Relationships between overall liking score and sensory meat attributes in different types of beef cattlee

Mohammed Gagaoua, Didier D. Micol, R.I. Richardson, Jean-François J.-F. Hocquette, Claudia Terlouw, Karine Meteau, Herve H. Juin, A.P. Moloney, K. Nuernberg, N.D. Scollan, et al.

RELATIONSHIPS BETWEEN OVERALL LIKING SCORE AND SENSORY MEAT ATTRIBUTES IN DIFFERENT TYPES OF BEEF CATTLE

M. Gagaoua[1,2], D. Micol[1], R.I. Richardson[3], J-F. Hocquette[1], C. Terlouw[1], K. Meteau[4], H. Juin[4], A.P. Moloney[5], K. Nuernberg[6], N.D. Scollan[7], A. Boudjellal[2] and B. Picard[1]

[1] INRA, VetAgro Sup, UMR1213 Herbivores, 63122 St-Genès-Champanelle, France

[2] INATAA, Constantine 1 University, Route de Ain El-Bey 25000, Algeria

[3] Division of Farm Animal Science, University of Bristol, Langford, Bristol, BS40 5DU, United Kingdom

[4] INRA, UE1206, Elevage Alternatif et Santé Animale, Le Magneraud, F-17700 Saint Pierre d'Amilly, France

[5] Teagasc, Animal and Grassland Research and Innovation Centre, Grange, Dunsany, Co. Meath, Ireland

[6] FBN Leibniz Institute for Farm Animal Biology, W-Stahl-Allee 2, 18196 Dummerstorf, Germany

[7] Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Gogerddan, SY23 3EB, United Kingdom

Abstract – This study aimed to explain overall liking score. It investigated sensory meat qualities of 248 animals (steers, young bulls and heifers) of 8 different breeds or cross breeds finished in France, Germany, Ireland and UK were investigated. Samples from *Longissimus* muscle aged for 10 or 14 days and cooked at 55 °C were rated by sensory panels in France (French and German animals) and UK (British and Irish animals). Regression analyses showed that 27% of the variability in overall liking of beef aged 10 days from steers could be explained by the scores for abnormal beef flavour. For beef aged 10 days from heifers, 51% of the variability in overall liking could be explained in terms of tenderness, juiciness, beef flavour and abnormal beef flavour. For beef aged 14 days from bulls, 75% of the overall liking could be explained by tenderness, beef flavour and abnormal beef flavour scores as well as by breed. Among muscle characteristics analysed, only citrate synthase activity explained a part of overall liking in young bulls from France and Germany. The results from this study show that to understand the relative contributions of various sensory attributes to overall liking it is necessary to take into account the gender or other aspects of the animal type, and possibly also the laboratory and protocol relative to sensory analysis.

Key Words – beef, meat qualities, sensory panel

I. INTRODUCTION

A better understanding and control of beef sensory quality is a major research objective. Beef sensory quality is very variable and depends on many interacting factors before and after slaughter. The perceived overall quality of meat depends on the overall liking and the individual preferences of consumers. Both criteria depend on the individual sensory responses during meat consumption, including perception of tenderness, juiciness, and flavour [1]. Other studies indicate that overall liking of beef may involve several sensory attributes and that the exact relationships vary across studies comparing different breeds [2, 3] or muscles [4, 5]. The present study aimed to increase our understanding of the contribution of various sensory attributes to the overall liking of beef from different breeds, gender and finished in different European countries. The study is part of the ProSafeBeef project (www.prosafebeef.eu) [6].

II. MATERIALS AND METHODS

Two hundred and forty-eight animals were studied in four experiments in four European countries, including young bulls, steers and heifers. Bull breeds were Limousin (LIM; n=25), Blond d'Aquitaine (BA; n=25) and Aberdeen Angus (AA; n=24), finished in France and Holstein (HO; n=25) finished in Germany. Heifers were Belgian-Blue x Friesian (BF; n=47) and Angus x Friesian (AF; n=47) finished in Ireland. Steers were Belgian-Blue x Holstein (BH; n=40) and a Charolais crossbred (CH; n=16) finished in the UK. Studies complied with welfare regulations of each country.

After slaughter under standard conditions in either commercial or experimental slaughterhouses in each country, the carcasses were chilled and stored at 4 °C until 24 h *postmortem*. *Longissimus thoracis* muscle was excised from the right side of each carcass. The loins of the carcasses were divided into different parts for sensory analysis. Muscles for sensory analysis were cut into steaks and placed in sealed plastic bags under vacuum and kept between 2–4°C for 14 days (bulls from France and Germany and heifers from ireland) or 10 days (steers from UK) for ageing. Subsequently, the samples were trimmed, vacuum-packed and frozen individually at -20°C until sensory analysis. German and French samples were assessed for sensory scores in France (Le Magneraud). Irish and British samples were assessed for sensory scores in UK (Bristol). The same protocol was used in both laboratories. Forty hours before the analysis, samples were thawed and placed in a refrigerator at 4–5°C. The morning of the analysis, the meat samples were cut into two 1.50 cm steaks and grilled between two contact plates heated to 310ºC. Steaks were heated for 2 min between two aluminium sheets, until the end-point temperature of 55°C was reached. After grilling, each steak was cut into 6 portions which were presented to 12 panellists trained in meat sensory analysis. The panellists rated the steaks for global tenderness (GT), juiciness (JUIC), beef flavour intensity (BF), abnormal flavour intensity (ABF), and overall liking (OL), on a 0 to 10 unstructured scale. The sessions were carried out in a sensory analysis room equipped with individual boxes under artificial non-coloured lighting. The FIZZ program (Fizz v 2.20h, Biosystemes, Couternon, France) was used for data entry, formatted on Excel.

Glycolytic (PFK, phosphofructokinase and LDH, lactate dehydrogenase) and oxidative (ICDH, isocitrate dehydrogenase, CS, citrate synthase and COX, cytochrome c oxydase) enzyme activities were assayed as in [7] and muscle fibre properties were quantified as described by [8].

Statistical analysis used SAS 9.2 and XLSTAT 2009 software and was based on Principal Component Analysis (PCA), involving all sensory attributes and multiple regression analyses in order to explain overall liking scores in terms of the other sensory attributes and animal type effects. The regression analyses selected best models using the option 'optimal model, maximal 5 variables' in terms of % of variability explained. The introduction of muscle fibres characteristics into the models was also tested. The GLM method was used to compare sensory attributes between animal types and loadings on the first and second principal axis between breeds/genders/countries.

III. RESULTS AND DISCUSSION

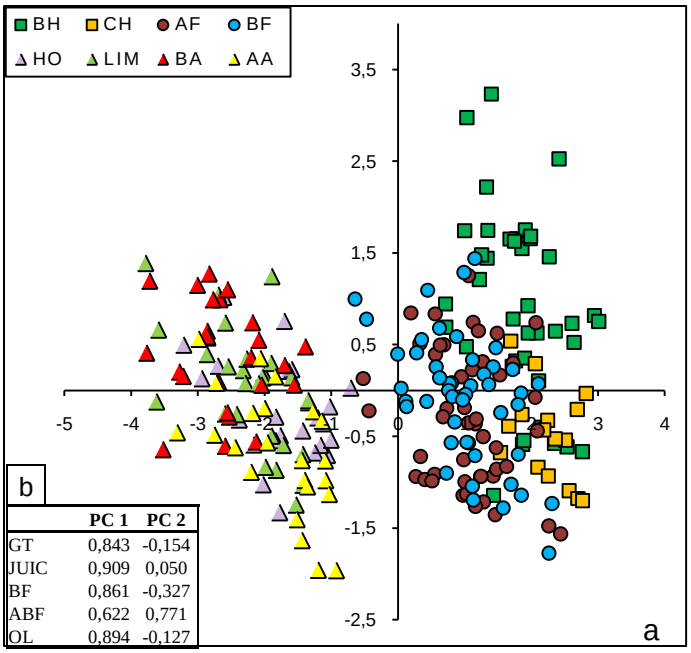
Sensory attributes of each group of animals are presented in Table 1. The PCA explained 84% of the variability between animals in sensory attributes (Figure 1a). Abnormal beef flavour loaded positively on the 2nd axis (PC 2 = 15%) and the remaining attributes positively on the 1st (PC 1 = 69%). Beef steaks from heifers and steers scored higher ($p<0.0001$) on the 1st axis than beef aged 14 days from bulls (Figure 1b). Beef aged 10 days from steers scored higher ($P<0.0001$) on the 2nd axis than from heifers (Figures 1a, b).

Within steers, CH had higher ($P<0.01$) scores for global tenderness, juiciness and beef flavour and lower ($P<0.0001$) scores for abnormal beef flavour. Within young bulls, AA had higher ($P=0.05$) scores for tenderness than HO. AA and HO had higher ($P<0.01$) scores for beef flavour and overall liking than LIM while BA had the lowest ($P<0.01$) scores. AA had lower ($P<0.001$) scores for abnormal beef flavour than the other breeds. Within heifers, no significant breed effects were found.

Table 1. Animal group (breed/gender/ageing time/ country) effect on meat sensory attributes.

	Sensory scores for different beef type (Country of rearing/ageing time/gender)				
Country of origin	Ireland	UK	France, Germany		
Ageing time and sensory analysis location	14 days UK	10 days UK	14 days France		
Gender Attributes	Heifers	Steers	Bulls	SEM	*P-value*
GT	6.5[a]	6.4[a]	4.8[b]	0.06	***
JUIC	7.4[a]	7.2[b]	4.7[c]	0.08	***
BF	5.2[b]	5.4[a]	4.1[c]	0.04	***
ABF	3.0[b]	3.8[a]	2.4[c]	0.03	***
OL	4.3[b]	5.6[a]	2.9[c]	0.06	***

On a same line, different superscripts indicate significant differences ($P < 0.05$).



b

	PC 1	PC 2
GT	0,843	-0,154
JUIC	0,909	0,050
BF	0,861	-0,327
ABF	0,622	0,771
OL	0,894	-0,127

Figure 1. Principal component analysis. **a)** Plot of the individual scores of the first two principal components of the 248 animals (using different symbols for bulls (Δ, ageing time 14 days), heifers (o) and steers (□, (ageing time 10 days)) using all sensory attributes; **b)** PCA loadings of the sensory attributes on the 1st (PC1) and 2nd (PC2) axis explaining 84% of the variability.

Gender effects were to a large extent confounded with breed, the country of production and ageing time and to a lesser extent, to the country of sensory analyses. Differences between 10-days aged beef from heifers and steers assessed for sensory scores in UK on the one hand and 14-days beef from bulls assessed for sensory scores in France on the other hand may be related to the country of sensory analysis.

The higher scores for tenderness and juiciness and lower scores for beef flavour, abnormal flavour and overall liking of heifers compared to steers may be related to the country of experimentation, diet and/or gender.

Concerning breed effects in young bulls, cooked meat of AA and LIM had higher shear values than CH, while HO had intermediate values [9]. An earlier study found no differences in tenderness or flavour, but higher juiciness in LIM compared to AA or CH [10].

As gender, ageing time and country of the experiment had a large impact on the sensory attributes, the regression analyses were carried out for each gender separately, while taking into account breed effects where relevant.

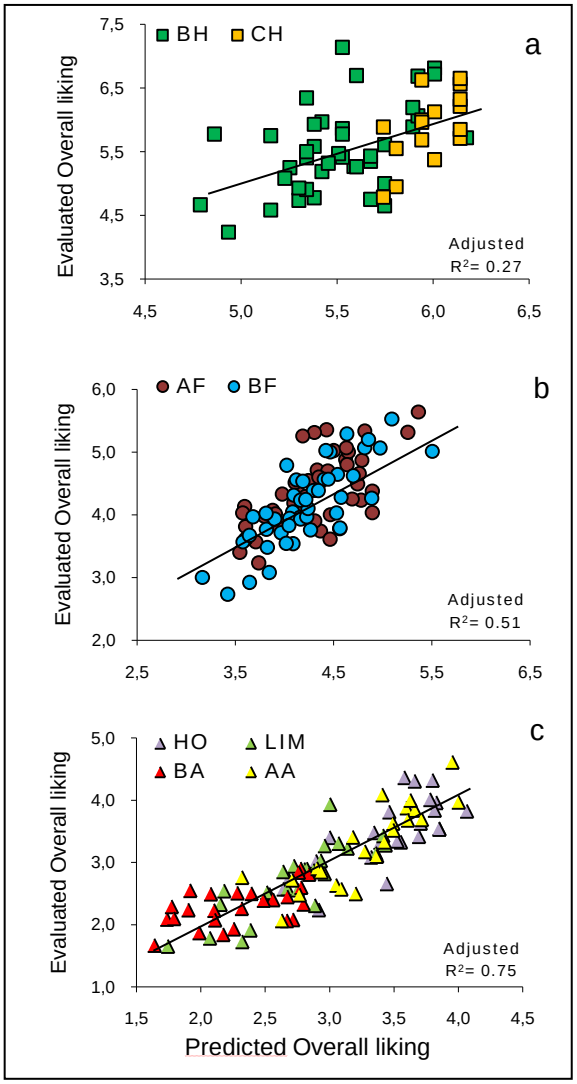


Figure 2. Correlations between predicted and measured overall liking scores for steers **(a)**, heifers **(b)** and bulls **(c)**. Prediction equations used were: Overall Liking = 7.7 – 0.5 * ABF (steers); = –0.4 + 0.2 * TG + 0.2 * JUIC + 0.6 * BF – 0.4 * ABF (heifers), and = –0.2 + 0.4 * TG + 0.5 * BF – 0.3 * ABF + 0.2 * AA breed – 0.3 * BA breed + 0.6 * HO breed (bulls).

Results show (Figure 2a) that 27% of the variability in overall liking (OL) in steers could be explained by the scores for abnormal beef flavour. In heifers, 51% of the variability in OL could be explained in terms of tenderness, juiciness, beef flavour and abnormal beef flavour. In bulls, 75% of the OL could be explained by tenderness, beef flavour and abnormal beef flavour scores as well as breed effects.

When muscle characteristics were introduced into the models, only CS was significant and only in young bulls, and the model obtained had less predictive power (OL = 2.2 + 0.1 * CS + 0.6 * AA breed – 0.4 * BA breed + 0.8 * HO breed ; 45% of variability explained). This result may be interpreted in terms of its relationship with other muscle characteristics. It was shown that CS activity is strongly associated with genetic selection for muscle growth [11] and nutritional factors [12] compared to ICDH and LDH.

CONCLUSION

The results of this study show that to understand the relative contributions of various sensory attributes to overall liking of beef meat, it is necessary to take into account the animal type (gender, breed, age). Sensory analysis conducted in UK found that for steers, the separate sensory attributes were only weakly related to overall liking. For young bulls finished in France and Germany and analysed in France, overall liking could be predicted to a large extent from sensory attributes and breed. Heifers finished in Ireland and analysed in UK had intermediate predictability of overall liking. Use of muscle characteristics contributed little to the predictive power of the regression models. Further studies are needed to determine which breed-related characteristics contribute to the overall liking scores in young bulls. Studies are also needed to evaluate the role of protocols used, including ageing, and of differences in country-specific sensory appreciation in the differences in the results of sensory analyses between UK and France.

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