51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

COMPARISON OF BEEF FLAVOUR AND RELATED COMPOUNDS BETWEEN COWS AND YOUNG BULLS AS INFLUENCED BY AGEING

Claeys E.[1], Raes K.[1]*, Dirinck P.[2], De Winne A.[2], Balcaen A.[1], Fiems L.[3] & De Smet S.[1]

[1] *Laboratory of Animal Production and Animal Product Quality, Department of Animal Production, Ghent University, Proefhoevestraat 10, 9090 Melle, Belgium*
[2] *Chemical and Biochemical Research Centre, Department of Chemistry and Biochemistry, KaHo Sint-Lieven, Gebroeders Desmetstraat 1, 9000 Ghent, Belgium*
[3] *Department of Animal Nutrition and Husbandry, Agricultural Research Centre, Ministry of the Flemish Community, Scheldeweg 68, 9090 Melle, Belgium*

Key Words: beef, ageing, flavour compounds, peptides, fatty acids

Introduction

The positive influence of ageing on beef tenderness has been convincingly demonstrated (e.g. Davey et al., 1976). Other sensory properties such as taste or flavour have been shown to change with ageing time as well, although the effects are not consistent (Spanier et al., 1997). Nevertheless, in the Belgian meat industry, it is generally accepted that beef ageing improves meat flavour. It is also believed that female cattle, having bred at least once, yield meat with more intense flavour than young male slaughter cattle.

Objectives

To investigate the effect of sex (cows vs. bulls) and ripening time on flavour properties and related parameters of bovine *Longissimus thoracis* (LT) muscle in the Belgian Blue beef strain breed.

Methodology

Three young bulls and 3 cows (aged between 12.6 and 14.6 and between 31.2 and 48 months respectively) of the Belgian Blue beef strain breed were slaughtered in the experimental slaughterhouse of our department after captive bold stunning. The bulls and one cow had been fattened on a high concentrate diet, whereas two cows had been fattened at pasture supplemented with dried sugarbeet pulp. pH was measured between the 7th and 8th thoracic rib in the LT muscle after 1, 3, 5 and 24 hours *post mortem* (pm). At 1 day pm following conventional cooling, the LT between the 6th and 8th rib of the left carcass half and between the 6th and 9th rib of the right carcass half were excised. Sub-samples were taken in the same order of anatomical location, vacuum packed and frozen at –18°C until analysis either immediately (1 day ageing), or after 6 or 13 days additional storage at 3°C (7 and 14 days ageing). Shear force (SF) and aroma profiling by GC-MS after Likens-Nickerson extraction of volatile aroma compounds were assessed according

to the methods described in Raes et al. (2003). The concentration of 3-10 kDa peptides was determined by SDS-PAGE and expressed as cytochrome c equivalents (Claeys et al., 2004). Taste intensity was scored by a semi-trained 6 member panel, to which in each session 2 plates with each 3 grilled samples (of the three ageing times) of one female and one male animal were presented. Panellists were asked to rank the 3 samples of each plate according to taste intensity. In addition, they were asked to indicate an overall preference for one of the two plates.

Fatty acid composition was analysed on a sample of 1 day ageing (Raes et al., 2003). Determination of the L*, a*, b* colour co-ordinates and sarcomere length was done on the same sample of 7 days ageing used for shear force (Raes et al., 2003).

Due to the low number of observations, non-parametric tests (Exact Wilcoxon rank-sum test, Kruskal-Wallis rank sum test) were used to compare sex and ageing groups.

Results & Discussion

Live weight at slaughter, pH values of the LT at various times pm and LT sarcomere length were not significantly different between bulls and cows (Table 1). There was a tendency (P=0.1) for lower CIE L* and b* values and higher CIE a* values for the cow samples, indicating a darker colour measured at 7 days pm. This confirms the finding that meat of older animals is darker (Fiems et al., 2003), a consequence of its higher myoglobin content (Monin and Ouali, 1991). Across sexes, the effect of ageing on shear force and 3-10 kDa peptide concentration was significant with the values for 1 day ageing being significantly different from those of 7 and 14 days ageing ($P<0.01$). Average shear force values declined similarly up to 7 days pm for cows and bulls, but continued to decline in the cow samples with further ageing, whereas this was not seen for the bull samples (Fig. 1). This corresponds with the changes in peptide concentration that were observed (Fig. 2), indicating a higher degree of proteolysis in the cow compared to the bull samples at 14 days pm. However, it should be mentioned that the differences in peptide concentration and shear force between bull and cow samples at 14 days pm were not significant.

As could be expected from the sex and age difference (Fiems et al., 2003), a tendency (P=0.1) for a higher intramuscular fat content (reflected in total fatty acid content) was found for the cow compared to the bull LT samples (Table 2). This was accompanied by a higher proportion of saturated and n-3 poly-unsaturated fatty acids (P=0.1), whereas there was no significant difference for the mono-unsaturated and n-6 poly-unsaturated fatty acid proportions. Dietary factors as well as differences in fat content may be responsible for these differences.

Since taste intensity was evaluated by ranking of the samples from the three ageing times within each animal, this does not allow to test for the effect of sex. Samples of 7 and 14 days ageing were ranked lowest and highest respectively for taste intensity with 1 day ageing samples being intermediate (mean values 2.07, 1.72 and 2.24 for 1, 7 and 14 days ageing respectively), at the borderline of significance (P=0.07). Campo et al. (1999) found, depending on the breed type, little differences in overall flavour intensity scores with time pm. Spanier et al. (1997) found that the ageing process is characterised by an enhancement of beef sensory quality due to tenderization, whereas this is not the case for the overall flavour because desirable flavours decline with ageing, while off-flavours

such as bitter and sour increase. Panellists, however, preferred cow samples more than bull samples in our study (14 vs. 4 times first choice respectively).

Aroma profiling (GC-MS) did not reveal a significant effect of sex for any of the groups of volatiles (Table 3). Only short-chain aldehydes, esters and S-compounds were slightly higher at each ageing time for the cow compared to the bull samples. With respect to ageing, the concentration of short-chain aldehydes was significantly higher at 7 and 14 days ageing compared to 1 day ageing ($P<0.01$) For the nitrogen containing compounds (N-compounds, e.g. pyrrol derivates, pyrazines, thiazole derivates and pyridine derivates) and the lactones, there was a significant increase between 1 and 7 days ageing ($P<0.05$), and a non-significant decrease thereafter. The concentration of ketones was significantly lower for the 14 days ageing samples compared to the 1 and 7 days samples. Overall, volatile concentrations tended to be higher in 7 days ageing samples, which does not correspond with the lowest taste intensity scores for these samples. The absence of a sex affect is also remarkable in view of the higher intramuscular fat content in the cow meat. Similar values for the long-chain aldehydes and the alcohols for the bull and cow samples probably indicates that there were no differences in the degree of auto-oxidation of unsaturated fatty acids for these two types of samples (Elmore et al., 1999).

Conclusions

Comparison between cow and young bull Belgian Blue LT muscle samples showed a darker colour for the cow samples. LT samples from cows had a higher total fatty acid content, which was accompanied by a higher saturated and n-3 poly-unsaturated fatty acid proportion. At 14 days pm, there was a tendency of the cow samples to be somewhat more tender compared to the bull samples, probably resulting from a higher degree of proteolysis, indicated by higher concentrations of 3-10 kDa peptides. The effect of ageing on taste intensity was unclear. There were significant effects of ageing for several of the volatile aroma compounds as determined by GC-MS, but there was no effect of sex. Meat from cows, however, was preferred to that of young bulls. Ageing brought about only clear changes in shear force values and peptide concentrations.

References

Campo, M.M., Sanudo, C., Panea B., Alberti P., Santolaria P. (1999). Breed type and ageing time effects on sensory characteristics of beef strip loin steaks. Meat Science 51, 383–390.

Claeys, E., De Smet, S., Balcaen, A., Raes, K. & Demeyer, D. (2004). Quantification of fresh meat peptides by SDS-PAGE in relation to ageing time and taste intensity. Meat Science 67, 281–288.

Davey, C.L., Niederer, A.F. & Graafhuis, A.E. (1976). Effects of ageing and cooking on the tenderness of beef muscle. J. Sci. Food Agric. 27, 251–256.

Elmore, J.S., Mottram, D.S., Enser, M. & Wood, J.D. (1999). Effect of the polyunsaturated fatty acid composition of beef muscle on the profile of aroma volatiles. J. Agric. Food Chem. 47, 1619–1625.

Fiems, L.O., De Campeneere, S., Van Caelenbergh, W., De Boever, J.L. & Vanacker, J.M. Carcass and meat quality in double-muscled Belgian Blue bulls and cows. Meat Science 63, 345–352.

Monin, G. & Ouali, A. (1991). Muscle differentiation and meat quality. In: Developments in Meat Science-5, Lawrie R. Ed, pp. 89–157.

Raes, K. Balcaen, A. Dirinck, P. De Winne, A., Claeys, E., Demeyer, D., De Smet, S. (2003). Meat quality, fatty acid composition and flavour analysis in Belgian retail beef. Meat Science 65, 1237–1246.

Spanier, A. M., Flores, M. McMillin K. W. & Bidne T. D. (1997). The effect of post-mortem aging on meat flavour quality in Brangus beef. Correlation of treatments, sensory, instrumental and chemical descriptors. Food Chemistry 59, 531–538.

Tables and Figures

Table 1. Mean live weight and pH, sarcomere length (SL) and colour co-ordinates of the LT muscle according to sex (n=3)

	Bulls	Cows	P-value
Live weight (kg)	665	623	0.7
pH 1 h pm	6.87	6.82	0.7
pH 3 h pm	6.32	6.31	1.0
pH 5 h pm	5.83	5.75	1.0
pH 24 h pm	5.63	5.63	1.0
CIE L*	38.1	27.3	0.1
CIE a*	22.1	25.5	0.1
CIE b*	24.4	22.3	0.1
SL (µm)	1.72	1.68	0.7

Table 2. Mean total fatty acid content (mg/100g muscle) and proportions of the major classes (%) of the LT muscle according to sex (n=3)

	Bulls	Cows	P-value
Sum FA	845	1225	0.1
SFA	37.0	41.2	0.1
MUFA	33.5	34.4	0.7
n-6 PUFA	16.9	11.7	0.2
n-3 PUFA	1.02	2.41	0.1

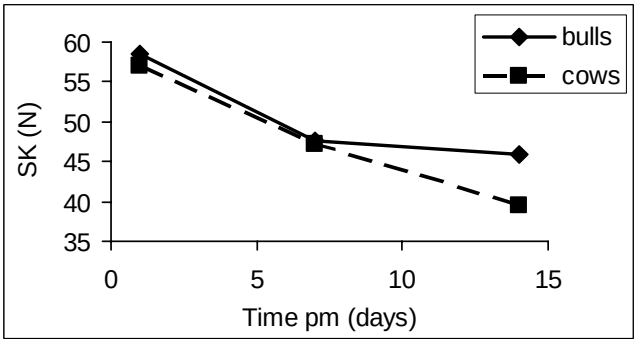

Fig. 1. Mean shear force values (N) of cow and bull LT samples with time of ageing (n=3). Differences between sexes are not significant.

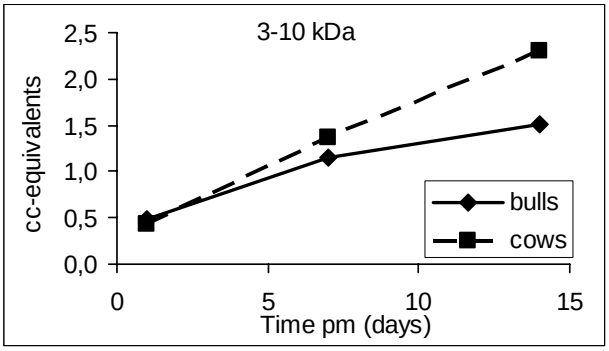

Fig. 2. Mean 3-10 kDa peptide concentration (mg cytochrome c equivalents/g muscle) of cow and bull LT samples with time of ageing (n=3). Differences between sexes are not significant.

Table 3. Mean values for the GC-MS aroma profiling of cow and bull LT samples at 1, 7 and 14 days of ageing (n=3). Concentrations as µg nonane/ kg muscle (nonane = internal standard). The effect of sex was not significant for any of the groups of volatiles. For significant differences between ageing times, see text.

	Day 1 pm		Day 7 pm		Day 14 pm	
	Bulls	Cows	Bulls	Cows	Bulls	Cows
Short-chain aldehydes	240	277	440	507	453	559
Long-chain aldehydes	28665	29580	34322	32923	29307	34336
Alcohols	8.1	9.3	13.6	10.5	14.9	10.6
Ketones	2713	2708	2738	2521	2106	2051
N-compounds	331	325	729	469	411	469
S-compounds	59.2	67.7	75.1	80.6	76.7	89.1
Furan derivates	89.6	88.7	112	126	106	151
Esters	49.5	60.3	57.3	58.6	44.5	56.8
Lactones	87.0	76.1	144	106	103	116