# RELATIONSHIPS BETWEEN MEAT TOUGHNESS, ASSESSED BY TIME INTENSITY MEASUREMENT, SENSORY PROFILE, AND ELECTROMYOGRAPHY RECORDINGS.

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## BACKGROUND

Texture is the predominant element of the quality and acceptability of meat. It is a multidimensional characteristic, perceived throughout mastication. During this process, meat undergoes continuous changes in structure whilst being broken down and mixed with saliva in preparation for swallowing. Toughness, perceived throughout mastication, is generally assessed by sensory profiles which provide only a snap-shot of overall perception. A new insight into toughness perception during mastication was obtained from electromyography recordings (EMG) which measures the masticatory muscle activity closely related to sensory assessment (Mathevon *et al.*, 1995) without disruption of masticatory process (Mioche and Martin, 1998). Another feature of toughness assessment was time-intensity (TI) measurement (Butler *et al.*, 1996 ; Duizer *et al.*, 1994 ; Brown *et al.*,1996) which is classically used for flavour (Leach and Noble, 1986 ; Guinard *et al.*, 1995 ; Gwartney and Heymann, 1995).

## OBJECTIVES

Study relationships between time intensity, EMG and sensory toughness, the influence of TI measurement on EMG recordings during mastication, the relationship between meat toughness assessed by TI and sensory profile.

## MATERIAL AND METHODS

### Meat samples

*Biceps femoris* (BF), *Longissimus dorsi* (LD), *Psoas major* (PM), *Pectoralis profundis* (PP), *Semimembranosus* (SM) and *Semitendinosus* (ST) of a six-year old cull cow were excised 24h *post-mortem* and then cut into two or three equal pieces which were aged for two (02), six (06) or twenty-one (21) days. The pieces were placed at +2°C until the required ageing time. Then, each piece was sliced (7x4x2 cm, Lxwxth) with the longest dimension parallel to the myofibres. Sixteen modalities were obtained by combining muscle and ageing factors. Vacuum-packed slices were cooked for 30 min by immersion in water maintained at 65°C and then frozen at -20°C. Just before measurement, the packed samples were thawed in a 15°C water rinse for 1h.

### Rheological tests

Compression measurement was performed at room temperature using an Instron Testing Machine, and the most discriminating variable (stress at 80%) is given (Mathonière *et al.*, 1998).

### Electromyography and sensory measurements

A panel of four women and six men, (25-50 years old) were trained for sensory assessment of meat texture. Toughness was assessed with non-structured scales either as a single-point value (called profile) or with a continuous evaluation as a function of time in the mouth (called TI). From the TI curves, maximum intensity and area under the curve were calculated. For EMG , the electrical activity of both the left and right *masseter* and *temporalis* muscles were recorded (Mathonière *et al.*, 1998). The number of bursts for all muscles and mean muscular work for each burst for each mastication were then calculated. To avoid the assessors using extra-oral clues, cubes of 1.5 cm were placed into the mouth by the experimenter with a toothpick. The recordings sessions were scheduled as follow:

| | Replicates | Sensory assessment | EMG recordings |
|---|---|---|---|
| Session 1 | 3 | profile | none |
| Session 2 | 2 | none | done |
| Session 3 | 2 | TI | done |

### Statistical analysis

Analysis of the variance and Student Newman-Keuls tests were performed on electromyography and sensory variables, and rheological measurements (SAS software, version 6.11, 1989).

## RESULTS AND DISCUSSION

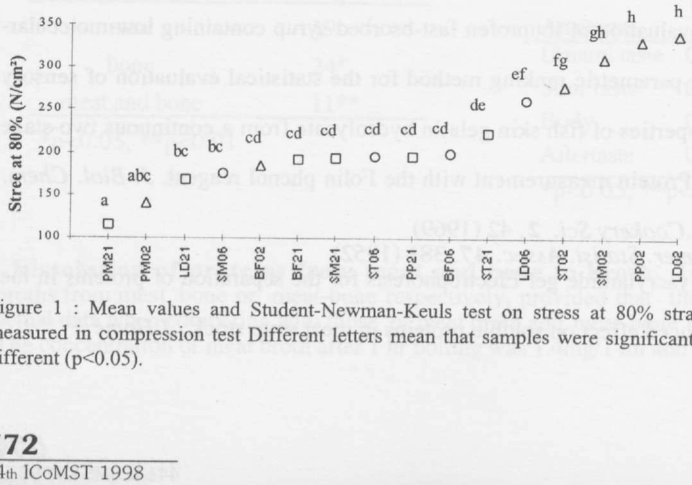


Figure 1 : Mean values and Student-Newman-Keuls test on stress at 80% strain measured in compression test Different letters mean that samples were significantly different (p<0.05).

### Rheological test

A large range of toughness was obtained with the sixteen samples. Eight groups of products were distinguished by the stress at 80% strain.

## Electromyography recordings

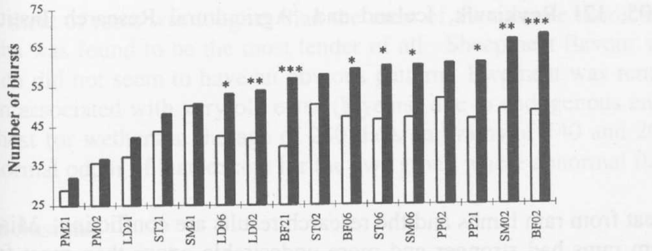


Figure 2A : Mean values and Student-Newman-Keuls test on the number of bursts. Different letters mean that the number of bursts was significantly different for the same product without TI (in white) and with TI (in dark) (*** = p<0.001 ; ** = p<0.01 ; * = p<0.05).

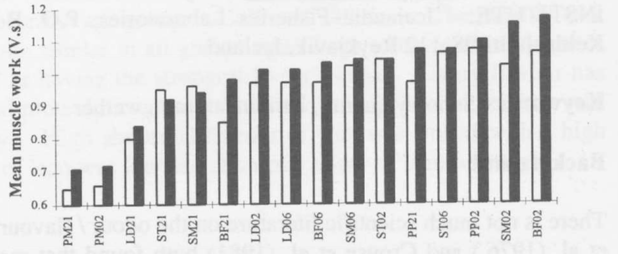


Figure 2B : Mean values and Student-Newman-Keuls test on mean muscle work. For the same product, mean muscle work without TI (in white) and with TI (in dark) were not significantly different.

Increasing toughness induced an increase in burst number and in mean muscle work by chew (calculated from the surface under the curve) (Figure 2 A and B). These results agree with the fact that chewing pattern was influenced by food hardness (Plesh *et al.*, 1985 ; Jack *et al.*, 1993 ; Duizer *et al.*, 1994 ; Mathevon *et al.*, 1995).

Toughness assessed by TI led to a significant increase in burst number calculated by EMG recordings, except for the samples assessed as the least tough (Figure 2A). In this case, similar numbers of bursts were found. Our results agree those obtained by Duizer *et al.* (1994), Mioche and Martin (1998) which showed that sensory assessment modified the chewing pattern.

Conversely, the mean muscle work by chew was not significantly increased by the TI toughness assessment (Figure 2B). These results reflected a fairly good reproducibility of this EMG parameter over two different recording sessions despite possible variations in electrodes location and skin electrical conductivity (Sakamoto *et al.*, 1989). Therefore, in contrast with burst number, mean muscle work appeared less sensitive to external and thus closer to texture properties.

Toughness assessed by profile was significantly correlated with those obtained by TI (r = 0.891*** with maximum intensity and r = 0.753*** with decrease area under the curve).

| | EMG with TI | | EMG without TI | |
|---|---|---|---|---|
| | NBBUR | TRMOY | NBBUR | TRMOY |
| Profile | 0.944 | 0.959 | 0.752 | 0.847 |
| TI (Int max) | 0.955 | 0.954 | 0.850 | 0.891 |
| TI (Area D) | 0.830 | 0.853 | 0.778 | 0.851 |

High correlation coefficients were found between sensory assessment, obtained either by profile or TI and EMG measurements even though the assessment with profile was obtained in different sessions from EMG recordings. Correlations were better with EMG parameters obtained simultaneously with TI sensory assessment when subjects focused on meat texture. Maximum intensity from TI curves always gave better correlations with EMG parameters than the decreasing area under the curve.

## CONCLUSION

EMG and sensory results were significantly correlated to a similar extent with TI or profile. Subject made a higher number of bursts before swallowing when they had to assess simultaneously toughness by TI method. Toughness assessment by TI method do not appear to bring additional information than those obtained by profile. However, it should be noticed that all sensory methods affected the EMG patterns. A more detailed analysis of toughness intensity with respect to each burst should be more indicative of texture perception.

## LITERATURE


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