4:17 Comparison of meat quality in steers and young bulls at different live weights and feed levels.

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Introduction

In Denmark, extensive studies of growth, feed efficiency, carcass characteristics and meat quality in relation to beef production have been carried out since 1969 in a close cooperation between the National Institute of Animal Science and the Danish Meat Research Institute. The objective of one of these studies has been to compare beef production in steers and bulls fed at different levels and slaughtered at different live weights. This experiment is fully reported by Andersen et al. (1983) in Danish with English summary and subtitles. This paper describes the meat quality results from the study.

Previous research reviewed by Field (1971) and Seideman et al. (1982) has generally indicated that young bulls grow more rapidly, utilize feed more efficiently and produce carcasses with lower fat percentages than steers. Disadvantages of young bulls are lower consumer acceptance, less tender meat as well as a more variable eating quality (Seideman et al., 1982).

Materials and Methods

A total of 120 Danish Friesian (SDM) calves from three sires were included in the experiment. At 73 days of age the calves entered the 2x4x4 factorial experiment comparing two sexes (steers and bulls), four live weights (425 kg, 550 kg, 675 kg and 800 kg (the latter group bulls only)) and four feed levels (Ad Libitum, Restrictive, Very Restrictive and Very Restrictive until 125 kg less than slaughter weight and thereafter Ad Libitum (VR/AL)).

Castration was performed at 3 to 4 months of age. Bulls and steers were fed alike and individually according to weight. The experimental feed was skimmilk (until 150 kg live weight), fodder beet, concentrates, hay and barley straw, minerals and vitamins. Table 1 indicates feed levels and daily gain.

Table 1. Feed levels, daily feed intake (SFU) and daily gain.

Feed levels	Feed intake in %		Daily feed intake, SFU		Daily gain, g	
	Planned	Realized	Bulls	Steers	Bulls	Steers
AL	100	100	6.37	6.52	1183	973
R	85	74	4.72	4.81	1063	872
VR	70	61	3.89	4.00	857	755
VR/AL	70/100	-	4.74	5.42	975	885

All animals were transported, slaughtered and chilled according to the Institute's standard procedures (Buchter, 1976). This includes that the carcasses should be cooled at 6°C for 24 hours and then kept at 4°C. Two days after slaughter carcass composition was determined by separation of the right side from each animal into lean, fat and bone, and the following samples were taken for meat quality evaluation:

1. Longissimus Dorsi (LD) between the 11th rib and 1st lumbar vertebrae (chemical analysis, colour measurement, shear force).
2. Longissimus Dorsi between the 2nd lumbar vertebrae and 5th lumbar vertebrae (sensory evaluation).
3. Semitendinosus (ST) (sensory evaluation).

The samples were vacuum packed and aged until 7 days after slaughter at 4°C. At 7 days post mortem the LD was divided into the following samples: Three 6 cm thick steaks for shear force measurement, a 2 cm thick steak for colour measurement and the remainder of the LD minced for other analyses.

Shortly after cutting the Elrepho reflectance (R535) was measured on a vacuum packed steak, and the pH-value was determined. The R535-value was converted to Hunter-lightness (L) using the equation: Lightness = 16.330 + 1.662 x R535-value.

Total pigment, % protein and % fat (SBR) were determined (based on wet weight) on minced meat after methods recommended by the Commission of the European Communities Beef Production Research Programme (Boccard et al., 1981). The minced meat had been frozen before analysis.

The shear force samples were vacuum packed and frozen after ageing at 4°C to respectively 7 days, 14 days and 21 days post mortem. The meat samples were thawed at 5°C, cooked to a final internal temperature of 72°C and cooled. Strips of meat were cut 10x20 mm in cross section, in the plane perpendicular to the direction of the fibre bundle and about 5 cm long. Each strip was sheared once with a Volodkewich shear attachment on an Instron Universal Testing Instrument TM-SM.

The meat for sensory evaluation was aged until 14 days post mortem and then frozen at -40°C. Before sensory evaluation the frozen LD-samples were sawn into 23 mm thick steaks. The steaks were thawed at room temperature for about 2 hours before being prepared on a 170°C griddle plate until they had a light pink colour inside (about 65°C). The ST was thawed overnight at 5°C and prepared as roastbeef in an oven with a starting temperature of 225°C. When the roast reached an internal temperature of 45°C it was removed from the oven, allowed to settle 1/2 hour and then served as 3 mm thick slices.

Nine taste panelists evaluated the samples for colour, flavour, tenderness, juiciness and overall impression using an 11-point scale with +5 (like extremely) to -5 (dislike extremely), where 0 is neither like nor dislike. Samples from LD and ST were judged in separate sessions.

Changes in meat composition during growth were estimated by use of a modified allometric function. The results shown in the figures are based on results from this function.

The results in the tables were computed as LS-means from an analysis of variance. Only animals with slaughter weights of 425 kg, 550 kg and 675 kg were included in the analysis, which covered the main effects of sex, slaughter weight, feed level and sires and interactions between these. Although the model included a sire effect, this effect is not discussed further in this paper. However, it should be noted that a variation due to sire was observed for several of the investigated variables.

Results

Results for intramuscular fat are shown in Figure 1. As expected steers had a considerably higher intramuscular fat content than bulls. The fat percentages increased with increasing slaughter weight and with increasing feed level. As a rough approximation the fat content in steers was about twice as high as that found in young bulls at the same weight and feed level.

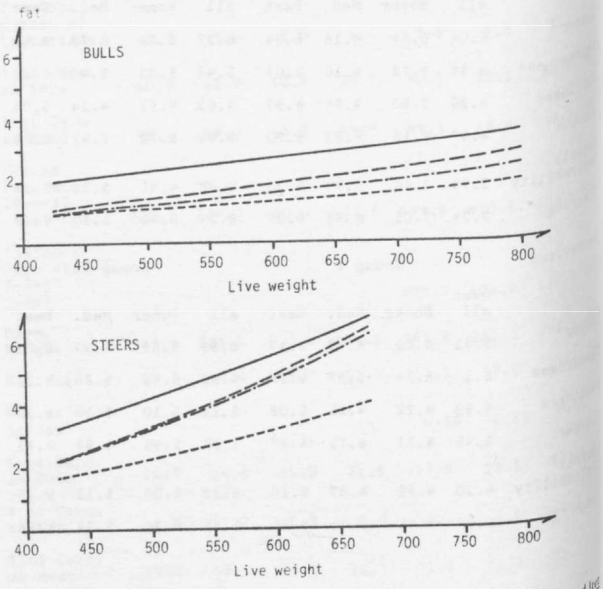

Figure 1. Fat percentage in LD from bulls and steers at different feed levels and live weight at slaughter

Feed Level: —— Ad Libitum, – – – Restrictive, ---- Very Restrictive, -·-·- Very Restrictive/Ad Libitum

In Figure 2 is shown that the protein content was unaffected by weight and feed level in bulls and showed a slightly decrease with increasing weight in steers. If protein is calculated on fat free basis protein content in both bulls and steers increased slightly with increasing weight and feed level.

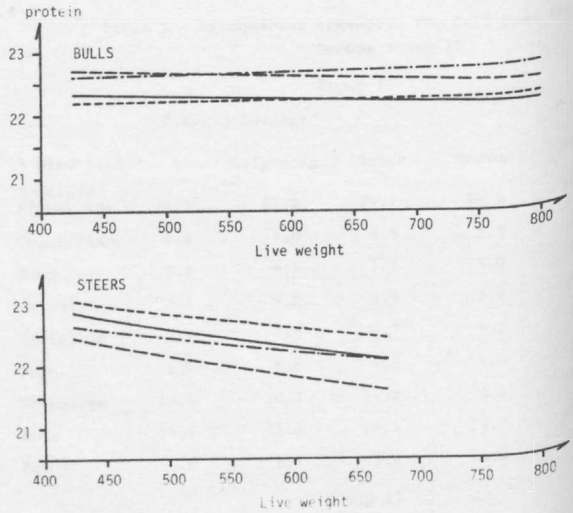

Figure 2. Protein percentage in LD from bulls and steers at different feed levels and live weight at slaughter.

Feed Level: —— Ad Libitum, – – – Restrictive, ---- Very Restrictive, -·-·- Very Restrictive/Ad Libitum

Meat quality characteristics of LD are presented in Table 2. Bulls had a slightly higher pH-value in LD compared to steers. The pH-value was not influenced by slaughter weight, but decreased with increasing feed level. It should also be noted that:

1. Animals from experimental farms in general are given a standardized transport so that occurrence of DFD meat is minimized.
2. Results from animals with pH ≥5,8 in LD are removed before the results are analysed. In this study two young bulls had pH ≥5.8.

The pigment content was slightly higher in steers compared with bulls. Pigment content increased for both sexes with approximately 30 ppm per 100 kg increase in live weight. For bulls the influence of feed level on pigment content was minimal, but for steers pigment content was slightly higher when fed at R and VR levels compared with AL and VR/AL.

Table 2. Meat quality characteristics of Longissimus Dorsi

	pH ult.	Total pigment, ppm	Hunter-lightness value	Shear force value, kg 7 days	14 days	21 days
Sex						
Bulls	5.52a	148a	35.4a	11.6a	9.4a	8.1a
Steers	5.46b	159b	35.4a	7.9b	6.8b	6.9b
Slaughter weight						
425 kg	5.49a	116a	37.4a	10.3a	8.4a	7.6a
550 kg	5.49a	155b	34.9b	10.3a	8.6a	7.8a
675 kg	5.49a	190c	33.8c	8.5a	7.3a	7.1a
Feed level						
AL	5.47a	147ab	36.3a	10.0a	8.4a	7.8a
R	5.49ab	164c	34.6b	8.7a	7.6a	6.8a
VR	5.52b	161bc	34.4b	9.8a	7.9a	7.7a
VR/AL	5.48a	142a	36.1a	10.3a	8.4a	7.7a

Value in the same column bearing different superscripts are significantly different ($P < .05$).

Though there were differences between the two sexes in pigment content the lightness value was apparently unaffected by castration. The meat darkned with increasing slaughter weight, and the meat from animals on the highest feed level was slightly lighter than the meat from the other feed levels. The lightness value is affected by the pigment as well as the fat content in meat. A higher degree of marbling will result in a slightly higher L-value, while a higher pigment content will result in a lower L-value.

Longissimus Dorsi from steers had a lower shear force value than LD from bulls, but ageing until two to three weeks post mortem reduced the difference. There was no significant influence of weight or feed level on shear force value in this experiment. Boccard et al. (1979) found that the shear force value increased from 8 to 16 months of age. Conflicting results about influence of age and feed level, when comparing different studies can be due to the circumstances under which the carcasses are chilled. In general it can be expected that young bulls are more exposed to cold shortening because of the thinner fat cover. The lightest animals in this study had a higher shear force value because the slaughterhouse used in the present study did not always manage to follow the planned chilling programme.

Sensory evaluation (Table 3 and Table 4) showed that LD and ST from steers were more tender and flavourful than the same muscles from bulls. Steers were also less variable in these sensory traits, and for all taste panel characteristics steer's meat was on a high and uniform level, namely at +2 to +3 points. With increasing slaughter weight the tenderness score for LD was unchanged or slightly higher (see comments above regarding cold shortening). For ST the tenderness score was reduced with increasing weight. This was very significant for bulls, while steers only showed small changes. These results are in accordance with Sørensen (1981).

Table 3. Sensory evaluation[1] of Longissimus Dorsi served as medium cooked steaks

	Colour	Flavour	Tender-ness	Juici-ness	Overall impres-sion	Cooking loss, %
Sex						
Bulls	2.4a	1.5a	0.0a	2.4a	0.2a	19.0a
Steers	2.6a	2.7b	2.2b	2.6a	2.0b	16.2b
Slaughter weight						
425 kg	2.3a	1.8a	0.8a	2.0a	0.7a	19.3a
550 kg	2.6b	2.1a	1.0a	2.6ab	1.1ab	17.7b
675 kg	2.6b	2.5b	1.4a	3.0b	1.6b	15.9c
Feed level						
AL	2.7a	2.4a	1.2a	2.7a	1.4a	16.7a
R	2.5a	2.2ab	1.7a	2.5a	1.5a	17.8a
VR	2.4a	2.0b	0.6a	2.3a	0.8b	18.3a
VR/AL	2.5a	1.9b	0.8a	2.5a	0.8b	17.7a

Values in the same column bearing different superscripts are significantly different ($P < .05$).
1) Scale from +5 (like extremely) to -5 (dislike extremely), where 0 is neither like nor dislike.

Table 4. Sensory evaluation[1] of Semitendinosus served as thin slices of rare cooked roastbeef.

	Colour	Flavour	Tender-ness	Juici-ness	Overall impres-sion	Cooking loss, %
Sex						
Bulls	2.2a	2.1a	1.6a	3.1a	1.4a	14.9a
Steers	2.5b	2.7b	2.5b	3.2a	2.4b	13.9b
Slaughter weight						
425 kg	1.7a	2.1a	2.5a	2.9a	1.9a	13.8a
550 kg	2.5b	2.5b	2.0ab	3.3b	1.9a	14.5a
675 kg	2.9c	2.6b	1.8b	3.3b	1.9a	15.0a
Feeding level						
AL	2.6a	2.6a	2.3a	3.3a	2.2a	14.0a
R	2.5a	2.5ab	2.2a	3.2a	2.1ab	14.8a
VR	2.2a	2.4bc	2.1a	3.1a	2.0bc	14.3a
VR/AL	2.2a	2.1c	1.7a	3.0a	1.6c	14.6a

Values in the same column bearing different superscripts are significantly different ($P < .05$).
1) See Table 3.

The taste panelists preferred the colour, the flavour and the juiciness from the heavier and fatter animals. The sensory evaluation scores of LD and ST had a tendency to become slightly higher with increasing feed level.

Conclusions

Steers had a considerably higher intramuscular fat content than bulls, and steer meat was more tender and uniform than meat from bulls.

These results are in accordance with previous experiments. The results show that - when steers and bulls are compared - the difference between the two sexes will depend on the age, weight and feed level at which the comparison has taken place.

Literature

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