MEASUREMENT OF INTRAMUSCULAR HETEROGENEOUSNESS OF TENDERNESS FOR 3 BOVINE MUSCLES

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Background

Tenderness is an important part of meat quality. Almost all consumers who buy beef expect it to be tender. Meat tenderness depends on the mechanical properties of muscle fibers and the amount of connective tissue as well as possible interactions between these two components. Tenderness is extremely variable between carcasses, between muscles and even in the same muscle. Several factors may influence meat tenderness : animal related factors such as age, gender, breed and factors related to processing conditions such as suspension, chilling, ageing, … In order to improve meat tenderness, meat processors have to control some of these factors. In France, traditionally, one of them (called "affranchi") consists in cutting a part of the muscle, often one extremity (less tender) used for ground beef, to keep the central part (more tender). This process is based on the butcher know-how, but at the moment, there are no objective data which confirm or not the significance of this process to improve meat tenderness.

Objectives

This study was designed to measure the heterogeneousness of tenderness in the muscle and eventually to provide meat processors with instructions for cutting the muscles at the right place in order to improve their tenderness. Moreover, the relationships between sensory evaluation and instrumental measurements were estimated.

Methods

Animals

48 carcasses from suckler breeds were randomly selected at the industrial slaughterhouse. The mean age of the animals was 86 months (sd = 27.9 months) and mean carcass weight was 398.07 kg (sd = 58.4 kg). The mean carcass score (conformation and fatness) was R3 according to the EUROP grading system. They were destined for sale as vacuum packaged meat.

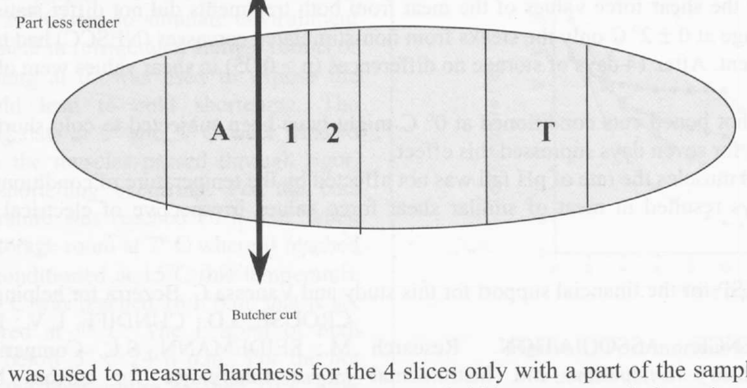
Cutting and sampling

The carcasses were quartered 24 h post mortem and cut. 3 muscles (*Triceps brachii* (TB), *Semintendinosus* (ST), *Rectus femoris* (RF)) were removed by carcass and vacuum packaged. 2 groups of 72 muscles were randomly selected and aged respectively for 10 days and 14 days at 0/2°C.Then, they were frozen (-25°C) until evaluation.

Sensory evaluation

Each muscle (TB, ST, RF) was cut by a butcher based on his know-how according to the figure 1. 4 slices (300-500 g) were removed : Slice A was removed in the potentially less tender part, slices 1 and 2 were removed after the cut realized by the butcher and slice T were removed in the potentially most tender part. Warm cubes of cooked roast were served to a trained twelve-member sensory panel. Each panelist evaluated each sample for tenderness, juiciness and flavor intensity based on a scale from 1 to 100 (1 = extremely though, dry and weak and 100 = extremely tender, juicy and intense).

Figure 1 : Muscle cut



Instrumental measurement

The Instron compression device was used to measure hardness for the 4 slices only with a part of the samples (20 ST and TB, 19 RF). The sample of raw meat with a cross-section of 10 x 10 mm across the fibers was held between metal plates that prevented lateral movement, but permitted movement in the direction the fibers were running. Parameters measured for each of 10 measurements per slice were the peak force required (CMax), load at 2mm (C20) and load at 8 mm (C80). According to the literature, C20 (stress at 20% compression) is related to the resistance of myofibrillar structure and C80 (stress at 80% compression) is related to the resistance of collagen.

Statistical analysis

Data were analysed by ANOVA using Mixed procedure of SAS.

Results and discussions

Evolution of tenderness

The results for the 3 muscles are showed in table 1. For each muscle, the results based on sensory evaluation and at a lesser extent on instrumental measurement (CMax and C80) showed a real difference between the 2 ends (except for the *Semitendinosus* aged 10 days with instrumental measurement). Slice T was always more tender than slice A (around 20 to 31 points for tenderness scored by sensory evaluation). Moreover, according to sensory evaluation, each muscle presented a longitudinal gradient in the tenderness from slice A to slice T. Instrumental measures (CMax and C80) showed globally the same gradient but less accurately. There was no difference between time of ageing. This longitudinal gradient has been already reported for the *Longissimus Dorsi* in the literature. The more logical explanation that could support the tenderness variation is the amount of collagen, probably superior at the ends. This explanation could be confirmed by the collagen analysis for each muscle and each slice.

Tableau 1 : Mean values for *Semitendinosus, Triceps Brachii* and *Rectus Femoris* slice tenderness sensory panel scores at 10 and 14 days ageing.

	Semitendinosus				*Triceps Brachii*				*Rectus Femoris*			
	Slice A	**Slice 1**	**Slice 2**	**Slice T**	**Slice A**	**Slice 1**	**Slice 2**	**Slice T**	**Slice A**	**Slice 1**	**Slice 2**	**Slice T**
aged 10 days												
Mtend	*34.9* ^{a}	*35.3* ^{b}	*43.3* ^{c}	*54.0* ^{d}	*42.4* ^{a}	*49.5* ^{b}	*54.0* ^{b}	*63.0* ^{d}	*42.5* ^{a}	*51.9* ^{b}	*58.0* ^{c}	*66.6* ^{d}
CMax	*134.3* ^{a}	*138.4* ^{a}	*137.1* ^{a}	*128.1* ^{a}	*166.4* ^{a}	*150.4* ^{a}	*101.7* ^{b}	*92.4* ^{b}	*134.1* ^{a}	*102.9* ^{b}	*86.7* ^{b}	*75.8* ^{b}
C20	*12.8* ^{a}	*12.8* ^{a}	*12.4* ^{a}	*10.22* ^{a}	*14.26* ^{a}	*12.6* ^{a}	*10.3* ^{b}	*9.7* ^{b}	*10.1* ^{a}	*10.0* ^{a}	*10.8* ^{a}	*12.3* ^{a}
C80	*83.3* ^{a}	*85.8* ^{a}	*85.5* ^{a}	*79.4* ^{a}	*106.25* ^{a}	*93.1* ^{b}	*65.6* ^{c}	*59.6* ^{c}	*89.8* ^{a}	*67.9* ^{b}	*55.3* ^{b}	*50.6* ^{b}
aged 14 days												
Mtend	*29.5* ^{a}	*34.0* ^{b}	*43.5* ^{c}	*49.1* ^{d}	*43.9* ^{a}	*50.8* ^{b}	*57.9* ^{c}	*65.2* ^{d}	*36.6* ^{a}	*49.3* ^{b}	*57.7* ^{c}	*64.7* ^{d}
compMax	*170.8* ^{a}	*182.2* ^{a}	*164.4* ^{ab}	*145.92* ^{b}	*177.5* ^{a}	*143.8* ^{b}	*119.6* ^{bc}	*105.0* ^{c}	*144.8* ^{a}	*124.6* ^{a}	*89.8* ^{b}	*72.0* ^{b}
comp20	*12.56* ^{a}	*11.17* ^{ab}	*10.69* ^{ab}	*9.66* ^{b}	*16.7* ^{a}	*15.1* ^{a}	*14.4* ^{ab}	*11.8* ^{b}	*8.5* ^{a}	*9.6* ^{a}	*9.6* ^{a}	*9.8* ^{a}
comp80	*98.50* ^{ab}	*106.64* ^{a}	*99.01* ^{ab}	*86.6* ^{b}	*112.8* ^{a}	*92.8* ^{b}	*78.6* ^{bc}	*70.3* ^{c}	*88.5* ^{a}	*77.2* ^{a}	*55.6* ^{b}	*43.7* ^{c}

Mean values within a line that do not share a common superscript letter differ ($P<0.05$)
Mtend : Mean value of tenderness score for each slice - Tenderness was scored on a scale from 0 (tough) to 100 (tender)

Relationships between sensory and instrumental measurement
Correlations between sensory evaluation and instrumental measurements of meat tenderness in the literature are very variable. Linear correlation coefficients between instrumental measures and between instrumental measures and sensory evaluation are presented table 2. Correlations between C80 and Cmax were close and highly significant ($P<0.0001$) suggesting that there was a close relationship between these two components. Correlations between C20 and C80 or Cmax were more variable. Correlation was around 0.6 only for the TB, but very lower (around 0.2-0.3) for the ST and the RF.
The correlations between sensory evaluation and instrumental measurements were lower for the stress at 20% compression (C20), around 0.25 and even non significant for the *Rectus Femoris*. This low relationship could be explained by the fact that ageing not differed. The correlations were the same for C80 and Cmax, from 0.48 to 0.60, except for the Semitendinosus (0.23 – 0.26). These results were lower than the bibliography (0.66 –0.79). The low relationship between instrumental measures and sensory evaluation could be explained by sampling. Moreover, according to the bibliography, instrumental measures are not able to reproduce sufficiently tenderness as it is perceived by a panelist during chewing and mastication.

Table 2 : correlation between each measurement

	Semitendinosus				*Triceps brachii*				*Rectus femoris*			
	C20	**C80**	**CMax**	**Mtend**	**C20**	**C80**	**CMax**	**Mtend**	**C20**	**C80**	**CMax**	**Mtend**
C20		*-0.28*	*-0.18*	*-0.24*		*0.69*	*0.64*	*-0.26*		*0.18*	*0.13 ns*	*0.09 ns*
C80			*0.92*	*-0.23*			*0.96*	*-0.48*			*0.96*	*-0.60*
CMax				*-0.26*				*-0.48*				*-0.56*

ns : no significant

Considering the good results obtained for the 3 muscles, the study of the heterogeneousness of tenderness will be continued with 3 new muscles with the same method based on sensory evaluation and instrumental measurements.

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