Effect of different feeding systems in the sensory quality of Uruguayan beef

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Abstract

A trained taste panel evaluated the sensory characteristics of meat aged for 20 days from 80 Hereford steers which were finished on one of the following diets with increasing amounts of concentrate: (D1) pasture (4% of animal live weight), (D2) pasture (3% LW) and concentrate (0.6% LW), (D3) pasture (3% LW) and concentrate (1.2% LW), and (D4) concentrate plus hay (*ad libitum*). With the increase of energy in diet, beef odour and flavour intensity declined. Other odours and flavours, in general, were better appreciated in grazing pasture diets supplemented with grain, especially in D2. Concentrate fed animals had globally an inferior sensory quality, since they had higher off flavours (although similar to D1) and less tenderness (although similar to D2).

Introduction

Beef consumption in Uruguay is one of the greatest in the world, but most of the production (75%) is exported. In this country, nowadays, enforces are focus in offering guaranteed high quality products, mainly oriented to high value markets, such as Europe. Beef production in Uruguay is characterized by extensive production based primarily on grass feeding. However, to increase productivity or overcome forage deficit periods, increasingly, animal diets are complemented with cereal grains (around 1% of live weight [LW]). Feedlot systems represent only the 8% of the total beef slaughtering, but could become an interesting option when market conditions are favourable (Montossi & Sañudo, 2007). The objective of this work was to analyse the sensory quality of beef aged for 20 days from Hereford steers finished in four different systems commercially practised in Uruguay.

Materials and methods

Eighty Uruguayan Hereford steers, raised on pastures until reaching 391 kg LW on average with 18-19 months of age, were assigned to 4 different finishing diet systems: (D1) pasture (4% LW), (D2) pasture (3% LW) and concentrate (0.6% LW), (D3) pasture (3% LW) and concentrate (1.2% LW), and (D4) concentrate plus hay (*ad libitum*). The pasture included a mix of alfalfa (*Medicago sativa*), white clover (*Trifolium repens*), and tall fescue (*Festuca arundinacea*). Animals supplemented with 0.6 and 1.2% LW of concentrate (D2 and D3) were fed with corn. The concentrate ration (D4) consisted of 85% ground corn, 12.8% sunflower, 0.98% urea, 0.61% calcium carbonate, 0.61% salt and Rumensin®, and alfalfa hay was fed *ad libitum*. Animals were slaughtered at around 500 kg LW. At 48 h post-mortem, samples of *Longissimus thoracis* were collected, vacuum packaged, aged at 4ºC for 20 days, frozen at -20ºC and shipped to Spain, where sensory analysis evaluation was performed. A 9-member selected and trained panel was used, applying a quantitative descriptive analysis in a complete balanced block design. Prior to analysis, samples were thawed at 4ºC over 24 h. Two cm-thick steaks were cooked on a pre-heated double hot-plate grill at 200ºC until 70ºC of internal temperature was reached. Panellists scored each attribute in a 10-cm non-structured line, and then results were transformed to a numerical scale (0 to 100) for statistical analysis purpose. Multivariant GLM was applied (with animal as experimental unit, and including in the model treatment and session as fixed effects). Differences between least squared means were obtained after applying Tukey tests. All the statistical analyses were performed by means SPSS software (v.14.0, 2005).

Results and discussions

Half of the beef sensory attributes evaluated were affected by the finishing diet system offered to Hereford steers (Table 1). In general, beef odour (and flavour) intensity decreased with the energy concentration increment in diet. This could be related to differences in meat fatty acid composition due to the finishing production system (Álvarez *et al*., 2007) and/or by differences in age, since in those treatments with higher growth rates, the animals were slaughtered before (i.e. D1 was slaughtered 140 days before than D4) (Del Campo *et al*., 2007). However, age may not have been involved in explaining these results, since Warren *et al*. (2008), comparing meat from steers with similar growth rates, feeding concentrate or grass

silage, at different slaughter ages (14, 19 and 24 months) found a significant but small effect of diet on flavour intensities without apparent differences associated with animal age.

Finishing production system had an effect also in strange odours. Those abnormal aromas were higher in both extreme treatments: D1 (all pasture) and D4 (all concentrate). The high intensity of strange odours found in D1 could be associated to the pasture, since it was reduced when it was supplemented with grain (D2 and D3). Controversially, when animals were fed without pasture (D4), strange odour had a similar intensity than D1, perhaps derived from oxidative damage of lipids, since it had lower content of muscle vitamin E than the rest of the treatments (3 versus 4 mg/kg muscle) (Álvarez *et al*., 2007) and probably less quantity of other natural antioxidants present in pastures, such as carotenoids. Furthermore, D4 samples were stored more time (animals were slaughtered earlier). However, the probable high lipid oxidation in D4 has not been supported by the sensory panel, since the fourth treatments had similar rancidity flavour intensity. It has to be taken into account that the fibre source in D4 was a high quality alfalfa hay, and also the concentrates had 12.8% DM of sunflower expeller, and that could have been perceived as 'strange' for Spanish assessors. Some sheep meat studies showed effects on meat flavour produced from legumes feedings (Sink & Caporaso, 1977). However, Cerdeño *et al*. (2006) did not found differences in meat sensory quality between young bulls finished with concentrate plus straw or with concentrate and alfalfa hay as fibre diet source.

Table 1. Sensory analysis of Uruguayan beef from different finishing systems

Attribute	D1	D2	D3	D4	RMSE	*p*
Beef odour intensity*	44 a	45 a	42 ab	39 b	4.53	0.001
Strange odour intensity*	22 ab	16 c	18 bc	26 a	5.79	0.000
Tenderness+	57 a	55 ab	57 a	50 b	6.71	0.002
Juiciness+	48	46	46	43	6.18	0.077
Fibrosity+	43	45	43	46	4.66	0.080
Beef flavour intensity*	56 a	54 ab	53 ab	52 b	3.98	0.031
Rancid flavour intensity*	20	16	17	18	4.73	0.106
Acidic flavour intensity*	32 a	27 b	32 a	32 a	4.23	0.000
Liver flavour intensity*	28	25	26	26	3.68	0.104
Fat flavour intensity*	29	28	27	28	4.64	0.648

(D1) pasture (4% LW), (D2) pasture (3% LW) and concentrate (0.6% LW), (D3) pasture (3% LW) and concentrate (1.2% LW), and (D4) concentrate plus hay (*ad libitum*). * 0=no odour/flavour to 100=very intense; + 0=very tough/dry/low fibrosity to 100=very tender/juicy/high fibrosity; a, b, c Least-squares means with different letters in the same row represent significant differences ($p \leq 0.05$). RMSE: rot of mean square error. *p*: significance of treatment with the statistical model used.

No differences were found between D1, D3 and D4 in acidic flavour. After of feeding during 54 days with maize based diet, animals raised on forage grazing had higher sour, bloody like and fat, and less gamey and sweet meat flavours (Larick & Turner, 1990). The last authors proposed that sour flavour could arise from lactic acid, which would be higher if higher levels of glycogen are present in the muscle. In our study, we cannot certainly explain the reason of the lower acidic flavour intensity for D2, but we can suggest that it is a desirable aspect, since acidic flavour was negative correlated with global sensory hedonic appreciation of the taste panel (Resconi *et al*., unpublished). Livery flavour was not related to the finishing system and the results were similar to those found by Campo *et al*. (1999) with meat aged for 21 days, but higher than for shorter ageing periods. Warren *et al*. (2008) found that livery flavour intensity was higher in grass silage versus concentrate for 14 and 24 months of age in steers, but no differences were observed for 19 months steers. If it is a positive attribute or not, will depend on the intensity of its perception, as well as with the culinary habits of consumers. In addition, the panel did not perceive differences in fat flavour intensity, despite of the differences found in the intramuscular fat content and composition between finishing diet systems (Álvarez *et al*., 2007). In a similar work with lamb, differences between fat flavour intensities were identified between treatments when they varied in at least 1.5 % of intramuscular fat content (Resconi *et al*., 2007).

Meat from concentrate system (D4) was the toughest, but not statistically different from D2. Results also showed a tendency of a lower juiciness and enhanced fibrosity in D4. This was an unexpected result, because animals from D4 had higher growth rates, were younger and with more intramuscular fat than the rest of the treatments. Some studies also showed texture measures improvement in grazing systems (Bruce *et al*., 2004; Realini *et al*., 2004). Those results are maybe related to differences in ultimate pH, or carcasses pH and temperature decline post-mortem. D2 and D4 had a mean of 5.5 in ultimate pH, against 5.7 obtained in D1 and D3. The higher carcass fatness of D4 should have affected the carcass internal temperature declining

(del Campo *et al*., 2007). Howard & Thompson (2001) suggested that there is an optimum pH and temperature post-mortem declining related to time of ageing resulting in improving shear force values. They found that rapid glycolysis (very rapid pH decline at high carcass temperatures) cause an earlier exhaustion of μ-calpain and therefore a low ageing potential.

Conclusions

Finishing diet systems resulted in differences in sensory quality, even when the animal grazing on pastures received a small supplementation of grains. This should be taken into consideration at the moment of marketing the products coming from different production systems. Globally, panellists preferred beef from grazing pasture diets supplemented with grain. Precaution has to be taken with the effect of animal diet composition in meat flavour, especially when long distance commercial transactions are involved. Furthermore, in terms of the preservation of beef intrinsic quality, other technological aspects should be looked at (eg. adequate abattoir management, packaging, etc).

Acknowledgements

Authors want to thank INIA Uruguay, INIA España and AECI for financial and technical support.

References

Álvarez, I.; De la Fuente, J.; Díaz, M.T. & Cañeque, V. (2007). Composición en ácidos grasos y vitamina E de la carne de novillos alimentados con niveles diferentes de concentrado. *INIA Tacuarembó* **168**, 61-66.

Bruce, H.L.; Stark, J.L. & Beilken, S.L. 2004. The effects of finishing diet and postmortem ageing on the eating quality of the M*. longissimus thoracis* of electrically stimulated Brahman steer carcasses. *Meat Sci.* **67**, 261–268.

Campo, M.M.; Sañudo, C.; Panea, B.; Alberti, P. & Santolaria, P.1999. Breed type and ageing time effects on sensory characteristics of beef strip loin steaks. *Meat Sci*. **51**, 383-390.

Cerdeño, A.; Vieira, C.; Serrano, E.; Lavín P. & Mantecón, A.R. 2006. Effects of feeding strategy during a short finishing period on performance, carcass and meat quality in previously-grazed young bulls. *Meat Sci*. **72**, 719–726.

del Campo, M.; Brito, G.; Hernandez, P.; Soares de Lima, J.M.; Vaz Martins, D.; San Julián, R.; Montossi, F. & Sañudo, C. (2007). Effect of different diets on carcass traits and meat quality in Uruguayan steers. *53er ICoMST China*, 285-286.

Hwang, I.H. & Thompson, J.M. (2001). The interaction between pH and temperature decline early post-mortem on the calpain systema and objective tenderness in electrically stimulated beef *longissimus dorsi* muscle. *Meat Sci*. **58**, 167-174.

Larick, D.K. & Turner, B.E. 1990. Flavor characteristics of forage and grain-fed beef as influenced by phospholipid and fatty acid compositional differences. *J. Food Sci.* **55**, 312–317.

Montossi, F. & Sañudo, C. 2007. Antecedentes, justificación y objetivos del proyecto. *INIA Tacuarembó* **168**, 9-14.

Realini, C.E.; Duckett, S.K.; Brito, G.W.; Dalla Rizza, M. & De Matto, D. 2004. Effect of pasture vs. concentrate feeding with or without antioxidants on carcass characteristics, fatty acid composition, and quality of Uruguayan beef. *Meat Sci.* **66**, 567–577.

Resconi, V.C.; Campo, M.M.; Font i Furnols, M.; Guerrero, L.; Cañeque, V.; San Julián, R.; Luzardo, S.; Montossi, F. & Sañudo, C. 2007. Sensory quality of Uruguayan lamb form different feeding systems. *53er ICoMST China*, 257-258.

Sink, J.D. & Caporaso, F. 1977. Lamb and mutton flavour: Contributing factors and chemical aspects. *Meat Sci*. **1**, 119–127.

Warren, H.E.; Scollan, N.D.; Nute, G.R.; Hughes, S.I.; Wood, J.D. & Richardson, R.I. 2008. Effects of breed and a concentrate or grass silage diet on beef quality in cattle of 3 ages. II: Meat stability and flavour. *Meat Sci*. **78**, 270–278.