

SENSORY EVALUATION OF BEEF MEAT PRODUCED UNDER DIFFERENT PRODUCTION SYSTEMS OF URUGUAY

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Introduction

The world-wide marketing for beef meat is very complex, mainly due to the presence of certain animal diseases, production costs and sale prices.

Within the global consumption of meat, the competition between animal species, different cooking and eating habits in each country impose limits for the growth of a determined sector. In Europe, there is a possibility for increasing beef meat market, since European countries stay with annual beef meat consumptions quite low (18.9 kg *per capita*) (Simpson, 2004).

The beef meat sector in Europe, mainly intensive orientated systems, has faced, in the last years, so many problems originated by the increasing constrain linked with the concept that red meat is a food product of low quality, no tender and potentially dangerous for human health. The excellent image given by consumers to those products which are coming from extensive production systems could benefit countries like Uruguay.

The scientific and technical information are basic and necessary platforms to promote and to valorize red meat products at world-wide level. Uruguayan exports of beef meat products towards to the international market can be limited if this country does not face key strategies for generating information in this especial area.

Objectives

To characterize and to analyze comparatively the sensorial quality of two Uruguayan beef products in relation to alternative products coming from three different European countries.

Material and methods

Animals of Uruguay

In Uruguay, 40 animals coming from two types of products were analyzed: steers of 2 or 3 years of age at slaughter. All the animals were castrated male of the Hereford breed (the main beef breed of Uruguay), raised under exclusive grazing conditions on native rangelands and fattened on improved pastures at the Central Progeny Test of the Uruguayan Hereford Breed Association.. The steers were slaughtered under commercial conditions, with 428.5 and 519.0 kg of average live weight for the 2 and 3 years old, respectively. Both types of steers generate the main beef products that Uruguay export to the international market.

Animals of Europe

In Europe, one commercial local product in three European countries (Germany, Spain and the United Kingdom) with two ageing times (7 and 20 days) were compared with the Uruguayan beef samples, using 20 animals by country. In Table 1, the main characteristics of the European products are compared with Uruguayan types.

In Germany, the animals were bulls, from Fleckvieh breed, although some Limousine crosses were included. Animals were finished in confinement with corn silage *ad libitum*, complemented with restricted amounts of concentrates, made of soybean meal and cereal grains. The slaughter age and carcass weight ranged from 19 to 24 months and from 283.2 to 447 kg, respectively.

Spanish animals were Holstein breed bulls, weaned and fed in an intensive concentrate system, were animals received diets with high energy concentration and cereal straw *ad libitum*. The slaughter age and carcass weight ranged from 19 to 24 months and from 209 to 254 kg, respectively.

In the United Kingdom, the animals were castrated males with very different genetic basis (crossbreeds between Devon, Hereford, Charolaise and Limousine and pure breeds like Friesian and Fleckvieh), finished basically on a grass diet, complemented with concentrates. The slaughter age and carcass weight ranged from 18 to 22 months and from 280 to 352 kg, respectively.

General Sampling

The muscle *Longissimus dorsi* (LD) was taken of all the animals for each country after 48 hours of slaughtering. In Uruguay, it was divided into pieces, which were vacuum packaged and aged for 20 days, which represents the regular aging period of the meat exported to Europe.

In Europe, the meat samples were aged during 7 days (most common situation in Europe) and for 20 days (similar to the Uruguayan ageing time).

Sensorial evaluation

The sensorial analysis was made with a trained panel of 10 people, in individual cabins with red light. Each panelists valued in a non-structured 1-100 mm line scales

(Sañudo *et al*, 2003) the following variables: beef odor intensity, strange odors intensity, tenderness, juiciness, beef flavor intensity, greasy flavors, strange flavors, quality of the flavor and global appreciation.

The meat was previously defrosted in water until reaching an internal temperature of 16-18 °C. The meat pieces were later cut into slices of 2 cm thickness, which were cooked in a double plate grill, preheated to 200 °C, until reaching an internal temperature of 70 °C. Each piece was cut in prisms of 2 cm side, and maintained warm until the tasting time began.

The analysis, performed with plates with four samples offered to panelists, included 8 types of beef, where all possible combinations were tested: 2 Uruguayan products and 6 meat samples coming from Germany, Spain and United Kingdom, aged for 7 or 20 days.

Statistical analysis

For the statistical analysis, it was used the GLM procedure (General Linear Model) of the SAS.

The applied model used for evaluations of the results of the sensorial analysis determined differences between type of samples, considering the plate within each session, and the panelist as fixed effects. Also, the interaction panelist by animal type was introduced into the model. The statistical differences ($P < 0,05$) between types of samples of the least square averages of each attribute were obtained by the Tukey test.

Results and Discussion

Characterization of Uruguayan products

In Table 2, the results obtained in carcass and meat quality traits (tenderness, WB Warner Bratzler, pH and meat color) for both Uruguayan products are summarized in table 2, in relation to the average of the European carcass and meat samples.

It is observed that the Uruguayan carcass have similar tissue composition compared to those of the young bulls of local breeds, they are longer and they have legs of similar conformation to the European ones. With the exception of the pH value (a little high), the rest of the characteristics defined by instrumental quality analysis, were located within the normal limits of acceptance for the beef meat in Europe.

Sensorial evaluation

The results of the sensorial panel evaluation are shown in Tables 3 and 4 and in Figure 1. In Table 3, it is presented the importance of the different main effects and the interaction between animal type and panelist. The corrected averages of the different sensorial attributes for the different beef types analyzed are presented in Table 4. The results of the analysis of main components are shown in Figure 1.

It was observed that the effect of the beef type was very significant for all the attributes of the sensorial profile (Table 3).

The Table 4 shows that, in the opinion of the tasting panel, the smaller intensity of beef odor occurred in the youngest animals, particularly for bull calves of Spanish origin and in the British meat aged for 20 days. The higher strange odors were associated to the Spanish and UK meats aged by 20 days, which is an expected result because the ageing tends to develop aromas from rancidity and microbial contamination that modify the normal odor of the meat. The lower note was for the British meat aged 7 days, possibly due to the fact that this test was developed by an English panel that would be familiarized with this type of meat.

The greater values of tenderness were observed in the meat of the British animals, followed by the meat of the youngest animals aged for 7 or 20 days and the Uruguayan meat, and finally in the meat of the German animals aged during 7 days. These results indicate the importance of the ageing time over other productive, industrial or processing aspects in order to obtain tender meats. Possibly, given by its greater fat content and its higher pH, the meat of the Uruguayan animals was the juiciest, followed by the 7 days aged Spanish meat, associated to younger animals, and the British meat of 7 days of ageing. The British and Spanish meat aged during 20 days, together to the German of 7 days, had the lower notes of juiciness.

The higher values of beef flavor were obtained for the British meat aged for 7 days, followed by the Uruguayan meat, possibly because it came from older animals. The lower notes of beef flavor were for the British meat aged for 20 days. The greater greasy flavor was observed in the Uruguayan and German meats and the lower in the Spanish and British meats, not presenting a clear relationship between these notes and the amount of intramuscular fat observed in the different meat types under studying, with the exception of the Spanish meat. The higher strange flavors were detected clearly in the British meat with 20 days of ageing, with very important differences compared to the rest of the meat types tested. These results can be explained by the occurrence of a particular problem, probably happened during ageing, since the meat coming from this country, aged only for 7 days, was the one that presented the lowest value on this parameter.

For the group of panelists, the British meat with 7 days of ageing was the most accepted, followed by the Uruguayan and German meats aged by 20 days. The Spanish meat, a product not well known because it came from a very intensive production system, and the German and British meats with 20 days of ageing, obtained the lower notes of acceptability (Figure 1). This result can be related to a greater presence of strange, little tempting flavors, more than associations with problems of texture, since, in fact, the tenderness would be more associated, as it can be appreciated in the Figure 1, to the located meats in a quadrant opposed to the one of the acceptability.

Conclusions

The Uruguayan meat presents values of pH a little elevated, which could be indicating that some pre-slaughter management techniques might be improved.

In general, the greater values of tenderness were observed in the meat of the youngest animals aged for 7 or 20 days and in the British and Uruguayan meats.

Long ageing periods (20 days) for beef meat, tend to develop especial aromas (abnormal and greasy flavors) that modify the normal odor and flavor of the meat, which are not well accepted by the tasting panelists.

Under the sensorial point of view, the most accepted meat was the British aged for 7 days, while both Uruguayan types occupied an intermediate position between the different European meats analyzed, demonstrating their good adaptability to the long ageing periods. There were not differences in meat characteristics between the Uruguayan steers with different ages.

It can not be assessed that the carcass weight, fat content or index of compactness of the carcass affect the acceptability of the Uruguayan meat, determined by a panel of experts.

References

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Tables and Figures

Table 1. Summary of some carcass and meat quality traits of the Uruguayan and European beef types analyzed.

	CCW (kg)	Conformation (1-5)	Fat cover (1-5)	pH 24 hours
Uruguayan 2 years	224.8	2.8 (R)	3.0	5.60
Uruguayan 3 years	282.0	3.2 (R)	3.5	5.71
German	382.4	3.4 (R+)	2.6	5.69
Spanish	229.0	2.0 (O)	2.0	5.42
British	313.3	2.5 (O+)	3.2	5.57

Note: CCW = cold carcass weight. Conformation and fat cover according to European Union System (SEUROP), CEE (1991).

Table 2. Carcass and meat quality traits compared between Uruguayan and European products. European information was obtained from Sañudo (personal communication).

	Two years steer	Three years steers	Intensive beef (local breed)	Intensive beef (meat breed)
Carcass quality				
Carcass length (cm)	132,6	138,2	130	120
Leg perimeter (cm)	103,6	110,1	105	110
Leg length (cm)	76,8	80,3	80	75
Fat (%)	11,9	13,6	12-16	5-10
Muscle (%)	63,2	62,7	58-65	70-75
Bone (%)	22,1	21,0	18-21	15-17
Others (%)	2,8	2,7	2-4	2-4
Meat quality				
pH	5,60	5,71	5,5-5,6	5,6-5,7
Tenderness (7 days)	4,9	4,7	4,5-5	4,5-5
Tenderness (20 days)	4,4	4,8	4-4,5	4-4,5
L *	37,0	35,6	40-41	37-38
a *	20,0	15,9	15-16	17-18
b *	10,4	6,9	9-10	9-10

Table 3. Statistical significance of the different effects on a broad sensorial attributes of beef meat.

	Beef odor intensity	Strange odor intensity	Tenderne ss	Juicines s	Beef flavor intensit y	Greasy flavor intensity	Strange flavor intensity	Flavor quality	Global acceptabili ty
Beef type (T)	***	***	***	***	***	***	***	***	***
Panelist (P)	***	***	***	***	***	***	***	***	***
Plate (session)	***	***	***	***	***	**	***	***	***
T*P	***	***	NS	NS	***	***	***	***	***
RMSE	1,21	1,59	1,78	1,64	1,44	1,03	1,70	1,68	1,60

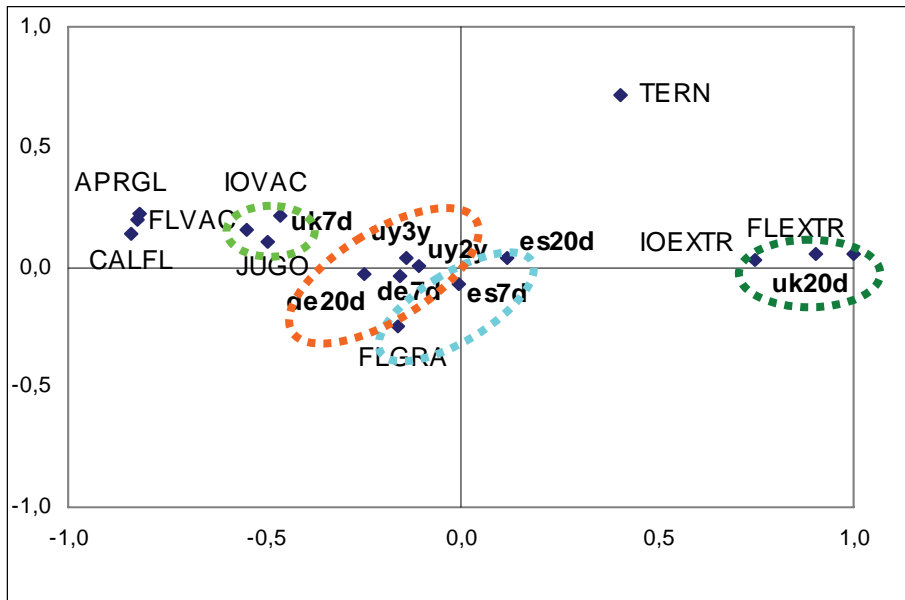
Note: NS: not significant differences; *** = P < 0.0001.
RMSE: Residual Mean Square Error

Table 4. Average global score of the beef meat given by the tasters.

Type of animal	Beef odor intensity	Strange odor intensity	Tenderness	Juiciness	Beef flavor intensity	Greasy flavor intensity	Strange flavor intensity	Flavor quality	Global acceptability
UY	2,82 ^{ab}	2,24 ^b	3,79 ^b	3,62 ^{ab}	2,77 ^{bc}	1,60 ^a	2,61 ^{bcd}	2,92 ^{bc}	2,65 ^{bc}
2 years									
UY	2,69 ^{bc}	2,13 ^b	3,83 ^b	3,93 ^a	2,93 ^b	1,56 ^{ab}	2,49 ^{cd}	2,93 ^{bc}	2,67 ^{bc}
3 years									
DE 7d	2,81 ^{ab}	1,82 ^{bc}	2,62 ^c	3,24 ^b	2,66 ^{bcd}	1,52 ^{ab}	2,43 ^{cd}	2,88 ^{bc}	2,22 ^c
DE 20d	2,90 ^{ab}	1,77 ^{bc}	3,73 ^b	3,58 ^{ab}	3,11 ^b	1,52 ^{ab}	2,24 ^d	3,28 ^b	2,87 ^b
ES 7d	2,52 ^{bc}	2,22 ^b	3,96 ^{ab}	3,62 ^{ab}	2,43 ^{cd}	1,30 ^{abc}	2,94 ^{bc}	2,71 ^{bc}	2,41 ^{bc}
ES 20d	2,51 ^{bc}	2,79 ^a	4,11 ^{ab}	3,21 ^b	2,27 ^d	1,13 ^c	3,19 ^b	2,56 ^c	2,24 ^c
UK 7d	3,19 ^a	1,44 ^c	4,25 ^{ab}	3,71 ^{ab}	3,82 ^a	1,35 ^{abc}	1,56 ^e	4,16 ^a	3,49 ^a
UK 20d	2,38 ^c	3,25 ^a	4,54 ^a	3,20 ^b	1,22 ^e	1,22 ^{bc}	6,78 ^a	0,74 ^d	0,77 ^d

Note: different letters between a type indicate significant differences (P<0.05).
 UY = Uruguay, DE = Germany; ES = Spain; UK = United Kingdom.

Figure 1. Analysis of main components between variables and beef type (de: German; es: Spanish; uk: British: 7 and 20 days: aged meat for 7 or 20 days; uy2y: Uruguayan 2 years; uy3y: Uruguayan 3 years).



Note: BEEFOD: beef odor intensity; GLAPP: global appreciation; FLAQUAL: flavor quality; STRFLA: strange flavor intensity; GREFLA: greasy flavor intensity; BEEFLA: beef flavor intensity; JUIC: juiciness; STRODO: strange odor intensity; TEND: tenderness.