Biochemical Indicators of Meat Quality.

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OBJECTIVES

The quality of meat today is highly variable. This is one of the biggest problems inherent in the beef industry. If the industry cannot supply a high quality product consistently and with a given amount of confidence, its development and full potential cannot be realised. This project aims at understanding the biochemical changes which affect beef quality, to identify and measure these indicators at the earliest possible stage of production and finally with this knowledge to modify beef production practices such that a product of known quality can be produced consistently with a given amount of confidence.

EXPERIMENTAL METHODS

Hereford X heifers (n = 16), of similar grade, size and age, were slaughtered in a local beef processing plant. The pH of the LD muscle was taken using a portable pH probe (Orion) and electrode (Amagruss) every hour for 8 hours and again at 24 hours *postmortem*. The temperature fall of the LD muscle and ambient temperature were recorded every half hour with a data logger (Grant Squirrel). At 3 hours samples were taken for capillary electrophoresis analysis and calpain/calpastatin activity measurements. At 6 hours *postmortem* samples were taken for lysosomal enzyme activity measurements. The LD muscles were excised at 24 hours post slaughter and samples were taken for capillary electrophoresis and enzyme activity measurements. The muscles were then stored at 4°C and sampled at 2,7 and 14 days *postmortem*. Samples were taken at 2, 3, 7, 9 and 14 days for capillary electrophoresis. A further sample for enzyme activity measurements was taken at 6 days. Intramuscular fat and moisture was determined using a CEM analysis system (Bostian et al., 1985). Sarcomere lengths were measured by diffraction of a laser beam according to the procedure described by Cross et al. (1980). Sensory Analysis was performed by an eight membered in-house trained taste panel on steaks grilled to an internal temperature of 70°C, according to the American Meat Science Association Guidelines (1978). Panelists ranked the steaks for tenderness, juiciness and overall acceptability using the scale of 1- 8. Warner Bratzler shear force values were taken on 1.25cm diameter cores, cut from 2.5cm steaks parallel to the fibres and cooked to an internal temperature of 70°C, using an Instron Universal testing machine. The percentage cook loss was determined at 70°C. Myofibrils were extracted and SDS - PAGE (sodium dodecyl sulphate polyacrylamide gel electrophoresis) according to the procedure of Greaser (1993). Sarcoplasmic proteins were extracted according to the procedure by LeBlanc (1994), and analysed on the HP3D capillary electrophoresis system using the *Biorad mode of capillary gel electrophoresis. Colour was measured at 1, 2, 7 and 14 days *postmortem*, according to the procedure of Strange (1974) , using a Hunter Lab Colourimeter. Calpain/calpastatin activity was measured using the procedure of Ivensen *et al.* (1995). The activity of cathepsin band the combined activity of cathepsin B&L was measured at 6 hours, 2 days and 7 days using the procedure of Erthjerg *et al* (1993).

PRINCIPAL RESULTS

The meat from the animals tested varied in quality attributes. Glycolytic rate in the few hours following slaughter is a major determinant of meat quality, and is known to vary widely and unaccountably; the nature of the neurological damage done at the time of stunning is a possible cause of this variability (Kauffman & Marsh., 1986). Results to date in this study have confirmed that the best potential indicator of meat quality is the rate of pH fall. Carcasses with a fast pH fall and a normal ultimate pH would be expected to give meat of a higher quality than carcasses having a slow pH fall. This correlates well with the results from sensory analysis, shear force measurements , sarcomere length measurements and cook loss. However, the pH value at 8 hours *postmortem* correlates well with tenderness at 14 days *postmortem* (r = -0.534) and colour measurements (r = - 0.567). The measurement of pH value can therefore indicate the meat quality of the carcass. The measurement of quality traits on the carcass while it is still in the abattoir is for many reasons the ideal solution, mainly because the links from the quality measurement to both the production facilities and to the utilisation of the carcass are still intact (Sorensen, 1989).

Capillary electrophoresis is a novel method for analysis of meat proteins. Analysis of sarcoplasmic proteins by C.E has shown no differences between animals of varying quality. However, changes do occur in the sarcoplasmic profile during ageing and these changes are not detected by conventional SDS-PAGE. Further investigation is needed to develop a method for the analysis of myofibrillar proteins by capillary gel electrophoresis. The 30kDa protein fragment, as observed in the SDS-PAGE profiles of myofibrillar proteins, has been suggested as an indicator of *postmortem* proteolysis (Olson *et al.*, 1977). It is hoped that capillary electrophoresis may reveal a protein fragment, previously undetected by SDS-PAGE, which could be used as an indicator of meat quality.

Proteolysis has a major effect on quality within the first 48 hours *postmortem*. The principal proteases and substrates involved in the this tenderisation process have not been clearly identified but the neutral protease system, calpains, has been widely proposed as being the principal component (Ouali, 1990). During the fall of pH the level of calpastatin decreases to about 70% of its initial value

*Biorad, Separation of SDS- Protein Complexes using CE-SDS Protein kit manual. Cat No. 148-4160. California, USA.

(Koohmarie *et al.*, 1987). Inhibitory activity of calpastatin is reduced when the pH is below 6.5 and is completely eliminated at pH 5.7 (Cottin *et al.*, 1981). However , in this study calpastatin at 3 hours did not correlate well with meat quality properties . Further work will be carried out to see if calpastatin measurements at other times postmortem could be of more benefit.

Several authors have suggested that the lysosomal enzymes may have a role in both the *postmortem* alteration of the myofibrillar component and the tenderisation of meat during conditioning (Yates *et al*, 1983). This assumption has been strengthened by the demonstration of the proteolytic action of cathepsin D on either myofibrils or isolated proteins (Noda *et al.*, 1981).The activity of the soluble fraction of combined cathepsin B&L was measured at 6 hours, 2 days and 7 days *postmortem*. The activity varied among the animals tested, demonstrating that the enzyme activity varies naturally and could possibly explain some of the inherent variability of meat tenderness.

CONCLUSION

The rate of pH fall and the ultimate pH are the best potential indicators of meat quality to date. On-line carcass measurements represent a good possibility for standardised and usable measurements, positioned as it is at the intersection between farming variations and meat processing variations.

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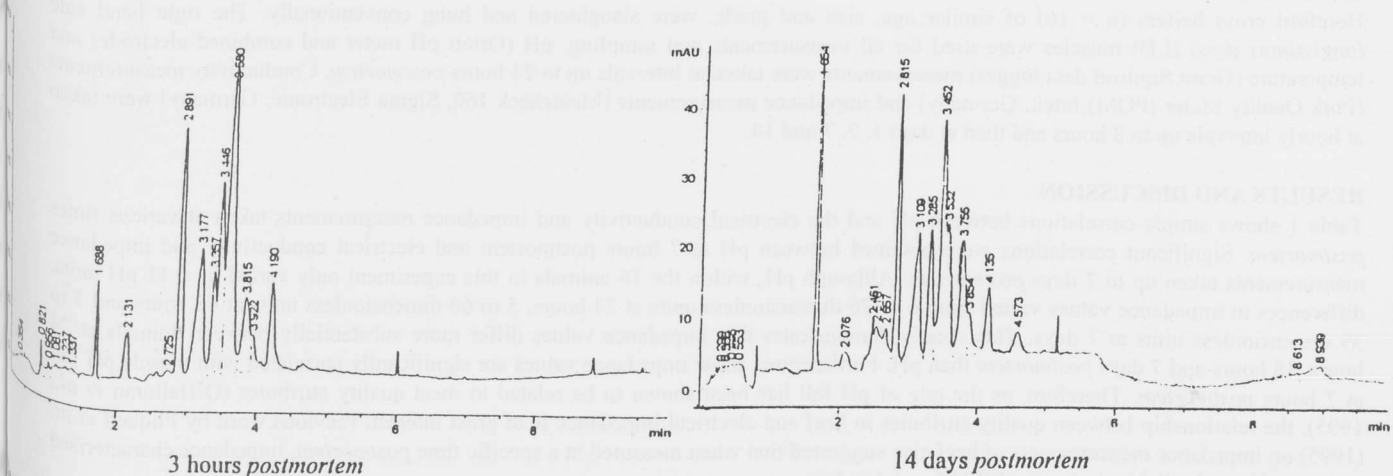
	TENDERNESS	JUICINESS	OVERALL ACCEPTABILITY	WARNER BRATZLER	COLOUR
H @ 3HOURS	-0.392	0.485	0.214	-0.403	-.0434
H @ 8HOURS	-0.534	0.053	-0.314	-0.543	-0.443
H @ 24HOURS	-0.375	0.307	0.540	-0.355	-.0790
ARCOMERE L	0.510	-0.110	0.422	0.540	0.433
EMPERATURE @ 8HOURS	0.300	0.026	0.157	0.373	0.495

BLE 1: Correlation coefficients of quality indicators against quality attributes.



3 hours *postmortem* 14 days *postmortem*

tropherograms of sarcoplasmic proteins at 3hours and 14 days *postmortem.*