DIFFERENCES IN TENDERNESS BETWEEN BULLS AND STEERS: EFFECTS IN DIFFERENT MUSCLES

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Background

Many studies have examined the quality of meat from entire male (bull) and castrated male (steer) cattle, with most concluding that tenderness in bulls is inferior to that in steers (e.g. Purchas and Aungsupakorn 1993). Putative causes for this difference include a greater post mortem calpastatin activity in bulls (Morgan et al. 1993) and a greater collagen concentration (Gariepy et al. 1992). These observed differences between bull and steer, with few exceptions, are based on measurements made in the *longissimus thoracis/lumborum (LTL)*. Dransfield et al. (1984) did examine, in addition to *LTL* (roast), muscles of very different quality (casserole, mince, grill) and showed that differences between bull and steer, distinguished by triangular tests, were observed mainly in *LTL* whilst Sinclair et al. (1998) found, surprisingly, that a taste panel rated bulls more tender than steers for all three muscles studied (*LTL, biceps femoris* (=*gluteobiceps*) and *semimembranosus*). Market value judgements placed on bull carcasses may need to be revised if assumptions about tenderness, based on data from the loin, are unsubstantiated in other valuable cuts.

Objective

To determine the size of the bull-steer difference in tenderness in four, intrinsically high quality, hindquarter muscles.

Methods

Six groups of 20 bulls and steers, 'continental' beef breed (mainly Charolais) x Holstein-Friesian, were reared to slaughter at 12, 14 and 16 months on a brewers grain/sugar beet pulp diet. A further group of 20 bulls from the suckler herd (Angus x Holstein-Friesian), also sired mainly by Charolais, were weaned at 6 months of age and reared to slaughter at 12 months on a cereal diet. Amount of feed was controlled to achieve predetermined, commercial slaughter weights and a carcass fatness of about 3 on the EUROP system. Samples of *longissimus lumborum* (*LL*, sirloin), *gluteus medius* (*GM*, rump), *gluteobiceps* (*GB*, silverside) and *semimembranosus* (*SM*, topside) were removed three days after slaughter and vacuum-packed. Maximum yield force was measured using a Stevens CR Analyzer fitted with Volodkevitch jaws on sub-samples of *LL* and *SM* aged to 4 and 14 days at 2°C and cooked to an internal temperature of 78°C. Myofibrillar fragmentation index (MFI) was determined in these same two muscles using the method of Culler et al. (1978). A trained taste panel assessed all four muscles after ageing at 2°C for 14 days. Steaks, 1.9 cm thick, were cut from *LL* and *GM* and grilled whilst *GB* and *SM* were oven roasted, all to the same internal temperature (74°C). Ten assessors rated texture, amongst other attributes, on 8-point category scales under red light. The combination of animal groups represented at any panel session (see Table 2) was determined by a wider overall experimental objective to study meat quality in bulls.

Results and discussion

Evidence from instrumental measurements

Yield forces in *LL*, after both 4 and 14 days ageing, were lower generally in the steers than in the bulls and specifically in the steers compared with age-matched bulls (Table 1). Comparable measurements in *SM* did not show consistent differences between the sexes. Although the 12 month bulls were significantly tougher than the corresponding steer group after 4 days ageing, there were no differences within the other two age-matched sex comparisons. After 14 days ageing, although not significantly different, the mean yield force values within each of the three age-matched comparisons were actually lower for the bulls than the steers.

Table 1. Instrumental texture measurements and myofibrillar fragmentation index (MFI) in two muscles, after two periods of ageing, for seven groups of steers and bulls .

	12 month steers	14 month steers	16 month steers	Suckler bulls	12 month bulls	14 month bulls	16 month bulls	sed
longissimus lumborum(LL)								
yield force, 4d	3.9^{a}	4.6^{ab}	4.5^{ab}	4.7^{bc}	6.9^{e}	5.8^{d}	5.3^{cd}	0.37
yield force, 14d	4.0^{ab}	3.7^{a}	3.6^{a}	4.6^{c}	5.1^{d}	4.3^{bc}	4.1^{abc}	0.25
MFI, 4d	24.0^{b}	23.6^{b}	22.1^{ab}	20.1^{a}	20.3^{a}	23.8^{b}	20.7^{a}	1.41
MFI, 14d	36.0^{d}	31.5^{c}	32.4^{c}	29.4^{bc}	26.2^{a}	28.1^{ab}	27.7^{ab}	1.54
semimembranosus (SM)								
yield force, 4d	6.1^{ab}	6.4^{bc}	5.9^{a}	6.3^{bc}	6.7^{c}	6.3^{bc}	6.2^{ab}	0.22
yield force, 14d	6.1^{c}	6.0^{c}	5.4^{ab}	5.9^{bc}	5.7^{abc}	5.6^{abc}	5.3^{a}	0.25
MFI, 4d	21.1^{b}	20.1^{ab}	18.6^{a}	23.4^{c}	19.9^{ab}	21.0^{b}	19.6^{ab}	1.07
MFI, 14d	26.3^{d}	20.9^{ab}	22.1^{bc}	22.9^{c}	21.5^{abc}	21.9^{abc}	19.1^{a}	1.42

The MFI values indicate that, in *LL*, proteolysis had generally proceeded further in the steers, particularly after the longer ageing time. This would support the hypothesis that calpaststin is more active in bulls. In *SM*, again there were no consistent differences between bulls and steers and values were appreciably lower than in *LL*.

Evidence from sensory testing

The comparisons between animals groups made possible through the experimental design are shown in Table 2. The values in this Table are panel mean values for tenderness of each of four muscles from the bulls minus the corresponding value for the steers.

Table 2. Differences (steer - bull) between animal groups in taste panel means* for tenderness of four hindquarter muscles

	12 month steer				14 month steer				16 month steer			
	LL	*GB*	*GM*	*SM*	*LL*	*GB*	*GM*	*SM*	*LL*	*GB*	*GM*	*SM*
Suckler bull	+0.5	+0.7	+0.2	+0.1	+0.3	0.0	+0.3	-0.1	+0.2	+0.2	+0.4	+0.3
12 month bull	+1.1	+0.9	+0.2	+0.2	-	-	-	-	-	-	-	-
14 month bull	+1.5	+0.9	+0.6	+0.3	-	-	-	-	-	-	-	-
16 month bull	-	-	-	-	+0.7	+0.3	+0.8	+0.5	+0.5	+0.3	+0.7	+0.4

* Scales 1 - 8 in which 1=extremely tough, 8= extremely tender

In the comparisons involving the 12 month old steers, there was a consistent hierarchy in the magnitude of the differences between the sexes with these being greater in *LL* and *GB* than in *GM* and *SM*. This polarisation of *LL* and *SM* is consistent with the instrumental results. However, this pattern did not emerge in the comparisons involving the older steers although, with one exception (16 month old steers), the values for *LL* were greater than those for *SM*.

There were significant negative correlations between instrumental yield force and taste panel mean tenderness in *LL* for four of the seven animal groups (Table 3) although for three of these the proportion of variation explained by the first variable was less than 30%. There were no significant correlations between *LL* and *SM* but *LL* was significantly correlated with *GM* in four animal groups and with *GB* in five groups.

Table 3. Correlation coefficients (r) between instrumental texture measurement of *LL* after 14 days ageing and corresponding taste panel texture ratings (tp), and between tp for different muscles

r	12 mo. steer	14 mo. steer	16 mo. steer	Suckler bull	12 mo. bull	14 mo. bull	16 mo. bull
14d yield force/tp *LL*	-0.53*	0.18	0.01	-0.56*	-0.79***	-0.50*	-0.20
tp *LL*/tp *SM*	0.37	-0.17	0.24	0.23	0.03	0.07	0.43
tp *LL*/tp *GM*	0.47*	0.38	0.21	0.30	0.48*	0.49*	0.64**
tp *LL*/tp *GB*	0.43	0.56*	0.35	0.52*	0.61**	0.56*	-0.46*
tp *SM*/tp *GM*	0.40	0.13	0.31	0.32	-0.16	0.46*	0.28
tp *SM*/tp *GB*	-0.11	0.27	0.24	0.23	0.02	0.42	-0.15
tp *GM*/tp *GB*	0.33	0.45	0.45	0.30	0.20	0.54*	-0.53*

*p<0.05,**p<0.01, ***p<0.001

Conclusions

Correlation between instrumental measurement of tenderness of *LL* and its assessment by a taste panel was significant only for some animal groups. Nevertheless, evidence from both sources was consistent in showing that the tenderness of *LL* was greater in steers than bulls and this difference, if it existed at all, was much reduced in *SM*. In fact, there was no significant correlation between the tenderness of these two muscles. Although there were no corroborating yield force measurements, sensory data indicated a reduced sex effect on *GM* with *GB* being the muscle most in alignment with *LL* in the magnitude of the sex difference in tenderness. Differences in tenderness between bulls and steers in *LL* should not be extrapolated universally to other hindquarter roasting joints.

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