INTER AND INTRAMUSCULAR VARIATION ON SENSORY CHARACTERISTICS OF BEEF STEAKS

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Introduction

Meat tenderness is the most important quality trait for consumer acceptance and the variability in this concept has become an increasing problem for the retailers. Tenderness is extremely variable between carcasses, between muscles and even within the same muscle, and in part can be due to total collagen content and its solubility, influencing the so-called "background" toughness of meat (Denoyelle and Lebihan, 2003, Torrescano *et al.*, 2003). Sensory analysis in meat determines the quality attributes that consumers are going to value. In this sense, Shackelford *et al.*, (1995) compared sensory and instrumental values of hardness in ten different bovine muscles and found that sensory values in the loin were very variable. The objective of this study was to observe inter and intramuscular variability on sensory characteristics and quality parameters of three muscles of different regions of the beef carcass included in the label from the PGI "Carne de la Sierra de Guadarrama".

Materials and Methods

Fifteen male yearlings from Limousin, Charollais or Brown Swiss bulls, and Avileña-Negra Ibérica dams (a bovine breed from the Central area of Spain) were studied. All animals were the quality label from the PGI "Carne de la Sierra de Guadarrama" (a Protected Geographical Indication of Madrid). Animals employed in this study were entire males 13-15 months old, 391 kg HCW and a carcass classification value of R3 (European Union, 1991). They were slaughtered in a commercial abattoir and processed according to the rules. M. *longissimus dorsi* (thoracic portion) (LD), M. *semitendinosus* (ST) and M. *supraspinatus* (SS) were removed at 7 days of ageing postmortem and cut in steaks (2 cm thick) of three homogeneous regions (1, 2 and 3). The regions in LD were cranial, middle and caudal, while that in ST and SS muscles were dorsal, middle and ventral regions, respectively. Attributes measured included pH, water holding capacity, collagen composition, and intramuscular fat content. Also, a compression textural measurement by TPA (texture profile analysis) method was studied (Velasco *et al.*, 2005). One cm x 1 cm-strips were made from each steak for texture assessment on raw meat. The texture analysis was made with a cylindrical 10 mm-diameter probe of ebonite and with a deformation force of 75%. Sensory analysis was performed on samples from three muscles from each of fifteen animals, grill-cooked till 80ºC (internal temperature). Samples were randomly served to a trained twelve member sensory panel. Sensory analysis evaluated hardness, springiness and juiciness, completed with the parameters of fat sensation (in mouth), flavour intensity, number of chewings until swallowing and overall analysis. Scales used to assess intensity of every parameter were interval scales of 10 cm long. Statistical analyses were carried out using the analysis of variance of the GLM procedure of the Statgraphics Plus (1994). Differences between means were compared using Duncan test.

Results and Discussion

Effects of different muscles and regions inside these muscles, on pH, water-holding capacity, and intramuscular fat and collagen contents are shown in Table 1.

Table 1: Arithmetic means and mean squares of the error of pH, WHC, intramuscular fat and collagen parameters of muscles and regions studied.

	Muscles (M)				Regions (R)					
	LD	ST	SS	Sig	1	2	3	Sig	MxR	MSE
pH	5.53[a]	5.54[a]	5.65[b]	*	5.59	5.54	5.59	NS	NS	0.015
WHC (%)	15.59[a]	18.21[b]	18.90[b]	*	18.51	17.24	16.95	NS	NS	9.16
Intramuscular fat (%)	2.04[ab]	1.42[a]	2.50[b]	**	2.07	2.00	1.90	NS	NS	0.82
TC (mg/g muscle)	6.04[a]	11.54[b]	10.39[b]	***	9.19	9.49	9.28	NS	NS	5.48
IC (mg/g muscle)	4.77[a]	9.11[b]	7.53[b]	***	7.17	7.03	7.21	NS	NS	3.60
Solubility (% total)	13.07	14.84	12.90	NS	13.67	12.79	14.35	NS	NS	23.90

Means in the same row not followed by a common letter differ significantly. Sig: Significance; NS (non significance), * ($p<0.05$), ** ($p<0.01$), *** ($p<0.001$). MSE: mean square of the error. LD= M. *longissimus dorsi,* ST= M. *semitendinosus*, SS= M. *supraspinatus*; Regions: 1 (cranial in LD, and dorsal in ST and SS), 2 (middle), 3 (caudal in LD, and ventral in ST and SS). WHC (water-holding capacity, expressed as percentage of expelled liquid), TC (total collagen), IC (insoluble collagen).

Significant intermuscular variation was detected at 7 days postmortem, with higher pH value in SS than in LD and ST muscles. Intramuscular fat was higher in LD and SS than in ST, while a higher quantity of exudate was seen in ST and SS than in LD muscle. Thus it could be due to the fact that the greater the pH the greater the WHC (Purchas, 1990). Total and insoluble collagen contents were higher in ST and SS than in LD as Torrescano *et al.*, (2003) noted. No difference within regions in the three muscles studied was observed for these parameters.

Table 2: Arithmetic means and mean squares of the error of textural and sensorial parameters of muscles and regions studied.

	Muscles (M)				Regions (R)					
	LD	ST	SS	Sig	1	2	3	Sig	MxR	MSE
TPA Hardness (N)	206.33[a]	369.96[b]	302.72[b]	***	262.19[a]	251.61[a]	365.20[b]	**	NS	8476
TPA Springiness (g)	74.60[a]	78.38[b]	76.80[ab]	*	74.63	77.14	78.01	NS	NS	20.55
TPA Chewiness	4211.9[a]	11966.6[b]	8527.5[c]	***	6879.2[a]	7044.2[a]	10782.7[b]	*	NS	$1.5\,10^{7}$
Hardness	4.47[a]	5.08[b]	5.06[b]	*	4.92	4.66	5.03	NS	NS	0.21
Springiness	4.42	4.50	4.88	NS	4.80	4.42	4.59	NS	NS	0.22
Juiciness	2.90[a]	1.97[b]	2.42[ab]	*	2.40	2.37	2.53	NS	NS	0.52
Fat sensation	2.56	2.06	2.35	NS	2.23	2.34	2.41	NS	NS	0.24
Flavour intensity	4.46	3.95	4.17	NS	4.23	4.22	4.13	NS	NS	0.24
Chewings (number)	24.24[a]	27.50[b]	27.19[b]	*	25.52[a]	24.37[a]	29.04[b]	**	NS	6.23
Overall	4.62[a]	3.58[b]	4.42[a]	**	4.28[a]	4.20[a]	4.15[b]	*	NS	0.32

Means in the same row not followed by a common letter differ significantly. Sig: Significance; NS (non significance), * ($p<0.05$), ** ($p<0.01$), *** ($p<0.001$). MSE: mean square of the error. LD= M. *longissimus dorsi*, ST= M. *semitendinosus*, SS= M. *supraspinatus*; Regions: 1 (cranial in LD, and dorsal in ST and SS), 2 (middle), 3 (caudal in LD, and ventral in ST and SS).

Effects of different muscles and regions inside these muscles on textural and sensorial parameters are displayed in Table 2. According to compression measurements by TPA method, each muscle presented a same gradient of hardness and chewiness. The region 3 showed a higher hardness ($p<0.01$) and chewiness ($p<0.05$), although only for SS and ST muscles (ventral region), while the LD muscle did not vary within the region in this study. These differences corresponded with the most number of chewings until swallowing ($p<0.01$) and a less overall ($p<0.05$) by sensorial analysis. There were no differences in sensorial hardness between the three muscles studied, similar to that found by Searls *et al.*, (2005) who did not observe tenderness differences among steak locations in four beef muscles.
The results based on sensorial analysis showed a significant difference between the muscles studied. LD was more tender ($p<0.01$) and with less springiness ($p<0.05$) than ST and SS muscles. Also LD showed less chewiness by TPA ($p<0.001$) than ST and SS muscles. Low compression rates, in raw meat, are clearly influenced by ageing in the development of meat tenderness and high compression rates demonstrate the influence of connective tissue composition (Campo *et al.*, 2000). ST muscle displayed a smaller juiciness ($p<0.01$) and overall ($p<0.01$) than LD and SS muscles, principally due to a smaller percentage of intramuscular fat and a higher content of total collagen. Springiness, fat sensation and flavour intensity were no different between muscles studied.

Conclusions

Cranial region in LD and dorsal in ST and SS showed the most overall. Between muscles we observed that ST was sensory depreciated principally due to its lower fat content, higher total collagen value and greater hardness and chewiness by TPA method than others, which was a good indicator of sensory hardness.

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