**PE9.06 Diets containing Acacia karroo foliage lower n-6/n-3 ratio in beef from Nguni steers 34.00**

*Cletos Mapiye (1) cmapiye@yahoo.co.uk, M Chimonyo( 1), K Dzama (2), A Hugo (3), PE Strydom (4), V Muchenje (1)*
*(1)University of Fort Hare, South Africa*
*(2)Stellenbosch University, South Africa*
*(3)University of Free State, South Africa*
*(4)Agricultural Research, South Africa*

**Abstract The objective of the trial was to determine fatty acid composition of beef from Nguni cattle supplemented with Acacia karroo leaf-meal. Thirty 19-month old steers were randomly assigned to A. karroo leaf-meal (AK), sunflower cake (SF) and the control (CN) diets. The m. longissimus thoracis et lumborum was sampled for analyses. Highest á-linolenic acid, eicosopentaenoic acid, docosapentaenoic acid and polyunsaturated fatty acids to saturated fatty acids (PUFA/SFA) ratio, and lowest n-6/n-3 ratio were recorded in beef from steers that received the AK diet (P < 0.05). The AK diet reduced n-6/n-3 ratio and increased PUFA/SFA ratio in Nguni beef.**

## I. INTRODUCTION

To reduce the risk of heart diseases, consumers are recommended to lower intake of saturated fatty acids (SFA) and increase consumption of polyunsaturated fatty acids (PUFA), particularly the n-3 PUFA at the expense of n-6 PUFA (Griffin, 2008; Muchenje, Dzama, Chimonyo, Strydom, Hugo, & Raats, 2009). Long chain n-3 PUFA, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are linked to cardio-protective and anti-carcinogenic functions (Simopoulos, 2004; Griffin, 2008). Currently, attention is on improving meat quality, particularly by altering dietary fatty acid composition. In Southern Africa, for example, Acacia karroo, a widespread and tannin-rich (80-110g/kg) indigenous browse legume tree that is being used as a protein supplement (Mokoboki, Ndlovu, Ngambi, Malatje, & Nikolova, 2005), has the potential to manipulate fatty acid composition of meat. No reports have evaluated the effect of A. karroo on fatty acid profiles of beef. The objective of the study was to determine fatty acid composition of meat from Nguni steers supplemented with A. karroo leaf-meal.

## II. MATERIAL AND METHODS

The trial study was conducted at the University of Fort Hare, Alice, South Africa. Thirty Nguni steers were rotationally grazed on natural pasture at a stocking rate of 5 ha/LU from April 2007 to March 2008. The steers were seven months old at the beginning of the trial. In April 2008, at 19 months of age, the steers were then randomly assigned to three dietary treatments: A. karroo leaf meal (AK), sunflower cake (SF) and the control diet with no supplement (CN. Each treatment group was made up of 10 steers and were kept in one paddock. In addition to natural pasture, steers on the AK and SF diets were offered 1.5 kg and 650 g of feed, respectively, to supply 150 g of protein per day. Veld hay (300 g) was added to AK diet A. karroo foliage to improve palatability. The steers on AK and SF diets were allowed 21 days to adapt to their respective diets prior to the 60-day supplementary feeding period and were trained to feed from individual troughs. Feed was offered daily at 0830 h. All the steers were released daily for grazing at 1000 h and kraaled at 1730 h throughout the trial. Residues for each steer on the supplementary diet were weighed at 1015 h. Water was freely accessible to the animals. The steers were dipped once using an acaricide to control ticks. Dietary components were assessed for dry matter (DM), crude protein (CP) and crude fat using the Association of Official Agricultural Chemists (2003) procedures. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest Robertson, & Lewis (1991) and condensed tannins (CT) assays were done using the butanol-HCl method (Bate-Smith, 1981). The in vitro DM and NDF disappearance were determined using the Daisy ANKOM system (Van Soest et al., 1991).

At the abattoir, the steers were deprived of feed overnight, but water was always available. The m. longissimus thoracis et lumborum (LTL) of the right side was sampled, a day after slaughter, from the 10th rib in the direction of the rump and a 100 mm thick piece of the posterior side of the right LTL was taken and vacuum-packaged at 0–3°C, pending analysis. Total lipids from A. karroo, sunflower cake and natural pasture, and muscle samples were extracted according to AOAC (2003) and Folch, Lees and Stanley (1957),

respectively. The following fatty acid combinations and ratios were calculated: total mono-unsaturated fatty acids (MUFA), total saturated fatty acids (SFA), n-3 PUFA, n-6 PUFA, total PUFA, PUFA/SFA ratio (P/S) and n-6/n-3 ratio. The effect of diet on meat fatty acid composition was analysed using Generalised Linear Model procedure (SAS, 2003). Pair-wise comparisons of least square means were performed using the PDIFF procedure of SAS (2003).

## III. RESULTS

Sunflower cake had higher CP content (360 g/kg) than A. karroo (150 g/kg) and natural pasture (31.9-39.6 g/kg). Crude fat was higher in sunflower cake (2.5 g/kg), followed by natural pasture (2.2 g/kg) and A. karroo (2.0 g/kg). Acacia karroo had higher ADF (290 g/kg) and condensed tannins (7.4 g/kg) than sunflower cake. In vitro DM and NDF disappearances after 48 hours were higher for the A. karroo (580 and 440 g/kg) diet than for sunflower cake (440 and 410 g/kg) and natural pasture (550 and 540 g/kg). Linoleic acid proportions were highest in sunflower cake, whilst á-linolenic acid was highest in A. karroo ($P<0.05$). The n-3 PUFA proportion was highest for A. karroo (Table 1). Sunflower cake had the highest PUFA, PUFA/SFA ratio and n-6/n-3 ratio (Table 1). Steers on the SF diet consumed all their daily feed allocation. Generally, consumption of the AK diet increased ($P<0.05$) from week 1 (0. 8 kg) to week 4 (1.48 kg) and remained constant up to week 8. Highest ADG were recorded in steers on the SF diet (380.0 ± 33.09 g/kg), followed by those on the AK (305.4 ± 33.09) and CN (270 ± 33.09) diets. Nguni steers that received the AK diet had higher ($P<0.05$) C18: 3c9,12,15 (n-3) than those on SF and CN diets (Table 1). Highest C20: 5c5,8,11,14,17 and C22: 5c7,10,13,16,19 proportions were recorded in meat from steers on the AK diet ($P<0.05$). The PUFA and n-3 fatty acid proportions were significantly higher in meat from steers on the AK and CN diets than those on the SF diet (Table 1). Meat from steers on the AK diet had the highest PUFA/SFA ratios. The lowest n-6/n-3 ratio was recorded in meat from steers that received the AK diet ($P<0.05$).

## IV. DISCUSSION

The highest proportions of individual PUFA in steers on the AK diet could be related to dietary fatty acid composition. Part of dietary 18:3n-3 fatty acids, such as á-linolenic acid, which was high in the AK diet, could have escaped ruminal biohydrogenation and got deposited in the tissues (Scollan, Richardson, Moloney, Dannenberger, Hocquette, & Nuernberg, 2006). The higher proportions of individual PUFA in the AK diet could also be ascribed to the presence of condensed tannins, which protect dietary lipids from biohydrogenation in the rumen, and inhibit growth and metabolism of ruminal bacteria responsible for ruminal biohydrogenation (Vasta, Makkar, & Priolo, 2009). Long chain n-3 PUFA, such as eicosapentaenoic acid, prevent heart diseases and some cancers (Simopoulos, 2004; Griffin, 2008). The observed higher intramuscular fat content in steers that received the SF diet partly explains their low PUFA proportions and PUFA/SFA ratios compared to AK and CN diets (Raes, De Smet, & Demeyer, 2004). The observation that n-6/n-3 ratio was lowest in steers that were given the AK diet was probably due to the higher proportions of n-3 PUFA in the meat. The PUFA/SFA and n-6/n-3 PUFA ratios are commonly used to assess the nutritional value and consumer health of beef (Scollan et al., 2006; Griffin, 2008; Muchenje Hugo, Dzama, Chimonyo, Strydom, & Raats, 2008).

## V. CONCLUSIONS

The AK diet reduced n-6/n-3 ratio and increased PUFA/SFA ratio in Nguni beef. Beef from cattle supplemented with A. karroo could, therefore, be a healthy food for humans.

## ACKNOWLEDGEMENTS

The authors are grateful to the Kellogg Foundation, National Research Foundation, and Cannon Collins Trust for their financial support. The fatty acids composition of feeds and meat were analysed at the University of Free State, Bloemfontein, South Africa.

## REFERENCES

AOAC (2003). Association of Analytical Chemists. Official Methods of Analysis (14th edition).

AOAC, Washington, DC, USA. Bate-Smith, E. C. (1981). Astringent tannins of the leaves of Geranium species. Phytochemicals, 20, 211-216.

Folch, J., Lees, M., & Stanley, G. H. S. (1957). A simple method for the isolation and purification of total lipids from animal tissue. Journal of Biological Chemistry, 226, 497–509.

Griffin, B. A. (2008). How relevant is the ratio of dietary n-6 to n-3 polyunsaturated fatty acids to cardiovascular disease risk? Evidence from the OPTILIP study. Current Opinion in Lipidology, 19, 57–62.

Mokoboki, H. K., Ndlovu, L. R, Ngambi, J.W., Malatje, M. M., & Nikolova, R. V. (2005). Nutritive value of Acacia tree foliages growing in the Limpopo Province of South Africa. South African Journal of Animal Science, 35(4), 221-228.

Muchenje, V., Dzama, K., Chimonyo, M., Strydom, P. E., Hugo, A., & Raats, J. G. (2009). Some biochemical aspects pertaining to beef eating quality and consumer health: a review. Food Chemistry, 112, 279-289.

Muchenje, V., Hugo, A., Dzama, K., Chimonyo, M., Strydom, P. E., & Raats, J. G. (2008). Cholesterol levels and fatty acid profiles of beef from three cattle breeds raised on natural pasture. Journal of Food Composition and Analysis, doi:10.1016/j.jfca.2008.10.019.

Raes, K., De Smet, S., & Demeyer, D. (2004). Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: A review. Animal Feed Science and Technology, 113, 199–221.

SAS (2003). Statistical Analysis System Institute Inc. Users Guide, Version 9, USA.

Scollan, N., Richardson, I., Moloney, A., Dannenberger, D., Hocquette, J. F., & Nuernberg, K. (2006). Innovations in beef production systems that enhance the nutritional and health value of beef lipids and their relationship with meat quality. Meat science, 74(1), 17–33.

Simopoulos, A. P. (2004). Omega-6/Omega-3 essential fatty acid ratio and chronic diseases. Food Reviews International, 20, 77–90.

Van Soest, P. J., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fibre, neutral detergent fibre, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 74, 3583–3597.

Vasta, V., Mele, M., Makkar, H. P. S., & Priolo, A. (2009). Ruminal biohydrogenation as affected by tannins in vitro. British Journal of Nutrition, doi:10.1017/S0007114508137898.

Table 1: Least square means and standard errors (s.e) of fatty acid proportions of the diets and meat from Nguni steers

| **Fatty acids of the diets** | Natural pasture (CN) | *A. karroo* | Sunflower cake | s.e |
|---|---|---|---|---|
| C18:2c9,12 (n-6) | $15.2^{b}$ | $13.7^{a}$ | $51.2^{c}$ | 0.068 |
| C18:3c9,12,15 (n-3) | $13.51^{b}$ | $27.8^{c}$ | $0.9^{a}$ | 0.014 |
| SFA | $63.33^{c}$ | $52.39^{b}$ | $15.65^{a}$ | 0.13 |
| PUFA | $29.55^{a}$ | $42.14^{b}$ | $52.24^{c}$ | 0.058 |
| *n*-6 | $15.9^{a}$ | $14.15^{a}$ | $51.31^{b}$ | 0.084 |
| *n*-3 | $13.64^{b}$ | $27.99^{c}$ | $0.93^{a}$ | 0.026 |
| PUFA/SFA | $0.47^{a}$ | $0.80^{b}$ | $3.34^{c}$ | 0.01 |
| *n*-6/*n*-3 | $1.16^{b}$ | $0.51^{a}$ | $55.32^{c}$ | 0.45 |
| **Fatty acids in meat** | | | | |
| Intramuscular fat (%) | $0.87^{a}$ | $0.88^{a}$ | $1.2^{b}$ | 0.11 |
| C18:3c9,12,15 (n-3) | $1.94^{a}$ | $2.59^{b}$ | $1.53^{a}$ | 0.212 |
| C20:5c5,8,11,14,17 (*n*-3) | $1.56^{ab}$ | $1.81^{b}$ | $1.09^{a}$ | 0.173 |
| C22:5c7,10,13,16,19 (*n*-3) | $2.20^{b}$ | $2.43^{c}$ | $1.60^{a}$ | 0.213 |
| SFA | 46.56 | 44.15 | 47.22 | 1.266 |
| MUFA | 36.97 | 37.58 | 39.47 | 1.129 |
| PUFA | $16.47^{b}$ | $18.27^{b}$ | $13.31^{a}$ | 1.574 |
| Omega- 6 fatty acids (*n*-6) | 10.07 | 10.71 | 8.51 | 0.947 |
| Omega- 3 fatty acids (*n*-3) | $6.40^{b}$ | $7.56^{b}$ | $4.80^{a}$ | 0.644 |
| PUFA/SFA | $0.36^{ab}$ | $0.42^{b}$ | $0.28^{a}$ | 0.043 |
| *n*-6/*n*-3 | $1.58^{b}$ | $1.44^{a}$ | $1.78^{c}$ | 0.448 |

Values with different superscripts within a row are significantly different ($P<0.05$).