Effect of feeding period on carcass and meat quality of dry cull cows

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Background.

A major part of the beef marketed for Danish retail consumers originates from dairy cows slaughtered when they are culled from milk production. As these cows are often slaughtered in various stages of lactation and with variable degrees of fatness the meat is often criticised for having a considerable variation in eating quality. In the first part of the lactation the dairy cow is often in a negative energy balance. However, to obtain good eating quality, it is assumed that the cows should be in a positive energy balance. Fat cows generally display more marbling in the meat. Previous research has documented that it is possible to fatten cows during lactation (Liboriussen & Klastrup, 1988), the effect on the eating quality of fattening dry cows has however not been investigated thoroughly.

Objectives

The purpose of this experiment was to investigate the effect of feeding dry Danish Friesian cull cows for 0, 2 or 4 months on carcass- and meat quality.

Methods

63 lactating Danish Friesian cows were purchased from commercial dairy herds and housed on an experimental station. The cows were culled by the farmer for different reasons. Three treatment groups were established (21 cows/group); a control group slaughtered after 7 days of drying off (C), a group dried off for 14 days and finishing-fed for a further 56 days (F2), and a group dried off for 11 days and finishing-fed for a further 122 days (F4). Half of each group was first lactation or older cows, respectively. Cows were housed in tie-stalls. In the drying-off period, the cows had free access to barley straw and water. In the finishing period, the cows had free access to a total mixed ration (10,6 MJ ME/kg DM and 130 g crude protein/kg DM) (Vestergaard & Madsen, 2000). A wide number of registrations were made during the feeding period. The results on production performance will be reported elsewhere.

At the day of slaughter, the cows were transported to the abattoir tied (< 1 hour). The animals were slaughtered immediately on arrival to the abattoir. Low voltage electrical stimulation was applied to the carcasses approximately 10 minutes after stunning. The carcasses were classified according to the EU-scheme and chilled at an air temperature of 10°C so that no part of the carcass reached a temperature below 10°C within 12 hours after stunning. Two days after slaughter pH was measured in the longissimus dorsi (LD) muscle. pH averaged 5.7 for all groups with an overall standard deviation of 0.1. A photograph was taken between the 1st and 2nd lumbar vertebrae to record the loin cross-sectional area (rib eye area). A semi-commercial boning of the right half was performed and weight of cuts, fat trim and bone was recorded. Samples from the LD muscle taken at the 12th and 13th rib and at the 1st lumbar vertebra was selected for laboratory analyses. Sirloin samples were taken for sensory assessment. All samples were vacuum packed. The samples for laboratory analyses were aged for 8 days at 4°C. They were then distributed as follows: The caudal portion of LD were cut out, vacuum packed and stored at –20°C for later measurement of texture. A 2 cm steak of LD was cut for colour measurement. The Hunterlab-colour (L, a and b) was measured on a Datacolor Dataflash 2000 after blooming at 4°C for 80 minutes. The remainder of LD was minced and used for determination of intramuscular fat (IMF) using the Soxtec HT-H$^+$ method and total pigment content using the Hornsey method. The samples for texture measurement were thawed at 5°C, cooked to a core temperature of 72°C and chilled in cold water for 20 minutes. Six strips of 10x20 mm cross section were cut perpendicular to the direction of the fibre bundle. The maximum force required to chew 80% into each strip was measured with a Volodkevich shear attachment on a Kar Frank 81559.

Sirloins for sensory assessment were vacuum packed, aged for 16 days at 4°C and then stored at –20°C until assessment could take place. The sirloins were thawed at 4°C for 20-21 hours, sliced in 23 mm steaks and trimmed completely for subcutaneous fat and tendons. The steaks were fried to a core temperature of 62-65°C. Trimming and cooking loss were recorded. The panel consisted of 8 trained assessors who evaluated the tenderness and juiciness of the meat on a scale from 0 to 15 according to an increasing intensity of the trait. The panel mean was calculated for each trait.

Data were analysed with Proc Mixed in SAS version 6.04 (SAS, 1985) using the following statistical model:

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + (\alpha_i * \beta_j) + \gamma w_k + \varepsilon_{ijkl}$$

Where Y_{ijkl} is the analysed trait, μ is the overall least square mean, α_i is the fixed effect of the i´th treatment (0,2,4), β_j is the fixed effect of the j´th lactation (1,>1), γ is the linear regression coefficient of the weight (w_k) of the individual cow at the beginning of the experiment expressed as a deviation of the mean weight within lactation groups (young or older cows) and ε_{ijkl} is the random residual

Results and discussions

The main effects of feeding period on carcass and meat quality are presented in Table 1. Feeding of the dry cows for 2 or 4 months showed a marked effect on the carcass size as well as on the composition of the carcass. Finishing the cows for 2 or 4 months increased the carcass weight 42 and 82 kg, respectively. Two months of feeding increased the dressing percentage from 45.1 to 47.2% while there was no significant effect of feeding for a further two months. EUROP conformation score increased one point on the scale by going from 0 to 2 or from 2 to 4 months of feeding. EUROP fatness on the other hand increased from 0 to 2 months but

not significantly from 2 to 4 months. The amount of saleable meat increased approx. one percentage unit for each 2 months increase in feeding time. Feeding for 2 month did not increase the cross sectional area of the rib eye significantly whereas the F4-cows had considerably larger areas. Factors expressing the fat deposition of the carcass (amount of caul and kidney fat, fat thickness over rib eye, dissection of loin) all showed a marked increase in the amount of fat deposited in the carcass with increasing time at feed. The C-cows had 2.8% IMF while the F2-cows had 4.0% and the F4-cows had 5.3%. Shear force did not differ significant between groups nor did the sensory panel detect any difference in tenderness or juiciness. The lightness was slightly higher in the F4-group than in the control group. These results are confirmed by the pigment content, as the control group had 234 ppm compared to 210 ppm (F2) and 214 ppm (F4). Due to the high amount of subcutaneous fat deposited (in F2 and F4), it was decided to trim the steaks before cooking. This resulted in a trim loss of 39% in the F4 group and 28 to 31% in the two other groups. The cooking loss amounted 17 to19%, which is not unusual for this category of beef.

Overall, the meat in all groups had a very fine texture (shear force 5.2 to 5.7 kg) which is as the same level as steers most commonly known for having an excellent meat quality. Surprisingly the meat quality of the control group was as good as the two treatment groups and one could speculate whether the drying off treatment may have influenced the meat tenderness probably by elevating the protein breakdown pre mortem due to the very low feeding level ?

Conclusions

Feeding cull cows for 2 or 4 months resulted in a marked improvement of carcass weight, EUROP conformation, rib eye area and percentage saleable meat, but did also increase the fattening of the carcasses considerably. In general the meat quality was very fine expressed as shear force (5.2 to 5.7 kg) as well as the sensory assessment. It is surprising that the overall meat quality of the control cows did not differ from the cows fed for 2 or 4 months.

Pertinent literature

Liboriussen, T. & Klastrup (1988). Fedning af slagtekøer. Medd. Nr. 715, Danish Institute of Agricultural Sciences, Denmark.

SAS (1985). SAS stat. SAS institute Inc. Cary NC.

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Table 1. Carcass and meat quality. Least square means by treatment groups.

	Treatment			Level of significance
	C	F2	F4	
Number of animals	21	21	21	-
Carcass weight	254^{a}	296^{b}	336^{c}	***
Dressing percentage	$45,1^{a}$	$47,2^{b}$	$48,2^{b}$	***
EUROP conformation	$2,7^{a}$	$3,6^{b}$	$4,7^{c}$	***
EUROP fatness	$2,1^{a}$	$3,0^{b}$	$3,4^{b}$	***
Hindquarter (kg)	$59,8^{a}$	$67,8^{b}$	$75,4^{c}$	***
Caul + kidney fat (kg)	$11,2^{a}$	$17,9^{b}$	$27,2^{c}$	***
Rib eye area (cm^2)	$52,2^{a}$	$54,0^{a}$	$62,2^{b}$	***
Fat thickness (mm)	$3,4^{a}$	$5,1^{a}$	$9,7^{b}$	***
Dissection of loin:				
Lean, %	$62,2^{a}$	$59,1^{b}$	$54,9^{c}$	***
Fat, %	$12,1^{a}$	$19,2^{b}$	$26,3^{c}$	***
Bone, %	$25,7^{a}$	$21,6^{b}$	$18,7^{c}$	***
Saleable meat, %	$73,5^{a}$	$74,5^{b}$	$75,7^{c}$	***
Colour:				
Lightness (L)	$33,0^{a}$	$34,1^{ab}$	$35,0^{b}$	**
Redness (a)	$21,1^{ab}$	$20,9^{a}$	$21,8^{b}$	*
Yellowness (b)	$9,7^{a}$	$10,0^{a}$	$10,5^{b}$	**
Intramuscular fat, %	$2,8^{a}$	$4,0^{b}$	$5,3^{c}$	***
Shear force (kg)	5,7	5,5	5,2	Ns
Pigment (ppm)	234^{a}	214^{b}	210^{b}	*
Tenderness (0-15)	9,2	9,3	9,5	Ns
Juiciness (0-15)	10,2	10,4	9,7	Ns
Trim-loss, % (n=53)	$28,2^{a}$	$30,8^{a}$	$39,2^{b}$	***
Cooking loss, %	$17,2^{a}$	$18,9^{b}$	$18,7^{b}$	*

ns: p≥0,05; *: p<0,05; **: p<0,01; ***p<0,001

^{abc} Means within a line with different letters are different (p<0,05)