HOW DO CONSUMERS JUDGE MEAT TENDERNESS? - FACTORS AFFECTING SENSORY ASSESSMENT

Wendy E. Brown, Denise Braxton, Keith Langley and Sue Marie[1]
Institute of Food Research, Reading, UK. [1]Meat and Livestock Commission, Milton Keynes, UK.

Keywords sensory assessment, meat tenderness, chewing behaviour, electromyography

Background

Trained sensory panels have been used extensively in the meat industry to provide judgements of sensory quality of meat and meat products. In addition much effort has been devoted to developing associations between specific sensory attributes and measured mechanical properties of meat This approach has increased understanding of the influences of many factors on sensory quality of meat including breed, pre- and post-slaughter treatment, muscle type, and cooking conditions, and the morphological and biochemical mechanisms underlying these effects. However agreement between sensory assessments of trained sensory panels and those of ordinary consumers shows considerable variation between studies, and is generally poor. Trained sensory panels usually develop specific strategies to be used for assessment of particular sensory attributes, and panel members are selected on the basis of their agreement with the consensus opinion of the panel. These procedures may contribute to inconsistencies between panel and consumer judgements. Low correlation between panel and consumer sensory scores may indicate that consumers in general are poor judges of sensory properties of foods. Alternatively it may arise from the use of different assessment criteria, or of different strategies for breaking down the food during eating. This study examined the degree to which individual differences in chewing behaviour influence the sensory assessments of meat tenderness of ordinary consumers, and seeks to identify criteria used by consumers in assessing tenderness.

Objectives

To monitor chewing behaviour in consumers during sensory assessment of a range of hot freshly cooked meat samples.

To compare the sensory assessments of tenderness by the consumers with those of a trained panel, and with the mechanical properties of the samples used.

To identify cues arising from oral breakdown of meat during mastication which underlie sensory judgements of tenderness.

Methods

Samples Four different meat joints were used in the study, beef and pork m. longissimus thoracis et lumborum (LTL) and m. gluteobiceps (GB). A tender and tough example of each muscle type was included, providing 8 different joint types in total; joints for use in the study were selected based on the assessments of a trained panel of meat assessors at the Meat and Livestock Commission, UK. For each set of 8 joints were obtained the sensory assessment of tenderness from a single consumer, the sensory assessment of tenderness of an adjacent portion of the muscle by a trained sensory panel, and a set of measures of the mechanical properties of the samples. Cubes of 1.2mm from the centre of the joints cooked to an internal temperature of 70°C for beef and 75°C for pork, were used for sensory assessment and the remainder of the joint used for the instrumental tests. A range of instrumental tests were performed on all joints in compression, tension and shear. Shear and tensile strengths and elastic (compression) moduli were determined.

Subjects (consumers) Twenty subjects (consumers), untrained in sensory analysis, were recruited and their chewing efficiencies with respect to a comminutable food (almond) and a non-comminutable food (chewing gum) determined as described by Braxton et al., (1996). They were asked to record their perception of "tenderness" of meat samples throughout the chewing sequence and return the cursor to the zero point on swallowing, generating a Time Intensity (TI) record. They attended 2 further sessions during which they were able to practice this technique on a range of meat samples (beef, pork and chicken). In a final session they assessed the 8 meat samples described above at the same time as their chewing patterns were recorded using electromyography (EMG).

Each of the consumers assessed one joint of each of the 8 types; the joints assigned to each consumer exhibited a wide range of "tenderness" and were evenly distributed across the tenderness range as determined by the sensory scores given by the trained panel.

Assessment of chewing behaviour Chewing patterns were recorded by electromyography of the masticatory muscles (left and right m.temporalis and m. masseter) throughout the chewing sequence for each sample as described by Brown (1994). Chewing time, number of chews, mean chew cycle time, chewing work (the sum of the areas under the EMG activity bursts for each chew for all four masticatory muscles), and chew work rate (work/sec) were determined from each chewing sequence (as Brown 1994).

Results and Discussion

All the consumers perceived marked differences between the samples in terms of tenderness, as revealed by the maximum intensity of their TI curves. However the consumers differed in the shapes of their TI curves which represent their temporal patterns of perception. Most of the consumers perceived tenderness to increase progressively throughout the chewing sequence. However several perceived an initial increase in tenderness followed by a decline, and others perceived an initial increase to a plateau level which was maintained to the point of swallowing. These differences suggest different concepts of tenderness among the consumers. To understand these concepts more closely the chewing patterns of the individual subjects were examined.

All the consumers modified their chewing patterns to accommodate the different meat samples. However they differed in the aspects of their patterns which were altered. For example some subjects exhibited large differences in the chewing time or number of chews required for the different samples, whilst others showed very little change in these parameters. Likewise some subjects showed large differences in the amount of chewing work undertaken, but these were not necessarily the same subjects who demonstrated large changes in chew time, indicating that some subjects modify chew rate rather than chew time and/or work across the meat samples. Finally subjects differed in the distribution of chewing work across the chewing sequence, some showing markedly greater work at the beginning of the chewing sequence for the tougher samples, others showing no such distinction. Variations in the way individual consumers adapt their chewing patterns to meats of different tenderness are likely to affect the sensory feedback they receive and on which they base their judgements of tenderness.

Table 1 shows where significant correlations were obtained for each subject between their assessment of tenderness (Imax of their TI curves) and aspects of their chewing patterns. Approximately half the subjects showed significant correlations between perceived tenderness and chew time or number of chews - criteria often used by sensory panellists for assessment of tenderness. However most of the subjects (84%) exhibited significant correlations between chewing work and perceived tenderness, although some subjects appeared to use the total chewing work involved when making their judgements of tenderness, whilst others concentrated more on the

work at the beginning of the sequence. Table 2 indicates the low level of significant correlation between consumer assessments of tenderness and those given by the trained sensory panel, or the results of the instrumental tests undertaken (Brown et al, 1996).

Chewing efficiency influenced both mastication patterns and perceptions of tenderness among the consumers. Subjects were divided into groups according to their relative chewing efficiencies with both substrates. Subjects with either low efficiency for both nuts and gum (group 1) or high efficiency for both foods (group 4) tended to have shorter chewing sequences (Table 3). They also had significantly lower values for the time at which they perceived maximum tenderness during their chewing sequence (Tmax) and for the relative position of Tmax within their chewing sequence (ratio of Tmax to Tend, where Tend is the end of perception i.e. the time of swallowing). Indeed observation of the TI curve shapes for all the consumers demonstrated that groups 2 and 3 (see Table 3 for group classifications) included only subjects with progressively increasing tenderness perception. In contrast groups 1 and 4 included all subjects with other curve shapes (see Braxton et al. 1996).

Table 1. Significant correlations between subjects' Imax and mastication parameters

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	19	20
Number of Chews	*					*	*	*		*	*		*				*	*	*
Chewing Time	*					*	*	*		*	*						*	*	*
Chew Work for:																			
First bite	*		*	*			*	*	*								*		
First 5 chews	*	*	*	*			*	*			*	*							
Complete sequence	*			*		*	*	*		*	*		*			*	*	*	*

Table 2. Significant correlations between subjects' Imax and trained panel scores and instrumental values (for both longitudinal and transverse orientation).

Subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	19	20
Trained Panel Score		*	*	*		*		*		*				*				*	
Instrumental values																			
Tensile stress LS										*									
Tensile strain LS																		*	
Youngs modulus LS											*								
Shear stress LS		*						*				*		*					
Elastic modulus LS			*										*						
Tensile stress TS						*	*											*	
Tensile strain TS			*										*					*	*
Youngs modulus TS																		*	
Shear stress TS							*	*										*	
Elastic modulus TS			*														*		

The way foods break down in the mouth depends on the mechanical properties of the food itself, but also on the mode of force application. The diversity of facial morphology, dentition, oral architecture, muscle strength, and habitual chewing behaviours of consumers imply that they will not all apply the same forces, in the same orientations and over the same time courses when breaking food down orally. Consumers appear all to register the amount of chewing work they have undertaken to process a mouthful of meat when assessing its tenderness, but, by virtue of the different mechanisms they employ to comminute the sample, they arrive at different judgments of tenderness. This underlies the problems associated with predicting consumer perceptions from mechanical properties of a food, and also in identifying segmentation of the consumer population. Greater knowledge of mastication patterns within the population may increase understanding of differences in consumer perceptions, and facilitate catering for these differences.

Table 3: Influence of chewing efficiency on chewing pattern and TI parameters

Group	1	2	3	4
Nut Chewing Efficiency	low	high	low	high
Gum Chewing Efficiency	low	low	high	high
Chewing Time (seconds)	24.4^{a}	$31.6^{b,c}$	35.3^{c}	$26.0^{a,b}$
Tmax (seconds)	12.8^{a}	32.5^{b}	32.0^{b}	15.0^{a}
Tmax/Tend	0.43^{a}	0.88^{b}	0.80^{b}	0.50^{a}

Values within a row with superscripts in common are not significantly different ($p > 0.05$)

Conclusions

Only 42% of consumers in the study agreed individually with the tenderness perceptions of a trained sensory panel.
The consumers' assessments of tenderness did not correlate significantly with any single mechanical property of meat.
The consumers differed in their temporal representations of tenderness, suggesting differences in their concepts of tenderness.
Tenderness perception in consumers appeared to be determined by the level of work they undertook chewing the samples.
Tenderness perceptions were influenced by subjects' chewing efficiencies.

Literature

Braxton, B., Dauchel, C. and Brown, W. (1996). Association between Chewing Efficiency and Mastication Patterns for Meat. Food Quality & Pref. (in press).
Brown, W.E. (1994). Development of a method to investigate differences in chewing behaviour in humans. I. Use of electromyography in measuring chewing. J. Texture Studies 25, 1-16.
Brown, W.E., Langley, K.L., Mioche, L., Marie, S., Gerault, S. & Braxton, D. (1996). Individuality of understanding and assessment of sensory attributes of foods, in particular, tenderness of meat. Food Quality and Pref. (in press).