THE NGUNI: FROM THE BREED OF THE PAST TO HIGH BEEF QUALITY UNDER TOUGH CONDITIONS

Voster Muchenje[a], Kennedy Dzama[b], Michael Chimonyo[a], Phillip E. Strydom[c], Thulile Ndlovu[d] and Jan G. Raats[a]

[a]Department of Livestock and Pasture Science, University of Fort Hare, P. Bag X1314, Alice 5700, Republic of South Africa;
[b]Department of Animal Sciences, Stellenbosch University, P. Bag X1, Matieland 7602, Republic of South Africa;
[c]Meat Industry Centre, Department of Nutrition and Food Science, Agricultural Research Council, Private Bag X2, Irene, 0062, Republic of South Africa
[d]Department of Biochemistry and Microbiology, University of Fort Hare, P. Bag X1314, Alice 5700, Republic of South Africa

With an increased preference for naturally or organically produced meat, adaptable cattle breeds, such as the Nguni, that can survive on natural pasture have an important role to play. Organic meat production entails the little or minimal use of chemicals in cattle management activities such as parasite control. The Nguni cattle breed provides an opportunity for natural beef production because of its adaptability to tough conditions, such as feed scarcity, ticks and tick-borne diseases. A considerable amount of work on tick infestation and meat production has been conducted on cultivated pastures and in feedlots. Furthermore, despite there being a possible relationship among tick loads, growth and meat production, these parameters have been covered separately on feedlots. Unfortunately, very little, if any, combined studies have been done on the relationship between tick infestation, growth, stress responsiveness and meat production of the Nguni cattle under natural grazing conditions.

Against this background, a comprehensive study on internal parasites, tick loads, tick tolerance, growth, carcass characteristics, stress responsiveness and beef quality was done over a period of four years on the Nguni steers at the University of Fort Hare in the Eastern Cape, South Africa. Also included in the study were nutritionally-related metabolites, response to pre-slaughter stress and effects of pre-slaughter stress on beef quality of the Nguni steers. Furthermore, the study covered consumer health aspects such as cholesterol levels and different types of fatty acids found in red meat. A professional sensory evaluation was also done on the Nguni beef.

These studies revealed the following:

- The Nguni can be successfully finished on natural pasture without supplementation (Muchenje *et al.*, 2008a; 2008b);
- The Nguni had the best growth performance during the dry season when there was no dietary supplementation as compared to other breeds that were studied at the same time (Table 1, Muchenje et al., 2008a);
- The Nguni had the lowest tick loads among the breeds that were studied (Figure 1, Muchenje *et al.*, 2008b);
- Non-dipping of the Nguni, despite causing high tick loads (Figure 2), did not reduce its growth rates, liveweight and carcass characteristics (Table 2, Muchenje *et al.*, 2008b);
- The Nguni had lowest nematode faecal egg counts compared to other breeds that were studied at the same time (Ndlovu, 2007);
- The Nguni had relatively high levels of nutritionally-related blood metabolites, such as urea, glucose, phosphorus and calcium that help it to adapt to limited grazing conditions (Table 3, Ndlovu et al., 2007);
- The Nguni maintained relatively high liveweight (Muchenje et al., 2008b) and body condition scores without supplementation during the dry season (Ndlovu, 2007);
- The beef quality of Nguni finished on natural pasture is comparable to beef quality of European breeds (Table 4, Muchenje et al., 2008a);
- The Nguni is generally docile as demonstrated by its calm behaviour and low levels of stress hormones at slaughter (Figure 3, Ndlovu et al., 2008)
- By being less vulnerable to pre-slaughter stress, and hence having the optimum ultimate meat pH levels, the quality of Nguni beef is high (Muchenje, 2007);
- The Nguni finished on natural pasture had low cholesterol levels (41.5mg/100g, far much lower than the critical recommended levels that may cause heart problems) (Muchenje, 2007);
- The Nguni finished on natural pasture had beneficial (in terms of health) fatty acid ratio levels that are within recommended international standards (Table 5, Muchenje et al., 2007);
- The Nguni finished on natural pasture had the highest sensory evaluation scores (for tenderness, flavour, juiciness, aroma, and amount of connective tissue) as performed by the professional food tasters (Table 6, Muchenje, 2007).

It was therefore, concluded that Nguni cattle plays a significant role in the production of high value organic beef under harsh environmental conditions prevalent in most parts of South Africa.

ACKNOWLEDGEMENTS

This research was funded by the Kellogg Foundation (Project 388). The cholesterol analyses were funded by Kellogg Foundation Project 3003636. The steers were raised at the University of Fort Hare farm and were slaughtered at the East London Abattoir, East London, South Africa. The cholesterol and meat quality analyses were done at the Agricultural Research Council (ARC) Meat Industry Centre at Irene, Pretoria, South Africa. Fatty acid profile analyses were done at the Department of Microbial Biochemical and Food Biotechnology, University of the Free State, Bloemfontein, South Africa. Blood metabolites were also analysed at the University of Pretoria Veterinary Clinical Pathology Laboratory. The urine stress hormones were analysed at Ampath Laboratories in Pretoria.

REFERENCES

Muchenje, V. (2007). Growth performance, carcass characteristics and meat quality of Nguni, Bonsmara and Angus steers raised on natural pasture.
PhD Thesis. University of Fort Hare, Alice, RSA.
Muchenje, V., Dzama, K., Chimonyo, M., Raats, J. G. and Strydom. P. E. (2008a). Meat quality of Nguni, Bonsmara and Angus steers raised on natural pasture in the Eastern Cape, South Africa. Meat Science, 79: 20-28.
Muchenje, V., Dzama, K. Chimonyo, M. Raats J. G. and Strydom P. E. (2008b). Tick susceptibility and its effects on growth performance and carcass characteristics of Nguni, Bonsmara and Angus steers raised on natural pasture. Animal (formerly Animal Science) 2: 298 - 304.
Muchenje, V., Dzama, V., Chimonyo, V., Raats J. G., Strydom, P. E., Hugo, A and Ndlovu, T. (2007). Comparison of fatty acid profiles of Longissimus thoracis et lumborum of Nguni, Bonsmara and Angus steers raised on veld. In Proceedings of the 53rd International Congress on Meat Science and Technology (ICOMST) that was held in Beijing, China from 5th to 10th August 2007 (pp 351 -352).
Ndlovu, T. (2007). Parasite prevalence, nutritionally-related blood metabolites and pre-
slaughter stress response in Nguni, Bonsmara and Angus steers raised on veld. MSc Thesis. University of Fort Hare, Alice, RSA.
Ndlovu, T., Chimonyo, M., Okoh, A. I. and Muchenje, V. (2008). A comparison of stress
hormone concentrations at slaughter in Nguni, Bonsmara and Angus steers. African Journal of Agricultural Research, 3, 96-100.
Ndlovu T., Chimonyo M., Okoh A.I., Muchenje V., Dzama K., Dube S. and Raats J.G.
(2007). A comparison of nutritionally-related blood metabolites among Nguni, Bonsmara and Angus steers raised on sweetveld. (In press: The Veterinary Journal, doi:10.1016/j.tvjl.2007.09.007).

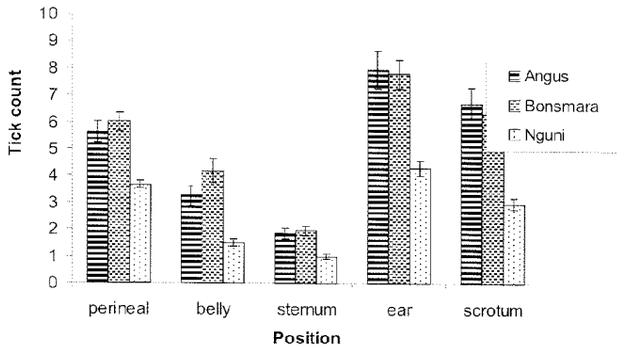

Figure 1. Tick counts per position in Nguni, Bonsmara and Angus steers.
Source: Muchenje et al. (2008b)

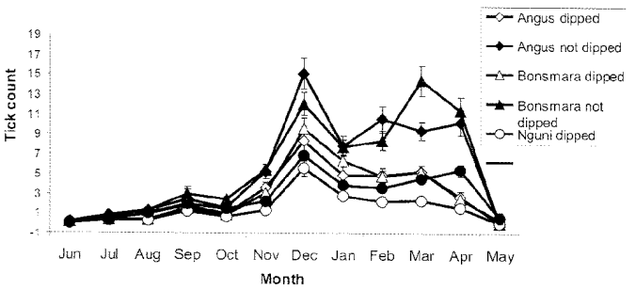

Figure 2. Tick counts per position by month in dipped and non-dipped Nguni, Bonsmara and Angus steers.
Source: Muchenje et al. (2008b)

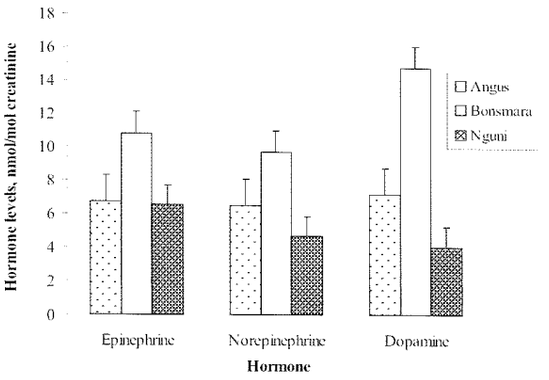

Figure 3: Urine adrenalin, noradrenalin and dopamine levels of Angus, Bonsmara and Nguni steers after transport and handling stress.
Ndlovu et al. (2008)

Table 1

Least square means and standard errors of means (in parenthesis) for productive performance of Nguni, Bonsmara and Angus steers

Trait		Breed		Significance
	Nguni	Bonsmara	Angus	
Gain 1 (g/day)	98 (13.7)^{a}	28 (14.2)^{b}	44 (16.9)^{b}	*
Gain 2 (g/day)	198 (15.8)	183 (16.4)	198 (19.4)	NS
March Weight (kg)	237 (6.8)^{a}	311 (7.0)^{b}	288 (8.3)^{b}	*
Slaughter Weight (kg)	205 (6.5)^{a}	255 (6.8)^{b}	240 (8.0)^{b}	*
Warm Carcass Weight (kg)	107 (3.5)^{a}	145 (3.7)^{b}	129 (4.4)^{c}	*
Dressing Percentage (%)	52.1 (0.75)^{a}	56.9 (0.78)^{b}	53.7 (0.92)^{a}	*

Means in the same row with different superscripts are significantly different ($P < 0.05$).
Gain 1 = the difference between the slaughter weight and the weaning weight divided by the number of days from weaning to slaughter at the end of April 2006.
Gain 2 = the difference between the March 2006 weight and weaning weight divided by the number of days from weaning to March 2006.

Source: Muchenje et al. (2008a)

Table 2

Least square means (± s.e.m) of daily gain and carcass characteristics of dipped and non- dipped Nguni, Bonsmara and Angus steers

Breed	Tick control	N	Average daily gain (g/day)	Slaughter weight (kg)	Warm carcass weight (kg)	Dressing Percentage	Eye muscle area (mm2)
Nguni	Not dipped	25	197 ± 11.9	220 ± 8.0^{a}	111 ± 4.5^{a}	50.3 ± 0.84^{a}	3648 ± 105^{bc}
	Dipped	13	210 ± 12.3	227 ± 10.7^{a}	116 ± 6.1^{ab}	51.0 ± 1.13^{ab}	3858 ± 151.4^{bcd}
Bonsmara	Not dipped	15	241 ± 11.2	265 ± 9.6^{c}	142 ± 5.4^{d}	53.8 ± 1.01^{d}	3996 ± 120.8^{d}
	Dipped	14	220 ± 16.9	254 ± 10.7^{bc}	135 ± 6.1^{cd}	53.4 ± 1.13^{cd}	3988 ± 141.5^{cd}
Angus	Not dipped	6	205 ± 29	240 ± 11.1^{ab}	129 ± 6.3^{bcd}	53.7 ± 1.17^{cd}	3291 ± 210.6^{a}
	Dipped	8	178 ± 33.7	235 ± 12.9^{ab}	123 ± 7.7^{abc}	52.3 ± 1.43^{bc}	3491 ± 170.9^{ab}
Level of significance			NS	*	*	*	*

Means in the same column with different superscripts are different (*$P < 0.05$), NS = Not significant.
Tick control: Dipped or not dipped, Average daily gain: growth rate from weaning to slaughter, Slaughter weight: weight of steers 24 hours before slaughter; Warm carcass weight: weight of carcass within 20 minutes of slaughter; Dressing percentage: Proportion of warm carcass to liveweight and expressed as a percentage.

Source: Muchenje et al. (2008b)

Table 3

Influence of breed on nutritionally related blood metabolites

Parameter	RR	Angus	Bonsmara	Nguni	Significance
Urea (mmol/l)	3.6-10.7	3.4 ± 0.209	3.17 ± 0.110	3.27 ± 0.099	NS
Creatinine (µmol/l)	10-133	112.11 ± 2.361^{b}	113.48 ± 1.286^{c}	107.56 ± 1.041^{a}	**
Globulin (g/l)	28-42	43.17 ± 0.996	43.22 ± 0.543	44.56 ± 0.431	NS

Albumin ((g/l)	28-37	31.92 ± 0.443	32.24 ± 0.241	32.62 ± 0.235	NS
A/G Ratio	0.9-1.4	0.77 ± 0.020	0.76 ± 0.012	0.74 ± 0.010	NS
Magnesium (mmol/l)	0.6-1.2	0.70 ± 0.015[a]	0.73 ± 0.008[b]	0.80 ± 0.008[c]	***
Calcium (mmol/l)	2-2.9	2.36 ± 0.037	2.44 ± 0.020	2.43 ± 0.016	NS
Phosphorus (mmol/l)	1.2-2.3	1.77 ± 0.060[a]	1.94 ± 0.033[b]	2.05 ± 0.026[b]	***
CK (U/l)	12-146	159.60 ± 50.017	158.89 ± 27.241	204.27 ± 25.388	NS
AST (U/l)	21-167	81.88 ± 4.227	79.68 ± 2.302	74.237 ± 2.196	NS
ALP (U/l)	33-328	73.5 ± 9.155[a]	99.09 ± 4.986[b]	144.18 ± 4.577[c]	***

[a,c] Values with different superscripts within each row are significantly different ($P < 0.05$)
* $P<0.05$, ** $P<0.01$, *** $P<0.001$. NS: $P>0.05$.
CK- creatinine kinase, AST-aspartate aminotransferase, A/G ratio-albumin/globulin ratio ALP-alkaline phosphatase
RR: Reference range (Farver, 1997)

Source: Ndlovu et al. (2007)

Table 4

Least square means and standard errors of means (in parenthesis) of meat quality characteristics of Nguni, Bonsmara and Angus steers

		Breed	
Meat quality characteristic	**Nguni**	**Bonsmara**	**Angus**
n	34	29	14
Lightness (L*)	37.0 (0.54) a	40.1 (0.53) b	40.4 (0.65) b
Redness (a*)	14.7 (0.45)	14.8 (0.37)	15.9 (0.45)
Yellowness (b*)	6.1 (0.27)	6.3 (0.18)	6.9 (0.25)
Colour saturation	15.9 (0.50)	16.1 (0.40)	17.4 (0.50)
Sarcomere length (µm)	1.6 (0.03)	1.6 (0.02)	1.6 (0.03)
WBSF2 (N)	42.1 (3.33)	46.1 (3.14)	42.1 (3.04)
WBSF21 (N)	31.4 (1.76)	34.3 (1.67)	36.3 (1.37)
MFL2 (µm)	28.2 (0.79)	30.8 (1.16)	29.3 (1.37)
MFL21 (µm)	22.9 (0.49)	21.9 (0.61)	21.4 (1.13)
pH	5.8 (0.06)	5.7 (0.04)	5.6 (0.02)
Drip loss (%)	2.0 (0.11)	1.9 (0.11)	1.8 (0.11)
Water holding capacity	0.35 (0.016)	0.30 (0.013)	0.32 (0.038)
Cook loss 2 (%)	24.8 (1.07)	24.3 (0.42)	25.3 (0.49)
Cook loss 21 (%)	23.6 (0.48)	24.1 (0.45)	24.9 (0.62)

[a,b]Means in the same row with different superscripts differ significantly at $P < 0.05$
1Polyunsaturated fatty acids. 2Monounsaturated fatty acids. 3Saturated fatty acids. 4Omega-6 fatty acids. 5Omega-3 fatty acids. 6Ratio of polyunsaturated fatty acids and saturated fatty acids. 7Ratio of n-6 and n-3 fatty acids. AA, arachidonic acid; LA, linolenic acid; CLA, conjugated linoleic acid; DHA, docosahexaenoic acid; DPA, docosapentaenoic acid; EPA, eicosapentaenoic acid

Source: Muchenje et al. (2007)

Table 5

Fatty acid profile (as percentage of the total fatty acids identified) (standard errors) of the Longissimus thoracis et lumborum muscle of Nguni, Bonsmara and Angus steers

Fatty acid		Breed	
	Nguni	Bonsmara	Angus
N	15	14	10
C14:0	1.73 (0.156)	1.78 (0.162)	1.67 (0.191)
C14:1c9	0.16 (0.048)	0.19 (0.050)	0.28(0.059)
C15:0	0.44 (0.047)	0.37 (0.049)	0.41(0.058)
C15:1c10	0.22 (0.033)	0.27 (0.035)	0.23(0.041)
C16:0	21.84 (0.616)	21.90 (0.637)	22.18 (0.754)
C16:1c9	2.29 (0.141)	2.09 (0.146)	2.29 (0.173)
C17:0	1.04 (0.047)	1.04 (0.049)	1.03 (0.058)
C17:1c10	0.36 (0.037)[a]	0.47 (0.039)[b]	0.39 (0.046)[ab]
C18:0	17.95 (0.544)	17.96 (0.563)	18.46 (0.667)
C18:1t9	1.44 (0.216)	1.40 (0.224)	1.85 (0.265)
C18:1c9	28.58 (0.738)[a]	29.04 (0.764)[a]	31.50 (0.904)[b]
C18:2c9,12 (n-6) (LA)	8.37 (0.602)[b]	8.51 (0.623)[b]	6.34 (0.737)[a]
C18:2c9t11 (n-6) (CLA)	0.30 (0.047)[a]	0.28 (0.048)[a]	0.39 (0.057)[b]
C20:0 (AA)	0.27 (0.034)[b]	0.17 (0.035)[a]	0.29 (0.042)[b]
C18:3c9,12,15 (n-3)	2.20 (0.155)	2.34 (0.161)	1.85 (0.190)
C22:0	0.43 (0.061)	0.40 (0.063)	0.46 (0.075)
C20:3c11,14,17 (n-3)	0.91 (0.084)	0.77 (0.087)	0.75 (0.103)
C20:4c5,8,11,14 (n-6)	5.68 (0.475)	5.50 (0.491)	4.42 (0.582)
C22:2c13,16 (n-6)	0.28 (0.040)	0.28 (0.042)	0.22 (0.050)
C20:5c5,8,11,14,17 (n-3) (EPA)	2.14 (0.193)	1.96 (0.200)	1.96 (0.237)
C22:5c7,10,13,16,19 (n-3) (DPA)	2.99 (0.240)	3.10 (0.249)	2.78 (0.294)
C22:6c4,7,10,13,16,19 (n-3) (DHA)	0.21 (0.044)	0.10 (0.045)	0.11 (0.054)

PUFA1	23.09 (1.647)	22.84 (1.694)	18.79 (2.004)
MUFA2	33.05 (0.837)[a]	33.47 (0.867)[a]	36.54 (1.025)[b]
SFA3	43.70 (1.128)	43.62 (1.177)	44.49 (1.382)
n-64	14.64 (1.024)	14.57 (1.060)	11.36 (1.254)
n-35	8.46 (0.64)	8.27 (0.661)	7.43 (0.782)
PUFA:SFA6	0.55 (0.049)	0.54 (0.051)	0.44 (0.060)
n-6/n-37	1.75 (0.049)[b]	1.79 (0.051)[b]	1.53 (0.060)[a]

Table 6

Least square means and standard errors of means (in parenthesis) of sensory characteristics of beef from Nguni, Bonsmara and Angus steers aged for two and 21 days.

Meat quality characteristic			**Breed**			
	Nguni		**Bonsmara**		**Angus**	
	Aged for 2 days	Aged for 21 days	Aged for 2 days	Aged for 21 days	Aged for 2 days	Aged for 21 days
Aroma intensity	5.9 (0.05)[b]	5.7 (0.05)[ab]	5.5 (0.06)[a]	5.5 (0.06)[a]	5.7 (0.13)[ab]	5.7 (0.13)[ab]
Initial impression of juiciness	5.6 (0.05)[c]	5.3 (0.05)[b]	5.5 (0.05)[bc]	5.5 (0.06)[bc]	5.5 (0.11)[bc]	5.1 (0.11)[a]
First bite	4.9 (0.09)[b]	5.8 (0.09)[d]	4.6 (0.10)[a]	5.7 (0.11)[cd]	4.4 (0.21)[a]	5.3 (0.21)[bc]
Sustained impression of juiciness	5.5 (0.05)[b]	5.3 (0.05)[ab]	5.5 (0.06)[b]	5.5 (0.06)[b]	5.3 (0.13)[ab]	5.1 (0.13)[a]
Muscle fibre & overall tenderness	5.1 (0.08)[c]	5.9 (0.08)[e]	4.9 (0.09)[b]	5.8 (0.09)[de]	4.4 (0.18)[a]	5.5 (0.18)[cd]
Amount of connective tissue	4.9 (0.07)[b]	5.6 (0.07)[d]	4.7 (0.08)[a]	5.5 (0.09)[cd]	4.5 (0.17)[a]	5.2 (0.17)[bc]
Overall flavour intensity	5.5 (0.05)	5.6 (0.05)	5.4 (0.05)	5.6 (0.06)	5.5 (0.11)	5.5 (0.11)
A-typical flavour intensity	1.9 (0.04)[ab]	2.1 (0.04)[bc]	1.8 (0.05)[a]	2.1 (0.05)[bc]	1.9 (0.10)[ab]	2.2 (0.09)[c]

Values in the same row with different superscripts are significantly different at $P < 0.05$.
Source: Muchenje (2007)