PE1.61 Meat Quality Attributes of Ankole bulls and their Crossbreds with Boran and Friesians 384.00

Kanifa Kamatara (1) dmpairwe@agric.mak.ac.ug;jom@life.ku.dk, Denis Mpairwe(1), Mette Christensen 2, David Mutetikka 1 Jorgen Madsen 2
(1)Makerere University, Department of Animal Science, Kampala. Uganda
(2)University of Copenhagen, Department of Food Science and Department of Large Animal Sciences, Frederiksberg C. Denmark

Abstract- This study was conducted to evaluate the effects of feeding system on sensory attributes and tenderness of Ankole and crossbreds of Ankole X Boran (AXB) and Ankole X Friesian (AXF) bulls. One hundred and forty four bulls (48 animals of each genotype) were stratified into three groups according to weight and allotted to three dietary treatments comprising of grazing alone (GZ), grazing and supplemented overnight with concentrate (GS) and, confined and fed maize stover *ad libitum* supplemented with concentrate in feedlot (FL). The animals were slaughtered after 120 days of the trial and the carcasses evaluated for pH changes 45min up to 48hrs postmortem. Samples of steaks from *Longissimus dorsi* were evaluated for tenderness, juiciness, flavour, palatability and overall acceptability by trained sensory panelists. Separate samples were aged for 2, 7, 14 and 21days postmortem and later subjected to Warner Braztler shear force (WBSF) determination. Results indicated that ultimate pH ranged from 5.5 to 5.7 in all carcasses and was not significantly affected by diet and genotype. Steaks from pure Ankole and Friesian crossbreds were more tender and juicier (p<0.05) than Boran crossbreds. Shear force values revealed that Ankole and AnkolexFriesian had more tender meat than the AnkolexBoran. Ankole bulls finished in a feedlot exhibited similar potential for producing meat with acceptable sensory attributes and tenderness as their crossbreds.

[#] Corresponding author: dmpairwe@agric.mak.ac.ug; tel +256-772-439372, +256-414-532269.
Makerere University, P.O.Box, 7062, Kampala Uganda
Department of Animal Science.
[1]Department of Animal Science, Makerere University P. O. Box 7062 Kampala, Uganda.
[2]Department of Food Science and Department of Large Animal Sciences, University of Copenhagen, Frederiksberg C, Denmark.

***Index Terms*: grazing, feedlot supplementation, Ankole cattle, meat tenderness**

I. INTRODUCTION

The beef industry in Uganda is supported by indigenous cattle with the Ankole breed contributing 50% of the beef produced [7]. However, the indigenous breeds are characterized by slow growth rates and attaining market weight after 4-5 years [8] and considered inferior, unproductive and without any foreseeable room for improvement [11]. To increase productivity of the indigenous breeds, cross-breeding with high-yielding-exotic breeds is on the increase and the crossbreds might in the future dominate the beef industry in the country. However both the indigenous and their crossbreds have not been evaluated for meat quality attributes to justify the crossbreeding for improved productivity. Moreover, studies carried out on other Sanga (*Bos taurus africanus*) cattle breeds have proved that their palatability and tenderness aspects compare favorably with exotic breeds [13, 14]. It is also well established that meat quality attributes are influenced by several factors including age and breed of the animal [16], feeding regime [2] and postmortem treatment [9]. Therefore, this study was undertaken to establish the influence of feeding system on meat quality attributes (sensory and textural tenderness) of indigenous Ankole cattle and their crossbreds with Boran and Friesians. The study also examined the effect of postmortem tenderization of meat from the breeds.

II. MATERIALS AND METHODS

The experiment was carried out between July and December 2007 on a private ranch in Nakaseke district which lies within the cattle corridor of Uganda at an altitude of 1080m, latitude $1^0\ 0''\ 0'$ North and longitude $32^0\ 19''\ 60'$ East. One hundred and forty four 18-months old bulls (48 each of pure Ankole (A), Ankole x Boran (B) and Ankole x Friesian (F) were stratified into three groups according to weight and allotted to three feeding systems in a completely randomized block design with a 3x3 factorial treatment arrangement. The feeding systems comprised of grazing alone (GZ), grazing and supplemented overnight with concentrate (GS) and, confined in a feedlot and fed maize stover *ad libitum* supplemented with concentrate (FL). The grazing pastures predominantly comprised of *Sporobollus ssp., Themeda ssp.,*and *Panicum ssp.,*. The concentrate was formulated to contain 15%CP and 11 MJ ME from 70% Maize bran, 20% Cotton seed cake, 10% Molasses and 1% rock salt. The experiment lasted for a period of 120days after which 8 animals per treatment were selected and transported to the abattoir 120 km away for slaughter. At the abattoir the animals were rested for 16 hrs and only offered water before slaughter.

pH readings on the carcasses were taken at 45 min, 3, 7, 24 and 48hrs postmortem, using a piercing pH electrode inserted in the *Longissimus dorsi* (LD) muscle at the 10^{th} rib on the right hand side of the carcass. At 48h postmortem, LD muscle between 7^{th} and 13^{th} rib on the left hand side of the carcass was excised and divided into two pieces of 2.5cm and 20cm in fibre direction for sensory and Warner Braztler shear force (WBSF) analysis, respectively. The 20cm piece for WBSF was divided into four equal parts of 5cm each, vacuum packed separately and aged in a refrigerator (+4^{0}C) for 2, 7, 14 and 21days. Pieces for sensory and for WBSF assigned for 2 days were immediately frozen in a deep freezer at -18^{0}C. The WBSF pieces assigned for 7, 14 and 21 days were kept at +4^{0}C in a refrigerator and then frozen according to respective ageing days until analysis.

Sensory attributes were determined using a nine-member trained descriptive panel in accordance with AMSA guidelines for cooking and sensory evaluation of meat [1]. A continuous scale of 1-9 was used to rank the sensory attributes (tenderness, juiciness, flavour and overall acceptability). On the scale, 1= extremely tough, very dry, extremely bland flavour and extremely unacceptable and, 9 = extremely tender, extremely juicy, extremely intense beef flavour and extremely acceptable. Samples for measurement of shear force were thawed at +4^{o}C for 24 hours and boiled at 75^{0}C in a pre-heated water bath for an hour. The samples were then cooled in tap water for 10 minutes before being cubed. Five cubes of 1cm x 1cm x 5cm length in fibre direction were cut from each sample and sheared twice with a rectangular shaped Warner-Braztler shear blade at a crosshead speed of 50mm/min and values (Newton) reported were average peak force measurements.

The data were analyzed using the General Linear Procedure of [12]. Postmortem pH were analysed as RCBD with repeated measures. Two way analysis of variance (ANOVA) was performed to determine the significance of the effect of genotype and feeding system on meat sensory attributes and textural tenderness.

III. RESULTS AND DISCUSSION

There were no genotype and dietary treatment effects on meat pH ($p>0.5$). However, all carcasses attained an ultimate pH range between 5.5 and 5.7 and was within the desirable range of 5.5 to 5.8 for cattle, which is associated with light-colored and tender meat [4]. Beyond this range, meat develops a dark colour, is tough with a high water holding capacity and prone to microbial spoilage [15]. The pH decreased quadratically ($p<0.05$) with advancing time during the 48hr postmortem period (Fig. 1). At 7 hrs postmortem pH values for all carcasses had dropped to 5.8 for all genotypes. These pH values indicated that the meat produced in this study had a longer shelf life and that animals had overcame pre-slaughter stress during the 16 hr rest period at the abattoir. [6] noted that animals subjected to pre-slaughter stress have high ultimate pH and later have tough meat.

Genotype ($p<0.05$) affected tenderness and juiciness while feeding system affected ($p<0.05$) tenderness and acceptability (Table 1). Pure Ankole and Friesian crossbreds were ranked more tender and juicer than Boran crossbreds. Feedlot finished bulls produced more tender and acceptable meat than grazed bulls.

The WBSF values at 2d were higher in Boran than in pure Ankole ($p< 0.05$) and Friesian crossbreds ($P< 0.001$) (Table 3)**.** A similar trend was observed at 7day with Boran crossbreds having higher ($p< 0.05$) WBSF values than pure Ankole and Friesian crossbreds. With increasing ageing time up to 14days, WBSF values were no longer ($p>0.05$) different across the three genotypes. When the mean WBSF values were compared within each genotype, it was clear that tenderness progressively improved ($p<0.001$) during the postmortem storage (Table 3). Feeding system was not affected ($p>0.05$) by ageing time (Table 4). However, there was a trend towards treatment X ageing time effect with WBSF values lower in feedlot than grazing bulls. Significant Feeding system X ageing time interactions were exhibited among the Ankole X Boran crossbreds. Boran crossbred bulls finished in a feedlot had lower WBSF values and tenderized much faster than grazed bulls (Table 4). Although the sensory panel ratings could not give the exact time when the tenderization process commenced, the general trend was that the WBSF values obtained in this study corroborated with the sensory panel tenderness ratings. These results indicated that sensory panelists can be relied on evaluating meat tenderness in places where equipment is not available. Improved tenderization noticed in Ankole and Friesian crossbreds may be attributed to rapid proteolysis followed by early onset of rigor [5]. The low pH attained early (3-7hrs postmortem) by the carcasses may have activated the calpains, with little or no effect on calpastatin activities, thereby accelerating the tenderization process [3].

IV. CONCLUSION

The findings of this study demonstrated that genotype and postmortem ageing are significant factors that influence the tenderness of beef from Ankole cattle and their crossbreds. The significant improvement in tenderness during ageing across all genotypes implied that ageing of beef from indigenous Ankole cattle and their crossbreds is of an added benefit. Thus beef producers and processors should take into consideration the genotype and postmortem tenderization to meet the consumer expectations. Finally, our results revealed that given the same management and slaughtered at the same age, Ankole bulls have an equal potential to produce tender meat compared to its Friesian crossbreds.

ACKNOWLEDGEMENTS

Authors thank Danida Fellowship Center for financial support of ENRECA project "Income Generation through Market access and improved Feed Utilization: Production of quality Beef and Goat Meat (IGMAFU-Meat" Project which funded this study.

REFERENCES

[1] American Meat Science Association (1978). Guidelines for cooking and sensory evaluation of meat. Chicago, IL: American Meat Science Association Livestock and Meat Board.

[2] Cerdeno A., C. Vieira, E. Serrano, P. Lavìn, A.R. Mantecón (2006). Effects of feeding strategy during a short finishing period on performance, carcass and meat quality in previously grazed young bull. *Meat Science 72:* 719-726.

[3] Dransfield, E. 1992. Modeling postmortem tenderization. V. Inactivation of calpains. Meat Science, 31: 85-94.

[4] Gardner, G.E., Kenny, L., Milton, J.T.B and Pethick, D.W. (1999). Glycogen metabolismand ultimate ph in merino first cross and second cross wether lambs as affected by stress before slaughter. Australian Journal of Agricultural Research 50, 175-181.

[5] Gadiyaram, K.M., Kannan, G. Pringle, T.D., B. Kouakou, B., McMillin, K.W. and Park, Y. W. (2008). Effects of postmortem carcass electrical stimulation on goat meat quality characteristics. Small Ruminant Research, 78: 106-114.

[6] King, D.A., C.E. Schuehle Pfeiffer, R.D. Randel, T.H. Welsh Jr., R.A. Oliphint, B.E. Baird, K.O. Curley Jr., R.C Vann, D.S. Hale, J.W. Savell, 2006. Influence of animal temperament and stress responsiveness on the carcass quality and beef tenderness of feedlot cattle. Meat Science 74: 546-556.

[7] MAAIF (2006). Summary of National Agricultural Statistics. Ministry of Agriculture, Animal Husbandry and Fisheries. Retrived from http://ww.agriculture.co.ug

[8] Mpairwe, D.R., Katongole, C., Bareeba, F.B. Mukasa-Mugerwa, E. and Ebong, C. (2003). Effect of plane of nutrition on growth performance and carcass characteristics of growing Ankole, N'ganda and crossbred (Friesian X Ankole). Proceedings of the 30th Scientific Conference of Tanzania Society of Animal Production (TSAP), 4H Centre-Tanga, October 28th-30th, 2003. pp 179-199.

[9] Monsón F, C. Sańudo, I. Sierra (2004). Influence of cattle breed and ageing time on textural meat quality. Meat Science 68: 595-602.

[11] Ndumu, D.B., Baumung, R., Wurzinger, M., Drucker, A.G., A.M Okello D., Semambo, D., 2008. Performance and fitness traits versus phenotypic appearance in the African Ankole Longhorn cattle: A novel approach to identify selection criteria for indigenous breeds. Livestock Science, 133: 234-242.

[12] SAS, (2003). Statistical Analysis Systems Institute Inc,Cary,NC,USA.

[13] Shackelford, S. D., Wheeler, T. L., and Koohmaraie, M., (1995). Relationship between shear force and trained sensory panel ratings of 10major muscles from *Bos indicus* and *Bos taurus* cattle. Journal of Animal Science, 73, 3333-3340.

[14] Strydom P.E, Naude R.T., Smith M.F., Scholtz M.M., Van Wyk J.B., 2000. Characterization of indigenous African cattle breeds in relation breeds in relation to meat quality traits. Meat Science *55:* 79-88.

[15] Warner, R.D., Walker, P. J., Edridge, G.A. and Barnett, J. C. (1998). Effects of marketing procedure and live weight change prior to slaughter and beef carcass and meat quality. Animal Production in Australia, 22, 165-168.

[16] Wulf, D.M., J.D. Tatum, R.D. Green, J.B. Morgan, B.L. Golden and G.C. Smith (1996). Genetic influences on beef Longissimus palatability in Charolais and Limousin sired steers and heifers. Journal of Animal Science. 74; 2394.

Figure 1. Effect of genotype on pH values during the first 48hrs postmortem storage

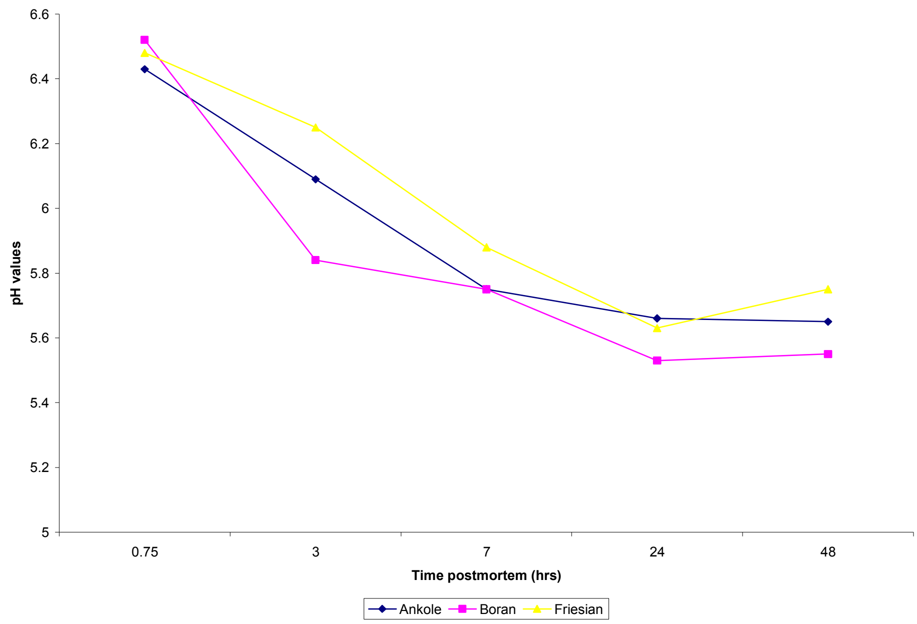

Table 1: Least square means for sensory meat quality attributes of Ankole cattle and their Boran and Friesian crossbreds and three feeding systems (n=8)

	GENOTYPE(GTPE)				DIETARY TREATMENT (T)				Significance	
Trait	**ANK**	**AXB**	**AXF**	**SEM**	**GZ**	**GS**	**FL**	**SEM**	**GTPE**	**T**
Tenderness	5.95	5.64	6.08	0.13	5.75	5.89	6.03	0.13	*	*
Juiciness	5.85	5.4	5.93	0.12	5.79	5.54	5.85	0.12	**	ns
Flavour	6.14	6.13	6.2	0.1	6.08	6.05	6.2	0.11	ns	ns
Palatability	6.15	5.9	6.25	0.11	6.12	5.97	6.2	0.11	ns	ns
Acceptability	6.16	6.15	6.41	0.12	6.22	5.99	6.51	0.12	ns	*

ns, not significant, * p≤ 0.05, ** p≤ 0.001, ***p≤ 0.0001;

Table 2: Effect of feeding system on sensory tenderness of Ankole cattle and their Boran and Friesian crossbreds (n=8)

	GENOTYPE			Significance level		
DIET	**A**	**AXB**	**AXF**	**AvsAxB**	**AvsAxF**	**AxBvsF**
GZ	5.97	6.23	6.03	*	ns	**
GS	6.08	5.66	6.41	**	ns	**
FL	6.37	6.50	6.16	ns	ns	ns
SEM	0.260	0.25	0.22			
Significance level						
GZ vs GS	ns	ns	ns			
GZ vs FL	ns	**	ns			
GS vs FL	ns	*	ns			

ns, not significant, * p≤ 0.05, ** p≤ 0.001, ***p≤ 0.0001;

Table 3: Least square means of Warner Braztler shear force (N) for Ankole (A) cattle with its Boran (B) and Friesian (F) crossbreds at different ageing times (n=8)

	GENOTYPE			Significance level		
Ageing (days)	**A**	**AXB**	**AXF**	**A vs B**	**A vs F**	**B vs F**
2	65.3	73.1	59.1	*	ns	***
7	58.4	60.0	52.9	ns	ns	*
14	52.3	53.2	46.0	ns	ns	ns
21	43.1	45.7	39.0	ns	ns	ns
SEM	2.44	2.39	2.37			
Significance level						
2 vs 7days	*	***	ns			
7 vs 14days	ns	*	*			
14 vs 21days	**	*	*			

ns, not significant, * p≤ 0.05, ** p≤ 0.001, ***p≤ 0.0001

Table 4: Effects of genotype and feeding system on Warner Braztler shear force (N) for Ankole cattle (A), AnkolexBoran (AXB) and AnkolexFriesian crossbreds (n = 8)

	Ankole			Ankole x Boran			Ankole xFriesian		
Ageing (days)	**GZ**	**GS**	**FL**	**GZ**	**GS**	**FL**	**GZ**	**GS**	**FL**
2	65.9	64.1	66.0	77.2	71.9	70.2	55.9	60.7	60.8
7	59.7	55.9	59.2	62.5	62.5	55.1	49.0	54.4	55.1
14	53.2	51.5	52.3	53.9	56.1	49.8	41.6	41.6	51.7
21	44.2	40.9	44.3	45.0	46.5	45.6	32.2	37.3	47.5
SEM	4.11	4.11	4.44	3.85	4.44	3.85	4.44	4.11	4.11
Significance level									
2 vs 7	ns	ns	ns	***	ns	***	ns	ns	ns
7 vs 14	*	ns	ns	ns	ns	ns	ns	ns	ns
14 vs 21	ns	ns	ns	ns	ns	**	ns	ns	**

ns, not significant, * p≤ 0.05, ** p≤ 0.001, ***p≤ 0.0001;