THE STRESS RESPONSIVENESS OF THREE DIFFERENT BEEF BREED TYPES AND THE EFFECT ON ULTIMATE PH AND MEAT COLOUR

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Introduction

Determining the factors that result in a low ultimate pH (pHu) and establishing the limits of residual glycogen levels obtained under various conditions (Immonen and Puolanne, 2000), are central to stress and meat quality research. A contributing factor towards meat tenderness is animal breed type but this has not been quantified in terms of breed stress responsiveness and the effect on meat tenderness. Meat tenderness was identified as one of the major contributing factors to the perception of meat quality (Koohmaraie, 1994). The tenderness of meat varies considerably and therefore prevents meat producers from marketing their produce on the basis of consistent quality (Maher *et al.*, 2004). The present study focuses on the urinary catecholamine output of three different beef breeds (Brahman-x, Simmental-x and Nguni-x), the pHu and the colour of the meat. The measurement of catecholamines in animals is usually highly invasive, but their measurement in excreted urine is not (Hay and Mormede, 1998). In this study the methodology was extended to the post-mortem situation. Previous studies have reported that the measurement of urinary catecholamine's indicated that despite the massive release of catecholamines associated with slaughter, urinary concentrations are unaffected by this owing to the delay between elevation of concentrations in the plasma and subsequent elevation in the urine. The concentration of nor-epinephrine is the result of neuronal washout from tissues with sympathetic nerves and thus an important indicator of sympathetic nervous system activity (Young *et al.*, 1984) and therefore an indicator of stress responsiveness. The two hormonally active catecholamines are the amine-containing derivatives of catechol, 1,2-dihydroxybenzene, nor-epinephrine and its methyl derivative epinephrine. These compounds are synthesised in the adrenal medulla from tyrosine and stored in granules to await their exocytotic release under the control of the sympathetic nervous system (Voet and Voet, 1995).

Materials and Methods

Animals (n=180) were slaughtered at the specified A-age (no permanent incisors) and fatness-class 2-3 (5-7mm). Three different beef breeds Brahman-x (Br-x), Simmental-x (Sm-x) and Nguni-x (Ng-x) were treated in exactly the same manner during the growth and feeding period, and fed the same feed. Sixty Br-x, 60 Sm-x crosses and 60 Ng-x crosses were divided into 2 different feed withdrawal groups each. Thirty animals from each breed group were transported 40 km to the abattoir after which feed were withdrawn for 24 hours pre-slaughter or 3 hours pre-slaughter. Thirty animals from each breed group were transported 40 km to the abattoir after which feed was withdrawn for 3 hours pre-slaughter. pHu was measured 20 hours post-mortem with a digital handheld meat pH meter (Sentron, Model 1001) fitted with a polypropylene spear type gel electrode. pH measurements were done on the *M. longissimus thoracis* of the carcasses. At 20 hours post-mortem the colour of the meat was measured with a Minolta colorimeter as described by Dunne *et al.* (2005). Catecholamine's were measured from a urine sample that was collected from the bladder with a syringe and needle approximately 12 minutes post-mortem, immediately after evisceration. The urine was preserved as described by Lowe *et al.* (2000) and analysed by HPLC-method as described by Gouarne *et al.* (2004). Concentrations of catecholamine's are volume related and for this reason only creatinine related concentrations were considered in the statistical analysis. The two different feed withdrawal groups were pooled together and a general linear model analysis were done on the pHu, colour 20 hours post-mortem and the urinary catecholamine output.

Results and Discussion

Table 1: Urinary catecholamine outputs from Brahman-x (Br-x), Simmental-x (Sm-x) and Nguni-x (Ng-x) breeds.

Catecholamine (ng/µmol creatinine)	Br-x	Sm-x	Ng-x
Nor-epinephrine	2.5633±1.04228[a]	2.47700±.88997[a]	4.7228±2.10624[b]
Epinephrine	1.1642±0.66371[a]	1.7074±1.17029[a]	3.3679±2.2891[b]

[a,b] $p<0.05$

There were statistically significant differences for the nor-epinephrine and epinephrine concentrations ($p<0.05$) with Ng-x having the highest output and the Br-x and Sm-x having lower outputs. Catecholamine's are often implied as the cause of the depletion of glycogen in the pre-slaughter period. This is based on their action of rapid mobilisation and depletion of glycogen. If livestock encounter stressors causing the release of catecholamine's in the immediate pre-slaughter period, there is a possibility for depletion of muscle glycogen (Lacourt and Tarrant, 1985), because of the fact that epinephrine activates muscle adenylate cyclase and thereby stimulates glycogen breakdown (Voet and Voet, 1995).

In turn, lowered glycogen prevents an acceptable decrease in pH and attainment of pHu for optimal conversion of muscle to meat (Purchas *et al.*, 1999; Warriss, 1990). The decrease in carcass pH was marginally slower for Ng-x compared to Br-x and Sm-x. The pHu values also tended to be higher in the Ng-x compared to Br-x and Sm-x. Colour measurements for Ng-x indicated significantly darker scores for Ng-x compared to Br-x and Sm-x. The results suggest that the Ng-x has a lower glycolytic potential and this agrees with the results obtained for indigenous goats in South Africa (Webb *et al.*, 2005).

Conclusion

Certain cattle breeds indigenous to Africa, such as the Nguni, have shown an ability to adapt to harsh extensive conditions. (Strydom *et al.*, 2000). Ng-x cattle had a higher urinary catecholamine output as well as significantly higher pHu values. This correlates with the fact that catecholamine's will have an effect on the glycogen profile of the animal, its glycolytic potential and the colour of the meat. One can therefore conclude that the Nguni breed is more stress responsive with a subsequent lower glycolytic potential. This does not mean that this breed will result in tougher meat as other parameters with regard to meat tenderness may be involved. This aspect is currently under investigation.

References

Dunne, P.G., O'Mara, F.P., Monahan, F.J., French, P. and Moloney, A.P. (2005). Colour of muscle from 18-month-old steers given long-term daily exercise. Meat Science, 71: 219-229.

Gouarne, C., Foury, A. and Duclos, M. (2004). Critical study of common conditions of storage of glucocorticoids and catecholamines in 24-h urine collected during resting and exercising conditions. Clinica Chimica Acta, 348: 207-214.

Hay, M. and Mormede, P. (1998). Urinary excretion of catecholamine's, cortisol and their metabolites in mesishan and large white sows: Validation as a non-invasive and integrative assessment of adrenocortical and sympathoadrenal axis activity. Veterinary Research, 29: 119-128.

Immonen, K. and Puolanne, E. (2000). Variation of residual glycogen-glucose concentration at ultimate pH values below 5.75. Meat Science, 55: 279-283.

Koohmaraie, M. (1994). Muscle proteinases and meat ageing. Meat Science, 36: 93-104.

Lacourt, A. and Tarrant, P.V. (1985). Glycogen depletion patterns in myofibres of cattle during stress. Meat Science, 15: 85-100.

Maher, S.C., Mullen, A.M., Moloney, A.P., Buckley, D.J. and Kerry, J.P. (2004). Quantifying the extent of variation in the eating quality traits of the *M. longissimus dorsi* and *M. semimembranosus* of conventionally processed Irish beef. Meat Science, 66: 351-360.

Purchas, P.W., Yan, X. and Hartley, D.G. (1999). The influence of a period of ageing on the relationship between ultimate pH and shear values of beef *M. longissimus thoracis*. Meat Science, 51: 135-144.

Strydom, P.E., Naude, R.T., Smith, M.F, Scholtz, M.M. and van Wyk, J.B. 2000. Characterisation of indigenous African cattle breeds in relation to meat quality traits. Meat Science. 55: 79-88.

Voet, D. and Voet J.G. (1995). Biochemistry, Publisher New York: Wiley C.

Warriss, P.D. (1990). The handling of cattle pre-slaughter and its effect on carcass and meat quality. Applied animal behaviour science, 21: 171-186.

Webb, E.C., Casey, N.H. and Simela, L. 2005. Goat meat quality. Small Ruminant Research, 60: 153-166.

Young, J.B., Rosa, R.M. and Landsberg, L. (1984). Dissociation of sympathetic nervous system and adrenal medullary responses. American Journal of Physiology, 247: E35-E40.