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TENDERNESS OF MEAT FROM CALVES SLAUGHTERED AT A TIME WITH MAXIMAL MUSCLE PROTEIN DEGRADATION

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Introduction

The association between tenderness and proteolysis in meat is well established and a linkage to muscle protein degradation in the live animal seems also settled. Thus, an optimisation of tenderness could involve slaughter of the animal at a time with maximal muscle protein degradation and thus expected maximal proteolysis *post mortem*. Experiments with steers (Jones et al., 1990) and rats (Millward et al., 1975) have suggested, that compensatory growth may be a way to maximise muscle protein turnover and thus muscle protein degradation. Thus, in a previous experiment we studied if muscle protein degradation reaches a maximum level during compensatory growth of young Friesian bull calves compared with bull calves offered feed ad libitum throughout the experiment (Therkildsen, 2005). We found that when 5 months old bull calves are fed restrictively for 3 months (50% of ad libitum) followed by ad libitum feeding, they respond with maximal fractional muscle protein degradation 5 to 8 weeks after the change to ad libitum feeding, and the level exceeded the level in control calves by 50 to 25% in this period, respectively. Thus, it is expected that if the calves had been slaughtered after 5 to 8 weeks of ad libitum feeding following the 3 months restriction period, the meat tenderness would have been superior to the tenderness of meat from control calves. Thus, a second experiment with similar calves was conducted to test that hypothesis.

Objectives

The aim of the study was to test if slaughter at a time with maximal muscle protein degradation would improve tenderness of beef.

Methodology

The experiment included 12 Holstein Friesian bull calves born after two sires. The calves entered the study at the age of 5 months and were allocated to two feeding strategies either ad libitum (AA) or restricted/ad libitum (RA) with respect to sire and age. The calves on the AA feeding strategy had free access to a concentrate mixture and a total mixed roughage ration (TMR). The calves on the RA feeding strategy were

restricted in energy intake from 6 to 8 months by allowing them free access to the TMR ration. From 6½ months to the end of the restriction period they were supplied with 1 kg of the concentrate mixture each day. From 8 months they were realimentated and given free access to the concentrate mixture and the TMR ration in 6 weeks. The first week of realimentation the calves were gradually adjusted to the free access of concentrate. All calves were slaughter at the age of 10 months. The calves were weighed at two consecutive days at the beginning of the experiment and at finish of the restriction period and on two consecutive days prior to slaughter.

Urine collection

Two days before slaughter urine was collected from the animals over a 24 h period in order to calculate the fraction breakdown rate of myofibrillar protein on the basis of 3-methylhistidin concentration in urine as described in Therkildsen (2005).

Slaughter procedure

The calves were slaughtered over two days in two following weeks, with 6 calves each day. The calves were slaughtered at the experimental slaughterhouse at Research Center Foulum (500 m), stunned by captive bolt pistol, hung and bled. The carcass was split and weighed. The carcasses were chilled at 12°C for 4 h *post mortem* and then stored at 3°C. Forty-eight hours *post mortem* the carcasses were weighed. *M. semimembranosus* (SM) were cut from both sides, weighed, vacuum-packed and aged until either 7 or 14 days *post mortem* at 3°C before storage at -20°C. The ageing time were switched between the carcass sides. The *M. longissimus dorsi* (LD) from the 2^{nd} to the 5^{th} lumbar vertebra from both sides were cut and aged as described for SM. In addition samples for shear force determination of LD was removed from 10^{th} to 13^{th} thoracic vertebra from both sides and cut in blocks of 7 cm and aged for 2 days (left side, cranial), 7 days (left side, caudal) and 14 days (right side, caudal) before storage as described for samples for tenderness determination.

Shear force

Vacuum-packed samples were heated to 62ºC in a water bath and exercised to rectangular blocks of 1.0 x 1.0 cm thick. Shear force was measured with a Texture Analyser HD100 equipped with a Warner Bratzler shear blade with rectangular hole.

Sensory evaluation of tenderness

The SM was prepared as roasts in an oven (160ºC) until a core temperature of 60ºC was reached. The LD was prepared as 1.5 cm thick steaks placed on a roasting pan in an oven at 160ºC and heated for 3 minutes on each side. A 10 member sensory panel evaluated the tenderness of the meat on a 15 cm unstructured line scale.

Statistics

The data was analyzed using a mixed model (SAS® System, 1996) with the fixed effects of feeding strategy and sire and the interaction between them. In the analysis of

the sensory determination of tenderness, judge and (animal x feeding strategy) was included in the model as a random effects.

Results & Discussion

The bull calves in the present experiment was slaughtered at an age of 10 months and with a live weight of 327 and 407 kg of RA and AA calves, respectively (see table). The live weight of the RA calves do not represent a typical slaughter group in the Danish beef slaughter categories, and was only a result of the wish to set up a similar experiment as the one, which showed a maximal fractional breakdown rate after 5 to 8 weeks of ad libitum feeding of young bull calves following restrictive feeding in 3 months from the age of 5 months. Thus, for an implementation of the compensatory feeding strategy it should be further developed to fit with the live weights of market slaughter categories.

At the time of slaughter, the RA calves had not shown compensatory growth yet, but the factional break down rate of muscle protein was higher than in the AA calves, which do suggest a larger muscle protein turnover at the time of slaughter (se table). However, when the shear force of LD was measured no significant effect of the feeding strategy was observed, whereas the sensory evaluation of the tenderness of LD showed a better tenderness of the meat from calves fed ad libitum through out the experiment (AA) both after 7 and 14 days of aging. In contrast, the tenderness of SM was positively affected by the compensatory feeding strategy both after 7 and 14 days of aging.

The explanation of the different response of the muscles to the feeding strategies and the non expected negative effect on tenderness of LD of the compensatory growth strategy is not clear. The different location of the two muscles and thus different functions in the animal most probably play a role, although fiber type frequency and area percentage is very similar in the two muscles according to the results of Kirchofer et al. (2002). However, Andersen (1975) demonstrated a very different growth pattern of the two muscles, i.e. the growth coefficient of LD being around 1.0 whereas the growth coefficient of SM is calculated to 0.78. Also, the oxidative capacity may vary between the muscles, in spite of similar fiber type distribution. The above facts may all result in different protein turn over and especially difference in muscle protein degradation, which lead to different effect on tenderness of the meat.

Conclusions

Slaughter of 10 months old bull calves after 6 weeks of ad libitum feeding following a 3 months period with restrictive feeding resulted in high fractional muscle protein breakdown rate and a positive effect on the tenderness of SM, but a negative effect on the tenderness of LD compared with similar bull calves fed ad libitum throughout the experimental period. The reason for the different response of the muscles is an issue for future studies.

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Tables and Figures

Table 1. Fractional breakdown rate, shear force and tenderness of bull calves slaughtered at a time with maximal muscle protein degradation (RA) and of control bull calves (AA)

Feeding strategy	AA	RA	SEM	P-value
Age at slaughter, days	301	304	3.5	ns
Weight at slaughter, kg	407	327	8.6	0.001
Fractional breakdown rate, %	1.84	2.57	0.24	0.07
Shear force				
Day 2, kg	8.70	8.50	1.10	ns
Day 7, kg	5.33	6.65	0.75	ns
Day 14, kg	4.36	4.82	0.24	ns
Tenderness LD[#]				
Day 7	8.2	6.2	0.62	0.08
Day 14	9.2	7.1	0.41	0.001
Tenderness SM[#]				
Day 7	8.5	10.2	0.69	0.06
Day 14	9.8	11.6	0.68	0.09

[#]Sensory evaluation of tenderness on a scale from 0-15, 15 being extremely tender