Effect of type of feed and feeding level on the meat quality and yellowness of the fat in cows

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SUMMARY: Twenty-seven Jersey cows were distributed on 6 different feeding regimes and slaughtered 30 weeks after calving. Results showed lower Hunterlab saturation values for the fat and a tencency towards less yellow fat colour and towards a higher intramuscular fat content in groups fed on a high energy level with low carotene content the last 8 weeks before slaughter compared to groups fed on a normal energy level in the same period. The carotene content was considerably higher in the group fed with a high carotene diet the 30 last weeks before slaghter than in the other groups. The scores for colour of the fat and overall impression of the meat were also slightly lower in that group.

INTRODUCTION: Many cows have poor muscularity and yellow fat at slaughter. These two factors are part of the beef carcass grading system in many countries and will in Denmark influence the price which the farmer can get for the cows.

It is known that the yellow fat is caused by beta-carotene in the animal's feed. It is most often seen in animals of the Jersey breed. It is also known that a period with ad libitum finishing feeding with a high energy level will improve the muscularity of cows (Liboriussen & Klastrup, 1988).

An examination has, therefore, been carried out in a close cooperation between the National Institute of Animal Science and the Danish Meat Research Institute. The objective of the experiment was to investigate, whether it is possible to improve the carcass characteristics and the meat quality of Jersey cows and to reduce the yellowness of the fat. This is attempted by feeding at a high energy level in the last 8 weeks before slaughtering and by using a low carotene diet. This paper decribes the results on the colour of the fat and on the meat quality.

MATERIALS and METHODS: The investigation included 57 cows over a period of two years, but only 27 cows are slaughtered at the moment. The cows were of the Jersey breed and were first and second calf cows. Before the start of the experiment the cows were fed on high carotene diet (grass-silage or grass). The cows were distributed on 6 treatments shown in Table 1.

Table 1: Experimental design

Treatment	Feeding, weeks after calving		
	0 - 20	20 - 22	22 - 30
1a	High energy level, High carotene	Adaption period	Normal energy level, High carotene
1b	High energy level, High carotene		High energy level, Low carotene
2a	High energy level, Low carotene		Normal energy level, Low carotene
2b	High energy level, Low carotene		High energy level, Low carotene
3a	Low energy level, Low carotene		Normal energy level, Low carotene
3b	Low energy level, Low carotene		High energy level, Low carotene

The feed with a high carotene content consists of grass-silage, and the feed with low carotene consists of corn-silage. In the first 20 weeks after calving all the cows were fed ad libitum. The last 8 weeks before slaughtering half the cows in three groups were fed at a normal energy level (a) and the remainder at a high energy level with corn-silage (b).

The cows were slaughtered 30 weeks after calving. All animals were transported, slaughtered, chilled and evaluated according to the Institute's standard procedures. This includes that the carcasses were electrically stimulated with low voltage. The carcasses were chilled at 12°C for 4 hours, at 5°C for 3 hours and then kept at 3°C. During the chilling the colour of the fat cover was evaluated subjectively.

The day after slaughter carcass composition was determined by separation of the right side from each carcass into saleable meat, excess fat and bone. Samples from the Longissimus Dorsi muscle and from the fat above the LD were selected for meat quality evaluation according to the methods recommended by Boccard et al., (1981).

The samples were vacuum-packed and aged until 7 days after slaghter at 4°C. 7 days post mortem the anterior part of LD was divided into the following samples: A 6 cm thick steak for shear force measurement, a 2 cm steak for colour measurement and the remainder of the LD was minced for measurement of ultimate pH and analysis of intramuscular fat content.

The shear force samples were vacuum packed and frozen. These samples were at a later stage thawed at 5°C, cooked to a final internal temperature of 72°C and cooled. Strips of meat with a cross section of 10 x 20 mm were cut in the plane perpendicular to the direction of the fibre bundle. Each strip was sheared once with a Volodkewich shear attachment on a Karl Frank 81559.

The Hunterlab-colour was measured on a Datacolor Dataflash 2000 after the steak had been exposed to air for about 80 min. The fat above the LD was measured after the same treatment, and the fat was then minced and frozen. The carotene and other yellow pigmentation in the fat were extracted according to a method decribed by Andersen (1991), and measured at 450 nm. The content of intramuscular fat was determined by using the Soxtec HT-H+.

The LD samples for sensoric evaluation were aged until 15 days post mortem at 2°C and then frozen at -40°C. The samples were cut into 23 mm thick steaks and thawed at room temperature for about 2 hours before being prepared on a griddle plate until the steaks had a centre temperature of approx. 65°C. Eight trained panelists evaluated the samples for colour of fat, colour of meat, flavour, tenderness, juiciness and overall impression using a scale from 0 to 10, where 10 is best.

The results from the 27 cows from the first year of the experiment were analyzed by analysis of variance using the Statistical Analysis System (SAS, 1985). The model included the six treatments as a main effect. Slaughtering of the cows from second year of the investigation has just begun.

RESULTS and DISCUSSION: The cows were slaughtered at an average live weight of 363 kg. Meat quality characteristics of LD from 27 cows are presented in Table 2. The feeding did not have any substantial influence on the meat quality characteristics, but there was a tencency towards a higher intramuscular fat content in group (b) fed on high energy level the last 8 weeks before slaughter, compared to group (a) fed on a normal energy level in the same period. Miller et al. (1987) found, that mature cows fed on high-energy diet were fatter and had more marbling than cows fed on a maintenance-energy diet 84 days prior to slaughter. Similar results were found by Liboriussen & Klastrup (1988).

Table 3 shows the quality characteristics of subcutaneous the fat cover and of the fat above LD. The Hunterlab saturation value and the carotene content were lower in the groups fed on high energy level the last 8 weeks before slaughter than in those fed on a normal energy level in the same period. The carotene content was considerably higher in the group fed with high carotene in the last 30 weeks before slaghtering (1a) compared to the other groups. A subjective evaluation showed a tendency towards a less yellow colour of the fat cover in group b than in group a.

A similar reduction in the yellowness of the fat was found in a Danish experiment with young Jersey-bulls (Jensen & Klastrup, 1991), where the young bulls were fed ad libitum with a low carotene diet for the last 1 1/2 to 3 months before slaughtering.

Sensoric evaluation of LD (Table 4) showed that the scores for colour of fat and overall impression were slightly lower for group 1a than for the other groups, because the fat was too yellow and, therefore, was assumed to be old. The panelists found that the meat from all groups was very tender and juicy. Miller et al. (1987) concluded that a high-energy diet resulted in cooked LD-steaks that were easier to fragment and lower in detectable connective tissue compared to a maintenance-diet. The cows in that experiment were older than the cows in this investigation, where the results are based on only a few animals. In another experiment it has been found than meat from the Jersey-breed has a very good quality (Andersen et al., 1986).

CONCLUSIONS: Results from 27 Jersey cows indicate that the yellowness of the fat will be reduced if Jersey cows are fed at a high energy level in the last 8 weeks before slaughtering using a low carotene diet (corn-silage) even if the cows had been fed with a high carotene diet before the finishing period. Feeding at a low energy level will not reduce the yellowness of the fat.

The meat from the Jersey cows had a good quality. The feeding did not have a substantial effect on the meat characteristics, but the taste panelists found that the fat was too yellow when the cows were fed a high carotene diet for the last 30 weeks before slaughtering.

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Table 2: Meat quality characteristics of Longissimus Dorsi muscle

	Treatment						Significance
	1a	1b	2a	2b	3a	3b	
Number	4	5	4	4	5	5	
pH ultimate	5,45	5,47	5,45	5,44	5,46	5,43	NS
Hunter:							
Lightness	31,3	30,7	31,7	33,3	33,0	31,9	NS
Hue	25,5	24,7	25,2	25,4	25,6	25,4	NS
Saturation	20,9	20,9	21,0	22,7	21,4	21,5	NS
% intramuscular fat	4,3	6,5	5,0	7,2	3,5	4,3	NS
Shear force value, kg	6,0	5,5	6,5	4,9	6,2	5,9	NS

Table 3: Quality characteristics of the fat cover and the fat above the Longissimus Dorsi muscle

	Treatment						Significance
	1a	1b	2a	2b	3a	3b	
Meat/fat colour 1)	5,0	4,4	4,5	3,5	4,6	4,2	NS
Hunter:							
Lightness	59,6	61,1	63,6	64,6	64,2	62,8	NS
Hue	71,7	74,1	70,9	72,3	67,4	71,6	NS
Saturation	$28,2^{c}$	$21,9^{ab}$	$22,4^{abc}$	$16,7^{a}$	$25,0^{bc}$	$21,9^{ab}$	*
Carotene content, ppm. 2)	$18,7^{c}$	$4,6^{ab}$	$7,1^{ab}$	$1,7^{a}$	$9,8^{b}$	$6,0^{ab}$	***

Values in the same line with different letters are significantly different.

1) Subjective evaluation of the fat cover: 1 = very light, 2 = light, 3 = normal, 4 = slightly dark/yellow, 5 = yellow

2) Content of other yellow pigmentation is included

Table 4: Sensoric evaluation[1] of the Longissimus Dorsi muscle served as medium cooked steaks

	Treatment						Significance
	1a	1b	2a	2b	3a	3b	
Colour of fat	4,1	5,9	5,9	7,1	5,6	6,0	NS
Colour of meat	8,4	8,5	8,6	8,7	8,6	8,7	NS
Flavour	7,9	8,5	8,4	8,8	8,3	8,4	NS
Tenderness	8,1	8,6	8,4	8,9	8,0	8,3	NS
Juiciness	8,3	8,4	8,6	8,9	8,5	8,6	NS
Overall impression	$7,2^{a}$	$8,1^{bc}$	$8,1^{bc}$	$8,6^{c}$	$7,8^{ab}$	$8,1^{bc}$	*

Values in the same line with different letters are significantly different.

1) Scale from 0 (dislike extremely) to 10 (like extremely)