MULTIVARIATE PREDICTION OF SENSORY TENDERNESS/HARDNESS FROM WARNER BRATZLER SHEAR PRESS CURVES OF BEEF

K.I. Hildrum* and B. Narum

MATFORSK, Norwegian Food Research Institute, Osloveien 1, N-1430 Aas, Norway
Email: kjell.ivar.hildrum@matforsk.no

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Introduction

Inconsistent meat tenderness has been identified as the major cause of consumer dissatisfaction with beef worldwide (Thompson, 2002). The tenderness problem has resulted in both increased interest in new efficient methods for tenderness assessment and improving existing methods. With the most used method, Warner-Bratzler (WB) shear force, the reported correlations with sensory analysis of tenderness have often been found to be less than satisfactory. The maximum value of the WB curve (in kg/cm^2 or N/cm^2) is usually used as estimator of tenderness, while the potential information in the remaining WB curve is neglected. The purpose of this study was to clarify if extraction of information by multivariate methods from the full WB shear force curve would contribute to improved and consistent correlations between WB shear force and sensory tenderness.

Materials and Methods

Longissimus thoracis (LT) samples from 27 young bulls were excised approx. 60min after stunning and four 15cm long pieces from each muscle were randomly assigned to different treatments and aged at 4°C for an additional 1 and 6 days (Hildrum *et al.*, 1999). Meat slices of 3.5cm thickness were vacuum-packed, heated at 70°C for 50 min in a water bath, cooled in ice water for 45min and, frozen at - 40°C, stored for 1-3 weeks, thawed for 18h at 4°C and slices of 1cm thickness cut along the fibre direction of the muscles. The second cut was also performed in the fibre direction to give samples cross-section dimensions of 1cm x1cm. Ten subsamples (replicates) were cut perpendicular to the fibre direction with the WB triangular device in an Instron Materials Testing Machine. 126 shear press values at equidistance along the WB curve of the replicates were used. Sensory analysis was performed on duplicate samples tempered at 20°C for 2 hours and served to 11 trained assessors (ISO 6564-1983). The variables assessed were hardness (first bite; across the fibre direction) and tenderness (whole chewing process) with a continuous intensity scale from tough (1) to tender (9) for tenderness and from soft (1) to hard (9) for hardness. The results were calculated by PLS regression on the Unscrambler®, version 9.2 and presented as the regression coefficient (r) and root mean square error of cross validation (RMSECV):

$$RMSECV = \sqrt{I^{-1} * \sum_{i=1}^{I} \left(y - \hat{y} \right)^2}$$

where the sample numbers are i [1,2,3,..,I], and y and ŷ are sensory method values and WB the predicted values, respectively. Jack-knifing was used to identify spectral regions that contributed to the models.

Results and Discussion

As both hardness and tenderness were assessed on the same samples, a very high univariate correlation was found between these variables (r = - 0.994) (Figure 1). Also reasonably high correlations were observed between sensory hardness/tenderness when only the WB maximum values were used (Figure 2, Table 1). PLS prediction of hardness from the whole WB curves (Figure 3) yielded a modest increase in the correlation coefficient, while the prediction error was reduced. Jack-knifing showed that information extracted was from almost the entire curve (Figure 4). However, performing predictions with only 3 values from the WB curve (early, max and late) yielded prediction results on a similar level. This means that making good baseline corrections for the curves are important for optimal correlations.

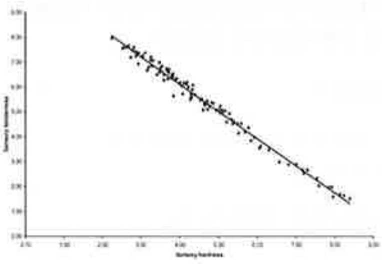

Figure 1: Correlation between sensory hardness and tenderness (108 samples).

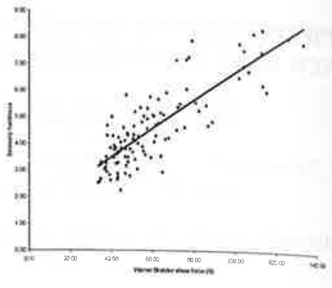

Figure 2: Correlation between sensory hardness and WB shear press (108 samples).

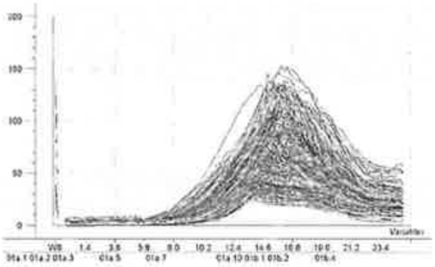

Figure 3: All replicate WB curves (1080) in the analysis.

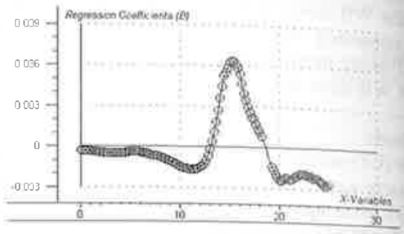

Figure 4: Jack-knifing showing the curve parts used in PLS prediction (y=regression coef.).

Table 1: Prediction of sensory variables from the WB shear press curve.

		PC's in model	r	RMSECV
Sensory tenderness				
	From WB max value	1	0.833	0.900
Sensory hardness				
	From WB max value	1	0.831	0.819
	From whole WB curve	3	0.849	0.776
	Best 3 WB values	2	0.847	0.783

Conclusion

Using PLS to extract information from the full WB shear force curves gave improved results in predicting sensor hardness from WB shear force. A corresponding improvement was attained by using 3 selected WB values (start, ma end) to secure a good baseline correction for the curves. Besides improving the prediction results, the use o multivariate techniques in extracting data from the WB curves presents the opportunity for efficient surveillance an quality control of the data.

Acknowledgements

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