BEEF WARNER-BRATZLER SHEAR FORCE MEASUREMENTS IN RELATION TO SENSORY-DETERMINED TENDERNESS. DOES MEASUREMENT TEMPERATURE INFLUENCE THE INTERPRETATION?

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Background

Warner-Bratzler shear force – measured as the maximal peak force – has been widely used for 70 years (Bratzler, 1932) as an objective method to determine meat tenderness. However, the correlation between Warner-Bratzler shear force and sensorically determined tenderness varies considerably, which could *e.g.* be caused by difference in the meat temperature at which the Warner-Bratzler shear force measurement is carried out and the sensoric evaluation, respectively. A temperature effect on the evaluation of meat tenderness could be speculated when testing meat with different intramuscular fat (IMF) content, as the physical state of the fat might influence the result. If so, this information may be hidden in sections of the shear force curves outside the maximal peak force area, which is not normally considered.

In general, the maximal peak force is used to reflect tenderness although maximal Warner-Bratzler shear force only resembles bite resistance and not the overall perception of tenderness from a sensory point of view. The development of multivariate data analysis techniques during the last few decades makes it possible to include the information from the entire Warner-Bratzler shear force curve, and herby extract potential information besides that resembling bite resistance in relation to the sensory tenderness, *e.g.* information on the influence of IMF, which must depend on temperature.

Objective

The objective of the present study was to investigate the influence of IMF and measuring temperature on Warner-Bratzler shear force in relation to sensory-determined tenderness using both traditional maximum peak force and multivariate data analysis techniques to analyse the correlation between the tenderness determined by instrumental (Warner-Bratzler shear force) and sensory analysis.

Methods

M. longissimus dorsi samples from 8 bulls and 32 heifers were used. The IMF content varied from 0.6 to 6.5% in the meat.

Intramuscular fat: The IMF content was analysed after hydrolysis, using petroleum ether for extraction (Soxtec System H+ equipment, Tecator AB, Höganäs, Sweden).

Warner-Bratzler shear force: The samples were aged for 14 days at 4°C and stored at –20°C until the shear force analysis. The samples were thawed overnight at 4°C. After thawing, the samples were cut in 5 x 5 x 12 cm samples and heated in a water bath at 70°C to a final temperature of 70°C, cooled under running tap water, stored overnight at 4°C and cut into 1 x 1 x 4 cm strips. The strips were then calibrated to 8°C, 20°C or 50°C (vacuum-packed in a water bath) and WB shear force was measured using a Stable Micro Systems Texture Analyser HD100 (Godalming, UK) equipped with a Warner-Bratzler shear blade with a rectangular hole, 11 mm wide and 15 mm high, a blade thickness of 1.2 mm and a temperature cabinet set to either 8°C, 20°C or 50°C. The maximum shear force for six strips per sample and temperature, sheared across the fibre direction, was recorded at a test speed of 50 mm/min (Honikel, 1998).

Sensory analysis: The samples were prepared in an oven at 150°C until an internal temperature of 65°C. The samples were evaluated for tenderness and bite resistance by a six-member selected and trained sensory panel using a 100-point rating scale. The panel tested 5 mm thick slices cut perpendicularly to the fibre direction. The samples had room temperature when tested.

Data analysis: A multivariate Partial Least Squares (PLS) regression model was computed between the full shear force curves (X) and IMF or sensory reference values (Y). The regression vectors from this multivariate factor model were used to interpret the results.

Results and discussion

The three measuring temperatures were chosen to be temperatures at which the fat would be mainly crystallised (8°C) or melted (50°C) and finally at the temperature at which they were served to the sensoric panel (20°C), of which the latter resemble normal Warner-Bratzler shear force procedure. The hypothesis was that the varying IMF (0.6 to 6.5%), the influence of IMF on Warner-Bratzler shear force and its relation to sensory tenderness could be extracted if of importance.

First, it was analysed if the Warner-Bratzler shear force determined as the maximal peak force correlated with IMF. The analysis showed that the Warner-Bratzler shear force did not correlate with the IMF, irrespective of measuring temperature (Figure 1). This indicates that the IMF did not contribute significantly to the Warner-Bratzler shear force. The multivariate data analysis, which included the entire Warner-Bratzler shear force curve, improved this relation (8°C: $r = -0.42$; 20°C: $r = -0.45$; 50°C: -0.27), which indicate that the meat temperature might influence the Warner-Bratzler shear force results.

The correlation between Warner-Bratzler shear force, determined both as the maximal shear force and by inclusion of the entire Warner-Bratzler shear force curve in a PLS-model, and sensory-determined tenderness and bite resistance are shown in Table 1. Both methods showed that Warner-Bratzler shear force measured at 20°C had the best correlation to the sensory evaluation and the worst at 50°C. The meat was evaluated at 20°C, which might be one explanation for the superior correlation at this temperature, when compared with the other two temperatures. The inferior correlation at 50°C may be due to methodology, and further studies are necessary to elucidate whether this is caused by temperature effect on the IMF contribution as meat is normally eaten at this temperature.

Finally, the multivariate data analysis showed that the regression coefficients of the PLS-model focused primarily on the Warner-Bratzler shear force curve peak area. No apparent information was present in *e.g.* the onset of the force peak. Consequently, the shape of the Warner-Bratzler shear force curve peak might be worth looking into, considering the influence found on Warner-Bratzler shear force data in relation to IMF content of the meat.

Conclusion

The evaluation of Warner-Bratzler shear force measurements in relation to sensory-determined tenderness was not improved by changing the measurement temperature as the present study showed that the best measuring temperature was 20°C, irrespective of IMF content. The multivariate data analysis showed that the information on tenderness is primarily found in the peak area of the Warner-Bratzler shear force curve, hence supporting the use of the maximal peak force area of the Warner-Bratzler shear force curve in relation to prediction of sensoric tenderness. Moreover, IMF seems to have a minor effect on entire Warner-Bratzler shear force curve.

Pertinent literature

Bratzler, L.J. (1932). Measuring the tenderness of meat by means of a mechanical shear, MSc. Thesis, Kansas State College.
Honikel, K.O. (1998). Reference Methods for the Assessment of Physical Characteristics of Meat. *Meat Science,* 49(4), 447-457.

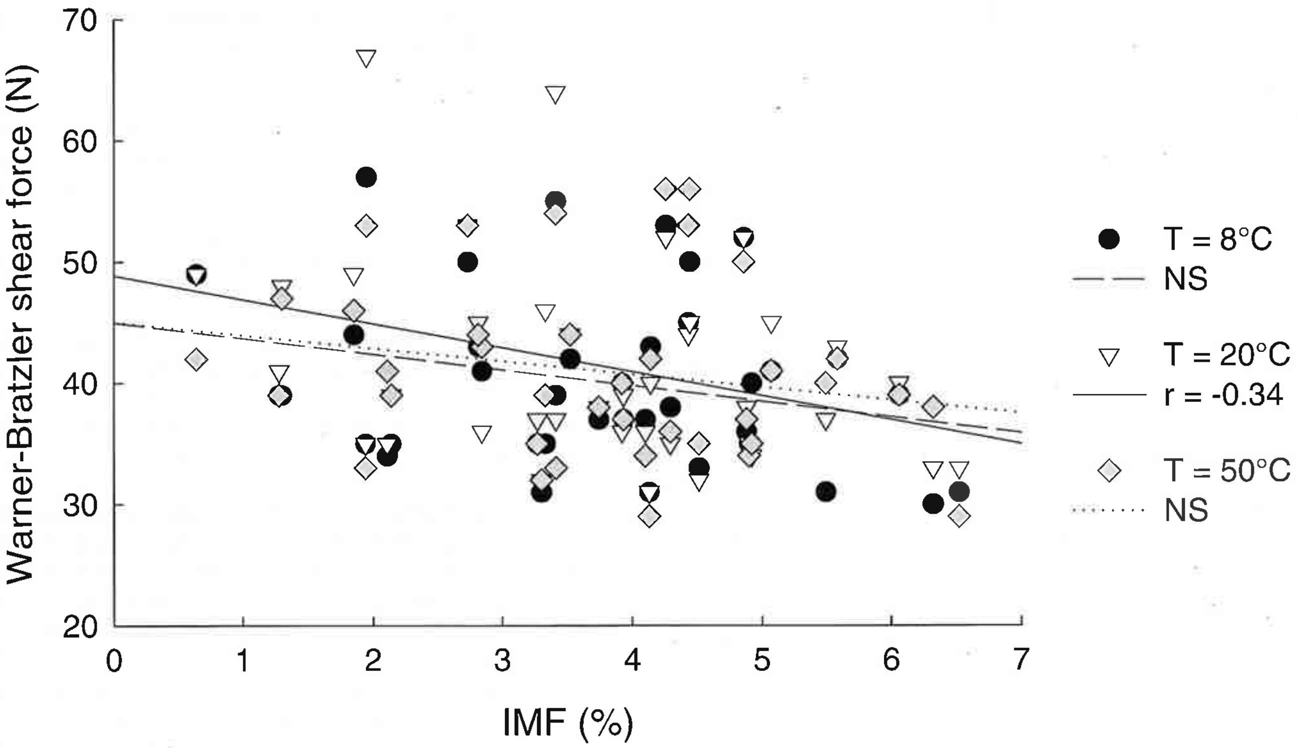

Figure 1 Correlation coefficient between intramuscular fat (IMF) and Warner-Bratzler shear force (max. peak force) measured at 8°C, 20°C and 50°C, respectively. NS indicates a non-significant correlation

Table 1 Correlation coefficients between Warner-Bratzler shear force and sensory determined tenderness and bite resistance. The Warner-Bratzler shear force was included either as the maximal peak force or a PLS-model was made including the entire Warner-Bratzler shear force curve

	Tenderness		Bite resistance	
Measurement temperature	Max. peak force	PLS-model	Max. peak force	PLS-model
8°C	-0.59	-0.59	0.57	0.55
20°C	-0.66	-0.73	0.63	0.72
50°C	-0.49	-0.55	0.48	0.53

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