Meat quality and sensory attributes of two Portuguese bovine breeds, Alentejana and Barrosã, under distinct feeding regimens

Costa A.S.H.*, Costa P., Alfaia C.M., Lopes P.A., Lemos J.P.C., Prates J.A.M.

CIISA, Faculdade de Medicina Veterinária, Universidade Técnica de Lisboa, Av. da Universidade Técnica, Pólo Universitário do Alto da Ajuda, 1300-477 Lisboa, Portugal. *adanacosta@fmv.utl.pt

Abstract - Fat content and fatty acid profile are major determinants of meat quality. While much has been hypothesised concerning the role of the genetic background in meat sensory quality, diet should not be neglected. We examined the effects of breed and diet (high silage *versus* low silage diets) on meat quality and its sensory attributes, in an experiment comprising thirty-nine young bulls from two philogenetically distant Portuguese bovine breeds, Alentejana and Barrosã. The pH and temperature were measured at 45 minutes, 3 hours and 24 hours *post-mortem* in the *longissimus dorsi* (LD) muscle. After an ageing period of 8 days, meat colour was assessed, in parallel with the determination of intramuscular fat (IMF) and fatty acid composition. In addition, meat sensory attributes were evaluated by a trained sensory panel. Results showed that breed affected initial pH and temperature *post-mortem*, with the lowest values in Barrosã's LD muscle. Alentejana meat was lighter than Barrosã's. Significant interactions between breed and diet for IMF and saturated fatty acids were found, reaching the highest values in low silage (LS) fed Barrosã bulls. Conversely, this experimental group showed the lowest proportions of polyunsaturated fatty acids (PUFA). The high silage (HS) diet promoted higher proportions of *n*-3 PUFA than the LS diet. Sensory panel scores and shear force values showed significant variations between breeds, favouring Barrosã. Our results revealed that whilst genetic background and diet were key factors influencing meat quality and composition, sensory quality depended mostly on breed.

Keywords - Beef cattle; Meat quality; Fatty acid composition.

I. INTRODUCTION

One of the major goals of the beef industry is to improve products' quality and healthiness, which are determined mainly by intramuscular fat (IMF) and fatty acid profile. The IMF content and composition depend mostly on breed and feeding [1]. The fatty acid composition of the IMF affects not only the nutritional value but also the sensory properties of meat. For instance, high polyunsaturated fatty acids (PUFA) contents may produce alterations in meat flavour due to their susceptibility to oxidation and the production of abnormal volatile components during cooking [2].

Meat quality is of prime importance to cattle breeders because an improvement in quality and consistency may contribute to an increase in beef consumption. The most important factor in a consumer's acceptability of meat is palatability, primarily influenced by tenderness and juiciness [3]. Currently there are no objective means of measuring the full range of interacting characteristics contributing to eating quality [4], thus evaluating the human response relies on the subjective assessment of sensory panels.

The influence of genetic background and feeding regimen in beef eating quality has been the subject of much speculation, with growth rate and fat level being important underlying factors. It is well known that large breeds have higher growth rates than small breeds and, therefore, deposit more muscle and less fat. In addition, the productive performance is also determined by diet. Therefore this study examined the effects of breed and diet on meat quality and its sensory attributes, by comparing two philogenetically distant bovine breeds (large framed Alentejana and small framed Barrosã) fed high or low silage diets.

II. MATERIAL AND METHODS

The experimental design comprised 39 young bulls from Alentejana (n=19) and Barrosã (n=20) breeds, fed low (30% concentrate/70% corn silage on a dry matter basis) or high-based (30% corn silage/70% concentrate) diets. Initial average weight was 266 ±

10.5 kg for Alentejana bulls and 213 ± 3.64 kg for Barrosã bulls.

Animals were slaughtered at 18 months-old at the INRB experimental abattoir by exsanguination after stunning with a cartridge-fired captive bolt stunner. Muscle pH and temperature were measured at 45 minutes, 3 and 24 hours after slaughter using a pH meter equipped with a penetrating electrode at the *longissimus dorsi* (LD) muscle between 12th and 13th ribs. Carcasses were suspended from the Achilles tendon and chilled at 6 ºC for 24 hours and weighted, to which followed an ageing period of 8 days at 2°C.

The LD muscle samples were collected, trimmed of connective and adipose tissues before being blended in a food processor, vacuum packed and stored at −80 ºC until further analysis. The colour of the LD muscle was measured using a Minolta CR-300 chromometer applying the CIE L*, a* and b* system one hour after air exposure to allow blooming.

Meat samples were lyophilised (−60 ºC and 2.0 hPa) to constant weight. The IMF in lyophilised samples was extracted, converted to fatty acid methyl esters and analysed as described by Jerónimo *et al.* [5].

Twelve panellists trained for bovine meat performed the sensory analysis for tenderness, juiciness, flavour and overall acceptability. The scale applied in the sensory analysis was structured into 8 points, representing 1 and 8 the minimum and maximum score of tenderness, juiciness, flavour and overall acceptance, respectively.

The GLM procedure of SAS, version 9.1, [6] was used to perform a 2×2 factorial analysis. The relationships between meat traits and sensory scores were examined through the CORR procedure. For all tests, the level of significance was set at 0.05.

III. RESULTS AND DISCUSSION

Effects of breed and diet on the LD muscle quality traits are shown in Table 1. Both pH and temperature at 45 minutes and 3 hours *post-mortem* were higher in Alentejana than in Barrosã young bulls. Yet, a different pattern was observed at 24 hours after slaughter. These results might be a consequence of a distinct fibre profile, which would in turn determine a glycolytic potential responsible for a faster decrease in the LD muscle pH of the Barrosã breed. Shear force values were higher in Alentejana than in Barrosã meat. Intramuscular fat, which was highest in the Barrosã meat, might have influenced tenderness through an effect on susceptibility to cold shortening [7]. Furthermore, it appears that a glycolytic rate resulting in a pH of 6.0–6.1 three hours after slaughter produces higher tenderness [8]. In fact, the pH of the LD muscle was lower in Barrosã than Alentejana. Concerning the colour-related parameters, higher L* values were observed in Alentejana than in Barrosã meat. Higher growth rates, as observed in this study for Alentejana breed (data not shown) involve a lower deposition of the haem pigment thus contributing to a lighter meat [9].

Significant interactions between breed and diet for IMF and saturated fatty acids (SFA) were found, with the highest values being observed in LS fed Barrosã bulls. Conversely, this breed showed the lowest proportions of PUFA. The Alentejana breed showed the lowest proportions of monounsaturated fatty acids (MUFA), which may reflect a differential Δ-9 desaturase activity. The HS diet promoted higher proportions of *n*-3 PUFA than the LS diet. The *n*-6 PUFA were lowest in the LS fed Barrosã bulls, showing a breed×diet interaction. Higher levels of branched chain fatty acids (BCFA) were also found in the HS fed bulls in comparison to the LS fed. In fact, BCFA are regarded as indicators of rumen activity, which is expected to be enhanced by high forage diets. Current nutritional recommendations are that the PUFA/SFA ratio should be above 0.45 and the *n*-6/*n*-3 PUFA ratio should be below 4.0 [10]. In view of the above, those guidelines were not met in the present study, perhaps due to the use of cereal silage, which is known to be rich in *n*-6 PUFA.

Sensory panel scores showed significant variations between breeds, favouring the Barrosã breed (Table 3). Tenderness scores were lower in the LS than in the HS fed Alentejana bulls, but the opposite pattern was observed in Barrosã. Juiciness and overall acceptance scores were higher in Barrosã than in Alentejana meats.

The correlation analysis revealed a negative relationship between shear force and tenderness scores (r=-0.76, $P<0.001$). Tenderness (r=0.40), juiciness (r=0.41) and overall acceptability (r=0.41) showed positive correlations with IMF muscle content

(P<0.05), thus reinforcing the positive contribution of IMF to the eating quality of beef.

IV. CONCLUSION

While the importance of genetic background in meat quality and composition, along with its sensory traits, has been reinforced, diet appeared to play a less relevant role under these experimental conditions.

ACKNOWLEDGMENTS

Financial support from FCT grant (PTDC/CVT/2006/66114) and individual fellowships to A.S.H. Costa. (SFRH/BD/2009/61068) and P. Costa (SFRH/BPD/2008/46135) are acknowledged. Paula A. Lopes is a researcher from the program "Ciência 2008" from FCT.

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Table 1. Effects of breed and diet on the *longissimus dorsi* muscle quality traits from Alentejana and Barrosã bulls fed high silage (HS) or low silage (LS) diets.

	Alentejana		Barrosã			Significance		
	HS	LS	HS	LS	SEM	Breed	Diet	Breed × Diet
Temperature (ºC)								
45 m	37.6	36.2	29.8	29.0	1.04	***	ns	ns
3 h	26.7	27.9	24.2	25.3	1.06	*	ns	ns
24 h	15.2	15.6	15.6	15.0	0.913	ns	ns	ns
pH								
45 min	6.79	6.75	6.52	6.40	0.070	***	ns	ns

3 h	6.45	6.24	6.16	6.20	0.070	*	ns	ns
24 h	5.65	5.71	5.73	5.67	0.068	ns	ns	ns
Colour								
L*	38.8	38.9	37.5	35.8	0.786	**	ns	ns
a*	17.7	16.2	17.6	19.0	0.924	ns	ns	ns
b*	8.79	7.47	7.72	7.88	0.627	ns	ns	ns
Shear force (kg)	6.37	6.32	4.83	5.20	0.510	*	ns	ns

Significance level: not significant (ns), $P>0.05$; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.

Table 2. **I**ntramuscular fat (g/100 g meat), partial sums of fatty acids (g/100g fatty acids) and ratios in *Longissimus dorsi* muscle from Alentejana and Barrosã bulls fed high silage (HS) or low silage (LS) diets.

	Alentejana		Barrosã			Significance		
	HS	LS	HS	LS	SEM	Breed	Diet	Breed × Diet
IMF	1.21^{c}	1.24^{c}	1.76^{b}	2.76^{a}	0.128	***	***	***
Partial sums								
Σ SFA	41.9^{ab}	40.9^{b}	41.2^{ab}	43.3^{a}	0.817	ns	ns	*
Σ MUFA	35.7	37.0	39.8	42.1	0.964	***	ns	ns
Σ TFA	1.65	2.03	2.49	2.62	0.124	***	*	ns
Σ PUFA	12.2^{a}	12.5^{a}	9.73^{c}	6.25^{b}	0.867	***	ns	*
Σ *n*-6 PUFA	10.5^{ab}	11.6^{a}	8.36^{b}	5.60^{c}	0.788	***	ns	*
Σ *n*-3 PUFA	1.52	1.12	1.29	0.597	0.104	***	***	ns
Σ BCFA	1.66	1.41	1.71	1.46	0.059	ns	***	ns
Fatty acid ratios								
PUFA/SFA	0.299^{ab}	0.311^{a}	0.238^{b}	0.145^{c}	0.026	***	ns	*
*n*6/*n*3	6.94	10.1	6.81	9.37	0.475	ns	***	ns

Significance level: not significant (ns), $P>0.05$; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.

Table 3. Taste panel evaluation of *Longissimus dorsi* muscle from Alentejana and Barrosã bulls fed high silage (HS) or low silage (LS) diets.

	Alentejana		Barrosã			Significance		
	HS	LS	HS	LS	SEM	Breed	Diet	Breed × Diet
Tenderness	4.43^{b}	4.76^{b}	6.00^{a}	5.69^{a}	0.135	***	ns	*
Juiceness	3.49	3.50	3.68	3.94	0.123	**	ns	ns
Flavor	4.63	4.46	4.59	4.70	0.114	ns	ns	ns
Overall acceptance	4.21	4.29	4.96	4.92	0.125	***	ns	ns

Significance level: not significant (ns), $P>0.05$; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.