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Evaluation of friesian x boran crossbred and Ethiopian Highland Zebu oxen with a reciprocal work effect on carcass characteristics

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Abstract

This study was intended to investigate the effect of cattle genotype and work stress on carcass characteristics of oxen maintained under slightly moderate management conditions. A total of 16 oxen representing two genotypes of the Ethiopian highland zebu (EHZ) and their contemporary Friesian x Boran (F x B) crossbred were used in the study conducted at on-station at Holetta Research Center where half numbers of each breed were put through work stress. The intrinsic heaviness of the crossbred oxen tended to yield more carcass (248.5±5.5Kg) than the genetically lighter zebu oxen (141.1±5.5Kg). Non-working F x B crossbred oxen appeared to put more weight than working oxen that were managed under similar conditions. The unadjusted rib eye area and fat thickness over the rib eye at the 12th rib were significantly greater for F x B crossbred (71.8±2.4 cm^2 and 3.0±0.1mm, respectively) than for EHZ oxen (50.4±2.4cm^2 and 2.2±0.1mm). Non-working F x B crossbred oxen had accumulated more adipose tissue (4.0±0.23mm) than the working contemporaries of the same genotype (2.0±0.16mm) that tended to partition extra energy for walking and work performance. Apparently, the EHZ oxen showed better feed conversion efficiency than their counterpart F x B crossbreds under solely roughage based feeding practice.

Key words: Carcass characteristics, Feed conversion efficiency, Genotype, Work stress

INTRODUCTION

The traditional mixed crop-livestock farming practice of the highland parts of Ethiopia demands male cattle to mainly serve as draught animals (IGAD, 2010). Draught oxen are normally released for beef when they retire from work. 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. Calves exhibit lower growth rate and this scenario ultimately results in less powerful draught oxen and the meat quality assumes to be sub optimal. When male cattle are used for work for a while and lastly fattened for beef, it is not well quantified to what extent work affects quality of meat.

These days, crossbred cattle that have exotic blood of European breed are being extended to smallholder farmers of the highlands particularly in peri-urban areas so as to promote semi-intensive dairy production in the country. As a result, the crossbred male calves have now become very good sources of draught power in the countryside to use them for land cultivation and also for beef in peri-urban areas (Yitaye, 2008). The present study was intended to investigate the effect of cattle genotype and work stress on carcass characteristics of oxen maintained under slightly moderate management conditions and also generates indicative baseline data that could be informative to set national beef quality standards.

MATERIAL AND METHODS

Location

The study was carried out on-station at Holetta Agricultural Research Center, 32 km north west of Addis Ababa, located at 9^0 3'N latitude and 38^0 30' E longitudes. The site, representing a typical highland environment of Ethiopia, is situated at an altitude of 2400m above sea level and receives a bimodal pattern of rainfall averaged annually to about 1060mm. The long-term mean minimum and maximum ambient temperatures are 6 and 22^0C, respectively.

Animals and treatment arrangement

A total of 16 oxen representing two genotypes of the Ethiopian highland zebu (EHZ) and their contemporary Friesian x Boran (F x B) crossbred were obtained from local market and the research center's dairy farm respectively to use them in the study. Castration was undertaken at 3 years of age of all the crossbred experimental animals at the beginning of the study while that of EHZ oxen was practiced traditionally by the farmers. And then after, four oxen from each one of the two breeds were subjected to work for about three years. The work cycle was arranged to include 4-5 hours of work in each day and this was sustained for four days per week. F x B crossbred oxen expended on average net energy of 13.0 MJ per day for ploughing croplands at a higher rate of work while EHZ oxen expended about 8.4 MJ implying that their rate of doing work was lower. The contemporary four from each breed were kept indoor without working. The plane of nutrition was based solely on natural grass hay and oats hay with an average nutrient content of 8.9 MJ/Kg dry matter of metabolizable energy (ME) and 7.2% crude protein (CP) that was offered daily in *ad libitum*. The feed samples were analyzed in the Animal Nutrition Laboratory at Holetta Research Center. Nitrogen was analyzed using Kjeldahl method while the energy content was determined through in-vitro organic matter digestibility procedure according to the method of Tilley and Terry (1963) with a two- stage rumen fluid-pepsin technique. The animals were all kept tethered in a barn except for the working time. Nutrient intake of the experimental animals was determined from the feed intake data collected during the course of the experimental period.

Carcass evaluation

A total of 16 oxen were transported to Debre Zeit Abattoir, 45 km south east of Addis Ababa, to slaughter them in a commercial slaughter facility after they have been made to undergo a 24 hours fasting period. Weight measurements on hide, edible internal organs and other low value organs were taken readily after slaughtering. The hot carcasses were weighed and channeled to a chilling room maintained at 2^0c to await there for about 24 hours. Data on carcass characteristics were collected after the chilling process. Fat surrounding the kidney knob, fat in pelvic and thoracic or heart areas (KPH) was weighed and expressed as percentage of the carcass weight. Rib eye area was determined first by tracing the cross sectional area of the longissimus muscle cut between the 12^{th} and 13^{th} rib on a transparent paper where its area was later measured using a planimeter. Fat thickness was measured at the 12^{th} -13^{th} rib perpendicular to the surface fat at a point $3/4^{th}$ of the length of longissimus muscle using a caliper. The external fat was trimmed off to the standard acceptance level of the local beef market and the carcass was finally deboned to separate the lean meat from the bone.

Statistical analysis

A 2x2 factorial arrangement of two factors, namely animal genotype and work, each with two levels was employed to analyze the carcass and nutrient intake data in a general linear model procedure (SAS, 2002). The data obtained from two oxen, one from each breed belonging to non-working group, was found to be outlier and hence was excluded from the analysis.

RESULTS

Carcass traits

The separate effect of work stress and genotype was significant ($P<0.05$) for slaughter weight. and the concomitantly hot carcass weight was also varied between the two genotypes, where non-working F x B crossbred oxen appeared to put more weight than any of the other treatment groups that was managed under similar conditions (Table 1).

The combined effect of genotype and work status was found to be significant for live weight, fat thickness, rib eye area and deboned lean meat mass. The effect of work stress seemed to be more considerable on carcass traits of F x B crossbred oxen than of EHZ oxen where the latter ones tended to anonymously exhibit similar trend in their major carcass characteristics despite the difference in work status (Table 2).

The unadjusted rib eye area and deboned lean meat were significantly greater for non-working F x B crossbred than for working oxen of the same genotype. Rib eye area consistently increased with increasing live weight (*Fig. 1*) and hence a regression equation has been

Table 1 Least squares means with standard errors of weight measurements of EHZ and F x B crossbred oxen before and after slaughtering.

Classifications	Weight measurements		
	Slaughter weight (kg)	Hot carcass weight (kg)	Dressing percent (%)
Genotype			
F x B crossbred oxen	489.7±10.6 [a]	248.5±5.5 [a]	51.3±0.8 [a]
EHZ oxen	274.9±10.6 [b]	141.1±5.5 [b]	51.4±0.8 [a]
Work status			
Non working	402.2±12.2 [a]	201.4±6.4 [a]	51.1±0.9 [a]
Working	361.7±8.6 [b]	188.3±4.5 [a]	51.6±0.6 [a]
CV (%)	6.5	6.6	3.4
R^2	96.4	96.3	68.3

Means in the same column and classification with a common superscript do not differ (P>0.05)

Table 2 Least squares means with standard errors of carcass traits of the interactions of genotype and work status.

Classifications	Carcass traits			
	Live weight (kg)	Fat thickness (mm)	Rib eye area (cm^2)	Deboned lean meat (kg)
Non-working F x B crossbred oxen	564.0±18.8[a]	4.0±0.23[a]	81.0±4.0[a]	214.0±10.0[a]
Non-working EHZ oxen	290.2±18.8[c]	2.4±0.23[b]	51.0±4.0[c]	102.5±10.0[c]
Working F x B crossbred oxen	484.0±13.3[b]	2.0±0.16[b]	62.6±2.8[b]	173.2±7.1[b]
Working EHZ oxen	290.0±13.3[c]	2.1±0.16[b]	49.7±2.8[c]	100.7±7.1[c]
CV (%)	6.7	13.1	9.4	9.8
R^2	96.4	87.4	85.1	93.7

Means in the same column with a common superscript do not differ (P>0.05)

Table 3 Least squares means with standard errors of carcass traits of EHZ and F x B crossbred oxen.

Classifications	Carcass traits	
	Lean meat/bone ratio	KPH fat percent (%)
Genotype		
F x B crossbred oxen	3.3±0.2 [a]	1.9±0.1 [a]
EHZ oxen	3.6±0.2 [a]	2.2±0.1 [a]
Work status		
Non working	3.4±0.2 [a]	2.5±0.2 [a]
Working	3.5±0.1 [a]	1.6±0.1 [b]
CV(%)	12.1	16.7
R^2	49.6	75.6

Means in the same column and classification with a common superscript do not differ (P>0.05)

developed to satisfactorily predict rib eye area (r^2=0.75) from live weight of a particular animal. Similarly, fat thickness appeared to follow the same pattern between working and non-working F x B crossbred oxen (Table 2). In corollary, non-working F x B crossbred oxen had accumulated more adipose tissue than the working counter parts that tended to partition extra energy for walking and work performance. Unlike that of the crossbreds, rib eye area, lean meat mass and fat thickness did not seem to significantly vary between working and non-working EHZ oxen. Working F x B crossbred oxen resulted in a significantly higher attributes

Table 4 Least squares means with standard errors of edible internal organs that worth for human consumption in the local market.

Classifications	Edible internal organs (kg) Kidney	Liver	Tongue	Heart	Viscera‡
Genotype					
F x B crossbred oxen	0.8±0.03 [a]	5.3±0.2 [a]	1.6±0.1 [a]	1.2±0.05 [a]	31.5±1.2 [a]
EHZ oxen	0.5±0.03 [b]	3.2±0.2 [b]	0.8±0.1 [b]	0.7±0.05 [b]	20.1±1.2 [b]
Work status					
Non working	0.7±0.03 [a]	4.2±0.2 [a]	1.3±0.07 [a]	1.0±0.05 [a]	26.7±1.4 [a]
Working	0.6±0.02 [a]	4.3±0.1 [a]	1.2±0.05 [a]	1.0±0.04 [a]	24.9±1.0 [a]
CV (%)	8.8	9.7	11.9	10.9	11.0
R^2	87.4	90.0	91.9	89.8	85.0

‡ Refers to empty viscera; Means in the same column and classification with a common superscript do not differ (P>0.05)

Table 5 Least squares means with standard errors of hide and low value organs that mainly are directed for pet-animals' use.

Classifications	Hide and low value organs (kg) Hide	Head	Legs	Spleen	Lung & trachea
Genotype					
F x B crossbred oxen	32.8±0.9 [a]	24.1±0.5 [a]	10.1±0.2 [a]	1.0±0.05 [a]	5.8±0.2 [a]
EHZ oxen	19.2±0.9 [b]	14.1±0.5 [b]	5.7±0.2 [b]	0.8±0.05 [b]	3.0±0.2 [b]
Work status					
Non working	27.7±1.0 [a]	19.5±0.5 [a]	8.2±0.3 [a]	0.9±0.06 [a]	4.6±0.2 [a]
Working	24.4±0.7 [a]	18.6±0.4 [a]	7.6±0.2 [a]	0.9±0.04 [a]	4.3±0.2 [a]
CV (%)	8.1	5.8	7.4	13.2	9.7
R^2	94.0	96.8	95.7	52.6	90.0

Means in the same column and classification with a common superscript do not differ (P>0.05)

of the major carcass traits than even the non-working EHZ counterparts except for fat thickness.

Dressing percentage was found to be invariable between the genotypes or the work status and hence the intrinsic heaviness of the crossbred oxen tended to yield more carcass than the genetically lighter zebu oxen (*Table 1*). The lean meat to bone ratio was also not affected by difference in genotype or work status. Besides, there was positive correlation (P<0.001) between live weight and lean meat mass and hence selection for larger framed animals seems to warrant higher yield of lean meat. KPH fat as percentage of live weight was not different between the genotypes (P>0.05) while work stress was deemed to lower this value (Table 3). It was, however, noted that the small sized EHZ oxen had a tendency of putting more fat deposit in their cavities as percentage of live weight (2.2% KPH fat) compared (P<0.09) to that of the F x B crossbred oxen (1.9% KPH fat) when kept under solely moderate roughage based diet.

Edible internal and low value organs and hide

All edible internal organs included kidney, liver, tongue, heart and viscera were found to be heavier in F x B crossbred than in EHZ oxen (*Table 4*). Nonetheless, these organs did not tend to be affected by work stress. Low value organs that mainly are sold for use to pet animals (*Table 5*) had more weight in the crossbred than in the EHZ oxen. The hide obtained from the F x B crossbred was heavier than from EHZ oxen. It has been noted that hide and all other organs showed assenting relationship with size of the slaughtered animals. As live weight of slaughtered animals increased the weight yields of all measured body organs seemed to increase.

Feed intake and conversion efficiency

The plane of nutrition was a roughage based feed mainly consisted of baled hay made from the natural grass and oats. F x B crossbred oxen had significantly higher (p<0.01) daily dry matter feed intake than EHZ. The resultant CP and ME intakes of the crossbreds were greater than of the EHZ oxen (*Table 6*). In contrast, EHZ oxen showed better feed conversion efficiency than their counterpart F x B crossbreds under solely roughage based feeding practice (*Table 6*). The residual work effect on feed conversion efficiency to regain weight immediately after the ploughing period was not significant. The effect of work stress on nutrient intake of

Table 6 Least squares means with standard errors of dry matter (DM), crude protein (CP) and metabolizable energy (ME) intakes as well as feed conversion efficiency (FCE) of EHZ and F x B crossbred oxen segregated under work stress and non-working condition

Classifications	Intake			FCE (kg DM/kg gain)
	DM (kg)	CP (g)	ME (mj)	
Genotype				
F x B crossbred oxen	7.5±0.19[a]	536.5±14.0[a]	66.3±1.7[a]	12.0±0.9[a]
EHZ oxen	3.4±0.19[b]	244.7±14.0[b]	30.3±1.7[b]	6.0±0.9[b]
Work status				
Non working	5.7±0.2[a]	411.3±16.2[a]	50.8±2.0[a]	8.6±1.1[a]
Working	5.1±0.1[a]	369.9±11.4[a]	45.7±1.4[a]	9.4±0.8[a]
CV (%)	8.4	8.4	8.4	23.8
R^2	96.7	96.7	96.7	72.5

Means in the same column and classification with a common superscript do not differ (P>0.05)

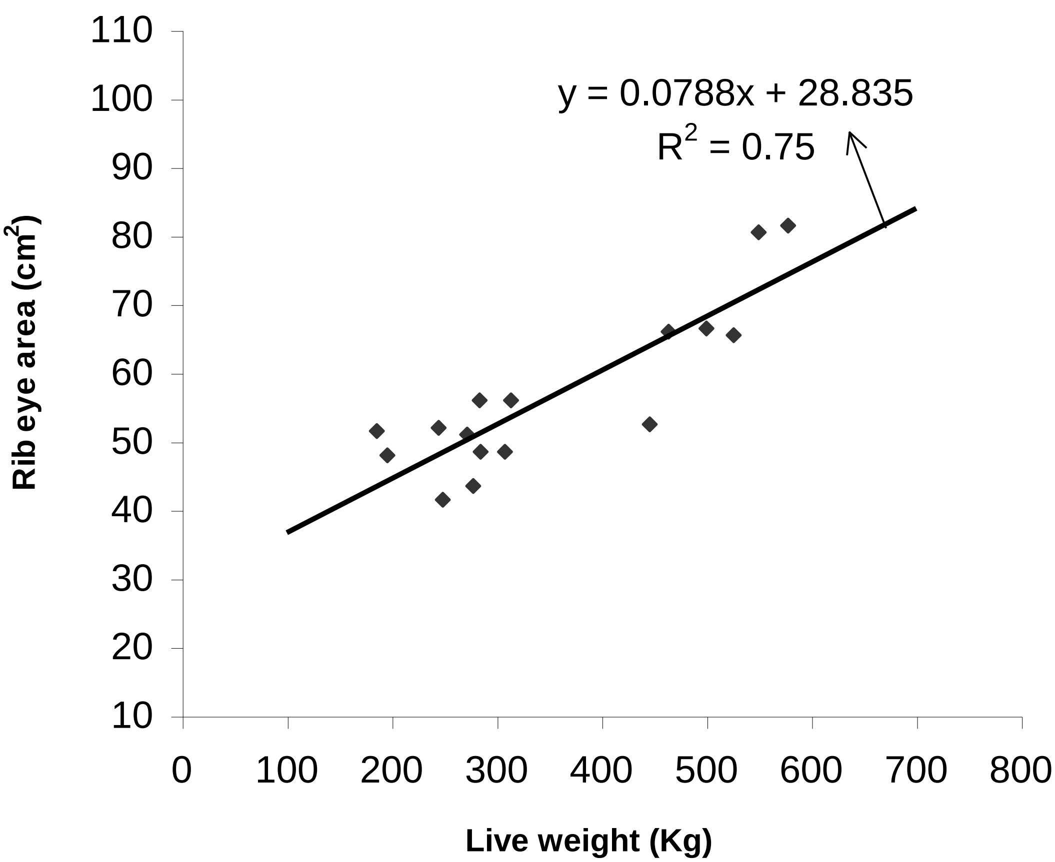

Figure 1. Rib eye area scatter plot and regression line over live weight of F x B and EHZ oxen.

the experimental oxen approached to a significant level (P<0.7) and intake of nutrients appeared to be suppressed by work stress.

DISCUSSION

Dressing percent is an important parameter because it reflects the amount of carcass in relation to the live weight of animals. The fill, finish, muscling, sex and type of animals affect dressing percent. Dressing percentages of zebu cattle reported by Rahman *et al*. (2012) are concurrent to the figure obtained in the present study. Teye and Sunkwa (2010) also reported quite similar dressing percentage for zebu beef cattle breeds in Ghana. Carcass weight of EHZ cattle reported by Michael *et al*. (2002) ranges between 126-155kg, which is consistent with the present figure. The hot carcass weight obtained for the crossbred oxen in this study gets closer to several figures reported by Casas *et al*. (2003), Orellana *et al.* (2008) and Asizua *et al.* (2009). However, other authors (Casas and Cundiff, 2006, Yong *et al.*, 2007, Casas *et al*., 2010) have reported carcass weights of tropical and temperate cattle breeds excelling that of the present figures. This could perhaps be due to the differences in environment, breed type, the level of fattening and the feeding regime where concentrate ingredients were entirely absent in the present study reflecting low plane of nutrition.

Rib eye area is the most useful indicator of muscling and that can be objectively quantified in a practical manner in the live animal or carcass. Yoseph *et al*. (2011) reported similar results for Ogaden bulls in the eastern part of Ethiopia. Casas *et al*. (2010) has however reported a higher figure of rib eye area (84 cm^2) mainly because of a target towards higher level of productivity intent as compared to the sate of the present study. Minick *et al.* (2000) also reported quite similar trend of rib eye area relationship with a scan weight of Angus heifers. The probable reason why the effect of work stress was to be exceptionally considerable on the carcass traits of F x B crossbred oxen might be associated with their higher energy expenditure in a day for increased rate of work as compared with that of EHZ oxen. Hence, it was noted that work had a lowering effect on accretion of adipose tissues of working F x B crossbred oxen resulting in a thinner external fat coverage, which is a likable attribute.

Honeyman *et al*. (2010) reported a mean KPH fat percentage of 2.4 for crossbred steers that substantiate the present results obtained for non working crossbred oxen and the *Bos indicus* type as represented by the EHZ oxen. Apple *et al*. (1999) reported a similar yield grade for British phenotypes of mature cull beef cows mainly in those that had fatter body condition scores. Wheeler *et al*. (1990) has noted that the yield grade of Brahman appears to be preferred to that of Hereford cattle supporting the trend investigated between F x B and EHZ oxen in the present study.

The report by Michael *et al*. (2002) totally agrees with the present figures of edible internal and low value organs of EHZ oxen as well as that of hide except for the case of heart where it is about double of the present result. Terry *et al*. (1990) has reported that hide of *Bos indicus* cattle is generally highest in relation to live weight percentage but the weight values *per se* are presumed to be similar in trend to the present study.

F x B crossbreds seemed to exhibit lower feed conversion efficiency. The explanation for this trend could be that body maintenance requirement of the crossbred oxen in the present study was higher on one hand, and the rate of gain from high roughage diet gets lower on the other as also reported by O'Donovan *et al.* (1978). Osuji *et al*. (1998) reported similar results of work to have negative effect on feed intake of working oxen in good body condition because of the reduced time available for eating and rumination (Pearson and Lawrence, 1992); and the stress of work where this associates with elevated body heat load of both metabolic and environmental origin (Upadhyay, 1989). Hence, provision of nutrient concentrated feed supplements particularly on workdays would be useful to minimize the rate of body weight loss as the ploughing season consistently matches with the time of depletion of farm feed resources.

CONCLUSION AND RECOMMENDATION

The intrinsic heaviness of the crossbred oxen tended to yield more carcass than the genetically lighter zebu oxen. Non-working F x B crossbred oxen appeared to put more weight than working oxen that were managed under similar conditions. Moreover, it was also observed that non-working F x B crossbred oxen had accumulated more adipose tissue than the working contemporaries of the same genotype that tended to partition extra energy for walking and work performance. It seems that, the EHZ oxen showed better feed conversion efficiency than their counterpart F x B crossbreds under solely roughage based feeding practice. As a nutshell, detailed study on different feeding regimes needs to be addressed so as to evaluate the effect of work performance on carcass characteristics of draught animals.

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