

Short communication. Sensory evaluation of commercial beef produced in Uruguay and three European countries

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Abstract

The main goal of this study was to characterize and compare the organoleptic quality of beef from Uruguay and from three European countries. In Uruguay, 40 Hereford steers were raised exclusively under grazing conditions up to either two or three years old. Meat samples were aged for 20 days, matching commercial conditions. In Europe, one commercial local beef type, with two ageing times (7 and 20 days), from Germany, Spain and the United Kingdom were compared with Uruguayan beef samples, using 20 animals of each treatment per country. The highest beef odour and flavour scores were for the British beef aged for 7 days followed by the German and Uruguayan meat. Beef from the youngest animals (Spanish) and, especially from the UK, were up to 42 and 62%, respectively, more tender than German beef, all of them aged for 7 days. The highest juiciness scores were for the Uruguayan three years old beef. Long ageing periods (20 days) tended to produce off-aromas in the case of the British beef, which showed the highest scores in abnormal odour flavour intensities. European beef showed a significant variability in its sensory attributes that could not be justified only by differences in the ageing time. Uruguayan beef has meat with similar sensory characteristics to some European meats, and because of that it could have good consumer acceptability.

Additional key words: ageing; extensive; Hereford steers; intensive; production systems; taste panel.

Resumen

Evaluación sensorial de carne comercial de vacuno producida en Uruguay y en tres países europeos

El principal objetivo de este estudio fue caracterizar y comparar las características organolépticas de la carne de vacuno producida en Uruguay y en tres países europeos. En Uruguay, 40 novillos Hereford fueron exclusivamente criados en pastoreo hasta alcanzar 2 ó 3 años de edad. La carne fue madurada durante 20 días, imitando condiciones comerciales. En Europa se estudió un tipo comercial, con carne madurada 7 ó 20 días, procedente de Alemania, España y Reino Unido, utilizando 20 animales por tipo. Las mayores notas de intensidad de olor y flavor a vacuno fueron para la carne británica madurada 7 días, seguida por la carne alemana y uruguaya. La carne procedente de los animales más jóvenes (española), y especialmente la carne británica, fueron un 42% y 62%, respectivamente, más tiernas que la carne alemana, todas ellas maduras durante 7 días. Las mayores notas de jugosidad fueron para la carne uruguaya de los animales de 3 años de edad. Los mayores tiempos de maduración (20 días) tendieron a producir aromas anormales en el caso de la carne británica, la cual presentó las notas más altas de intensidad de olor y de flavor anormal. La carne de vacuno Europea presentó una variabilidad significativa en sus atributos sensoriales, que no puede ser solamente justificada por diferencias en los tiempos de maduración. La carne uruguaya presentó características similares a las de algunas carnes europeas, por lo que podría tener una buena aceptabilidad por parte de los consumidores.

Palabras clave adicionales: extensivo; intensivo; maduración; novillos Hereford; panel sensorial; sistemas de producción.

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Abbreviations used: GLM (general linear model); LL (*Longissimus lumborum*).

The global meat market is very complex, mainly because of differences in production costs, sale prices and the presence of animal diseases that limit the exchanges between countries. In recent years, the beef meat industry in Europe, where there are production systems that differ in their degree of intensification (from grazing to *ad libitum* with concentrate reared animals), has faced too many problems associated with the public's perception that red meat is a food of low quality, poor tenderness, and potentially dangerous to their health (Ursin *et al.*, 1993). On the other hand, the positive image that consumers have of products produced under extensive production systems might benefit countries such as Uruguay (Montossi & Sañudo, 2004). The public perception of production systems requires that the opinion of the consumer must be taken into consideration to assure the success of any changes. Also, the scientific and technical information, including sensory characteristics, are central to the promotion of red meat products worldwide. Thus, sensory quality, evaluated with trained panels, is a useful technique to evaluate meat characteristics, which directly affect consumer perception (Serra *et al.*, 2008). Product quality is affected by many pre and post slaughter factors. Among them, breed, production system, and ageing are some of the most important. The objective of this work was to characterize and to compare the sensory quality of two Uruguayan beef types, reared under traditional grazing conditions, which are exported to European markets, with three commercial bovine meats produced in three European countries.

In Uruguay, the study used 40 castrated Hereford males, 20 for each of the slaughter ages: 2 and 3 years old (221 ± 12.7 kg and 282 ± 15.2 kg of cold carcass weight, respectively). The animals were reared exclusively under grazing conditions on native rangelands and fattened on improved pastures. Those types of steers are the main source of the Uruguayan beef products exported to international markets. In Europe, the three commercial types analysed represent some of the most common productive systems during beef fattening across Europe. In Germany, most of the animals were Fleckvieh bulls, being the rest Limousin crosses. Animals were finished in confinement and given corn silage *ad libitum*, supplemented with restricted amounts of a soybean meal/cereal grain concentrate. Slaughter age and carcass weights ranged from 19 to 24 months (382.4 ± 41.1 kg cold carcass weight). In Spain, the animals were Holstein bulls weaned and fed under an intensive concentrate system in which the animals received concentrate and cereal straw *ad libitum*. This

type of animal represents one of the most important products in the country. Slaughter age and carcass weights ranged from 10 to 11 months (229.9 ± 13.5 kg cold carcass weight). In the UK, animals were castrated commercial males with different genetic origin (crossbreeds between Devon, Hereford, Charolais and Limousin, and pure breeds such as Friesian) that had been finished on a grass diet, supplemented with concentrates. Age at slaughter and carcass weights ranged from 18 to 22 months (323.6 ± 23.2 kg cold carcass weight). For more information about carcass and instrumental meat quality of these beef types, see Montossi & Sañudo (2004) and Oliver *et al.* (2006).

In Uruguay, the entire carcasses were kept at 2 °C until 96 hours *post mortem*. Later the m. *Longissimus lumborum* (LL) was removed from the animals and divided into 2-cm-thick steaks, which were vacuum packaged and aged for 20 days, the typical ageing period for the meat exported to Europe. Samples were aged at 4 °C, frozen, and stored at -20 °C. Frozen samples were sent to Europe by plane, following the standard procedures for this type of product. In each European country, the LL muscle was removed from the animals 48 h after slaughtering, divided into 2-cm-thick steaks, which were vacuum packaged and aged for 7 days and for 20 days at 4 °C. Samples were frozen and stored in the way described for the Uruguayan samples.

The sensory analysis was performed at the Division of Farm Animal Science, University of Bristol, Langford, UK. On the day of tasting, samples were thawed in water at 18-20 °C until the internal temperature reached 16-18 °C, and cooked on a preheated (200 °C) double-plate grill until an internal muscle temperature of 70 °C was reached as measured by a thermocouple probe. Each piece was cut into 2-cm³ cubes, wrapped in aluminium foil, code with a 3 random digits, and kept warm (55 °C) until they were given to the panel. To avoid the possible effects of the order of presentation and first-order carry-over effects, the samples were shown to panellists in different orders (Macfie *et al.*, 1989). The test used a quantitative descriptive method within a complete and balanced design (Cochran & Cox, 1978) that included 40 plates containing 4 samples each. The sensory room had individual cabins with controlled conditions (ISO 8589, 1988). The panel, using unstructured 10 cm line scales, evaluated the variables shown in Table 1.

The statistical analysis was performed using the GLM (General Linear Model) procedure of the SAS software (SAS, 1999). From the data base obtained the

Table 1. Average scores (scale from 0 to 10 points) for sensory attributes of beef from Uruguay and three European countries assessed by a trained taste panel

Sensory attributes	UY ¹		GE ²		SP ³		UK ⁴		Beef type		RMSE ⁵
	2 yr	3 yr	7 d	20 d	7 d	20 d	7 d	20 d	F	Sig.	
Beef odour intensity	2.82 ^{ab}	2.69 ^{bc}	2.81 ^{ab}	2.90 ^{ab}	2.52 ^{bc}	2.51 ^{bc}	3.19 ^a	2.38 ^c	7.4	***	1.21
Abnormal odour intensity	2.24 ^b	2.13 ^b	1.82 ^{bc}	1.77 ^{bc}	2.22 ^b	2.79 ^a	1.44 ^c	3.25 ^a	21.4	***	1.59
Tenderness	3.79 ^b	3.83 ^b	2.62 ^c	3.73 ^b	3.96 ^{ab}	4.11 ^{ab}	4.25 ^{ab}	4.54 ^a	16.2	***	1.78
Juiciness	3.62 ^{ab}	3.93 ^a	3.24 ^b	3.58 ^{ab}	3.62 ^{ab}	3.21 ^b	3.71 ^{ab}	3.20 ^b	4.4	***	1.64
Beef flavour intensity	2.77 ^{bc}	2.93 ^b	2.66 ^{bcd}	3.11 ^b	2.43 ^{cd}	2.27 ^d	3.82 ^a	1.22 ^e	43.8	***	1.44
Greasy flavour intensity	1.60 ^a	1.56 ^{ab}	1.52 ^{ab}	1.52 ^{ab}	1.30 ^{abc}	1.13 ^c	1.35 ^{abc}	1.22 ^{bc}	4.4	***	1.04
Abnormal flavour intensity	2.61 ^{bcd}	2.49 ^{cd}	2.43 ^{cd}	2.24 ^d	2.94 ^{bc}	3.19 ^b	1.56 ^c	6.78 ^a	141.3	***	1.70
Flavour quality	2.92 ^{bc}	2.93 ^{bc}	2.88 ^{bc}	3.28 ^b	2.71 ^{bc}	2.56 ^c	4.16 ^a	0.74 ^d	52.0	***	1.68
Overall acceptability	2.65 ^{bc}	2.67 ^{bc}	2.22 ^c	2.87 ^b	2.41 ^{bc}	2.24 ^c	3.49 ^a	0.77 ^d	38.3	***	1.60

¹UY = Uruguay, ²GE = Germany; ³SP = Spain; ⁴UK = United Kingdom. ⁵RMSE: residual mean square error. ^{y, a, b, c, d, e}: different letters between animal types indicate significant ($p \leq 0.05$) differences.

mean for each attribute per animal was obtained and used in the final model, which included treatment, session and plate within session as fixed effects. Significant ($p < 0.05$) differences between the types for each attribute were evaluated using the Tukey Test.

The results of the taste panel evaluation are shown in Table 1. Beef type had a highly significant effect on all the attributes of the sensory profile ($p < 0.001$). The meat from the British origin aged 20 days had the lowest intensity of beef odour, even not significantly different from the Spanish meat aged 7 or 20 days and the Uruguayan meat from 3 years old animals. The strongest beef odour was for the British meat aged 7 days, associated to the lowest presence of abnormal odour intensity, even not significantly different from the German meat aged 7 or 20 days and the Uruguayan meat from 2 years old animals. The highest abnormal odours were associated with UK meats aged for 20 days, although not significantly different from the Spanish meat aged 20 days. The British beef aged 20 days had the highest values of tenderness, although not significantly different from British meat aged 7 days and Spanish meat aged 7 or 20 days. The meat from German animals aged 7 days was rated the least tender ($p < 0.05$). The beef from Uruguayan animals of 3 years old was assessed juicier than the British and Spanish beef aged 20 days, and the German beef aged 7 days. The highest values of beef flavour were for British meat aged 7 days ($p < 0.05$) and the lowest for British meats aged 20 days ($p < 0.05$). The Uruguayan beef had higher greasy flavour scores than the Spanish and British beef ($p < 0.05$). Abnormal flavour intensity scores of British beef aged 20 days were significantly ($p < 0.05$)

higher than those from all the other meats. The lowest abnormal flavour scores were for British meat aged 7 days ($p < 0.05$). Flavour quality was significantly ($p < 0.05$) higher for British meat aged 7 days and lower for British meat aged 20 days. British meat aged 7 days was the most well-liked by the panellists ($p < 0.05$), whereas the British beef aged 20 days obtained the lowest notes of acceptability.

The lowest ratings in beef odour intensity were for the British meat aged 20 days in correspondence with its highest abnormal odours. The same tendency, but in a lower extend, was observed in the Spanish meat aged 20 days. These results could be expected because ageing tends to develop aromas from rancidity and microbial contamination that modify the normal odour of the meat, to which the panellists could be especially sensitive, increasing the global odour intensity. Campo *et al.* (1999), in a study on meat from various beef breeds, demonstrated that overall odour intensity increased through ageing being particularly high in the meat aged for 21 days. The high intensity of abnormal odours probably masked the perception of the normal beef odour, which could reduce meat value for the consumers (Campo *et al.*, 2006). In any case, this increase of abnormal odours with ageing was not noticeable in the German meat neither in the Uruguayan meats, apparently because of its similar scores with the other meats aged for 7 days. Both types from Uruguay had the highest quantity of vitamin E in their muscle (De la Fuente *et al.*, 2009) because of their extensive grass-based production system, which increases the content in natural antioxidants. Thus, Realini *et al.* (2004) found that the levels of α -tocopherol in the meat from pasture-fed cattle were above the pro-

posed critical concentrations for improving beef meat shelf life ($3.5 \mu\text{g g}^{-1}$) and lipid stability and, subsequently, the reduction of unappreciated odours. Therefore, the abnormal odours found in the British beef might not be completely related to lipid oxidation processes, since the levels of vitamin E in these animals, although lower than the Uruguayan meat, were higher than the values of the German beef (De la Fuente *et al.*, 2009).

The production of tender meat is more influenced by ageing than by some other factors (Cifuni *et al.*, 2003). In addition, breed can have a significant effect on sensory eating quality. Serra *et al.* (2008) found a significant effect of breed-production system on sensory attributes. Also, Monsón *et al.* (2005) found a significant effect of breed on tenderness. The authors observed a significant interaction between breed and ageing, being the meat of Blonde d' Aquitaine or Holstein more tender at longer ageing periods than Limousine, which needed intermediate (7 days) ageing periods to get its highest tenderness values. In this way, ageing clearly improved German meat, but this effect was less marked in British meat and, especially, in Spanish beef. On the other hand, ageing time tends to eliminate differences in meat texture. Thus, differences in tenderness between the European meats aged for 7 days were of 1.63 points, reduced to 0.81 points when the ageing was of 20 days. No differences were found neither between UY 2 years old and UY 3 years old. The beef from Uruguay (from 3 years old animals) was the juiciest, in comparison with British and Spanish beef aged for 20 days and German beef aged for 7 days, possibly because of differences in fatness, fatty acid composition and its optimal final pH values (5.6-5.7) (Montossi & Sañudo, 2004; De la Fuente *et al.*, 2009).

The highest beef flavour notes for British meat aged 7 days, followed by the Uruguayan and German meats ($p > 0.05$), might be related to the older age of these animals, in relation with the Spanish ones, and the inclusion of grass or silage in their diet. No differences have been found between the Uruguayan types, even with a difference of one year of age between them. It has also been previously reported the lack of differences in flavour intensity within different cuts, in animals over 24 months of age (Schoenfeldt & Strydom, 2011). In Serra *et al.* (2004), beef flavour scores were positively correlated with intramuscular fat content and fatness scores. The relationship between greasy flavour notes and the amount of intramuscular fat was not obvious, with the exception of the Spanish beef (only if we considered the samples aged 20 days), which had the lowest scores in this note and the least amount of

fat (1.67% of intramuscular fat in the m. *Longissimus dorsi*; De la Fuente *et al.*, 2009). With the exception of British beef aged 20 days, Spanish beef, although without significant differences with the Uruguayan beef 2 years old, produced the highest abnormal flavour notes. These results can be explained by the worst behaviour of these meats through the ageing. The Spanish animals, due to their lower age and, probably, because of their intensive production system with higher average daily gain, might have developed a higher glycolytic metabolism (Hocquette *et al.*, 1998) whose fibres are more unstable through ageing, and, because of that, easier to develop off flavours. In both cases, the British and the Spanish beef aged 20 days, the results could be explained, at least partially, by the development of relatively faster off flavours that were especially detected by the panel. However, the consumers from UK and ES evaluated, in other study, the same meat with an acceptable quality (Oliver *et al.*, 2006).

The low scores in overall acceptability registered in our study were more due to the presence of abnormal flavours than to differences in texture. Savell *et al.* (1987) found that preferences for meat are influenced primarily by tenderness and juiciness, but most of the variation in the overall liking was better explained by a function that included juiciness, flavour quality and tenderness (R^2 range = 0.80–0.85). In the current study, British meat aged 7 days, German meat aged 20 days and both Uruguayan meats had the highest scores in overall acceptability by the taste panel.

European beef show a significant variability in its sensory attributes, variability that could not be only justified by differences in the ageing time. Animals produced in extensive pure grass systems from Uruguay, aged for 20 days, have meat with similar organoleptic characteristics to some European meats, aged 7 or 20 days. In general, the most tender meats come from the Spanish and British meat both aged for 7 days or 20 days. Long ageing periods tended to cause more tender meat, but these differences are significant only in German beef. Also, in UK meat, ageing developed off aromas that could be noticed by some groups of consumers.

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