ATTRIBUTES IMPORTANT FOR THE EATING QUALITY OF BEEF AND LAMB LOIN

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Abstract: This study aims to identify which sensory attributes are most important to consumers and how these relate to instrumental quality measurements. A combination of sensory profiling and consumer assessment techniques were used to analyse beef and lamb with a wide range of eating qualities. Warner Bratzler Shear Force, sarcomere length, reducing sugars, nucleotides and fatty acids were also determined. External preference mapping was used to relate these parameters. The results for beef and lamb were similar with consumers preferring tender meat with a sweet flavour and disliking rubbery or chewy meat with a sour or bitter flavour or aftertaste. Fat content had no consistent impact on the consumer scores. As expected, WBSF correlated well with attributes associated with toughness. Of particular interest is the apparent relationship for both species meats of six-carbon reducing sugars and AMP with desirable flavour qualities and n-6 fatty acids with undesirable qualities. Further research is ongoing to determine the nature of these relationships.

***Index Terms*—beef, lamb, sensory, consumer**

I. INTRODUCTION

Beef and lamb are relatively expensive foods and the consumer expects them to deliver reliably good eating quality. However, they do not always deliver the quality or consistency expected. Many studies have investigated the impact of different pre- or post-slaughter factors on the eating quality of red meats but few have attempted to identify which sensory qualities are most important to the consumer. Some studies have evaluated the relative importance of flavour and texture liking (Thompson et al. 2005; Oliver et al. 2006) but few have investigated the relationship between consumer scores and specific sensory profiling attributes: Schmidt et al. (2010) studied beef steaks cooked to different temperatures and Prescott et al. (2001) investigated the role of selected lamb flavour compounds.

This paper reports aspects of a study which used external preference mapping to relate the sensory profile obtained from trained sensory profiling panels to both the results of consumer panels and selected instrumental methods for measuring aspects of eating quality. The results for grilled beef and lamb loins are compared.

II. MATERIALS AND METHODS

Fourteen experimental groups were selected for beef (B1-14) and 14 groups for lamb (L1-14) to provide a wide range of eating quality attributes. The groups differed in one or more pre-slaughter (age, breed, sex, diet) or post-slaughter (ageing time, electrical stimulation, hanging method) factors. A total of 28 cattle and 289 lambs were slaughtered on different occasions at commercial abattoirs as described elsewhere (Oltra et al., 2009, 2010). The carcasses were boned out 48 hours after slaughter and the longissimus dorsi (sirloin/loin) was removed, vacuum packed and aged for the time assigned to each group. The beef muscle was then cut into 25mm steaks and the samples frozen. For the lamb the whole longissimus dorsi was frozen. Both types of samples were held at -20ºC until required for analysis, when they were thawed at 4ºC for 12 hours. The lamb lean loin was then excised and cut into 25mm steaks.

Sensory profiling panels were conducted using nine trained panellists. Beef and lamb loin samples were grilled using a Silesia clam shell grill (York, UK) heated to 180ºC. The cooking time was designed to deliver "well done" steaks, as preferred by more than 50% NI consumers: 5.5 mins for beef and 4.5 mins for lamb. The panellists were trained as described elsewhere (Oltra et al., 2009, 2010). After removal of redundant attributes, 48 descriptors for both beef and lamb were used. Panellists assessed, in triplicate, grilled steaks of all 14 treatments. Sample presentation and data collection was conducted using FIZZ Network (Biosystemes, Dijon, France). Restricted maximum likelihood analyses (REML) and principal components analysis (PCA) were used to select the seven most different treatments.

Consumer panels using 120 naive consumers were conducted on the seven selected treatments, using the same cooking methods. For beef steaks, consumers scored liking of aroma, flavour, tenderness, juiciness and overall liking while for lamb the terms, liking of appearance, aroma, flavour, texture and overall liking, were used. Consumers scored

each sample on a scale between 0 and 100 on paper forms prepared using FIZZ Forms by Biosystemes.

Sarcomere length was measured 48 hours after slaughter using a laser diffraction technique. All other measurements were conducted after the set ageing time for the treatment. Warner-Bratzler Shear Force (WBSF) was measured using a texture analyzer (Instron 3366, High Wycombe, UK). Fatty acids and total intramuscular fat were determined in the lean meat and the results expressed as mg g^{-1} tissue. These methods have been described in full elsewhere (Dawson et al., 2010). Sugars, sugar phosphates and nucleotides were analysed by perchloric acid extraction followed by different HPLC methods as described by Oltra et al. (2010).

External preference mapping, using a vector model, was conducted using the sensory profiling data on the seven selected treatments, using those attributes for which P<0.25 for lamb and P<0.20 for beef. The statistical analyses were conducted using GenStat 11th edition by VSN.

III. RESULTS AND DISCUSSION

Figures 1 and 2 show the external preference maps for grilled beef sirloin for principal components, PC1, PC2 and PC3. Figures 3 and 4 show the same for grilled lamb loin.

For grilled beef sirloin, PC 1 accounts for 67% of the variation and differentiates between tender and juicy texture and sweet flavour to the left and chewy, rubbery texture and sour and cardboard attributes to the right (Figure 1). The consumer scores for liking, tenderness and juiciness also align strongly with PC1 and these attributes. In contrast, PC2 and PC3 (Figure 2) account for only 16% and 12% of the variation and do not correlate with the consumer liking scores. These PCs differentiate between fatty flavour and aftertaste, livery aftertaste, crumbly texture and open appearance. Thus, consumer liking for grilled beef sirloin appears to be most influenced by tenderness, juiciness, sweet flavour and the absence of chewy, rubbery, sour and cardboard attributes.

For grilled lamb, similarly, PC1 (56% of the variation) differentiates between tender texture and sweet, meaty and roast lamb flavours and aftertastes, this time on the right, and rubbery texture and bitter flavour and aftertaste on the left (Figure 3). Again, the consumer scores are associated with the first of these sets of attributes. PC2 and PC3 account for 27% and 9% of the variation for lamb and appear to relate mainly to open and brown appearance and bitter flavour and aftertaste (Figure 4). Consumer liking scores are less correlated with these PCs than PC1, but there is some negative correlation with the bitter attributes.

Many of the instrumental measurements show similar relationships with the sensory profiling attributes in both species. As expected, WBSF was associated with rubbery and/or chewy attributes for both beef and lamb (Figures 1 and 3). In contrast, sarcomere length was not associated consistently with sensory measures of tenderness in either meat.

Figure 1. External preference map for grilled beef sirloin, showing consumer rated attributes (bold), sensory profiling attributes (normal) and instrumental analyses (italics): PC1 versus PC2. *(Abbreviations: AP, AR, AT, F, T = appearance, aroma, aftertaste, flavour, texture; Conts = connective tissue; Cardb = cardboard; G6P, R5P = glucose-6-phosphate, ribose-5-phosphate; AMP, IMP = adenosine 5'-monophosphate, inosine 5'-monophosphate; n-6 and n-3, MUFA (monounsaturated), Unsat (unsaturated), Sat (saturated) = total fatty acids in these classes; C18-2c, etc = cis linoleic acid, etc; Hx = hypoxanthine; pHu = ultimate pH; TemppH6 = temperature at pH 6).*

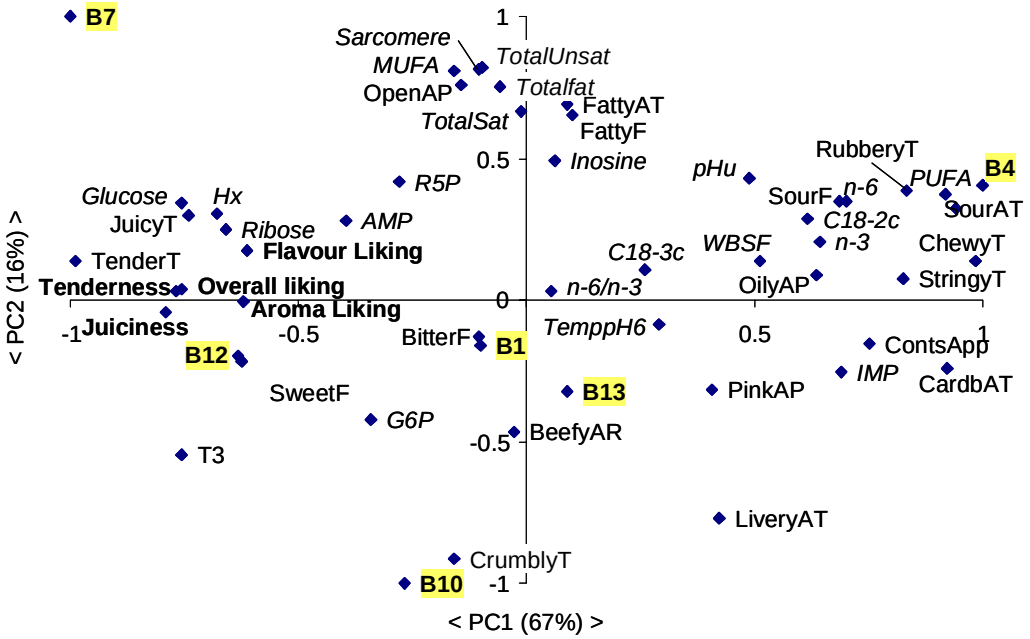
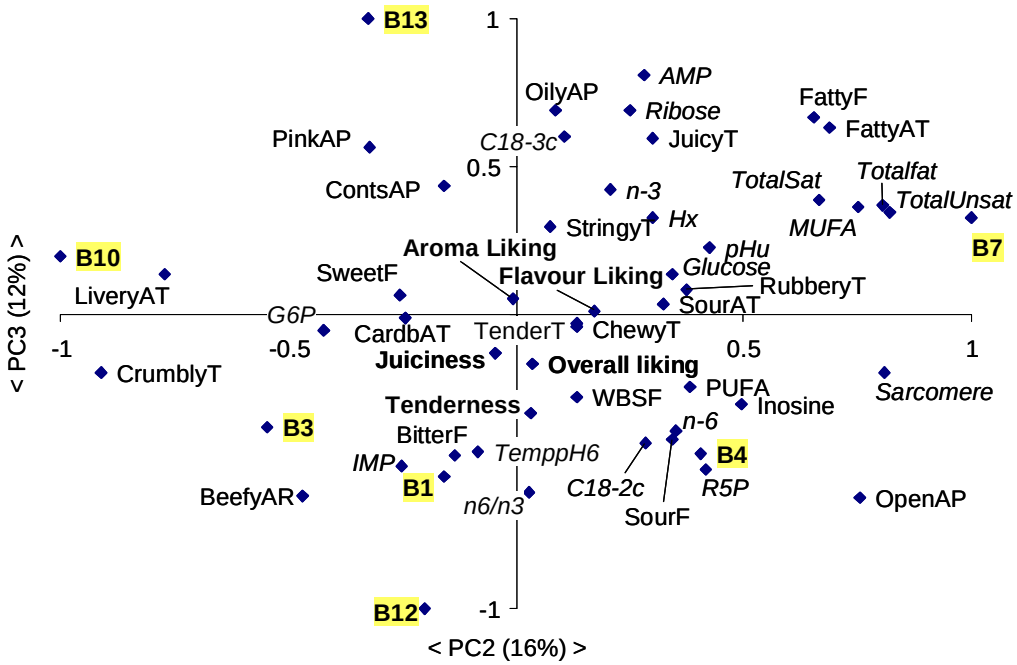


Figure 2. External preference map for grilled beef sirloin, showing consumer rated attributes (bold), sensory profiling attributes (normal) and instrumental analyses (italics): PC2 versus PC3. *(Abbreviations: see Figure 1)*



Fatty flavour and aftertaste in beef were closely associated with the analytical results for total intramuscular fat (Figures 1,2). Correlations between total fat and some fatty acid classes were expected as all were recorded as concentration per gram wet weight. However, these measurements and attributes were unrelated to consumer scores for liking. For lamb, fatty flavour did not differ significantly between the experimental groups and so is not shown in Figures 3 and 4. However, as for beef, the total fat content showed little association with consumer liking scores.

In beef, sour flavour and aftertaste (and cardboard aftertaste to a lesser extent) correlated with n-6 fatty acids and especially linoleic acid (Figures 1and 2). A similar association was observed in lamb between n-6/n-3 ratio and bitter flavour and aftertaste (Figures 3 and 4). Thus, it appears that n-6 fatty acids are associated with undesirable flavours. This is likely to be related observations by others (Young et al., 1997; Campo et al. 2006) that greater lipid oxidation in meat can arise from the lower levels of antioxidants in diets high in concentrates and n-6 fatty acids.

Analyses for sugars show correlation with sweet flavour for both meats and roast lamb flavour for lamb (Figures 1 and 3). Glucose, glucose-6-phosphate and AMP show a consistent association with these attributes and with consumer liking. This data supports the proposed role of 6-carbon sugars in red meat flavour formation (Farmer et al., 2009).

Figure 3. External preference map for grilled lamb loin, showing consumer rated attributes (bold), sensory profiling attributes (normal) and instrumental analyses (italics): PC1 versus PC2. *(Abbreviations: see Figure 1; R = Roast)*

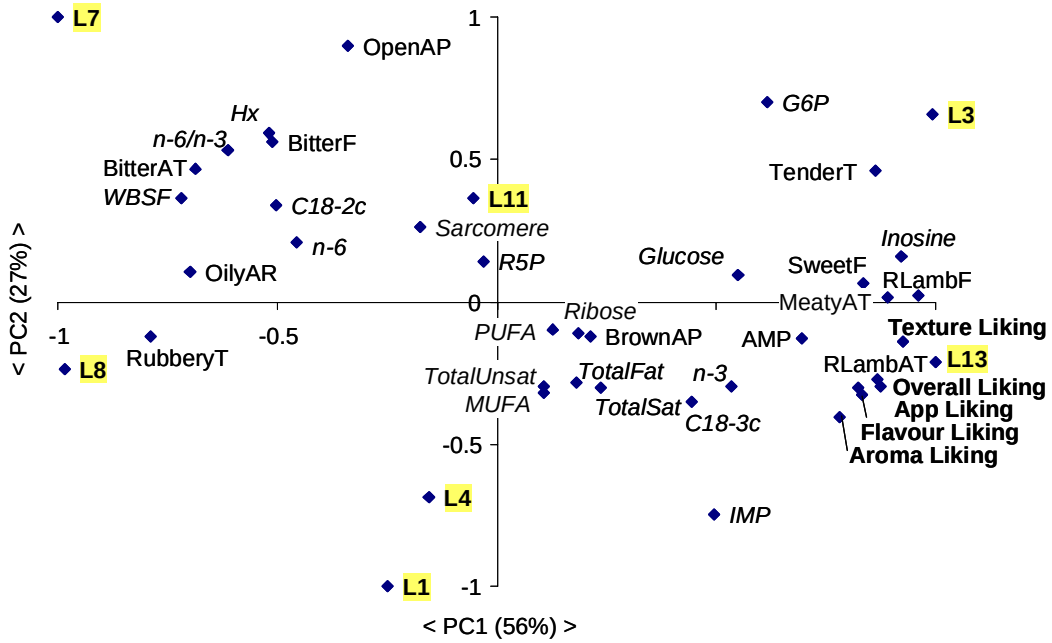
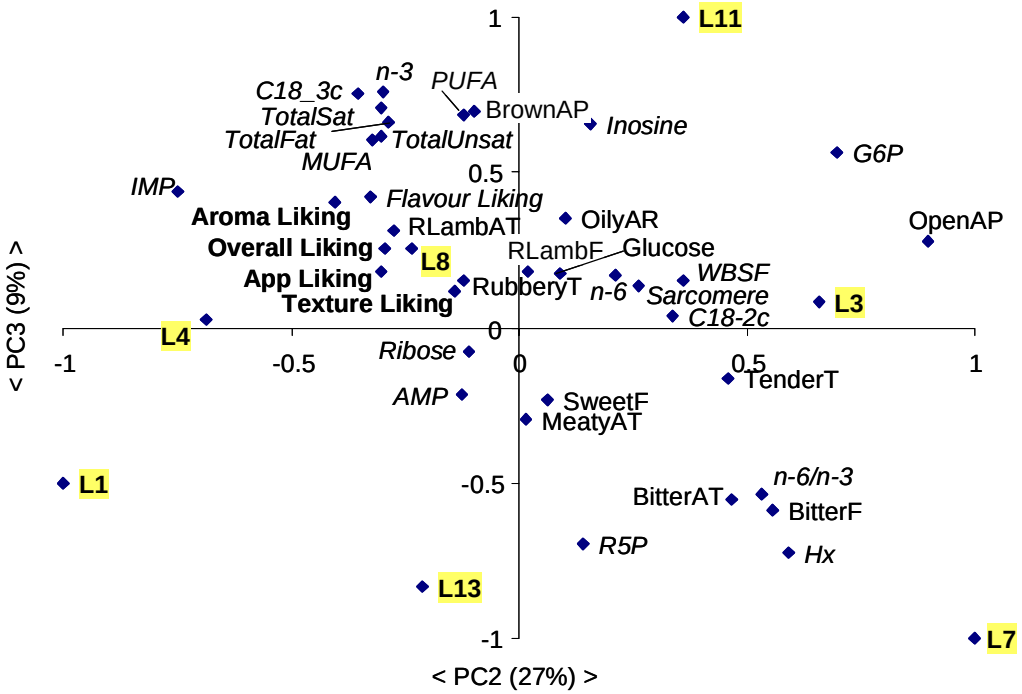


Figure 4. External preference map for grilled lamb loin, showing consumer rated attributes (bold), sensory profiling attributes (normal) and instrumental analyses (italics): PC2 versus PC3. *(Abbreviations: see Figures 1 and 3)*



IV. CONCLUSION

For both beef and lamb, consumers favoured tender meat with a sweet flavour and disliked rubbery or chewy meat with a sour or bitter flavour or aftertaste. Fat content had no consistent impact on the consumer scores. Of particular interest is the apparent relationship for both species of six-carbon reducing sugars and AMP with desirable flavour qualities and of n-6 fatty acids with undesirable qualities. Further research is ongoing to investigate these relationships.

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