EFFECT OF CHILLING METHODS ON MEAT TENDERNESS FROM LIGHT VEAL CARCASSES

Borzuta K., Strzelecki J., Borys A. Pospiech E.
Meat and Fat Research Institute, Poland

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Introduction

It has long been known that rapid decrease of meat temperature after slaughter leads to tenderness deterioration as result of cold shortening (Locker and Hagyard 1963; Bendall 1978; Sanudo et al. 1998). Literature data indicate that the lighter the carcasses subjected to rapid chilling, the more extensive the cold shortening in red muscles appears to be. The problem of tough meat caused by rapid chilling was observed first in lambs of lightweight (Marsh and Leet 1966). However, it was soon found that tough meat could also occur in beef, which was chilled too rapidly, as well as in veal (Moerman and Wechel 1973, Klont et al. 1996). Experiments carried out by Dutch researchers (Moerman and Wechel 1973, Klont et al. 1996) concerned veal carcasses weighing approximately 100 kg. Poland is one of very few countries where very light calves are slaughtered at the age of 2 to 6 weeks. It can be presumed that rapid chilling after slaughter of this category of veal carcasses can have a strong influence on the deterioration of meat tenderness. The goal of this study was to analyse, which of the chilling methods applied in meat industry could affect negatively this quality trait.

Material and methods

The experimental material comprised 120 carcasses of young Friesian calves (30 animals in one group) of 40.1 kg average weight (approximately 64 kg live weight). After slaughter, carcasses were chilled using the following methods: method A – conditioning at air temperature from 11 to 14°C for 20 h; method B - conditioning at air temperature of about 15°C for 8 h followed by chilling for 13 h at the temperature of 0 to 2°C; method C – rapid, one-step chilling at the temperature of 0 to 4°C for 20 h; method D – very fast chilling at the temperature of -10°C for 2.5 h followed by chilling at approximately 0°C for 17 h. In the course of chilling the temperature in the centre of the leg was recorded. After chilling, *biceps femoris* muscle was excised from the carcass and roasted at the temperature of 175°C until 80°C in the centre of the sample was reached. Its tenderness was sensory evaluated using the 5 point scale. The shearing force was measured using a Warner-Bratzler apparatus (sample diameter – 2.5 cm). The sensory assessment of tenderness was carried out across the entire cross-section of the muscle, while the measurement of the shear force – in two of its layers: outer (near the skin) and inner (near the bone). Furthermore, consistency measurements in a sample of fresh meat were carried out by means of an AP-41 penetrometer according to Krzywicki's method (1972) using needles of 2 mm diameter. The needle piercing depth of the penetrometer was measured in five muscle layers counting from the outer part towards the inside of the leg.

Results

Changes in the muscle thermal state in the examined carcasses were characterised with the aid of temperature drop index 'Se'. It shows the speed of temperature drop in the centre of leg from 35°C to 18°C and was expressed in °C/h. The mean Se value of the examined carcasses was as follows: method A – 1.29°C/h, method B – 1.59 °C/h, method C – 3.21 °C/h and method D – 4.44 °C/h.

All obtained results associated with tenderness evaluation confirm unequivocally the negative influence of the intensification of the chilling process on the value of this important quality trait of veal. The most tender meat was observed in the control group (method A) and in the group of carcasses which were subjected to slow chilling with the application of the initial 8 hour conditioning at the temperature of 15°C (method B).

Rapid, one-step chilling (method C) resulted in a significant deterioration of meat tenderness to the depth of approximately 3cm from the surface. The toughening of meat tissue - even to the deepest layers of the examined muscles - was observed in the case of chilling by means of the very fast method in which minus temperature of the chilling air during the initial phase of the process was applied. Out of 30 assessed samples of carcasses subjected to very fast chilling, 50% of the material obtained scores below 3 points in the course of sensory evaluation. This meat was qualified as tough.

Moerman and Wechel (1973) reported results similar to those obtained in this study. They found that rapid chilling of veal carcasses weighing approximately 100 kg resulted in tenderness deterioration of 4 examined muscles (slow and rapid method – mean score of 4 muscles – 7.3 and 5,5 points, respectively), significant increase of the W-B shear force (35 and 66 N, respectively) and shortening of the sarcomere length (respectively, 2.1 and 1.7 µm). They stated that, even after 10 days of aging, the meat of calves subjected to rapid chilling was tough. Therefore it can be concluded that cold shortening causing tenderness deterioration leads to negative quality results both in light and heavy slaughter calves.

Conclusions

1. Very fast chilling of light veal carcasses leads to considerable deterioration of meat tenderness in all the examined layers of the *biceps femoris* muscle, while in the one-step method (0 – 4°C temperature) greater toughness is observed only in the 3 cm outer muscle layer
2. Muscle toughness caused by cold shortening can be effectively prevented by conditioning of veal carcasses at the temperature of about 15°C for 8 hours followed by chilling at the temperature of 0°C to 2°C for about 13 hours.

References

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Table 1. Tenderness evaluation of the *biceps femoris* muscle in groups of carcasses subjected to different methods of chilling

Chilling method	Sensory evaluation (points)	Shear force, N Outer muscle layer	Inner muscle layer
A	4,64^a	36,8^a	35,0^a
B	4,66^a	45,6^b	38,9^a
C	4,19^b	69,9^c	54,0^b
D	3,76^c	75,5^c	68,5^c

^{a,b,c,d} – means followed by different indexes are different statistically at $P < 0.01$

Table 2. Consistency measurements of various layers of the *biceps femoris* muscle depending on the chilling method (needle piercing in mm/s)

Chilling method	Successive muscle layers from surface to inside a	b	c	d	e	Significance of differences between layers
A	10,8^t	10,5^t	10,4^t	11,1^t	11,4^t	non-significant
B	11,2^t	11,7^t	11,9^t	12,2^t	12,1^t	non-significant
C	8,2^g	9,3^g	9,4^g	11,4^t	10,1^t	a<b,c (0,05) d, e(0,01)
D	7,9^g	8,3^g	8,8^g	9,3^g	8,3^g	a<d (0,05)

^{t,g} - means followed by different indexes are different statistically at $P < 0.01$