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Eating quality in Danish cattle as related to sex and age.

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Introduction

The beef cattle population in Denmark consists mainly of Red Danish and Danish Friesian, both of which are dual purpose breeds. Traditionally the main emphasis has been placed on milk production and the production of high quality 250 kg live weight skimmilk fed calves for export.

An official grading system for all male animals was introduced on a trial basis from April 1st this year in order to improve the conformation of carcasses as this is the major quality criterion in the beef trade at present. It could also be foreseen that some sort of grading of meat cuts for retail sale might be required.

The Danish Meat Research Institute has a great deal of information from calves and experimental young bulls and steers, but only few experiments have involved determinations of the eating quality of commercial beef. This paper describes the results obtained in the first systematic experiment to investigate the eating quality in different commercial categories of beef.

Experimental

A total of 119 commercial animals were bought and slaughtered by a major beef plant. The animals represented the average quality available on the market of the categories shown in Table 1. 20 young bulls from the progeny testing station "EGTVED" formed a reference group.

Table 1. Experimental material

Category		No. of animals	Breed	Approximate age	Live weight (kg)	Dressed weight (kg)
"EGTVED" young bulls		20	Danish Friesian	12 months	449	256
COMMERCIAL	Young bulls	20		2 years	573	313
	Steers	20		$2\frac{1}{2}$-3 years	592	323
	Heifers	20		2-$2\frac{1}{2}$ years	466	248
	Cows I	20		$2\frac{1}{2}$-3 years	499	256
	Cows II	19		3-5 years	563	284
	Cows III	20		5-7 years	617	292

The carcasses were chilled at 6°C for 24 hours and stored at 4°C according to the Institute's experimental program (Buchter, 1970). 2-3 days after slaughter the right sides were dissected into muscle, bone and fat. Three different cuts were investigated from each animal. These cuts were chosen to represent different carcass positions and different muscle types with regard to the content of connective tissue and to whether the muscles had primarily light or dark muscle fibres. These cuts were the semitendinosus and triceps brachii muscles and part of longissimus dorsi. These muscles were vacuum packed and aged at 4°C to 13-14 days post mortem. After ageing the muscles were sampled and analysed as described in Figure 1.

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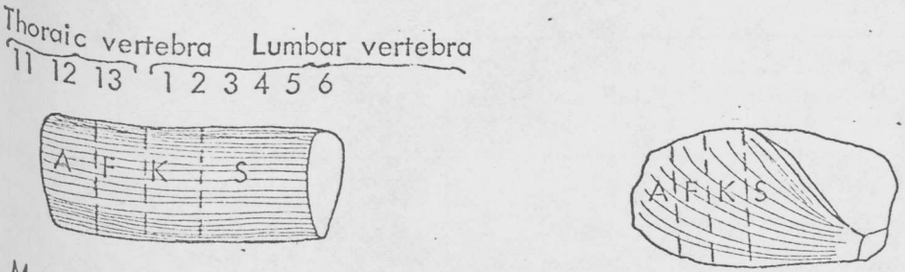
Figure 1. Sampling of muscles



M. Longissimus dorsi (loin muscle)

M. Triceps Brachii (shoulder muscle)

M. Semitendinosus (thigh muscle)

A = Minced for analysis of fat ect..

F = 2 cm slice vacuum packed for colour measurement on Elrepho.

K = 6 cm slice cooked in water to a centretemperature of 70°C. 10 x 20 mm fibre-parallel strips were then cut out for objective measurements of tenderness.

S = Repacked in vacuum bags and frozen at - 40°C until used for taste panel.

Objective measurements of the tenderness (consistency value) were performed on an Instron Universal Testing Machine fitted with a pair of rounded wedges similar to wedges used on the Volodkewich Apparatus. The consistency values were calculated as the average force in kg which had to be applied before the wedges had bitten through 8 mm of the 10 mm high (20 mm wide) fibre-parallel strips.

Taste panel evaluation took place on steaks prepared by frying without addition of fat. 23 mm wide slices were sawn from the frozen samples. After thawing the slices were placed on a 170°C hot griddle plate and fried for 12 minutes for the longissimus dorsi muscle, 14 minutes for the semitendinosus muscle, and 16 minutes for the triceps brachii muscle. These times were chosen so the centre of the steaks just turned from light pink to grey. A panel of 8 experienced judges scored the samples for fried colour, flavour, juiciness, tenderness, and total impression on a hedonic scale from + 5 to - 5.

Results.

Intramuscular fat. All categories had a fairly low intramuscular fat content (Table 2). The steers, heifers, and cows had an average of 2.5% in the loin muscle, while the commercial young bulls had as little as 1.1%.

In order to evaluate the influence of the fat content on the tenderness, the panel scores for tenderness in the loin muscle were plotted against the % fat in the same muscle. A low but highly significant correlation was found when all seven categories were considered ($r \sim 0.3$). The "threshold values" above which samples with a higher % fat mostly received tenderness scores better than - 1 point, increased from 1.5-2.0% for young bulls and steers, to 2-3% for heifers and cows 1, and to 3-4% for the older cows.

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Table 2. Results of analyses and taste testing

Muscle		Property	"EGTVED" YOUNG BULLS $\bar{x}$ s	COMMERCIAL YOUNG BULLS $\bar{x}$ s	STEERS $\bar{x}$ s	HEIFERS $\bar{x}$ s	COWS I $\bar{x}$ s	COWS II $\bar{x}$ s	COWS III $\bar{x}$ s
LONGISSIMUSDORSI	Analyses	% Fat	1.6±0.5	1.1±0.5	2.8±1.1	2.5±1.3	2.3±0.8	2.5±1.1	2.5±1.0
		Colour R_{535}	14.1±1.0	12.3±0.6	11.1±0.6	10.5±0.8	-	10.4±0.6	10.4±0.6
		Consistency kg	9.8±3.9	9.6±2.4	6.5±1.9	8.4±3.6	8.3±2.1	9.9±3.6	11.2±2.7
	Taste Panel	Flavour	1.5±0.8	-0.1±1.4	0.4±1.5	0.0±1.2	0.5±1.5	0.4±1.3	1.1±1.1
		Juiciness	1.7±0.6	2.0±0.7	2.1±0.9	2.3±0.6	2.5±0.6	1.9±0.6	1.9±0.6
		Tenderness	0.9±1.9	-0.2±1.6	2.0±1.5	1.6±1.7	0.6±1.6	-0.3±1.2	-0.6±1.4
		Total impression	0.9±1.2	-0.5±1.3	0.6±1.4	0.2±1.1	0.3±1.5	-0.3±1.0	-0.1±1.1
TRICEPS BRACHII	Analyses	% Fat	1.2±0.5	0.9±0.2	2.6±0.8	2.6±0.8	2.2±0.7	2.7±0.9	2.4±0.8
		Colour R_{535}	13.6±0.7	12.5±0.8	11.1±0.4	11.3±0.5	10.9±0.4	10.6±0.4	10.5±0.4
		Consistency kg	9.2±1.3	11.8±1.4	9.5±1.3	10.2±1.6	10.6±1.5	11.0±2.4	12.0±2.8
	Taste Panel	Flavour	0.6±0.8	-0.6±1.2	-0.6±1.1	-0.8±1.2	-0.2±0.9	0.0±1.4	1.0±0.8
		Juiciness	1.1±0.8	1.2±1.1	1.5±0.6	1.6±0.6	1.5±0.6	1.4±0.5	2.1±0.6
		Tenderness	0.3±1.1	-1.2±1.3	-0.5±1.3	-0.3±1.1	-0.9±1.3	-1.3±1.0	-1.4±0.8
		Total impression	0.2±0.9	-1.1±0.9	-0.8±0.9	-0.8±1.1	-0.7±0.9	-0.8±1.1	-0.6±0.6
SEMITENDINOSUS	Analyses	% Fat	1.1±0.2	1.0±0.3	2.0±0.6	1.5±0.4	1.6±0.4	1.8±0.4	1.5±0.5
		Colour R_{535}	18.0±1.4	14.9±1.1	12.4±1.4	13.5±1.4	13.2±1.1	12.0±1.0	12.8±1.0
		Consistency kg	8.8±1.5	10.9±2.0	9.8±1.2	10.5±1.1	11.0±1.4	12.6±1.3	13.0±1.8
	Taste Panel	Flavour	0.4±0.6	-0.5±0.9	-0.7±0.9	-0.6±0.9	-0.4±1.0	-0.6±1.3	0.3±0.8
		Juiciness	0.3±0.7	0.9±0.6	0.6±1.0	1.0±0.7	0.8±0.5	0.7±0.8	0.8±0.6
		Tenderness	0.2±0.9	-0.8±1.3	-1.5±0.8	-1.0±0.9	-1.6±1.2	-2.5±0.7	-2.6±0.7
		Total impression	-0.2±0.8	-1.1±0.8	-1.4±0.7	-1.0±0.7	-1.0±1.1	-1.7±0.8	-1.5±0.4

Whether or not such "threshold values" do exist and are reliable enough for practical purposes have to be confirmed by further experiments. It is, however, important to notice that the majority of the animals in this experiment, with the exception of the steers, contained less intramuscular fat than the suggested "threshold values".

Fresh meat colour. The colour values are shown in Table 2. A higher R_{535} value indicates a lighter meat colour, and a difference of 1 to 2 units can be seen by a trained eye. Practical differences in meat colour were only found for the young bulls. The 12 months old "EGTVED" young bulls had the lightest colour in all three muscles. The commercial young bulls (2 years) had also a lighter meat colour than the steers, heifers, and cows, but from 2 years and upwards the meat darkened only slightly with increasing age. No correlation was found between meat colour and tenderness in this experiment. The emphasis placed on meat colour by the trade to predict the quality of the prepared meat is not confirmed by these results.

Taste-panel results. The panel's scores for total impression of steaks from the longissimus dorsi muscle were highly correlated with flavour scores ($r \sim 0.8$) and tenderness scores ($r \sim 0.7$) and indicate the importance of these two factors. Off-flavour are very seldom found in young bulls from "EGTVED", but as these animals are still very young and only have a low intramuscular fat content the beef flavour is not fully developed. The panel's flavour scores of 1.5 points for the loin muscle is, therefore, typical for these animals when judged as beef. The average flavour scores for loins from the commercial animals cannot, however, be considered satisfactory (Table 2, Figure 2).

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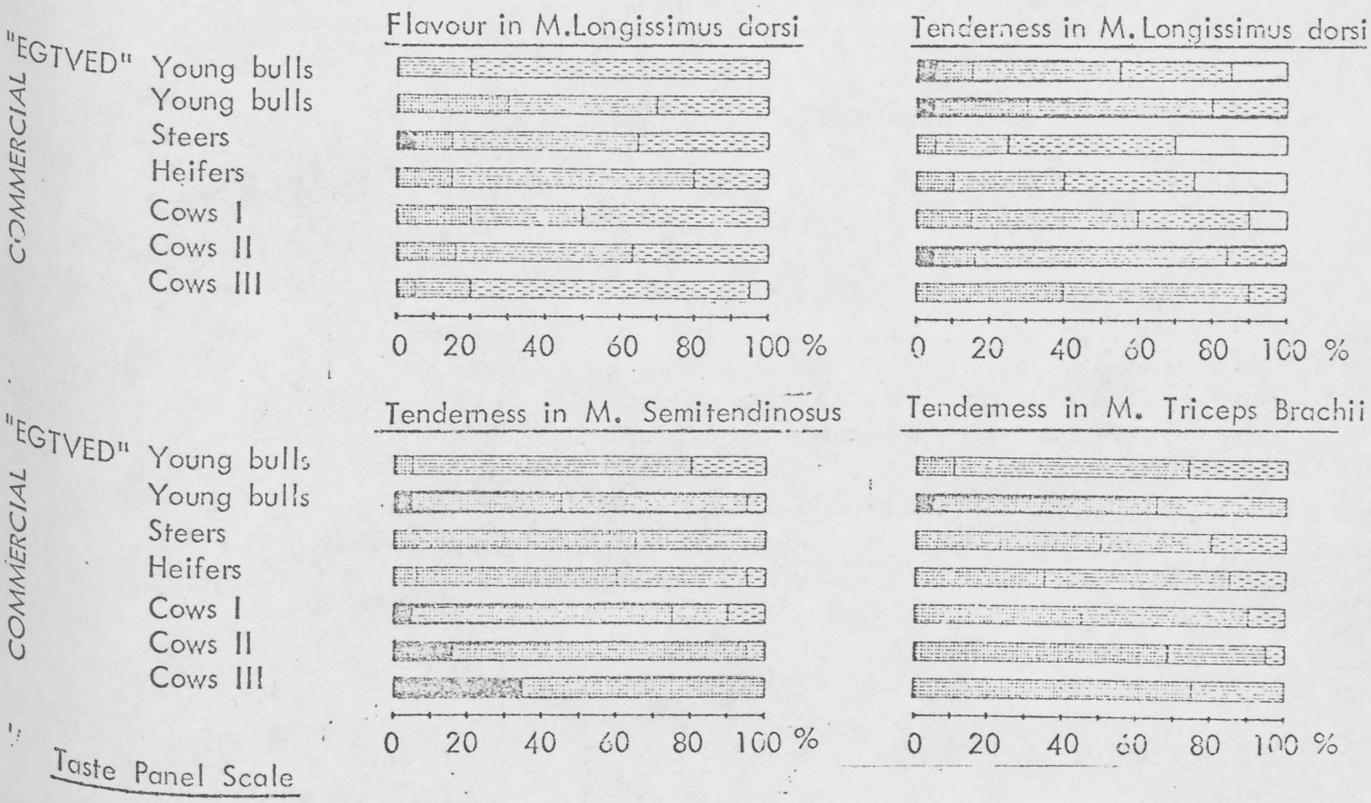
Figure 2. Distribution diagrams for taste panel scores for flavour and tenderness



The flavour in the longissimus dorsi muscle was related to the flavour in triceps brachii and semitendinosus muscles ($r \sim 0.73$ and 0.65 respectively). Tenderness scores are shown in Table 2 and Figure 2. Significant differences in tenderness between the different categories were found to be related to age and sex. In the loin muscle the highest average scores were obtained by steers and heifers. The tenderness decreased with increasing age for both cows and young bulls. The least tender categories were the young bulls when age is considered. The 12 months old "EGTVED" young bulls thus obtained the same scores as the cows I, while the 2 years old commercial young bulls corresponded to the cows II.

For the thigh muscle, semitendinosus, the age was the overall dominating factor in the development of the toughness. The tenderness scores dropped from 0.2 points for "EGTVED" young bulls to -2.6 points for cows III. Age was also the most important factor for the tenderness in the shoulder muscle, triceps brachii. But the influence of sex could be seen in the increased toughness in the commercial young bulls. Within each category the tenderness scores for the longissimus dorsi muscle were related to the tenderness scores in triceps brachii and semitendinosus muscles ($r \sim 0.4$ in each case). The correlation between the tenderness in the three muscles was better when calculated from the consistency values ($r \sim 0.6$ and $r \sim 0.4$).

The objective tenderness measurements supported the taste panel's findings but the regression lines between consistency values and the panel's scores varied with category and muscle.

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Discussion

The present experiment, the first of a series, was designed to examine the eating quality of beef, bred and fed locally and treated post mortem under optimal standardized conditions. Such information is of some importance not only in connection with the establishment of a grading system of cuts for retail sale, but also to provide advice on the breeding and feeding of Danish beef animals which may lead to their improved eating quality.

All the animals were of one breed and represented the average quality in terms of carcass conformation, according to their age and sex, available on the open market. Given this variation, it was possible to find differences in tenderness which could be explained largely in terms of the age and sex of the animals, but these were of such a magnitude that the average consumer would detect them too. In addition, there were marked variations in meat flavour both within and between groups, but there was a clear indication that the flavour of the meat from commercial animals was less acceptable.

The results of the taste panel investigations on individual muscles were so correlated that it may be possible in future experiments to restrict such evaluations to one muscle, longissimus dorsi.

In view of the pattern of increasing beef consumption in Europe, it might be necessary to consider additional methods of production of superior beef to supplement the traditional method used in Denmark, i.e., from calves fed skimmilk. The potential alternative is the rearing of males from sires with proven ability to produce offspring superior in meat and carcass quality. These animals could be slaughtered at 1 year intact or at 18 months as steers.

Acknowledgement

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