THE EFFECT OF BREED-TYPE AND SLAUGHTER WEIGHT ON MEAT TEXTURE THROUGHOUT AGEING

Sañudo, C. (1), Macíe, E.S. (1), Begoña, P. (1), Olleta, J.L. (1), Campo, M.M. (1) and Albertí, P. (2)
(1)Department of Animal Production and Food Science, University of Zaragoza, 50013- Zaragoza, Spain
(2)Agricultural Research Service, D.G.A., 50080- Zaragoza, Spain

Key words: cattle, breed-type, meat texture, ageing.

Background

Tenderness is one of the most important criteria to evaluate meat acceptability and purchasing decisions. Meat texture is affected by the composition, state and interactions of different muscle components, especially myofibrillar and connective tissues (Lepetit *et al.*, 1986), which can be studied by different textural devices (Campo *et al.*, 2000). Chilling rate, ultimate pH and cooking temperature have been considered, together with other technological procedures (electrical stimulation, hot deboning, etc), as important factors affecting meat textural characteristics (Jeremiah *et al.*, 1997). On the other hand, some intrinsic effects such as gender, breed, age or quality grade, have been reported to affect meat texture at one specific ageing time (Touraille and Bayle, 1982; Jeremiah, 1996). But these effect have not been thoroughly studied during ageing. Although Campo *et al.* (1999) and Campo *et al.* (2000) analyse the influence of breed-type and ageing on meat sensorial and textural properties, little is known about the influence of breed-type and slaughter weight on meat quality through ageing.

Objectives

To assess the effect of breed-type and slaughter weight on beef meat texture throughout ageing.

Methods

In two consecutive years, 105 yearlings (54 and 51 respectively) from seven Spanish cattle breeds were studied. They were fed in a commercial feedlot with concentrate and cereal straw *ad libitum*. Within each breed, animals were divided in two groups. One of then was slaughtered at 300 kg live weight (light group) and the other was slaughtered at 550 kg live weight (heavy group). Slaughtering was performed in an EU-licensed abattoir under animal welfare regulations.

At 24 hours post-mortem, the muscle *Longissimus thoracis* (T7- T10) was excised from the left side of the carcass and chopped into 3.5-cm thickness steaks that were vacuum packaged and kept at 2 to 4ºC for 1, 7 and 21 days of ageing. Samples were then frozen and kept at -18ºC until analysis. An INSTRON 4301 was used to assess meat texture by two different devices: Warner-Bratzler (WB) and compression (Campo *et al.*, 2000). With the WB, we calculated shear force and toughness; with the compression device we calculated stress at 20% of compression, which is related with the resistance of myofibrillar component and stress at 80% of compression, which is related with the connective tissue characteristics (Lepetit y Culioli, 1994).

The SPSS 8.0 package was used for statistical analysis. Breeds were grouped, according to their productive and carcass quality characteristics (Campo *et al.*, 1999) into four different groups: double muscle, double purpose, fast growth and rustic type. A GLM procedure was performed to analyse breed-type, slaughter weight and ageing time effects and their interactions. Differences between groups were assessed by a Duncan *t*-test.

Results and discussion

Significance of the different effects is showed in Table 1. Breed-type effect was especially significant on values at high compression rates (F value = 57.4) and, consequently on collagen characteristics. Slaughter weight effect was not significant at compression rate 20%, but it was at 80% and WB values. The effect of ageing time was important ($P<0.05$) on low compression rates and WB values, as previously found by Campo *et al.* (2000). Interaction between breed-type and ageing time was significant ($P<0.05$) on low compression rates, showing that ageing varies depending on the breed group considered.

Table 1. Significance of main effects in the studied texture parameters and their interactions (F-values).

	G	W	A	G*W	G*A	W*A	G*W*A
Shear force (kg)	6.37**	34.81**	41.35**	14.26**	0.85	0.20	1.51
Toughness (kg/cm2)	4.30**	7.79**	16.61**	10.68**	0.94	0.32	2.50*
Compression at 20% (N/cm2)	6.73**	0.70	6.97**	1.00	5.69**	0.81	0.54
Compression at 80% (N/cm2)	57.43**	6.26*	0.30	5.32**	1.28	0.25	1.49

*G.- breed-type effect; W.- weight effect; A.- ageing effect. * the effect is significant at 0.05 level; ** the effect is significant at 0.01 level.*

Table 2 shows the textural characteristics of the four breed-types. In all of then, shear force, toughness and compression rates at 20% decreased as ageing time increased, as expected, because ageing affects mainly the myofibrillar component of muscle. Compression at 80% was not affected by ageing because the ageing effect on connective tissue is negligible compared with the degradation of the myofibrillar structure (Stanton and Light, 1988).

Heavy slaughter weight animals, in double purpose and rustic type groups, had higher compression at 80% values than lighter animals, indicating an increment of collagen crosslinking concomitant to an increase of age (Bosselman *et al.*, 1995). Nevertheless, these heavy groups showed lower shear force and toughness values than lighter animals. Therefore, we could consider that cooking affected the collagen structure in an important way. However, in the other breed-types (double muscle and fast growth groups) no significant differences between light and heavy animals were found in practically all the textural characteristics evaluated. Differences in animal maturity between breed-types could explain these results.

In light animals the lowest WB and compression values appeared in double muscle animals at short ageing times showing a faster tenderisation in this type of animals (Campo *et al.*, 2000). Double purpose and rustic groups had the toughest meat in short ageing periods but differences between breed types were not so clear at longer ageing times, showing a tendency to homogenate meat textural characteristics with long ageing periods. In heavy animals the rustic type showed the lowest WB values at any ageing time. However, at short ageing periods the lowest compression 20% rates were for the double muscle animals and the highest for the double purpose group. As in light animals, ageing made the textural differences between breed-types became smaller.' In both weights, double purpose and rustic animals, more precocious types, had higher compression 80% rates than meat types.

Conclusions

Ageing and slaughter weight are more important effects than breed-type in meat texture assessed by a Warner Bratzler device. At high compression rates, and probably due to connective properties, breed-type is more important than slaughter weight. At low compression rates, due to myofibrillar characteristics, weight does not have a significant effect. Ageing produces a reduction of meat textural differences between breed types.

Acknowledgements

This work has been supported by the MAPA, INIA and INVAC and by the technical assistance of J.J. Pardos and R. Tena.

References

•Bosselman, A., Möller, C., Steinhart, H., Kirchgessner, M. and Schwarz, F.J. (1995). Pyridinoline cross-links in bovine muscle collagen. *Journal of Food Science*, **60**: 953-958. • Campo, M.M., Sañudo, C., Panea, B., Albertí, P. and Santolaria, P. (1999). Breed type and ageing time effects on sensory characteristics of beef strip loin steaks. *Meat Science*, **51**: 383-390. • Campo, M.M., Santolaria, P., Sañudo, C., Lepetit, J., Olleta, J.L., Panea, B. and Albertí, P. (2000). Assessment of breed type and ageing time effects on beef meat quality using two different texture devices. *Meat Science*, **55**: 371-378. • Jeremiah, L.E. (1996). The influence of subcutaneous fat thickness and marbling on beef palatability and consumer acceptability. *Food Research International*, **29**: 513-520. • Jeremiah, L.E., Aalhus, J.L., Robertson, W.Y. and Gibson, L.L. (1997). The effects of grade, gender and post-mortem treatment on beef. II. Cooking properties and palatability attributes. *Canadian Journal of Animal Science*, **77**: 41-54. • Lepetit, J., Salé, P. and Ouali, A. (1986). Post-mortem evolution of rheological properties of the myofibrillar structure. *Meat Science*, **16**: 161-174. • Lepetit, J. and Culioli, J. (1994). Mechanical properties of meat. *Meat Science*, **36**: 203-237. • Stanton, C. and Light, N. C. (1988). The effects of conditioning on meat collagen. Part 2.- direct biochemical evidence for proteolytic damage in insoluble perimysial collagen after conditioning. *Meat Science*, **23**: 179-199. • Touraille, C. and Bayle, M.C. (1982). Influence du sexe et de l'age à l'abattage sur les qualités organoleptiques des viandes de bovins Limousins abattus entre 16 et 33 mois. *Bulletin Technique CRZV. Theix. INRA*, **48**: 83-89.

Table 2. Textural characteristics of four Spanish cattle breed-types (means and standard deviations)

	Variable	DM			DP			FG			RU		
		1 day	7 days	21 days	1 day	7 days	21 days	1 day	7 days	21 days	1 day	7 days	21 days
Light weight	Shear force (kg)	5.92 bA (0.63)	4.67 aA (1.46)	4.55 aA (0.97)	7.86 yB (1.41)	7.60 yB (1.53)	6.37 yB (1.46)	6.04 bA (1.54)	4.59 aA (1.54)	4.26 aA (1.65)	8.35 cyB (2.24)	6.20 byB (1.86)	4.95 ayA (1.84)
	Toughness (kg/cm2)	2.08 A (0.34)	1.72 A (0.39)	1.84 (0.39)	2.82 yB (0.52)	2.63 yB (0.53)	2.26 y (0.54)	2.11 A (0.64)	1.73 A (0.57)	1.74 (0.61)	3.07 byB (0.81)	2.33 ayB (0.78)	1.92 ax (0.65)
	Compression at 20% (N/cm^2)	4.77 xA (1.17)	4.56 x (0.83)	4.31 x (0.81)	11.84 bC (5.49)	6.15 a (2.20)	4.49 a (0.94)	7.16 bAB (3.36)	5.86 ab (2.37)	4.74 a (0.75)	9.61 bBC (3.84)	4.72 a (1.23)	4.53 a (0.72)
	Compression at 80% (N/cm^2)	26.18 A (2.32)	30.74 A (5.94)	29.37 A (10.93)	43.81 xC (7.36)	40.35 xC (10.20)	41.13 xB (8.62)	35.39 B (8.62)	33.12 AB (6.29)	29.95 A (5.64)	37.85 xBC (9.23)	38.23 xBC (5.91)	41.91 xB (5.17)
Heavy weight	Shear force (kg)	7.26 bB (2.20)	5.14 abB (1.97)	3.98 a (0.91)	6.04 bxAB (1.81)	4.46 axAB (1.46)	3.87 ax (0.96)	5.58 bA (2.06)	4.56 abAB (0.88)	3.96 a (0.70)	5.42 bxA (1.28)	3.84 axA (1.15)	3.49 ax (0.72)
	Toughness (kg/cm^2)	2.55 (0.60)	2.26 (1.15)	1.73 (0.40)	2.30 bx (0.31)	1.77 ax (0.46)	1.77 ax (0.28)	2.04 (0.67)	2.13 (0.62)	1.72 (0.40)	2.06 bx (0.57)	1.65 ax (0.46)	1.81 abx (0.39)
	Compression at 20% (N/cm^2)	6.92 byA (2.23)	4.55 ax (0.62)	4.87 axAB (0.68)	11.83 bB (3.83)	5.79 a (2.89)	4.17 aA (0.68)	8.82 bAB (4.08)	5.60 a (1.31)	5.26 aB (1.11)	8.95 bAB (4.30)	4.65 a (1.12)	4.45 aAB (0.86)
	Compression at 80% (N/cm^2)	23.15 A (3.83)	25.61 A (9.23)	29.20 A (6.67)	55.08 yB (15.48)	49.57 yB (9.09)	44.22 xB (9.21)	31.83 A (8.50)	33.04 A (6.89)	32.64 A (6.90)	45.98 yB (11.70)	46.71yB (9.65)	42.76 xB (9.15)

DM.- double muscle breed-type; DP.- double purpose breed-type; FG.- fast growth breed-type; RU.- rustic breed-type
a, b, c, d . Different lower case letters in the same row implies significant differences between ageing time within every weight and breed- type
x, y. Different letters in the same column implies significant differences between weights within every ageing time and breed- type
A, B, C, D. Different upper case letters in the same row implies significant differences between breed-types within every weight and ageing tin