Effect of animal age on cull cow beef tenderness

Niels T. Madsen Danish Meat Research Institute, Roskilde, Denmark e-mail: ntm@dmri.dk

Abstract

Primal cuts of beef are marketed to the Danish consumers but complaints about variable tenderness are increasing. Insufficient tenderness is often explained by the age of the animal despite the fact that scientific documentation for this is unclear. The purpose of this study was to investigate effect of animal age on tenderness in longissimus dorsi and semitendinosus muscles in Danish cull cows when applying optimal slaughter procedures and ageing. Striploins (LD) and eye of round (ST) from 185 cull dairy cows between two and nine years of age were collected at a commercial abattoir. Sensory panel evaluation of hardness at first bite (HLD) and toughness (TLD) at the end of chewing was made on fried LD steaks. ST was prepared as roastbeef for evaluation of hardness (HST) and toughness (TST). Warner Bratzler (WLD) and Volodkewich (VLD) shear force were measured on boiled samples of LD. For ST only Warner Bratzler was used (WST). Very low, simple correlations between age and LD tenderness (HLD 0.30***; TLD 0.31***;VLD 0.09; WLD 0.13) indicated that age is no efficient selection criteria for tender striploins eg. even loins from ten year old animals can be perfectly tender when treated correctly. ST tenderness was more clearly affected by animal age probably due to the higher collagen content of this muscle (HST 0.44***; TST 0.56***; WST 0.40***).

Methods and materials

Striploins from Holstein Friesian (90%) and Red Danish (10%) cull cows were collected in a commercial abattoir. They were selected according to six age groups with the aim to achieve an even age distribution from two to nine years of age based on herd registrations of birth date. Mean age was 5.1 years. The cows had an average carcass weight of 286 kg; standard deviation (SD) 39 kg, EUROP conformation 4.4; SD 0.8 and EUROP fatness 2.8; SD 0.6.

Low voltage electrical stimulation with a pulsating current (80 to 85 volt DC, 14 Hz) was applied to the carcasses for periods of 40 seconds approximately 10 minutes after stunning. Carcasses were 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. 12 hours after stunning the air temperature was reduced to 2°C, and then increased to 4°C from 15 hours after stunning to boning the following day. A fabric tube chilling system ensured an even air distribution around each carcass.

On the day after slaughter the LD was cut from 12th rib to 3rd lumbar vertebra. Samples were aged for 14 days at 4°C. Then a 6 cm thick slice was cut for VLD and another 6 cm slice for WLD. The remaining part was used for sensoric assessment. Samples were vacuum packed and frozen at -20°C. Samples for VLD & WLD were thawed at 5°C, cooked to a final internal temperature of 72°C and cooled. Strips of 10 x 20 mm were cut (6 strips per animal) perpendicular to the direction of the fibre bundle. The maximum force required to chew 80% into the strip was registered with a Volodkewich shear attachment on a Karl Frank 81559. WLD maximum force was also measured on samples prepared just as for VLD using a 0.5 mm rectangular edged knife pulled through the meat against a slit of 1.2 mm. ST was excised along with the LD and aged the same way. Then 12 cm cut from the hip end was sampled for sensoric assessment and the following 6 cm was cut for WST. Sample preparation and shear force measurement, WST was performed as for WLD.

Samples for sensoric assessment were thawed for 18 hours at a temperature of 4°C before cooking. LD samples were cut into 23 mm steaks and fried to a centre temperature of approx. 61°C. ST samples were oven roasted at 180-200°C reaching 50-55°C in the centre. After a rest period of 15-20 min. in alufoil 3 mm slices were served. The test was a sensoric profile analysis, i.e. a taste panel of 9 members made a joint evaluation of the traits best describing tenderness. Two traits were evaluated: hardness (at first bite with back (molar) teeth) (HLD/HST) and toughness (toughness at the end of chewing) (TLD/TST). A scale of intensity from 0 - 15 was used. After each experiment it was checked whether there were differences of opinion between the panel members, interaction between panel members and test groups and reliability of the panel with respect to the individual traits. All tests had a reliability figure around 0.8 which was considered satisfactory (Godt, 1995).

The relationship between tenderness and age was modelled as linear or quadratic if relevant with the GLM-procedure in SAS (SAS, 1985). Likewise correlations to age were calculated with PROC CORR.

Results and discussion

The results of sensoric and mechanical analyses are shown in Table 1. The correlation between VLD and HLD respectively and TLD is in good agreement with previous results by the institute and is to be expected with the variation of material. Shear force (WST) correlation with sensory tenderness was about the same level as for LD (TST 0.54**, HST 0.41**). Maximum force VLD and WLD were moderately correlated indicating that compression and shearing are different characteristics. LD and ST tenderness were poorly related which is probably due to the collagen influence on ST tenderness. The VLD level was surprisingly similar to and not higher than the approx. 7 kg usually achieved for Danish young bulls. HLD and TLD were highly correlated (0.89***) which was also the case for HST and TST (0.77***). Consequently only toughness results are shown in figures.

A linear relationship for sensory tenderness was modelled for LD. Though the model is very poor, it appears that sensory tenderness decreases only about 0.2 panel point per year over 2 years. For mechanically measured tenderness in LD, animal age does not appear to have any practical importance as seen in Figs. 1 and 2. Overall there seems to be little reason to discriminate cull cow beef with respect to LD for reasons of age.

For ST a quadratic model was slightly better (Table 1, Figs. 3 and 4). A linear model for ST indicated that tenderness seems to decrease about twice as fast for WST and TST compared to LD. WST seems to increase by 0.5 kg per year.

Table 1. **Tenderness traits of 185 LD and ST from cull cows, and the relationship between animal age and tenderness.**

Trait	n	Mean	Std.dev./min./ max	Correlation with –			Linear prediction model: Trait= a + b x age			Quadratic prediction model: Trait= a+b₂ x age²	
				Age	VLD	TLD	R^2	RMSE	Estimate	R^2	RMSE
VLD, kg	181	7.13	2.41 / 3.5 / 20.0	0.09^{ns}	–	0.49^{***}	0.008	2.41	0.11^{ns}		
WLD, kg	183	8.20	2.50 / 4.3 / 21.8	$0.13^{p=0.07}$	0.58^{***}	0.46^{***}	0.018	2.48	$0.18^{p0.07}$		
HLD	185	5.47	1.35 / 1.8 / 8.3	0.30^{***}	0.52^{***}	0.89^{***}	0.09	1.30	0.22^{***}		
TLD	185	6.15	1.35 / 2.6 / 10.4	0.31^{***}	0.49^{***}	–	0.10	1.29	0.22^{***}		
WST, kg	183	13.1	2.24 / 7.1 / 22.2	0.40^{***}	$0.13^{p0.08}$	0.33^{***}	0.16	2.06	0.47^{***}	0.17	2.05
HST	185	5.28	1.16 / 2.4 / 8.6	0.44^{***}	0.15*	0.34^{***}	0.19	1.09	0.27^{***}	0.25	1.01
TST	185	6.41	1.18 / 3.6 / 9.5	0.56^{***}	0.10^{ns}	0.31^{***}	0.32	0.98	0.36^{***}	0.35	0.96

R^2 is expected to be slightly overestimated due to selection for achieving equal age representation.
Significance levels: p<=0.001 ***, p<=0.005 **, p<=0.05 *

Conclusion

- **Animal age from two to nine years influences tenderness in LD from cull dairy cows very little and seems to have limited application as a sorting criterium, provided the carcass is chilled gently and the meat is aged. Consequently primal cuts of cull cow beef (like LD) should not be discriminated as poor quality due to tenderness alone.**

- **Animal age does influence tenderness in ST from cull cows linearly or with a quadratic relationship over the age interval from 2 to nine years which may be due to the collagen contribution to reduced tenderness**

References

Godt, J., 1995. Evaluation of measured references for tenderness and statistical models, phase 4, trial 1 and 2. Work nr. 17231/4 18 Aug. Danish Meat Research Institute.

SAS, 1985. SAS stat. SAS institute Inc. Cary NC.

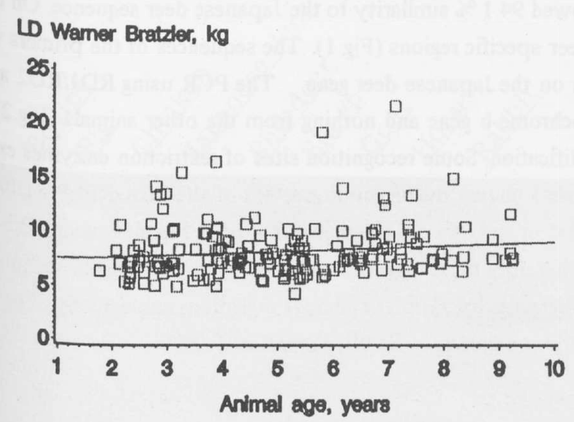

Figure 1.

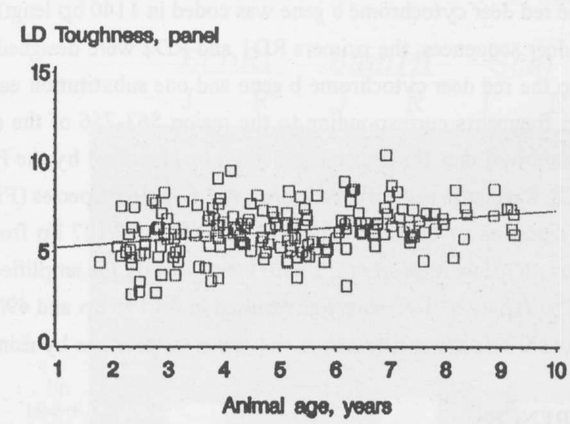

Figure 2.

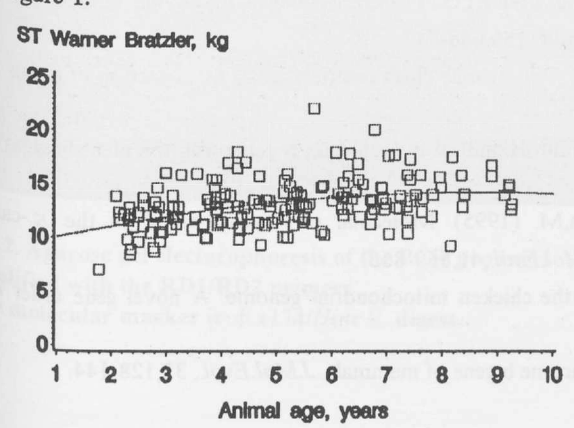

Figure 3.

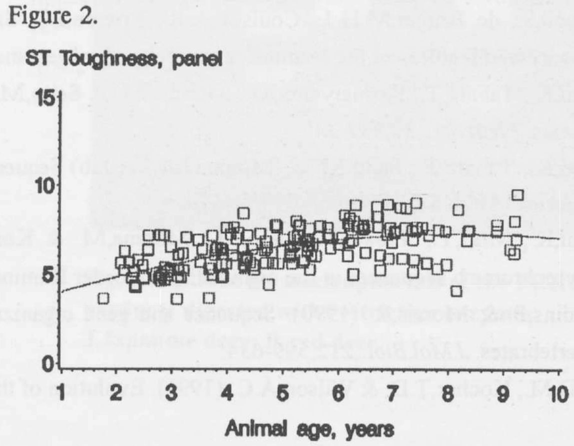

Figure 4.