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Sensory evaluation of lamb produced under different production systems from Uruguay and Europe

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SUMMARY – Some geographical areas in South America have a very high potential in ruminant meat production (i.e., Humid Pampas). This meat, produced at low cost under grazing conditions, has an undoubted growing potential and represents one of the main exports from those countries to USA and Europe. The aim of this study was to compare, with a trained taste panel, Uruguayan lamb aged for 20 days (11.1 and 19.4 kg carcass weight being 3-4 and 12-13 months old, respectively) with European lambs, aged for 7 or 20 days. European lambs were produced in Spain (10.2 kg carcass weight and 3 months of age), United Kingdom (22.8 kg from commercial animals) and Germany (23.2 kg and 4-6 months old). Results showed that lamb type had a significant effect in all the parameters considered, except in lamb flavour intensity, and that ageing had a strong influence in lamb sensory profile. The key factors related to the differences found in the sensory evaluation between lamb meats are highlighted.

Key words: Meat quality, concentrate, grass, panel test.

RESUME – "Evaluation sensorielle d'agneaux produits sous différents systèmes de production d'Uruguay et d'Europe". Plusieurs régions d'Amérique du Sud présentent un potentiel très élevé pour la production de viande de ruminants. Cette viande est produite assez économiquement en conditions de pâturage (Pampa), elle a une qualité indiscutable et elle est un des produits les plus exportés vers les USA et l'Europe. L'objectif de cet article est donc de comparer par un panel sensoriel la viande de l'Uruguay maturée pendant 20 jours (11,1 et 19,4 kg de carcasse et 3-4 et 12-13 mois d'âge, respectivement) à des moutons de l'Europe : Espagne (10,2 kg carcasse et 3 mois d'âge), Royaume-Uni (22,8 kg pour des animaux commerciaux) et Allemagne (23,2 kg et 4-6 mois). Les études réalisées montrent que l'effet du type de mouton est significatif pour tous les paramètres étudiés, à l'exception de l'intensité de la saveur, et que la maturation de la viande est très importante pour les caractéristiques du produit. Les facteurs relatifs aux résultats trouvés lors de l'évaluation sensorielle sont aussi discutés.

Mots-clés : Qualité de la viande, concentré, pâturage, panel sensoriel.

Introduction

World lamb consumption is around 2 kg *per capita* with large variations between continents (17 kg in Oceania or 0.7 kg in North America) or even between countries or regions inside the same country. With 1.1 million tm in 1996, the international trade of sheep represents a small percentage of all the international meat trade. However, among all the meats, sheep meat remains the most internationally traded (15% of total world production is exported), which explains the potential existence of different lamb products in the same market.

In this sense, sheep production systems vary considerably across the world, and reflect the different local environmental conditions, which determine, to a large extent, breeds, housing, levels of intensification and, at the end, local market requirements. Pastoral systems are especially important in some areas of South America (i.e., Humid Pampas) where high amounts of grass grow naturally at

low cost and grazing is the obvious productive system orientation. Meat production in these regions, such as in Uruguay, is one of the most important exports to USA and Europe.

To those countries with these natural privileged grazing regions, that have a well-developed meat chain, it is a very important and positive competitive advantage to know the preferences and acceptability of their products in foreign markets. In Europe, there is a large variability in lamb production and subsequently in the culinary background of its citizens. In any case, this variability makes, a priori, a clear difference between North and Mediterranean countries, and even between consumers that has high or low lamb consumption levels. Thus, Mediterranean regions apparently have pale and delicately flavoured flesh, in contrast to the larger, fatter and more robustly flavoured types produced in northerly areas. Also, countries such as Spain or UK have relatively high lamb consumption whereas others, such as Germany, have very low rates. Historically, it has been shown that in areas with low meat consumption, sheep meat is generally disliked because its strong flavour and odour. However, in areas where people consume a large amount of sheep meat, apparently flavour is more enjoyed (Griffin *et al.*, 1992).

That variability in tastes represents market opportunities to change or to diversify the offer. Nevertheless, in any case, it is not completely clear which type of lamb products respond to the demand.

In a previous work, with Uruguayan and European lamb meat, consumer tended to prefer known or local meat (Font i Furnols *et al.*, 2006). But, up to date, nothing has been scientifically published based on the results of trained panels that could generate interesting meat sensory profiles and large comparative results between grass fed animals from South America and those produced in some European conditions. In this sense, there are some experimental sensory studies comparing animals produced inside Europe, (Sañudo *et al.*, 1998), USA (Griffin *et al.*, 1992) or Canada (Jeremiah, 1988). But in these studies, the lamb variability analysed was not too large having the animals similar carcass weight and rearing system, which imply, a priori, low variability in their sensory properties (Carluzzi *et al.*, 1999; Arsenos *et al.*, 2002; Priolo *et al.*, 2002). The purpose of the present paper was to assess the sensory characteristics of grass-fed animals from Uruguay in comparison with local European products.

Material and methods

Animals

Twenty light (11.1 ± 1.4 kg cold carcass weight, 3-4 months old) and twenty heavy (19.4 ± 2.2 kg cold carcass weight, 12-13 months old) Uruguayan castrated male lamb from Corriedale breed were selected. Lambs were reared in an improved grass fed system. Sixty more commercial lambs were chosen in Germany (DE), Spain (ES) and United Kingdom (UK), being 20 in each country.

In Germany, lambs (23.2 ± 3.6 kg cold carcass weight) had 4-6 months of age, they were males from crossbreeds between Suffolk or Schwarzköpfiges Fleischschaf x Merino Landschaf breeds. Animals were finished on pasture (clover mainly) supplemented with wheat, bean and pea concentrate.

In Spain, lambs (10.2 ± 0.6 kg cold carcass weight, 3 months old) were males from Rasa Aragonesa meat breed. They were reared intensively and fattened indoors with concentrate and cereal straw *ad libitum*.

In United Kingdom, animals (22.8 ± 1.7 kg cold carcass weight) were commercial castrated from different commercial crosses. British lambs were reared extensively on pasture and supplemented only at specific times.

Sampling

Lambs from the four countries were slaughtered in commercial EU licensed abattoirs using standard procedures.

Carcasses (Table 1) were kept entire at 2°C for 48 hours after slaughtering. Then, loins were deboned and the *Longissimus thoracis* muscle, left side (T6 – T13) was cut for the sensory panel study. They were vacuum packaged in aluminium bags and kept at 2°C until the end of the ageing period (20 days for both Uruguayan types and 7 and 20 days for all the European lambs). After that, they were frozen at -20°C until the day before running the panel test. Twenty days represent the time that the Uruguayan meat would take to reach the European Market and seven days is an approximate local ageing time for European meat.

Table 1. Main carcass characteristics (means) of the different types of lambs used in this experiment

	Cold carcass weight (kg)	Conformation score [†]	Fatness score ^{††}
Light Uruguayan lambs	11.1	2.5 (O+)	2.3
Heavy Uruguayan lambs	19.4	2.8 (R)	2.9
German lambs	23.2	2.6 (R-)	2.8
Spanish lambs	10.2	1.0 (P)	1.8
British lambs	22.8	3.6 (U-)	3.0

[†]EUROP (Lamb Carcass Classification System).

^{††}1-5 scale.

Sample preparation and panel test design

An eight-member Spanish trained sensory panel was used to evaluate the samples using a quantitative descriptive analysis. Assessors were trained (ISO 8586-1:1993) in sensory profiling for lamb meat.

After thawing in tap water until reaching an internal temperature of 16-18°C, lamb samples were cut (Fig. 1) into four 2 cm-thick slices and cooked on a pre-heated double hot-plate grill at 200°C until the internal temperature reached (70°C). Samples were wrapped in aluminium foil and identified with a single random three-digit code; they were kept warm until serving (10-15 minutes after cooking).

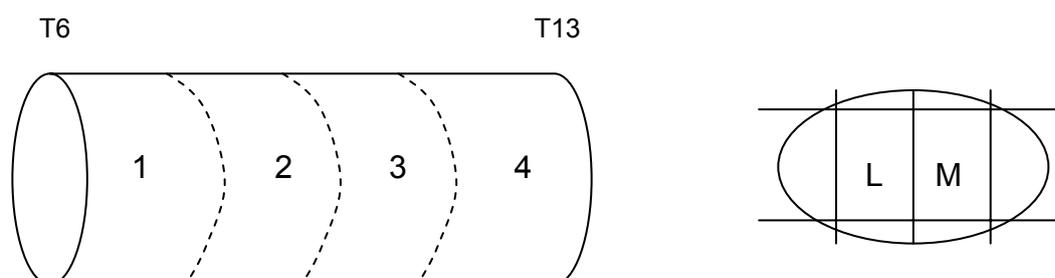


Fig. 1. Slices distribution along *Longissimus thoracis* (1-4) and inside for each chop offered to each panel member (L, lateral - M, medial).

Sensory tests were performed in 14 sessions in a controlled sensory analysis laboratory (ISO 8589:1988) with individual booths and red light, to mask any differences in meat colour. In each session, panellist received three sets (plates) of four samples. The plates were prepared following the experimental designs proposed by Cochran and Cox (1978). Samples represented four of the eight experimental treatments (2 lamb types of Uruguay and three lamb types at two ageing types in each European country). Meat was served following a balanced design to avoid the effect of the first sample and carry over effect. Panellists were asked to eat a bit of bread and to drink a bit of still water at the beginning of the sensory evaluation and between samples to try to make the palate conditions similar for each sample.

Panellist evaluated the meat samples following an eight-point scale. Lamb odour intensity, off-odour intensity, tenderness, juiciness, lamb flavour intensity, fatty flavour intensity, off-flavour intensity, flavour quality and overall acceptability. Scores ranged between 1 (no odour, very tough, very dry, no flavour and unpleasant) and 8 (very intense odour, very tender, very juicy, very intense flavour and very pleasant).

Statistical analysis

One hundred and sixty judgements were obtained per treatment (as a result of the combination of lamb type and ageing time). Data were analysed using GLM procedure of SAS (1999). Panellist, plate (within session) and treatment were considered as fixed effects; also panellist by treatment interaction was introduced into the model. The Tukey multiple range test was used to show significant differences among means. Differences were considered significant at the $P < 0.05$ level. A Procrustes transformation, that corrects differences in the use of the scale between panellist, was performed previously to a principal component analysis (PCA).

Results and discussion

Significance of the effects considered is shown in Table 2. Panellist was a significant factor for all the sensory attributes ($P < 0.001$), which is quite common in sensory studies due to the different uses of scale (Rousset-Akrim *et al.*, 1997). Also, plate (within session) was significant, which is normal because not the same treatments were tasted in the same plates. A significant interaction between treatment and panellist was found for the odour, flavour and hedonic attributes, but it was ordinary and little important.

Table 2. Significance for the sensory descriptors evaluated in the *Longissimus thoracis* of lamb, according to the studied factors

	Lamb odour intensity	Off odour intensity	Tenderness	Juiciness	Lamb flavour intensity	Fatty flavour intensity	Off flavour intensity	Flavour quality	Overall acceptability
Treatment	+	***	***	+	NS	**	***	***	***
Panellist	***	***	***	***	***	***	***	***	***
Plate (session)	***	*	***	***	***	***	***	***	***
Root MSE	1.24	1.63	1.24	1.53	1.15	1.35	1.87	1.35	1.41

[†] $P < 0.10$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; NS = not significance.

Treatment was almost significant in all the variables studied, except in lamb flavour intensity. Higher significance was observed for off flavours and odours, tenderness and hedonic variables than for fatty flavour intensity and, specially, lamb odour intensity and juiciness. The same tendency, higher F-values for tenderness, comparatively with juiciness, and for flavour respect to odour, was found by Martínez-Cerezo *et al.* (2005) when breed, slaughter weight and ageing time effects were analysed.

In Table 3, it can be observed that the highest "lamb odour intensity" was found in the Spanish lamb aged by 7 days, probably because the Spanish panel is more used to this type of lamb and ageing time. However, it was only statistically different from the Uruguayan light lamb. Between both Uruguayan types there were not significant differences due to slaughter weight and age, which agrees with Carluzzi *et al.* (1999), showing that in animals castrated and reared in similar way, age differences higher than 8-9 months are not important in lamb odour.

The highest "off odour intensity" notes were associated with longer ageing times, in animals fed with concentrates. Ageing tends to modify odour according to proteolysis and oxidative processes. Obviously, animals produced in extensive systems support better ageing than younger, especially

those from Spain or Germany, probably because of differences in muscular structure and physiology as well as of the higher content of antioxidant compounds in grass.

Table 3. Sensory profile of different types of lamb[†] from Uruguay or Europe aged by 7 or 20 days

	Lamb odour intensity	Off odour intensity	Tenderness	Juiciness	Lamb flavour intensity	Fatty flavour intensity	Off flavour intensity	Flavour quality	Overall acceptability
UY light	4.51 b	2.80 c	6.96 bc	4.94 ab	5.91	4.55 ab	4.29 cd	4.08 ab	3.94 ab
UY heavy	4.71 ab	3.02 c	7.23 b	5.19 a	5.80	4.74 ab	4.78 b	3.96 b	3.87 b
ES 7 days	5.03 a	3.12 c	7.38 a	5.07 ab	6.11	4.83 a	4.76 b	3.87 b	3.78 b
ES 20 days	4.87 ab	3.35 a	7.73 a	4.89 ab	5.95	4.57 ab	5.58 a	3.25 c	3.14 c
DE 7 days	4.82 ab	2.59 c	6.53 c	4.64 b	5.83	4.28 b	3.69 d	4.62 a	4.43 a
DE 20 days	4.84 ab	3.35 a	7.31 a	4.82 ab	6.01	4.47 ab	3.90 cd	4.41 ab	4.29 ab
UK 7 days	4.77 ab	2.74 c	6.65 c	4.81 ab	5.76	4.29 ab	4.39 cd	4.25 ab	4.06 ab
UK 20 days	4.80 ab	3.13 b	7.15 b	4.96 ab	5.75	4.43 ab	4.55 bc	4.09 ab	3.97 ab

[†]UY = Uruguay; ES = Spain; DE = Germany; UK = United Kingdom.

^{a,b,c}Different letters significant differences between treatments (P < 0.05).

The highest "tenderness" scores were found in lamb aged for 20 days, and from young animals reared intensively (3 months old). Within Uruguayan meat, comparing animals of 3-4 vs 12-13 months old, there was not significant differences, showing the importance of ageing in lamb texture and that age, considering long ageing periods, is less important than what it could be expected (Santos-Silva *et al.*, 2002; Sañudo *et al.*, 2003). The lowest tenderness was found in older animals aged for 7 days, showing the importance of ageing in meat textural characteristics.

Given its higher intramuscular fat content (Díaz *et al.*, 2006), heavy Uruguayan lambs have shown the highest "juiciness" since high levels of fat could make meat more tender and juicy (Martínez-Cerezo *et al.*, 2005). Only significant differences were found with German meat aged for 7 days.

"Lamb flavour intensity" was not statistically different between lamb types, showing, as in odour, some identification of lamb perception with that at which the panel was more confident. It could be expected that odour and flavour intensity were scored higher in older and grass feed animals as found by Sañudo *et al.* (1998) when British and Spanish typical lambs were tasted.

On the other hand, "fatty flavour intensity" was higher in the Spanish and Uruguayan animals, although the only significant difference was found between the Spanish and the German lambs, both aged for 7 days. The more unsaturated fat in the Spanish lambs, with lower melting temperatures, and the highest fat content of the Uruguayan heavy lambs (Díaz *et al.*, 2006) could justify the results.

Within each country, the highest "off flavour" rates were detected, as expected, in meat aged for longer times. It could also be observed that, in general, flavour differences were higher than those found in odour. These results are in agreement with Martínez-Cerezo *et al.* (2005) and Rousset-Akrim *et al.* (1997). These latest authors indicated that proteolysis products (peptides), which are some of the many compounds involved in off flavour, are largely increased from 7 days onwards. Also, for Uruguayan lambs, heavier animals had higher off flavour notes.

Given the presence of off flavours and fatty flavours, which have low acceptability, the lowest scores for "flavour quality" and "overall acceptability" were found for the Uruguayan heavy animals and the locals, especially if the meat was aged for 20 days. The same meat was also penalised by the Spanish consumers in the same animals (Font i Furnols *et al.*, 2006). Also, Martínez-Cerezo *et al.* (2005) found that Rasa Aragonesa lambs had slightly lower flavour quality associated with their highest fat and off flavour intensities. Besides, it is known that flavour is one of the main characteristics in determining acceptability in lamb (Corcoran *et al.*, 1999).

In Fig. 2 can be observed how the different treatments and attributes are grouped according to the PCA. Axis one explains 74.48% and axis two 12.97% of the total variability. Thus, the panel separated by the axis 2 (vertical) the younger and more intensively fed animals (Spanish and

Germans) from the older and more extensively fed lambs (Uruguayan and British). This axis was also associated to lamb odour and flavour and juiciness, probably the most important attributes to discriminate these types of animals coming from different production systems (Sañudo *et al.*, 1998). The horizontal axis-1, associated with overall acceptability, tenderness and off and fatty flavours discriminated German, especially aged for 7 days, and Spanish lambs, specially those aged for 20 days. Animals reared mainly with grass remained in an intermediate position.

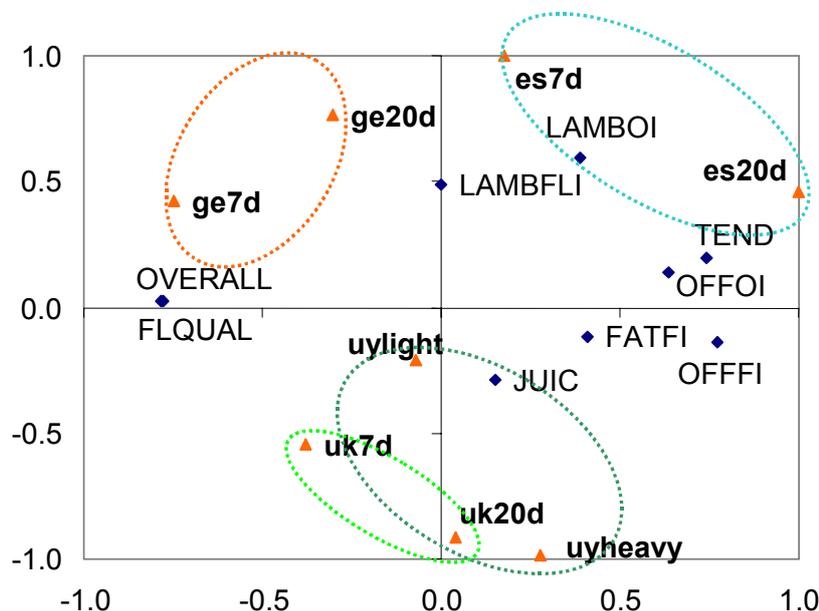


Fig. 2. PCA between sensory traits and lamb types (treatments). Ge: German; es: Spanish; uk: British; 7 and 20 d: meat aged by 7 or 20 days; uylight: Uruguayan light lambs; uyheavy: Uruguayan heavy lambs. LAMBBOI: lamb odour intensity; OFFOI: off odour intensity; LAMBFLI: lamb flavour intensity; TEND: tenderness; JUIC: juiciness; OVERALL: overall acceptability; FLQUAL: flavour quality; FATFI: fatty flavour intensity and FLEXTR: off flavour intensity.

Conclusions

Sensory meat quality is significantly influenced by lamb type – production system and ageing time. These two effects produce a large variability in lamb quality, which could cover consumer demands across Europe. This is particularly important in this continent, given its large variability in consumption and culinary background in lamb products.

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