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

A thesis presented in partial fulfilment
of the requirements for the degree
of Master of Agricultural Science
in Animal Science
at Massey University
New Zealand

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1990

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.

ACKNOWLEDGEMENTS

I wish to express my gratitude to my supervisors, Dr R.W. Purchas and Mr S.T. Morris for their guidance, help and advice during the experimental work and the preparation of this thesis. Special thanks and appreciation is due to Dr R.W. Purchas for his continued interest, encouragement and invaluable help given to me throughout my study.

Thanks are also extended to Waitaki International Limited for providing meat samples and to the staff for their excellent co-operation during carcass data and meat sample collection.

I also appreciate the help given to me by Mr A.Y. Abdullah during sample collection, Mr S. Phimsarn, Mr W. Chatupote and Mrs L. Phetpradap for advice with computer processing, and Mr W. Sereeprasert for data analysis.

For help with chemical analysis, I would like to thank Ms R.A. Watson and Mr D.A. Hamilton of the nutrition laboratory.

I wish to thank Professor B.R. Watkin for encouraging me to come to study in New Zealand. Mrs G. Eustace for taking care of me and for her warm hospitability which made my stay an enjoyable and memorable one, and my family in Thailand for the care they gave my husband and children while I was away from them.

The financial support from the New Zealand government and the permission to come to study here from the Dairy Farming Promotion Organization of Thailand are gratefully acknowledged.

Finally, special appreciation is due to my mental supporters, Supachai, Wisarut and Wamarin Aungsupakorn for the love, understanding, patience and encouragement given to me during my time of study.

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

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

TABLE OF CONTENTS

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 (Szczesniak & 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.