Are there relationships between blood glucose and cholesterol, and meat pH, colour and cholesterol levels?

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Abstract

The current study determined relationships between blood glucose levels and meat pH and colour, and blood cholesterol and meat cholesterol levels in Nguni and Bonsmara steers. Fifteen Bonsmara and 25 Nguni steers slaughtered at 18 months were used. Blood glucose and cholesterol concentrations were measured 24 hours before slaughter. The *m. longissimus thoracis et lumborum* was sampled 24 hours post mortem for the determination of pH, L*, a*, b* and meat cholesterol levels. There was a positive correlation between blood cholesterol levels and L, and a negative correlation between blood glucose levels and a* in Nguni, but not in Bonsmara steers. There were no correlations between blood glucose levels, and pH and b* in both breeds. Cholesterol levels in blood and beef were not correlated in both breeds. Therefore, although the relationship between blood glucose and cholesterol levels and colour could be breed-dependent, there are no relationships between blood glucose and beef pH, and blood cholesterol and beef cholesterol levels, respectively.

Introduction

Blood metabolite concentrations represent an integrated index of the adequacy of nutrient supply in relation to nutrient utilization of cattle (Chester-Jones *et al.*, 1990). Raised plasma urea concentrations have been reported to be indicators of catabolism of proteins due to low intake of energy (Wiklund *et al*., 2003). Prediction of meat quality using blood metabolites is uncommon. In animals in good body condition, the muscles contain enough glycogen to guarantee optimal ultimate pH (pHu) values in meat (Wiklund *et al*., 2003). Insufficient energy intake can reduce circulatory glucose and cholesterol levels, thereby affecting the amount of the glycogen reserves in the muscle.

Cholesterol levels in meat have received an increased interest considering their implications for human health and product quality (Wood *et al.*, 2004; Muchenje *et al*., 2008a). Both dietary cholesterol and that synthesized *de novo* are transported through the circulation in lipoprotein particles and stored in cells as cholesteryl esters. Studies on blood metabolites and meat quality (Wiklund *et al*., 2003; Kouakou *et al*., 2005; Kadim *et al*., 2006) have not established relationships among the metabolites in blood and in meat. If there is a relationship between cholesterol levels in blood of an animal during its growth phase and the amount of cholesterol in meat then animal management systems can be designed early to reduce cholesterol levels in meat. There is therefore need to establish whether metabolites such as glucose and cholesterol prior to slaughter have any relationship with pH, colour and cholesterol levels of meat. This study was to determine relationships between blood glucose levels and meat pH and colour, and blood cholesterol and meat cholesterol levels in Nguni and Bonsmara steers.

Materials and methods

Fifteen Bonsmara and 25 Nguni steers were raised on natural pasture at the University of Fort Hare farm until slaughter at 18 months. Blood samples were collected 24hours before transportation of the animals to the abattoir. The serum was stored at −20 °C pending analysis. Serum samples were analysed for glucose and cholesterol using a Chexcks machine (Next/Vetex Alfa Wasseman Analyser) and commercially purchased kits (Siemens). The steers were transported to the East London abattoir where they were slaughtered after 24 hours and the carcasses were chilled in a chilling room at 4 °C.

A pH meter was used to measure pHu of the LTL 24 hours *post mortem*. The extraction and quantification of cholesterol were carried out by the method of Al-Hasani *et al*. (1993). The correlations between

blood glucose and cholesterol, and meat pH, colour and cholesterol levels were determined using PROC CORR of SAS (2003).

Results

There was a positive correlation ($P < 0.05$) between blood cholesterol levels and L, and a negative correlation ($P < 0.05$) between blood glucose levels and a* in Nguni, but not ($P > 0.05$) in Bonsmara steers (Tables 1 and 2). There were no ($P > 0.05$) correlations between blood glucose levels, and pH and b*, and cholesterol levels in blood and meat in both breeds.

Table 1. Correlations of blood glucose and cholesterol concentrations and meat colour and pH of Nguni beef

Parameters	Glucose concentrations	Blood cholesterol concentrations
L	-0.273	0.522*
A	-0.498*	0.177
B	-0.392	-0.174
pH	-0.140	-0.090

*Values where P < 0.05

Table 2. Correlations of blood glucose and cholesterol concentrations and meat colour and pH of Bonsmara beef

Parameters	Glucose concentrations	Blood cholesterol concentrations
L	-0.263	0.453
A	-0.003	0.014
B	0.078	0.359
pH	0.0560	-0.452

Discussion

The explanation for a positive correlation between blood cholesterol levels and L * values in Nguni steers is not clear, although this may be ascribed to breed differences in L* (Muchenje *et al*., 2008b) and blood cholesterol levels (Ndlovu *et al*., 2007). The negative correlation between blood glucose levels and a* could be due to the reduction in enzymatic activity where myoglobin remains oxidised when the glucose levels are low.

The explanation for the absence of correlations between blood cholesterol and meat cholesterol is not clear given the possible positive relationship between serum cholesterol concentration and muscle growth (Harris *et al.,* 2004). High insulin level of plasma in cattle probably accelerates hepatic cholesterol synthesis by activating the HMG-CoA reductase and possibly results in higher plasma cholesterol concentration in cattle. However, the cholesterol content of a membrane has been shown to vary with the tissue and with specific membrane function (Harris *et al.,* 2004).

Absence of correlations between blood metabolites and meat quality traits may be due to biochemical processes in the blood and in the muscles. For example the energy status of cattle does not only depend on blood glucose, but also depends on β-hydroxy butyrate and non-esterified fatty acids (Kouakou *et al*., 2005). In under-nourished animals, blood levels of propionate and other precursors derived from the diet decreases causing a reduction in the rate of glucose synthesis (Reynolds *et al*., 2003). The relationship between blood metabolites and meat quality may depend on age, breed, sex and physiological status of the animal.

Conclusion

Blood metabolites were generally not correlated to meat quality traits, although a few of them were breed-dependent. The absence of correlations between metabolites in blood and meat indicate that blood metabolites may not be useful in predicting meat quality traits.

Acknowledgements

Research was funded by Kellogg – Foundation. Meat sample analyses at ARC, Pretoria.

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