PHYSICAL QUALITY OF SEVERAL EUROPEAN BEEF BREEDS: PRELIMINARY RESULTS

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Background

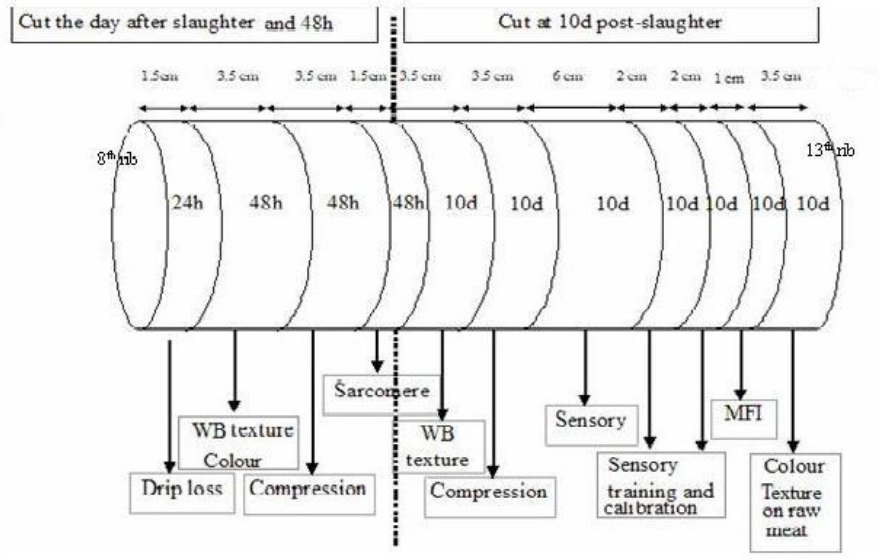
This research is a part of an European Union ongoing project aiming to compare carcass and meat quality of young bulls from several European cattle breeds (both dairy and beef), raised under standardized conditions to minimize environmental differences. *In vivo* measurements, covering production, slaughter data, meat and carcass quality parameters (both physical and chemical) and qualitative traits and their relationship with meat quality characters were investigated.
Some peculiarities of the different European cattle breeds are renowned, but we still need to improve our knowledge of their meat quality to understand the genetic background of these traits, to facilitate the design more efficient breeding programmes.
In particular, the extrinsic quality traits of meat, mainly tenderness and colour which are more appreciated by the consumer. These parameters are dependent on many *ante mortem* and *post mortem* factors, which need further study to understand the mechanisms determining their variability.

Objectives

Assess differences in instrumental meat quality traits (colour, water holding capacity and texture) in eight beef breeds from three European countries.

Materials and methods

The research was carried out on 243 young bulls from 8 different European beef breeds: Asturiana de los Valles, Asturiana de la Montaña, Avileña-Negra Ibérica and Pirenaica from Spain, Piemontese and Marchigiana from Italy, and Limousine and Charolaise from France. Diet and slaughtering methods were standardized for all the animals and are described in Sañudo *et al.* (2004).
At 24 hours after slaughter the *Longissimus thoracis* muscle was removed from carcass and stored at 3+/-1°C until 48 hours and then a section was subdivided in three slices and frozen, the other section was aged for 10 days and then was subdivided as shown in figure. The samples were frozen at -18°C. In this paper only the data performed at 10 days and water loss and pH at 24 hours are reported.



The water loss, by the drip method of Barton-Gade *et al.* (1994), and pH, by putting the probe into the muscle, were performed on fresh meat, then on samples aged 10 days thawing losses were recorded.
On the raw meat samples colour and compression tests were

performed. Colour coordinates were measured at ten points on the surface of slices, 3 cm thick according to Cassens *et al. (*1995). After exposure to oxygen for 1 hour, lightness (L*), redness (a*), yellowness (b*), chroma (C) and hue (H) were calculated with CIEL*a*b* System using D65 illuminant using spectrophotometer Minolta CM-2600d; reflectance spectra between 360 and 740 nm (by steps of 10 nm) were also measured.
On ten samples 1 cm^2 of cross section, with fiber direction paralleled to length (long axis), maximum load, stress at 20% and 80 %, maximum compression were measured with an Instron 4301 machine, using a modified device which avoids transverse elongation of the sample (Campo *et al.*, 2000).
Shear force was measured on raw and cooked meat. Samples were cooked in a waterbath at 80°C to an internal temperature of 78°C, then cooled in running tap water for 45' and stored in a refrigerator for 4 hours. Cooking losses were later calculated as percentage. Shear force was measured by a Warner Bratzler device mounted on an Instron 1011, on ten cores with section 1x1 cm for each animal, both of raw and cooked meat. Analysis of variance using breed as a factor was performed using GLM procedure of SAS package.

Results and discussion

pH and water losses
The pH at 24 hours (Table 1) showed that Limousine had significantly the higher values (5.90), than all other breeds. The Asturiana de la Montaña was significantly different from other breeds with mean pH values of 5.82. The lowest values were found in Charolaise, Pirenaica and both the Italian breeds (5.58 in average) which did not differ significantly, whilst the pH values of Avileña and Asturiana de los Valles were intermediate. A similar trend was found in the thawed meat aged 10 days, except for Limousine, which unlike the data at 24 hours, showed a lower pH, however close to the mean value of all breeds.
A low pH was generally found in the animals with a more marked beef aptitude, in particular Piemontese, while the more rustic breeds had a higher pH, even if within the norm, showing muscular fibres with a lower glycolytic power.
The drip losses (Table 1) showed a definitely lower value in Asturiana de la Montaña (1.11%) followed by Avileña (1.91%), while intermediate values were found in Marchigiana and Asturiana de los Valles, whilst Pirenaica, Piemontese and the French breeds had higher losses. Also with regard to thawing losses Asturiana de la Montaña gave the lowest value (6.85%), while the Avileña mean value did not differ from the other breeds. Cooking losses were generally lower than those reported in bibliography (Destefanis *et al.*, 1996) for the relevant losses caused by thawing, mainly in Limousine, Pirenaica and Asturiana de los Valles which showed the lowest value for cooking loss, while Charolaise and Italian breeds lost higher percentages of liquids. Water losses were higher in animals with a relevant muscular development and a slight adipose covering (Sañudo *et al*., 2004).
The pH and in particular its rate of fall in the first 48 hours after slaughter was highly correlated with water losses and shear force, this is in accord with Thompson (2002).

Colour
Analyzing colour (Table 2), a group of breeds, Italian and French, did not differ in lightness and hue, higher than the others, but were lower than other breeds in redness (a*), ranging from 14.74 to 15.84, except for Asturiana de los Valles which showed similar values (15.51). The opposite conditions (the lowest L* and H and the highest a*) were found in Asturiana de la Montaña and Avileña-Negra Ibérica. The remaining two Spanish breeds (Asturiana de los Valles and Pirenaica) showed intermediate values for L* and H and only Pirenaica for a*. The same group, which had lighter meat, showed a higher yellowness (b*): Charolaise was significantly different from Limousine (15.72 vs 15.03), and showed intermediate values with the Italian breeds and Pirenaica, with respect to the whole group. The remaining Spanish breed had lower b* values, particularly Asturiana de la Montaña compared to Asturiana de los Valles and Avileña-Negra Ibérica (13.51 vs 14.34 and 14.44 respectively). The latter had higher chroma being definitely different from the others, whilst Charolaise and Pirenaica had intermediate values, but different only from Limousine and Asturiana de Valles. Piemontese, Marchigiana and Asturiana de la Montaña had an intermediate chroma value and differed significantly only from Avileña-Negra Ibérica.

Texture
The Spanish rustic breeds and Charolaise presented a higher value of shear force on raw meat (Table 3), in particular compared with Piemontese. However, in these breeds a low shear force on cooked meat was

observed, together with Pirenaica, differing from Marchigiana, which was significantly tougher than the others on cooked meat, also if it showed intermediate value in raw meat.
With cooking Asturiana de los Valles and Piemontese meat became tougher, it is possible that excessive water losses and a marked shrinkage effect by the muscle contraction during cooking undervalued the Asturiana de los Valles and Piemontese, which had lean meat, with a greater development of muscle fibers, being hypertrophic animals. In particular Piemontese meat is commonly deemed as tender by the consumers and is consumed rare or raw (carpaccio).
Compression at 20% values, which can be related with myofibrillar resistance (Lepetit and Culioli, 1994), were in general low (near of 4 N/cm^2), showing an adequate tenderization through ageing (10 days in our study). The differences between breeds were not important, which showed the natural tendency of homogenizate myofibril resistance differences among breeds or individuals with ageing time. According to previous results (Sañudo *et al*., 2004), the highest values were found in Marchigiana breed, in correspondence with its shorter sarcomeres and its higher shear force values.
Compression at 80% values, which is probably due to the connective component resistance, showed important variability among breeds. This was expected since their differences in precocity and subsequent collagen characteristics (Campo *et al*., 2000), whereby the lowest values in Piemontese were related with the collagen composition of high muscularity animals. Conversely, two rustic type breeds and Charolaise gave the highest values (up to 40 N/cm^2), which are more characteristic of unimproved breeds.

Conclusions

Breed has an important effect on instrumental meat quality characteristics.
In particular, Asturiana de la Montaña shows very good water holding capacity and tenderness, while Italian and French breeds are characterized by their lightness and bright red appearance, appreciated by the consumer.
The data variability of these animals made us hope in the possibility of improving some quality traits, obtaining products appreciated by the consumer.

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Table 1. pH and water losses on *longissimus thoracis* muscle

	pH 24h	pH thawed meat at 10d	Drip losses (%)	Thawing losses (%)	Cooking losses (%)
ASV	5.73 ^{c}	5.57 ^{b}	2.28 ^{b}	7.33 ^{ab}	24.90 ^{cd}
ASM	5.82 ^{b}	5.59 ^{a}	1.11 ^{c}	6.85 ^{b}	25.44 ^{bc}
AV-NI	5.68 ^{c}	5.57 ^{b}	1.91 ^{bc}	7.52 ^{ab}	25.56 ^{bc}
PI	5.57 ^{d}	5.55 ^{c}	3.15 ^{a}	7.50 ^{ab}	24.02 ^{d}
PIE	5.58 ^{d}	5.51 ^{d}	3.02 ^{a}	7.10 ^{ab}	25.66 ^{ab}
MARC	5.58 ^{d}	5.52 ^{d}	2.47 ^{b}	7.45 ^{ab}	27.31 ^{a}
LIM	5.90 ^{a}	5.56 ^{bc}	3.58 ^{a}	7.77 ^{a}	24.74 ^{cd}
CHAR	5.57 ^{d}	5.57 ^{b}	3.29 ^{a}	7.06 ^{ab}	26.64 ^{ab}
Mean	5.67	5.56	2.61	7.31	25.52
Root MSE	0.137	0.046	1.602	1.837	2.92

Table 2. Colour determination on *longissimus thoracis* muscle, aged 10 day

	L*	a*	b*	C	H
ASV	41.88 ^{b}	15.51 ^{c}	14.34 ^{c}	21.21 ^{c}	42.88 ^{b}
ASM	39.06 ^{c}	17.00 ^{a}	13.51 ^{d}	21.73 ^{bc}	38.59 ^{c}
AV-NI	39.81 ^{c}	17.84 ^{a}	14.44 ^{c}	22.98 ^{a}	39.03 ^{c}
PI	42.84 ^{b}	16.60 ^{b}	14.87 ^{b}	22.34 ^{b}	42.07 ^{b}
PIE	44.39 ^{a}	15.42 ^{c}	15.32 ^{ab}	21.79 ^{bc}	45.01 ^{a}
MARC	44.75 ^{a}	15.84 ^{bc}	15.49 ^{ab}	22.19 ^{bc}	45.52 ^{a}
LIM	44.60 ^{a}	14.74 ^{c}	15.03 ^{b}	21.09 ^{c}	45.82 ^{a}
CHAR	45.67 ^{a}	15.63 ^{c}	15.72 ^{a}	22.20 ^{b}	45.27 ^{a}
Mean	42.86	16.07	14.83	21.94	42.89
Root MSE	2.941	2.095	1.289	2.047	3.661

Table 3. Texture determinations on *longissimus thoracis* muscle, aged 10 day

	Shear force		Compression test			
	raw (N)	cooked (N)	maximum load (N)	stress at 20% (N/cm^2)	stress at 80% (N/cm^2)	sarcomere length (µm)
ASV	40.44 ^{bc}	54.45 ^{b}	55.45 ^{c}	4.01 ^{b}	39.58 ^{c}	2.04 ^{b}
ASM	43.81 ^{ab}	47.36 ^{d}	58.89 ^{bc}	4.17 ^{b}	43.84 ^{a}	2.33 ^{a}
AV-NI	46.46 ^{a}	43.45 ^{d}	57.96 ^{bc}	4.10 ^{b}	41.60 ^{a}	2.08 ^{b}
PI	37.13 ^{c}	48.32 ^{cd}	54.14 ^{c}	4.12 ^{b}	37.06 ^{c}	2.11 ^{b}
PIE	32.38 ^{d}	54.67 ^{b}	39.71 ^{d}	4.25 ^{b}	27.29 ^{d}	2.04 ^{b}
MARC	38.76 ^{c}	61.84 ^{a}	63.69 ^{b}	5.19 ^{a}	39.95 ^{b}	1.95 ^{b}
LIM	37.57 ^{c}	53.08 ^{bc}	46.54 ^{d}	3.99 ^{b}	31.21 ^{d}	2.11 ^{b}
CHAR	45.67 ^{a}	47.09 ^{d}	64.28 ^{a}	4.23 ^{b}	42.95 ^{a}	2.13 ^{ab}
Mean	40.30	51.16	55.10	4.22	37.73	2.12
Root MSE	8.172	10.666	9.405	0.737	6.579	0.438

** data of Compression test and Sarcomere length are referred to only 15 animals for breed.*
ASV- Asturiana de los Valles; ASM- Asturiana de la Montaña; AV-NI- Avileña-Negra Ibérica; PI– Pirenaica; PIE- Piemontese; MARC- Marchigiana; LIM- Limousine; CHAR- Charolaise.
NOTE different letters mean significant differences with P<0.05.