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Chemical and histological parameters associated with the tenderness of hemicastrate and steer beef

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ABSTRACT

Hemicastrates and steers were slaughtered at similar carcass weights at 14, 18 and 22 months of age for the assessment of factors associated with tenderness differences in representative forequarter muscles. Objective tests indicated that hemicastrate meat was tougher than that from steers at 22 months of age only. Heat labile collagen content was the major parameter associated with tenderness in *M. longissimus;* in both *M. splenus* and *M. triceps brachii* it was sarcomere length.

INTRODUCTION

That bulls grow faster and more efficiently than steers is well known, but meat quality differences are less clear cut and appear to be age and weight dependent (Field, 1971). Histological and chemical studies of bull and steer meat by Watson (1969) and Jeremiah and Martin (1978) revealed consistent differences only in the proportion of intramuscular fat. Recently, Boccard *et al.* (1979) suggested that collagen solubility may also vary between bulls and steers of similar age. The present aim was to assess differences in the tenderness of forequarter muscles from hemicastrates and steers of 3 ages and to relate any such differences to variations in histological and chemical characteristics.

MATERIALS AND METHODS

Four Hereford hemicastrates and 4 Hereford steers which had been reared on pasture were slaughtered at each of 14, 18 and 22 months of age and at similar carcass weights (132, 142, 168 kg). The carcasses were aged at 2°C for 170 hours before *M. longissimus* (ML), *M. triceps brachii* (MTB) and *M. splenus* (MS) were dissected from each right forequarter.

Fibre diameter, sarcomere length and the proportion of wavy fibres were estimated by the methods of Locker (1960) and Jeremiah and Martin (1978). Duplicate chemical analyses for fat (Fosslet 15310), protein (micro-kjeldahl) and moisture (freeze drying) were made on freshly minced muscle. The proportions of total and heat labile collagen were determined by the extraction/hydrolysis (Field *et al.*, 1970) and hydroxyproline (Bergman and Loxley, 1963) procedures. Objective meat tenderness assessment was by Warner-Bratzler (W/B) shear on cooked muscle.

For each muscle analysis of covariance, adjusting for differences in carcass weights, was used to examine sex and age effects and objective tenderness was related to each of the other parameters by step-wise regression after ranking according to their standardised partial regression coefficients.

RESULTS

Mean W/B shear values were greater in hemicastrates than in steers for all muscles, but this difference was significant ($P<0.05$) for all muscles only at 22 months (Table 1). Of the chemical and histological

TABLE 1 Age changes in objective tenderness values and the proportions of heat-labile collagen in 3 muscles from hemicastrates and steers.

	Age (months)	*M. longissimus* Bull	*M. longissimus* Steer	*M. splenus* Bull	*M. splenus* Steer	*M. t. brachii* Bull	*M. t. brachii* Steer
Shear values kg/cm²	14	4.1b	3.5a	4.1b	3.3a	4.9cd	3.7a
	18	6.5cd	6.1c	5.3c	5.0c	3.7a	4.3b
	22	6.7d	4.4b	6.1d	4.8c	4.7c	5.1d
	14	8.5c	20.1d	4.2b	8.2d	13.0b	15.0b
% Heat-labile collagen	18	4.4b	8.6c	3.8b	3.0b	15.7b	9.8a
	22	1.8a	8.1c	2.0a	5.1c	14.6b	16.6b

Different letters indicate significant differences ($P<0.05$) between sex or age within muscles.

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TABLE 2 Mean values for histological and chemical parameters in 3 muscles of hemicastrates and steer carcasses

	M. longissimus		*M. splenus*		*M. t. brachii*	
	Bull	Steer	Bull	Steer	Bull	Steer
Fibre diam (μ)	52.4	50.6	49.9	37.5*	42.3	40.5*
Sarcomere (μ)	1.93	1.75	1.86	1.92	2.23	2.27
Wavy fibre (%)	3.1	3.4	2.7	2.9	1.7	1.8
Protein (%)	23.8	23.8	22.6	22.4	20.7	20.1*
Moisture (%)	72.1	70.7***	72.4	71.9	73.8	71.9***
Intramuscular fat (%)	5.1	8.2*	4.6	9.3**	7.1	12.0**
Total collagen (mg/g protein)	9.4	8.7	12.5	10.3*	12.7	12.8

parameters studied only fibre diameter ($P < 0.05$) and intramuscular fat and moisture contents ($P < 0.01$) differed consistently between the sex types (Table 2). However, hemicastrates had less heat-labile collagen in ML and MS than steers ($P < 0.01$) and the amount of heat labile collagen declined ($P < 0.05$) with increasing age (Table 1). Fibre diameter and total collagen increased with increasing age in hemicastrates ($P < 0.05$) and hemicastrates and steers ($P < 0.01$) respectively.

For ML, the heat-labile and total collagen contents were predominant in explaining W/B shear variations, with 27% of the variation explained by these components. For MTB and MS only sarcomere length had a significant association with W/B shear variations explaining 18 and 24% of variation respectively, although for MS the association with heat labile collagen content approached significance and explained an additional 9% of W/B force variation.

DISCUSSION

The fact that tenderness differences in ML of hemicastrates and steers reached significance only at 22 months of age is consistent with the findings of Field (1971) and Boccard *et al.* (1979) that such differences between the sexes in cattle are not significant until at least 18 months. Of the parameters studied, the proportions of total collagen (increase with age) and heat-labile collagen (decrease with age) best explained the greater toughness of ML as both hemicastrates and steers grew older (Table 2). These trends are in agreement with those reported by Boccard *et al.* (1979). The greatest sex differences in collagen solubility were at 14 months; by 18 months, values for steer ML had stabilised at about 8% while those for bulls continued to decline.

The same patterns were not, however, exhibited by the other 2 muscles. In MS, sex differences in tenderness were evident at 14 months reflecting the relatively lower solubility levels of collagen in this muscle. This suggests that muscles that are differentially influenced by male hormones may show tenderness differences in favour of steers at younger ages than those (e.g., ML) whose proportions are not altered by male hormones. For MS, sarcomere length as well as collagen solubility, were important in explaining tenderness variations. Hemicastrates MS, relatively greater in mass and less protected by subcutaneous fat than that of steers, may have been more susceptible to cold shortening particularly at 22 months when sarcomere length of bull muscle was significantly less than for steers.

The MTB, on the other hand, maintained high levels of collagen solubility at each of the 3 ages studied. As for MS, however, sarcomere length explained the major proportion of tenderness variation with age, and once again the superficial nature of MTB and its relative lack of fat cover in hemicastrates may have resulted in differential cold shortening between the 2 sexes.

It can be concluded from these findings that tenderness differences between hemicastrate (or bull) and steer meat at different ages are due either to differences in collagen solubility or the susceptibility of particular muscles to cold shortening. The magnitude and importance of these differences varies with the location of the muscle and possibly the relative growth responses of individual muscles to male hormones.

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