EVALUATION OF MEAT TENDERNESS OF INDIGENOUS SOUTH AFRICAN CATTLE BREEDS

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SUMMARY:
A test sample of each of two indigenous Sanga breeds, Nguni and Afrikaner, and one *Sanga/Bos taurus* breed, Bonsmara, are being compared against two *Bos taurus* (British and European) breeds, and one *Bos indicus* breed, Brahman. Muscle tenderness of humped beef breeds from South Africa (*Sanga)* compare favourably with that of the foreign breeds.

INTRODUCTION
Various studies (Koohmaraie *et al.* 1995; Dransfield, 1995) showed that *Bos indicus* cattle produce tougher meat than *Bos taurus* cattle under those specific pre-slaughter and slaughter conditions. According to these reports, the calpain system (a muscle proteienase system that is involved in the ageing of meat) explains most of these genetic differences. As a result of theses studies, cattle breeds with humps are excluded from meat quality improvement schemes due to the belief that all humped animals are I*ndicus*, and therefore, produce less tender meat. However, although South African indigenous cattle breeds such as the Nguni, Afrikaner and the synthetic breed Bonsmara have humps, it was found consistently through the years that they do produce tender meat (Strydom *et al.*, 2000).

OBJECTIVES
To compare the inherent meat tenderness of Sanga (African indigenous breeds), *Bos indicus*, and *Bos taurus* (British and European) cattle breeds, and determine the role of the calpain system in meat tenderness of these genotypes.

MATERIALS AND METHODS
After being raised under intensive feedlot conditions, a total of 36 young bulls (6 animals of each breed) were slaughtered and sampled for meat quality evaluation (between 10 and 12 months of age at slaughter, between 4 and 8 mm back fat; 150 to 250 kg carcass weight). Chilling was delayed for six hours (holding temperature = 10 to 15°C), followed by an 18 hour chilling period at 2°C ± 2°C. Carcass pH and temperature of the *M. longissimus lumborum* (LL) were measured every hour up to 10 hours post slaughter and then again at 24 hours post slaughter. The *M. longissimus* of both sides of each carcass was sampled for the different tests at 1 day, 3 days, 7 days, 14 days and 21 days after slaughter. Samples removed for enzyme studies were frozen in liquid nitrogen and preserved at –70 °C, while samples for the other tests were stored at –20°C following the different ageing periods. Samples were aged in vacuum-packaging at 2°C ± 2°C.

Tenderness was measured by means of a 10-member trained sensory panel and Warner Bratzler shear force measurements. Sarcomere lengths and myofibril fragment lengths were measured by means of a Video Image Analyzer. Calpains and calpastatin were extracted from frozen samples as described by Dransfield (1996) and separated by means of the two-step gradient ion-exchange chromatography-method according to Geesink and Koohmaraie (1999). μ- Calpain activity in eluates containing both μ-calpain and calpastatin was estimated from calpastatin measurements before and after heating of the eluates. Calpain assays were done using azo-casein as substrate according to Dransfield (1996). 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.

RESULTS AND DISCUSSION
As expected, meat tenderness (sensory and shear force) of the Brahman differed significantly from the other breeds at 1 day and 21 days post mortem. However, meat tenderness of the *Sanga* breeds (Bonsmara, Nguni and Afrikaner) compared favourably with the other *Taurus* breeds. The Simmenthal was also significantly tougher than the Hereford and Sanga breeds, which agrees with the findings of De Bruyn (1989). According to sarcomere lengths, tenderness differences between breeds were probably not a function of myofibrillar contraction. This was confirmed by the low correlation between sarcomere length and tenderness (Table 1). However, significant differences in myofibril length occurred among breeds at both 1 and 21 days post mortem, indicating differences in longitudinal fragmentation of myofibrils. Correlation coefficients between sensory tenderness and myofibril length and sensory tenderness support this statement (higher tenderness scores for shorter myofibril fragments. It I accepted that myofibril length does not explain tenderness differences due to fragmentation completely, since fragmentation also occurs in other dimensions than the longitudinal dimension of the muscle fibre. The calpain system activities seem to support some of the meat tenderness similarities and differences of the breeds evaluated. The favourable tenderness measurements of the Bonsmara, Nguni and Afrikaner (Table 2) were associated with low calpastatin activities and high μ-calpain and m-calpain activities, resulting in lower calpastatin/calpain ratios. The higher calpastatin levels and lower calpain activities of the Brahman breed correspond with the lower tenderness scores, as reflected by relationships between tenderness and calpain/calpastatin activities presented in Table 1. In addition, calpastatin activity for the Simmenthal at 1 hour post mortem also corresponded with its tougher meat, although calpain activities compared with those of the *Sanga* breeds. The relatively high calpastatin activity (1 hour PM) and high calpastatin/μ-calpain + m-calpain ratio of the Hereford was not expected, considering this breed's favourable tenderness measurements. Other tenderness related characteristics such as, myofibril protein degradation, total collagen, collagen solubility, fibre typing, osmolalities, water-holding capacity, drip loss are currently under investigation.

CONCLUSION
Although meat tenderness is highly dependent of pre- and post-slaughter practices, measurable genotype differences in meat quality characteristics (specifically tenderness) do exist due to differences in biochemical and physiological factors. In this project it was

found that the specific biochemical and physiological characteristics related to meat tenderness favour the two *Sanga* breeds and the synthetic *Sanga/Bos taurus* breed when compared to the Brahman (and Simmenthal). Therefore, the results refute the international view that cattle breeds with humps generally produce less tender meat.

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Table 1. Correlation-matrix showing how tenderness measurements statistically correlates with histological and biochemical measurements.

	Tenderness:		Shear force (N):	
	1 day PM	21 days PM	1 day PM	21 days PM
Myofibril fragmentation length				
7 d PM	**-0.384**	**-0.380**	0.135	**0.367**
14 d PM	**-0.430**	**-0.516**	0.101	0.186
21 d PM	**-0.450**	**-0.328**	-0.019	0.016
Sarcomere length	0.180	0.241	-0.064	-0.165
Calpastatin – 1 h PM	-0.247	-0.292	**0.505**	**0.394**
μ-Calpain – 1 d PM	**0.435**	**0.358**	0.000	0.085
m- Calpain – 1 d PM	**0.349**	0.254	-0.033	-0.197
Calpastatin/μ-Calpain	**-0.451**	**-0.369**	0.239	**0.447**
Calpastatin/(μ-Calpain + m-Calpain)	**-0.435**	**-0.402**	**0.323**	**0.329**

PM = Post mortem

Table 2. Least square means and standard errors for meat characteristics of six beef breeds.

	SEM	Bonsmara	Brahman	Nguni	Afrikaner	Hereford	Simmenthal
PH - 24 h PM	0.03	5.61^{a}	5.59^{a}	5.55^{a}	5.62^{a}	5.72^{b}	5.70^{ab}
Carcass temperature (°C):							
2 h PM	0.72	31.0	30.7	30.1	29.6	29.8	31.7
6 h PM	0.56	19.5	20.2	18.6	18.4	20.2	19.7
Shear force (N/2.5 cm ∅):							
1 d PM	6.7	108^{a}	164^{c}	120^{a}	105^{a}	115^{a}	145^{b}
21 d PM	6.7	85^{a}	101^{ab}	90^{a}	77^{a}	87^{a}	108^{ab}
Tenderness[1]:							
1 d PM	0.25	5.5^{a}	3.7^{c}	4.9^{a}	5.6^{a}	5.1^{a}	4.6^{ab}
21 d PM	0.25	6.5^{a}	5.6^{b}	6.2^{a}	6.6^{a}	6.4^{a}	5.8^{ab}
Sarcomere length (μm)							
1 d PM	0.044	1.762	1.700	1.700	1.750	1.743	1.70
21 d PM	0.044	1.812	1.767	1.850	1.820	1.823	1.903
Myofibril fragment length (μm)							
1 d PM	1.278	30.05^{a}	34.77^{ab}	32.35^{a}	33.91^{a}	34.20^{ab}	34.30^{ab}
21 d PM	1.278	17.01	18.77	17.98	16.8	16.54	16.26
Calpain system- (U/g meat)							
Calpastatin 1 h PM	0.37	4.44^{a}	5.95^{b}	4.13^{a}	4.14^{a}	5.57^{ab}	5.95^{b}
Calpastatin 1 d PM	0.42	4.5	4.84	4.15	4.92	5.08	5.06
μ-Calpain – 1 d PM	0.08	0.894^{a}	0.506^{b}	0.855^{a}	0.833^{ab}	0.626^{b}	0.899^{a}
m-Calpain – 1 d PM	0.05	0.819^{ab}	0.753^{b}	0.924^{a}	0.953^{a}	0.993^{a}	0.741^{b}
Calpastatin / μ-Calpain– 1 d PM	0.93	5.58^{ab}	10.69^{b}	4.90^{a}	6.37^{ab}	8.15^{b}	6.12^{ab}
Calpastatin / m-Calpain– 1 d PM	0.674	5.75	7.07	4.47	5.23	5.14	7.05
Capastatin /(μ-Calpain + m-Calpain) – 1 d PM	0.308	2.72^{b}	4.19^{d}	2.32^{a}	2.78^{b}	3.14^{c}	3.19^{c}

PM = Post mortem; [1]Tenderness (1 = extremely tough; to 8 = extremely tender).

^{abcd}Means in a row with different superscripts differ significantly ($p<0.05$) with the Fishers' means separation test.