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**A STUDY OF RELATIONSHIPS BETWEEN MUSCLE
ULTIMATE pH AND MEAT QUALITY CHARACTERISTICS
FOR M. LONGISSIMUS SAMPLES FROM FRIESIAN STEERS,
CHAROLAIS CROSS STEERS AND FRIESIAN BULLS**

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ABSTRACT

Comparisons of carcass and meat quality characteristics were made between forty Friesian bulls, twenty Friesian steers and nineteen Charolais x Angus cross steers which were grown on mixed pastures and slaughtered at a similar age of approximately 16 to 20 mo. Carcasses were evaluated and dressed under normal commercial conditions and samples of M. longissimus were taken from the right side of each carcass within 90 min of slaughter for meat quality assessments.

A comparison of the growth rates of Friesian and Charolais cross steers during the finishing period revealed no significant differences in initial liveweights, final liveweights or overall average daily liveweight gains ($p>0.05$). Differences in growth patterns indicated that the Friesians grew slightly faster initially while the Charolais cross steers exhibited higher average daily gains at later stages.

The Charolais cross steers had significantly greater dressing-out percentages ($p<0.001$), higher fat depths ($p<0.001$), shorter carcasses ($p<0.001$), larger rib-eye areas ($P<0.001$) and heavier steaks ($p<0.01$) than the Friesian steers when compared at a similar carcass weight. The Charolais cross steers had a greater mean meat yield than the Friesian steers of a similar carcass weight, as assessed by the sum of the six major hind-quarter cuts. There were no breed effects on ultimate meat pH, sarcomere length, meat tenderness, meat colour, cooking loss or expressed juice value for meat samples from the two steer groups.

Bulls produced leaner carcasses as evidenced by lower fat depth and intramuscular fat levels than steers. At a constant carcass weight, bulls had similar dressing-out percentages to Friesian steers, but the value was significantly lower than that of Charolais cross steers ($p<0.001$). The bulls possessed the longest carcasses and the largest rib-eye area after adjustments to the same carcass weight. Bull meat had significantly higher ultimate pH values ($p<0.01$) and a darker colour ($p<0.001$) than steer meat. Although there were no differences in sarcomere length, tenderness, cooking loss and expressed juice between meat from bulls and steers, bull meat appeared on the basis of shear-force deformation-curve parameters to contain more connective tissue.

However, when pH effects were adjusted for by covariance analysis bull meat had a lower WHC and was slightly tougher.

There was a significant curvilinear relationship between ultimate pH and meat tenderness with a minimum tenderness at a pH of approximately 6.1. The improved tenderness above this point was associated with improved WHC, while the decrease in meat tenderness from pH 5.4 to 6.1 appeared to be partly due to a significant decrease in sarcomere length. Meat colour darkened markedly with increases in pH values whereas WHC changed very little as pH values increased from 5.4 to 6.2, but was increased sharply with further increases in pH values above 6.2.

A comparison was made between the conventional vee-shaped Warner-Bratzler shear blade and a modified square-blade. The results were closely correlated, but the square-blade always provided clearer initial yield points on the shear deformation curves and higher peak shear force values. All shear parameters (PF, IY, PF-IY and WD) obtained from shear force deformation curves showed significant curvilinear relationships ($p < 0.001$) with ultimate pH.

It is concluded that differences in ultimate meat pH can lead to subsequent differences in several important meat quality characteristics. Nevertheless, the effects may sometimes be overshadowed by other factors such as cold-shortening conditions.

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LIST OF TABLES

Table	Page
4.1	Initial and final liveweights and growth rates over nine periods for Charolais x Angus cross steers and Friesian steers.40
4.2	Least squares means of carcass characteristics for Friesian (F) bulls, Friesian steers and Charolais (C) x Angus cross steers.43
4.3	Least squares means for the six major hind-quarter cuts of Friesian steers and Charolais x Angus steers.44
4.4	The significance of regression relationships between carcass weight (ccwt), rib-eye area (REA), carcass length (cc length), and fat depth (fat.d) and the sum of the last 3 cuts or the sum of all 6 cuts. Independent variables were fitted in the sequence shown.45
4.5	Unadjusted means of several muscle characteristics of medium (M) and central (C) parts of <u>M. longissimus</u> from Friesian bulls, Friesian steers and Charolais x Angus cross steers.46
4.6	Least squares means of several muscle characteristics of medium (M) and central (C) parts of <u>M. longissimus</u> from Friesian bulls, Friesian steers and Charolais x Angus cross steers, after adjustment for ultimate pH.47

4.7	Regression relationships between sarcomere length and ultimate pH for samples of <u>M. longissimus</u> with an ultimate pH of less than 6.2 (n = 37).	48
4.8	Means for the work done and the peak shear force values of the conventional Warner-Bratzler shear blade (Vee-blade) and the modified Warner-Bratzler shear blade (Square-blade).	53
4.9	Least squares means for initial yield force (IY), peak shear force (PF), work done (WD) and peak-initial yield force (PF-IY) measured from shear force deformation curves for <u>M. longissimus</u> from Friesian bulls, Friesian steers and Charolais x Angus cross steers.	56
4.10	Means of shear force deformation curve parameters and some meat quality characteristics measured at different parts of <u>M. longissimus</u>	61
4.11	Least squares means of initial yield force (IY), peak shear force (PF), work done (WD) and peak-initial yield force (PF-IY) for <u>M. longissimus</u> from Friesian bulls, Friesian steers and Charolais x Angus cross steers. Values were adjusted for pH and sarcomere length (SCM). Independent variables were fitted in the sequence shown.	60
4.12	The significance of regression relationships between Warner-Bratzler peak shear force (PF), pH and sarcomere length (SCM) for samples of <u>M. longissimus</u> with ultimate pH of less than 6.2 (n = 37). Independent variables were fitted in the sequence shown.	62

LIST OF FIGURES

Figure	Page
4.1	Mean liveweights for Friesian and Charolais cross steers over the finishing period. Vertical bar show standard errors. 41
4.2	Mean average daily gains for Friesian and Charolais cross steers, plotted at the midpoint between each weighing time. Vertical bars show standard errors. 41
4.3	The relationship between ultimate pH and colour of <u>M. longissimus</u> as assessed by percent reflectance at 630 nm. Values are shown for Friesian bulls, Friesian steers and Charolais cross steers together with the quadratic regression line and 95 percent confidence limits. 49
4.4	The relationship between ultimate meat pH and sarcomere length of <u>M. longissimus</u> . Values are shown for Friesian bulls, Friesian steers and Charolais cross steers together with the quadratic regression line and 95 percent confidence limits. 50
4.5	The relationship between ultimate meat pH and cooking loss of <u>M. longissimus</u> . Values are shown for Friesian bulls, Friesian steers and Charolais cross steers together with the quadratic regression line and 95 percent confidence limits. 51

- 4.6 The relationship between ultimate meat pH and expressed juice of M. longissimus. Values are shown for Friesian bulls, Friesian steers and Charolais cross steers together with quadratic regression line and 95 percent confidence limits.52
- 4.7 The relationship between the mean of 436 values per shear obtained using either square- or vee-blades in the Warner-Bratzler shear machine for M. longissimus samples from 14 animals. Standard error bars are shown for each variable within each animal, together with the overall regression equation based on the 96 individual shears. These mean shear force values are referred to as the work done (WD) in the text.....54
- 4.8 The relationship between peak shear force values obtained using either square or vee-blades in the Warner-Bratzler shear machine for M. longissimus samples from 14 animals. Standard error bars are shown for each variable within each animal, together with the overall regression equation based on th 96 individual shears.55
- 4.9 Four shear on 13 x 13 mm cores from M. longissimus of a 16 mo steer after cooking at 70 °C in a water bath for 90 min. Initial yield values are shown by the vertical arrows.57
- 4.10 The relationship between ultimate meat pH and peak shear force of M. longissimus. Values are shown for Friesian bulls, Friesian steers and Charolais cross steers together with the quadratic regression line and 95 percent confidence limits58

LIST OF ABBREVIATIONS

h	Hour
ml	Milliliter
mm	Millimeter
°C	Degree Celcius
mg	milligram
g	Gram
kg	kilogram
d	Day
mo	Month
min	Minute

TABLE OF CONTENTS

	Page
: ABSTRACT	i
: ACKNOWLEDGEMENTS	iii
: LIST OF TABLES	iv
: LIST OF FIGURES	vi
: LIST OF ABBREVIATIONS	viii
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: REVIEW OF LITERATURE	4
2.1 INTRODUCTION	4
2.2 MEAT TENDERNESS	4
2.2.1 The measurement of meat tenderness.....	4
2.2.1.1 Subjective methods.....	5
2.2.1.2 Objective methods	6
2.2.2 Factors affecting meat tenderness.....	9
2.2.2.1 Myofibrillar proteins.....	9
2.2.2.1.1 Shortening effects	9
2.2.2.1.2 Proteolytic activity.....	10
2.2.2.1.3. Cooking effects.....	11
2.2.2.2 Connective tissue	12
2.2.2.2.1 Cooking effects.....	12
2.2.2.2.2 Aging effects.....	13
2.3 MEAT pH.....	13
2.3.1 Factors affecting the rate of pH change and ultimate meat pH.....	14
2.3.1.1 Pre-slaughter factors	14
2.3.1.1.1 Species effects	14
2.3.1.1.2 Variability between animals.....	14
2.3.1.1.3 Muscle fibre types.....	15

2.3.1.1.4 Pre-slaughter glycogen-depleting treatments	16
2.3.1.1.5 Pre-slaughter administration of drugs	17
2.3.1.2 Post-slaughter factors.....	17
2.3.1.2.1 Chilling procedures.....	17
2.3.1.2.2 Electrical stimulation	18
2.3.2. Meat quality characteristics affected by ultimate pH	19
2.3.2.1 Water holding capacity (WHC).....	19
2.3.2.2 Tenderness	20
2.3.2.2.1 Effects of pH through WHC	20
2.3.2.2.2 Effects of pH and proteolytic activity	22
2.3.2.3 Colour	23
2.3.2.4 Keeping quality.....	24
2.3.2.5 Flavour	25
2.4 BREED AND CASTRATION EFFECTS ON CARCASS AND MEAT QUALITY CHARACTERISTICS.	25
2.4.1 Carcass characteristics	25
2.4.1.1 Breed effects	25
2.4.1.2 Castration effects	27
2.4.2 Meat quality characteristics	28
2.4.2.1 Breed effects.	28
2.4.2.1.1 Tenderness	28
2.4.2.1.2 Juiciness.....	29
2.4.2.1.3 Flavour.....	29
2.4.2.1.4 Colour	30
2.4.2.2 Castration effects	31
2.4.2.2.1 Tenderness	31
2.4.2.2.2 Juiciness.....	32
2.4.2.2.3 Flavour.....	32
2.4.2.2.4 Colour	33

CHAPTER 3: MATERIALS AND METHODS	34
3.1 ANIMALS	34
3.2 CARCASS ASSESSMENT.....	35
3.3 MEAT QUALITY ASSESSMENTS	35
3.3.1 Sample preparation	35
3.3.2 Muscle pH.....	36
3.3.2.1 pH ₃ measurement	36
3.3.2.2 Ultimate pH	36
3.3.3 Sarcomere length	36
3.4.3 Meat colour (Reflectance Spectrophotometry).....	37
3.3.5 Warner-Bratzler shear force values	37
3.3.6 Water holding capacity (WHC)	38
3.3.7 Intramuscular fat.....	38
3.4. STATISTICAL METHODS.....	39
 CHAPTER 4: RESULTS	 40
4.1 GROWTH RATE	40
4.2 CARCASS CHARACTERISTICS.....	42
4.3 MUSCLE CHARACTERISTICS.....	45
4.4 MEAT TENDERNESS	53
4.5 RELATIONSHIPS BETWEEN SHEAR FORCE DEFORMATION CURVE PARAMETERS WITH ULTIMATE pH AND SARCOMERE LENGTH	59
 CHAPTER 5: DISCUSSION	 63
5.1 ULTIMATE pH AND MEAT QUALITY CHARACTERISTICS.....	63
5.2 MEAT TENDERNESS MEASUREMENT	65
5.3 BREED AND CASTRATION EFFECTS.....	67
5.3.1 Growth rate	67
5.3.2 Carcass characteristics	68
5.3.2.1 Dressing-out percent.....	68
5.3.2.2 Rib-eye area	69

5.3.2.3 Meat yield	70
5.3.3 Muscle characteristics.....	71
5.3.3.1 Muscle pH, colour and water-holding capacity (WHC)	71
5.3.3.2 Meat tenderness	73
CHAPTER 6: CONCLUSIONS	75
REFERENCES	78
APPENDICES.....	98

CHAPTER 1

INTRODUCTION

All forms of meat, regardless of species of animal, are good sources of essential amino acids, certain minerals and vitamins (Lawrie, 1985). Surveys conducted in Great Britain indicated that beef was usually more expensive than chicken, pork and lamb, but it was considered by the consumers to provide an excellent meal and to be a very appetizing, nourishing and tasty meat (Baron, 1984). Moreover, beef products were also ranked first on the usefulness factor, followed by chicken, while lamb and pork were considered poorly in this respect.

The acceptability of meat is related to its visual characteristics and its eating qualities, with the nature of these properties in the most acceptable meat varying considerably with cooking procedures. It is, therefore, difficult to compare organoleptic assessments of cooked meat between different taste panels. However, of the attributes of the eating quality of beef, tenderness has most often been ranked first, according to consumer attitudes and demand for meat (Baron, 1984). Meat tenderness was also shown to be the best predictor of overall acceptability of beef by taste panels from eight European countries (Dransfield *et al.*, 1982). The variation in meat tenderness may be the result of the collective effects of numerous traits, including the myofibrillar structure and its state of contraction, the connective tissue content and its degree of cross-linking, and the water holding capacity of the meat protein (Bouton *et al.*, 1973a). It is known that the prevention of cold-shortening can greatly diminish the contribution of myofibrillar structure to tenderness (Marsh & Leet, 1966; Davey *et al.*, 1967; Hostetler *et al.*, 1972). When cold-shortening conditions are avoided, an increase in muscle ultimate pH from 5.5 to 6.2 has been shown to lead to an increase in toughness of beef (Purchas *et al.*, 1988a). The increase in pH over this range has been reported to be associated with a significant decrease in sarcomere length (Purchas, 1988), although this association was not very close. The curvilinear relationships obtained between shear force value and ultimate pH showed the maximum shear force values at a pH of approximately 6.0 with further increases leading to lower shear force values, higher water-

holding capacity, darker colour and the phenomena of dark-cutting beef (Lawrie, 1985). Unfortunately, improvement in meat tenderness obtained by increasing pH above 6.0 are always accompanied by an undesirable dark colour, less flavour and poorer keeping quality. Consequently, more practical benefits will come from improvements in tenderness through an improved understanding of the negative relationship between tenderness and pH up to 6.0.

The main objective of this study was:

To examine the relationship between ultimate muscle pH and meat quality characteristics, with particular emphasis on its relationship with meat tenderness under conditions where cold-shortening is avoided.

One of the most widely used objective methods for assessing meat tenderness has been the Warner-Bratzler shear device which measures the force required to shear through a meat sample perpendicularly across the fibres (Bouton & Harris, 1972a). Although the peak shear force values from this device provide a good predictor of meat tenderness (Seideman & Theer, 1986), the correlations between peak shear force values and taste panel assessments are reported to be very variable (Szczeniak & Torgeson, 1965). Bouton & Harris (1972a) suggested that it might be difficult to acquire reliable predictive values when a single parameter is used to assess meat of widely differing structural properties. For example, the Warner-Bratzler shear device, peak shear force values mostly measure the strength of myofibrillar structures, whereas measures of compression strongly indicate the connective tissue strength. However, it has been suggested that these two components of meat tenderness could be measured effectively by the additional variables obtained from shear-force deformation curves, in which shear force values are plotted against the distance travelled by the shear blade (Bouton *et al.*, 1975c).

Therefore, a second objective of this study was:

To compare several variables derived from shear force deformation curves with regard to their relationships with ultimate pH and other meat characteristics.

The animals used in this study were Friesian steers, Charolais x Angus cross steers and Friesian bulls. Therefore, the opportunity existed to evaluate

differences in carcass and meat quality characteristics between these groups. Previous reports of comparisons between breed and sex groups of cattle have shown that, although differences in carcass and meat quality characteristics may sometimes exist, this is not always the case.

Thus, the third objective of this study was:

To determine the effects of breed and castration on carcass and meat quality characteristics.