TENDERNESS OF TYPICAL SOUTH AFRICAN CATTLE BREED CROSSES, THE EFFECTS OF FEED WITHDRAWAL PERIOD AND ELECTRICAL STIMULATION

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Introduction

The concept of meat tenderness is very complex, as it is biologically dependent on a combination of many physiological factors such as: proteolytic degradation of cytoskeletal proteins during *post mortem* storage in the calpain system; changes in the nature of actin/myosin interaction - these changes are reflected in the sarcomere length; the amount of intra-muscular connective tissue and the nature of the intra-muscular connective tissue as measured by total collagen content and % collagen solubility (Purslow, 1999). Although it is reported that *Bos indicus* cattle generally produce tougher meat than *Bos taurus* cattle under specific pre-slaughter and slaughter conditions (Shackelford *et al.*, 1995), sometimes *Bos taurus* cattle can also produce tough meat (Frylinck *et al.*, 2003; De Bruyn, 1991). The calpain system explains most of these genetic differences. Due to the belief that all humped animals are *Indicus*, cattle breeds with humps are excluded from meat quality improvement schemes. Although certain indigenous South African breeds such as the Nguni, have humps, their genetic composition are predominantly *taurine* (Frylinck *et al.*, 2003) and they consistently produce tender meat. In the present study, we measured physiological factors to try to explain the tenderness characteristics of typical breed-crosses in the South African feedlots. Also, how the duration of stimulation and pre-slaughter feed withdrawal period would influence these meat tenderness characteristics.

Materials and Methods

Simmental cross, Brahman cross and Nguni cross (Sanga) bulls (n=180) were raised, treated and slaughtered as specified by Strydom and Frylinck (2005). Carcasses were treated and samples were taken as follows. *M. longissimus* aged for 1 or 14d were prepared and Warner Bratzler shear force (SF) was measured as the peak force (kg). Sarcomere lengths (SL) and myofibril fragment lengths (MFL) were measured using a Video Image Analyzer. Calpains and calpastatin were extracted and measured (Frylinck *et al.*, 2003). One unit of calpain activity was defined as an increase in absorbance at 366 nm of 1.0 per hour, at 25 °C. One unit of calpastatin activity was defined as the amount that inhibited one unit of m-calpain activity. Total collagen content and collagen solubility were extracted and measured (Frylinck *et al.*, 2003). Collagen content was expressed as hydroxy-proline nitrogen per total protein nitrogen. Collagen solubility was calculated by expressing hydroxy-proline in the filtrate, as a percentage of the total hydroxy-proline of the filtrate plus residue. The data were subjected to a three-way analysis of variance. Means for the main effects and their interactions were separated using Fisher's protected t-test least significant difference (LSD) at the 5% level.

Results and Discussion

Strydom and Frylinck (2005) reported that the Brahman and Nguni carcasses were similar in tenderness after 14 d *post mortem*, but they were both significantly more tender than that of the Simmental carcasses. Variation in SL did not explain that; Nguni cross SL measured at 1 d *post mortem* was the shortest on average, yet the meat was tender (shorter SL of Nguni could be considered a breed characteristic). The high SF values could be partly explained by the fact that the SL of the Simmental cross was less than 1.6μm (muscle shortening, not shown) when animals were on the long feed withdrawal period and not stimulated (NS). Improvement in SF due to 15 sec electrical stimulation was reflected by longer SL, but after 120 sec ES the SL corresponded with those of the not stimulated carcasses, probably as a result of heat shortening.

MFL of the Nguni at 7d and 14d *post mortem* was on average the shortest (indicating to the most effective *post mortem* proteolytic enzyme degradation for tenderness). MFL of the Simmental and the Brahman did not differ significantly from each other. These results correspond with that of the calpain system (Table1), where the Nguni had significantly more favourable μ-calpain levels and calpastatin/μ-calpain ratio than that of the Brahman and the Simmental (which had similar values in this respect). Pre-slaughter treatments (24h feed withdrawal vs. 3 h feed withdrawal) were found to significantly influence SF measured at 1d and 14d *post mortem* and SL measured at 1 d *post mortem* ($p<0.001$) (Table 1), but the calpain proteolytic system seemed to be influenced very slightly. Improvement in SF due to 15 sec ES was reflected by longer SL and shorter MFL measurements especially after 14 d *post mortem*, thus a simultaneous relaxation of the muscle fibres and an enhanced rate of proteolysis could have contributed to the tenderizing. It can be derived that all three cross breeds showed an improvement on tenderness with 15 sec ES, but that the toughest cross-breed *i.e.* the Simmental had the most benefit from this post-slaughter treatment. The percentage collagen solubility measured in the Nguni-X was the most favourable, and could explain some of the tenderness characteristics of the Nguni carcasses (Table 1).

Table 1: The effect of breed, feed withdrawal period and ES treatment on meat tenderness characteristics.

Breed	Brahman	Nguni	Simmental	SEM[1]	P-value
Shear force 1 d p.m. (kg)	6.9^{ab}	6.7^{a}	7.3^{b}	0.1627	0.027
Shear force 14 d p.m. (kg)	4.3^{a}	4.4^{a}	4.9^{b}	0.1324	0.005
Sarcomere length (μm)	1.72^{b}	1.65^{a}	1.70^{b}	0.0146	0.001
Total Collagen (Hypro N x 10^3/ Total N)	1.56	1.71	1.66	0.0588	0.201
% Collagen solubility	17.8^{b}	19.3^{a}	17.5^{b}	0.4190	0.005
MFL ˉ14 d p.m. (μm)	26.5^{b}	24.7^{a}	26.3^{b}	0.510	0.026
μ-Calpain- (U/g meat)	1.71^{b}	2.03^{a}	1.86^{a}	0.064	0.002
Calpastatin/μ-calpain	1.74	1.52	1.66	0.060	0.028
Feed withdrawal	**20 hours**	**3 hours**		**SEM[2]**	**P-value**
Shear force 1 d p.m. (kg)	7.3^{a}	6.7^{b}		0.1329	0.004
Sarcomere length (μm)	1.67^{a}	1.72^{b}		0.0119	0.004
Calpastatin/μ-calpain	1.69	1.58		0.049	0.108
Electrical stimulation (ES)	**None**	**15 sec.**	**120 sec.**	**SEM[2]**	**P-value**
Shear force 1 d p.m. (kg)	8.7^{b}	6.3^{a}	6.0^{a}	0.1627	<0.001
Sarcomere length (μm)	1.67^{a}	1.74^{b}	1.65^{a}	0.0146	<0.001
MFL ˉ14 d p.m. (μm)	25.43^{a}	24.56^{a}	27.55^{b}	0.510	<0.001

[a,b] Means within a row with different superscripts differ significantly ($P<0.05$),
[1] Standard error of means

Conclusions

Longer feed withdrawal coincided with higher shear force values in general, although it was more evident for NS carcasses. According to the Shackelford *et al.*, (1995) tenderness decreased as percentage *Bos indicus* inheritance increased, but this does not explain the Simmental's *(Bos Taurus)* low tenderness measured in this project and others (Frylinck *et al.*, 2003; De Bruyn, 1991). Variations in tenderness due to breed effects could be influenced by different combinations of pre-slaughter and slaughter practices.

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