et al., 1908). The finding could be explained by the fact that the University beef farm had been established long ago with the intention of improving beef performance of Ogaden cattle and that selection have been practiced at the farm in order to retain better performing animals. Thus, the difference in dressing percentage between the present result (Ogaden bulls) and previous reports on other Zebu cattle types might be attributed to the fact that this experiment employed slightly improved genotypes instead of acquiring from open market and/or breed difference.

Conclusion

This experiment demonstrated that supplementing Ogaden bulls with a concentrate to hay ratio of 50:50 at 1% of body weight to grazing based diet (T3) improved average daily body weight gain, body condition score, empty body weight and hot carcass weight compared to supplementation with concentrate and hay at a ratio of 25:75 (T2) and the control (T1). Thus, it could be concluded that supplementation of Ogaden bulls with T3 diet would be a better feeding strategy to improve the performance of Ogaden bulls in tropical environment.

ACKNOWLEDGEMENTS

The authors would like to thank the Haramaya University for providing the experimental animals and farm facilities to run the experiment. The Federal Government of Ethiopia, through the Ethiopian Agricultural Research Organization, is duly acknowledged for partial financing of this experiment. The assistance received from the University beef farm crew is highly appreciated. Our appreciation also goes to Ato Kassahun Delelegne (University abattoir) for his assistance in animal slaughtering.

REFERENCES

Abi-Saab S, Sleiman FT, Nassar KH, Chemaly I, El-Skaff R (1997). Implication of high and low protein levels in puberty and sexual maturity of growing male goat kids. Small Rumin. Res., 25: 17-22.

Adugna T, Sundstol F (2000). Supplementation of graded levels of *Desmidian intortum* hay to sheep feeding on maize stover harvested at three stages of maturity 2. Rumen fermentation and nitrogen metabolism. Animal Feed Sci. Technol., 87: 215-229.

AOAC (1990). Official methods of Analysis. AOAC (Association of Official Analytical Chemists), 5th Ed. Washington, DC, pp. 69-88.

Azage T, Mukassa-Mugerewa E (1995). Body growth and blood metabolite concentrations in Boran and Boran x Frisian bulls grazed on natural pastures: Effect of dry season dietary supplementation. Proceedings of the 3rd National Conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p. 331.

Chestnut DMB (1994). Effects of lamb growth rate and growth pattern on carcass fat leaves. Animal Prod., 58: 77-85.

Devendra C, Burns M (1983). Goat production in the tropics. Commonwealth Agricultural Bureaux, Farnham Royal, England.

Fadol SR, Babiker SA (2010). Effect of feedlot regimen on performance and carcass characteristics of Sudan Baggara Zebu cattle. Livestock Research for Rural Development. 22(2). Retrieved May 27, 2010, from http://www.lrrd.org/lrrd22/2/fado22027.htm.

Fekadu A, Alemu Y (2000). The feed resource base and feeding management of the traditional draught oxen fattening practice by smallholder farmers in the eastern Hararghe highlands. In: ESAP (Ethiopian Society of Animal Production) Proceedings: Livestock Production and the Environment-implications for sustainable livelihoods. Proceedings of the 7th Annual Conference of ESAP held in Addis Ababa, Ethiopia, 26-27 May 1999. Addis Ababa, Ethiopia, p. 442.

Gebre-Egiziabher G/Y, Mullugeta K (1995). Daily live weight gain of cattle grazing wet season natural pasture at Bako Research Center. Proceedings of the 3rd National Conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p. 331.

Hirut Y (2008). Supplementation of concentrate mix to Hararghe highland sheep fed a basal diet of urea-treated maize stover: effect on feed utilization, live weight change and carcass characteristics. MSc Thesis submitted to Haramaya University, Haramaya, Ethiopia, p. 75.

Knoblich HV, Fluharty FL, Loerch SC (1997). Effect of programmed gain strategies on performance and carcass characteristics of steers. J. Animal Sci., 75: 3094-3102.

Lamond DR (1970). The influence of under-nutrition on reproduction in the cow. Anim. Breed. Abstr., 38:358-372.

McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA (2002). Animal Nutrition. Sixth Ed. Pearson Education limited, Edinburgh gate, Harlow, UK, p. 693.

Mekasha Y, Tegegne A, Rodriguez-Martinez H (2007). Effect of supplementation with agro-industrial by-products and khat (Catha edulis) leftovers on testicular growth and sperm production in Ogaden bucks. J. Vet. Med. A, 54:147-155.

Mishra BB, Heluf G/Kidan, Kibebew K, Mohammed A, Bruk E (2004). Soil and land resource inventory at the Alemaya University research farm with reference to land evaluation for sustainable agricultural management and production. In: Heluf G/Kidan, and Mishra, B.B. (eds.). Specific features and management options of soil and land resources of eastern Ethiopian highlands for sustainable agricultural production. Synthesis of working papers. Dire Dawa, Ethiopia: Alemaya University: Soil Sci. Bull., p. 1.

Mullu M (2005). Effects of feeding different levels of brewer's dried grain on weight gain and carcass characteristics of Wogera sheep fed on hay as basal diet. MSc. Thesis. Alemaya University, p. 71.

Nicholson MJ, Betterwoth MH (1986). A guide to condition scoring of zebu cattle. International Livestock Research Center for Africa (ILCA), Addis Ababa, Ethiopia.

Osuji PO, Capper B (1992). Effect of age on fattening and body condition of draught oxen fed tef straw (Eragrostis tef) based diets. Trop Anim Health Prod, 24: 103-108.

Preston TR, Leng RA (1986). Matching livestock production systems to available resources. ILCA, Addis Ababa, Ethiopia.

SAS (1999). Statistical Analysis System (SAS), SAS Institute Inc., Cary, NC, USA.

Solomon M, Peters KJ, Azage T (2004). Microbial nitrogen supply, nitrogen retention and rumen function in Menz sheep supplemented with dried leaves of multi-purpose trees, their mixtures o wheat bran. Small Rumin. Res., 52: 25-36.

Solomon M, Simret B (2008). Body weight and carcass characteristics of Somali goats fed hay supplemented with graded levels of peanut cake and wheat bran mixture. Trop. Anim. Health Prod., 40: 553-560.

Talib NH, Ahmed FA (2008). Performance and carcass characteristics of intact zebu bulls fed different levels of deep stacked poultry litter. J. Animal Vet. Adv., 7(11): 1467-1473.

Tesfaye H (2007). Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: Effects on feed intake, digestibility, live weight and carcass parameters. An MSc Thesis presented to the School of Graduate Studies of Haramaya University, p. 82.

Tesfaye L, G/Egziabher G/Y, Gizaw K, Mullugeta K (2000). Body weight changes of male cattle grazing on natural pasture at Bako. Livestock production and the environment-implications for sustainable livelihoods. Proceedings of the 7th annual conference of Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p. 442.

Tesfaye WM, Osuji PO, Asfaw Y, Alemu Y (2002). Effect of wheat bran supplementation on feed intake, body weight change and retained energy in the carcass of Ethiopian highland zebu (bos indicus) oxen fed teff straw (eragrostis tef) as basal diet. ESAP (Ethiopian Society of Animal Production). Livestock in Food security-Roles and contributions. Proceedings of the 9th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p. 433.

Tilley JMA, Terry RA (1963). A tow stage technique for in vitro digestion of forage crops. J. Br. Grassland, 18: 104-111.

Van Soest PJ, Robertson JB, Lewis BA (1991). Methods for dietary fiber and non-starch polysaccharides in relation to Animal nutrition. J. Dairy Sci., 74: 3583-3597.

Whiteman PC (1908). Tropical pasture science. Oxford University Press, Oxford, p. 392.

Wolf BT, Smith C, Sales DI (1980).Growth and carcass composition in the crossbred progeny of six terminal sire breeds of sheep. Animal Prod., 31: 307-313.

Wondwossen A, Solomon M (2010). Supplementation of cottonseed, linseed, and noug seed cakes on feed intake, digestibility, body weight, and carcass parameters of Sidama goats. Trop. Anim. Health Prod., 42: 623-631.

Zinash S, Seyoum B, Lulseged G/H (1995).Effect of harvesting stage on yield and quality of natural pasture in the central highlands of Ethiopia. Proceedings of the 3rd National Conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p. 331.