TEXTURE OF PIEMONTESE BEEF CULLED COWS AGED 4-13 YEARS

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Abstract –This study examine the effect of age of the animals and ageing time (d1, d9, d15) on meat texture of ten double-muscled Piemontese culled cows, slaughtered under "young" and over "mature" 5 years of age. The analyses carried out on *longissimus thoracis et lumborum* (LTL) muscle were: pH (at 30 hrs p.m.), sarcomere length, cooking losses (CL), Warner-Bratzler shear force (WB), compression test (CT). The considered parameters for WB were: peak force (PF), initial yield (IY) and their difference (PF–IY). The compression test was performed at 20% (H20%) and 80% (H80%) of original height of the sample. Compared with young cows, mature cows, had a higher PF–IY value. The lower IY and the higher difference PF-IY at d9 and d15 in comparison with d1 certify the tenderizing effect of ageing on myofibrillar tissue. Similarly, a lower H20% was detected at d9 and d15, which reflects the tenderizing effect of the proteases on the myofibers. This results indicate that the tenderness significantly improved until 9 days of ageing. Therefore, a further extension of ageing do not seem convenient to improve meat tenderness also considering the costs involved in the process.

I. INTRODUCTION

The double-muscled Piemontese is the most important Italian beef breed. In 2011, the total number of animals registered in the herd book was 267.000 and it has been estimated that a total of 36.000 ton of meat have been produced (1). Cows, culled for various reasons, none of which prevent them from being used for butchering, represent 47% of total Piemontese cattle. Since these animals are of considerable economic value for producers and beef chain, management and marketing strategies enhancing the value of these animals and beef production are worth considering. As regard meat quality, it is well known that tenderness is the qualitative characteristic that most influences product acceptability. Therefore the problem of inconsistent meat tenderness is a top priority of the meat industry. Meat tenderness depends on several factors such as breed, age at slaughter, cooling condition and ageing of meat. The high degree of specialization reached by meat industry in slaughter procedure and meat refrigeration implies that age at slaughter is the major cause of inconsistency in meat tenderness of Piemontese culled cows and ageing is considered one of the main method of improving beef tenderness. As the studies on meat texture of Piemontese culled cows are lacking, the aim of this research was to assess the effect of age at slaughter and ageing period on meat tenderness.

II. MATERIALS AND METHODS

Ten double-muscled Piemontese cull cows, aged 4÷13 years, were selected and divided in two groups of 5 animals: "young" (< 5 years) and "mature" (> 5 years). The animals were slaughtered at the same slaughterhouse. The average weight of the carcasses was kg 444 ± 54 and kg 400 ± 36 for "young" and "mature" cows, respectively. Carcasses were graded according to the European beef grading system. All carcasses were classified U2 except for two carcasses of the young group which were classified E2.

Twenty four hours *post mortem* the portion of *longissimus thoracis et lumborum* (LTL) between 8th thoracic and 1st lumbar vertebra was removed from the right side of each carcass and stored in a cooler at 2°C and at 78% R.U. Then at 30 hrs *post mortem* the pH was measured by a Crison pHmeter with an Ingold spear electrode and a muscular section was dissected for the sarcomere length analysis by diffraction method,

using a helium-neon laser (2). At 1, 9 and 15 days *post mortem* a section 9 cm thick was taken from LTL muscle and each section was divided into three 3 cm thick steaks. The first steak was used for cooking losses analysis, the second for Warner-Bratzler shear measurement and the third for the compression method.

The steak for cooking losses determination was sealed in a polyethylene bag and heated in a water bath, preheated at 75°C, to an internal temperature of 70°C (3). The shear force was measured on meat samples 1 x 1 x 3 cm of raw meat, taken parallel to muscle fibers, using an Instron 5543 equipped with a triangular Warner-Bratzler blade and a crosshead speed of 200 mm/min (4). As suggested by Møller (1980), from the WB force deformation curve two parameters were considered: the initial yield (IY) and peak force (PF). IY (in N) is a measurement of the myofibrillar component of tenderness. This value was estimated as described by Purchas and Aungsupakorn (1993). PF (in N) is the maximum force required for cutting the sample and represents the overall toughness, reflecting both myofibrillar and connective tissue. The difference between PF and IY values (PF-IY) were calculated and were considered as an index of the connective tissue contribution to meat tenderness (7). The energy (area under force deformation curve in Ncm) of PF (E PF) and IY (E IY) was also calculated from the force-distance curves.

The compression method was performed with an Instron 5543 to measure Hardness as the force (in N) required to drive a 10 x 10mm square compression cell into a sample of raw meat. The cell was equipped with two lateral walls to limit free strain of the sample to a direction parallel to the myofibers (8). Meat samples 1x1x3 cm were compressed at 200 mm/min speed perpendicular to the fiber axis to 20% (H20%) and 80% (H80%) of their original height.

The data were analysed using the GLM procedure of SPSS, considering as factors age at slaughter, ageing and their interaction.

III. RESULTS AND DISCUSSION

As no significant age at slaughter x ageing interactions occurred, only main effects are reported in the tables. The effect of the age at slaughter on the studied parameters is reported in table 1.

The mean value for pH of 5.45 ± 0.02 (s.d.) indicate a regular development of post-mortem glycolysis. None of animals expressed an ultimate pH above 6.0, because precautions were taken to prevent DFD conditions and the duration of transport to the slaughterhouse did not exceed 1 hour.

The sarcomere length measurements were slightly higher (1.86 *vs* 1.68) than that observed by Barge *et al.* (1997) in bulls of the same breed and reflects the absence of cold shortening.

Even if not significant, cooking losses resulted slightly higher in young cows.

In relation with the Warner-Bratzler shear force parameters, no significant differences were observed between young and mature cows, except for PF–IY difference.

The significant higher PF–IY value observed in the mature cows suggest a greater contribution of the connective tissue to the meat toughness.

Table 1 Effect of age at slaughter on pH_u, sarcomere length, cooking losses and texture of beef from Piemontese culled cows

	Young Cows	Mature Cows	s.e.
pH_u	5.46	5.44	0.07
SL (μm)	1.91	1.80	0.06
CL (%)	22.09	20.18	0.73
IY (N)	13.62	11.89	0.77
PF (N)	27.32	31.29	1.82
PF-IY (N)	13.70 b	19.40 a	4.34
E IY (Ncm)	9.05	7.13	1.03
E PF (Ncm)	16.04	16.16	1.11
H20% (N)	13.89	14.44	0.84
H80% (N)	30.80	29.95	1.68

a, b means in the same row with different letters differ significantly (P<0.05);

The effect of ageing period on cooking losses, Warner-Bratzler shear force and compression test is reported in table 2.

In comparison with d1, d9 and d15 significantly decreased cooking losses (P<0.01), IY (P<0.01), H20% (P<0.01) and increased PF–IY (P<0.05).

As regards cooking losses, different findings were reported by Destefanis *et al.* (2002) for Piemontese bulls.

The effect of ageing in reducing meat toughness is well documented (11). In fact, in our research the lower IY and the higher difference PF-IY at d9 and d15 in comparison with d1 certify the tenderizing effect of ageing on myofibrillar tissue and, therefore, its lower contribution to the overall toughness.

The decrease of IY resulted 27% between d1 and d15, but the largest tenderizing effect (24%) occurred between d1 and d9.

Also the trend of difference PF–IY confirms this finding. Consequently, nine days of ageing may be considered enough to improve beef tenderness of Piemontese cows.

No significant differences were observed for PF, because the measurements were carried out on raw meat and consequently the tenderizing effect of cooking on connective tissue was lacking.

According to Lepetit and Culioli (1994), the meat compression at 20% is related to myofiber strength, while the compression at 80% regards the resistance of connective tissue. Our results are in agreement with this statement. In fact, compared to d1, a significantly lower force was detected at d9 and d15 for compression at 20%, which reflects the tenderizing effect of the proteolytic enzymes on the myofibers. Similarly to IY and difference PF–IY, the most remarkable decrease of resistance was observed in the first nine days of ageing.

On the contrary, because ageing does not influence the mechanical resistance of connective tissue, no significant differences were detected in ageing time for the compression at 80%.

The compression test values at 80% were low and indicated that connective tissue, even in Piemontese cull cows, had no significant impact on tenderness.

Table 2 Effect of ageing period on cooking losses and texture of beef from Piemontese culled cows

	Ageing period			
	d1	d9	d15	s.e.
CL (%)	24.18 A	18.90 B	20.33 B	0.90
IY (N)	15.36 A	11.73 B	11.16 B	0.95
PF (N)	25.83	30.80	31.27	2.23
PF-IY (N)	10.47 b	19.07 a	20.10 a	5.32
E IY (Ncm)	10.22	7.28	6.76	1.26
E PF (Ncm)	15.17	15.84	17.29	1.36
H20% (N)	16.71 A	12.96 B	12.82 B	1.03
H80% (N)	31.02	28.35	31.74	2.06

a, b means in the same row with different letters differ significantly (P<0.05);
A, B, C means in the same row with different letters differ significantly (P<0.01).

IV. CONCLUSION

The measurements of initial yield from WB shear force deformation curve, as suggested by Purchas and Aungsupakorn (1993), turned out to be useful to estimate the myofibrillar contribution to overall meat toughness. The Warner-Bratzler shear force and the compression test gave consist results, even if they measure different textural meat characteristics, such as tensile force for WB and penetration force for compression test.

Textural properties of meat, apart from PF-IY, did not vary between young cows and mature cows and significantly improved throughout the ageing period until 9 days. A further extended ageing period did not seem convenient to improve meat tenderness also considering the costs involved in the process.

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