A simple and portable electric device to measure cooked meat tenderness

T.L. Cummings, A.W. Pitt, N.J. Simmons*, N.V. Johnson, J.M. McGurk & C.C. Daly
Carne Technologies Ltd, P.O. Box 740, Cambridge 3434, New Zealand.
*Email: nicola.simmons@carnetech.co.nz

Abstract

In the 1980's, MIRINZ developed a device for measuring shearforces using a simplified shear-head and a pneumatic drive that reduced costs and simplified construction compared to other shear devices. Shearforces measured with the MIRINZ tenderometer correlate well with the Warner-Bratzler but the instrument is limited to use in a laboratory environment. This paper reports on the recently developed Electric Tenderometer (ET), based on the MIRINZ shear-head but using an electric linear motor to develop the shearforce. Advantages of this device are it is lightweight, portable and has a semi-automatic sample loading and shearing process. We evaluated the performance of the prototype ET, comparing it to the MT. Over 1000 shearforce measurements taken from *M. longissimus* samples from both beef and lamb, covering a wide range of tenderness were measured with the unit. A strong positive relationship between the two instruments was demonstrated (r^2 0.83). This work shows that the ET provides a quick, portable alternative to the existing WB and MT for obtaining an objective estimate of cooked meat tenderness.

Introduction

The MIRINZ Tenderometer (MT) is a pneumatically-driven device developed in 1983 by Frazerhurst & MacFarlane principally for the NZ Meat Industry. It generates a shearforce measurement on a cooked sample by compressing and shearing with a blunt wedged-shaped tooth. The Warner-Bratzler (WB), developed in the early 1930's (Bratzler, 1932; Warner, 1928), derives the shearforce from placing cooked samples in a flat plate with a triangular hole and shearing between two fixed plates. Despite the differences in shearing action, comparisons show the two units to be highly correlated r=0.94 (Bouton & Harris, 1972) and r=0.91 (Graafhuis *et al*., 1991). The MT and the WB continue to be widely used in research laboratories and the MT is used as a basic meat quality auditing tool by many of the New Zealand processing plants and some overseas supermarkets and central cutting plants. However, both units have some limitations; the WB is generally part of a general materials testing device and is therefore expensive and laboratory-bound. In contrast, the MT is a relatively compact and simplified unit but requires a source of compressed air to drive the pneumatics within the unit, and the pneumatics are relatively complex and require regular maintenance to ensure reliability. This essentially limits the mobility of the device.

Recently, an updated version of the MT was developed which uses an electric linear motor to compress the cooked sample; while still using the same style blunt wedge-shaped tooth as the MT. A cartridge allows a number of samples (up to 10) to be loaded onto the device at the same time to speed the processing operation. A linear motor drives the specimen platform towards the static shearing head. The head is mounted on a load cell (Celtron MBB-100) that measures the resultant shearforce. The peak force is displayed via an LED on the unit, and the force-deformation information can also be acquired in real time and transmitted and stored to either a computer or PDA via cable or wireless data transmission. This system weighs approximately 4 kg and has the option of being battery operated.

The performance of the ET was evaluated and compared to the MT using beef and lamb *M. longissimus* samples with a wide range of tenderness.

Materials and methods

Samples derived from a number of research trials with beef and lamb quality assessments were utilised for this comparative work. Tenderness measurements were made after a variety of treatments and included such processing variables as electrical stimulation, pre-rigor temperatures and different ageing times. Measurements were made from samples at rigor aged through to 21 days. A total of 1528 samples were evaluated through both the MT and ET.

Beef and lamb samples were cooked from the chilled state in a 100°C waterbath to an internal endpoint of 75°C as measured by internal probe thermometer. Cooked samples were immediately cooled on ice. Once samples were ≤4°C, 20 samples of 10 mm x 10 mm cross-section portion with a length, parallel to the fibre axis, of at least 25mm were prepared from each LD sample; 10 were then tested with the MT and 10 with the ET, in all cases the samples were sheared at right angles to the fibre direction.

Results and discussion

The relationship between the MT and ET show a high correlation (r^2=0.83). The regression equation is ET (kgF) = 0.391MT(kgF) + 2.08 and allows users to convert shearforce values from the MT to ET. This high correlation indicates that the ET can confidently be used as an alternative to the existing WB and MT for obtaining an objective estimate of cooked meat tenderness.

Objective measurements of tenderness allow comparison of different treatments but do not provide a measurement of consumer acceptability of that product. As consumer studies are often expensive and time consuming an instrumental device is often used to predict an acceptable tenderness level.

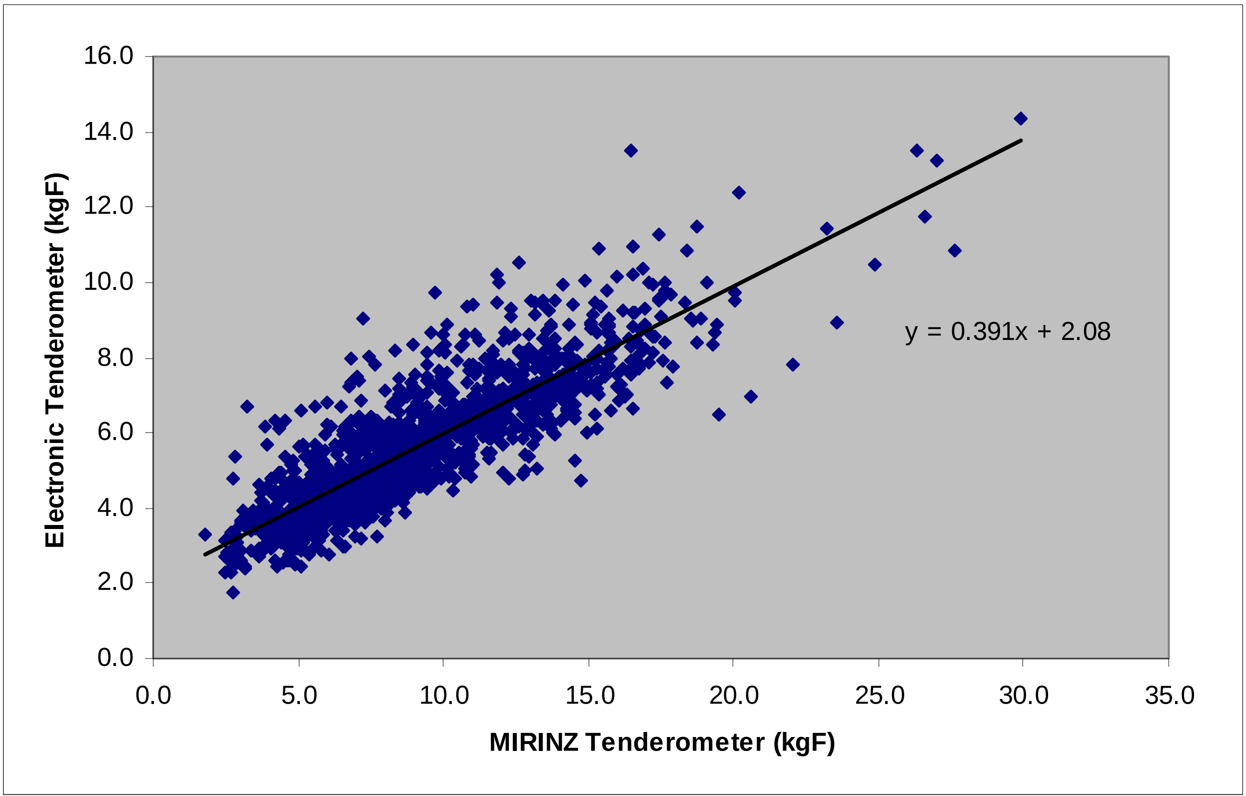

Figure 1. Relationship between MT and ET measured shearforce (kgF) based upon LD samples from both beef and lamb.

Past studies have demonstrated that the WB effectively predicts sensory or consumer tenderness perception (Perry *et al.*, 1998 & 2001; Shackelford *et al.*, 1995). Peachey *et al.* (2002) found a high correlation between MT and sensory tenderness (r=0.71), and more recent work (Destefanis *et al.*, 2008) shows that consumers can discriminate tough from intermediate and tender meat and classify meat with WB values >52.68N (5.37 kgF) as tough and those of <42.87 N (4.37 kgF) as tender. Given the high correlation between the ET and MT, and, by inference, the WB, the ET can be used as an instrument to predict consumer acceptability.

Conclusions

The ET is a reliable shear device tool that can be used as an alternative to the WB and MT to provide objective meat tenderness assessments. The modifications to the ET include simplification of the drive mechanism and miniaturisation of the unit. This makes the device portable and lightweight. The ability to load multiple samples and faster sample processing, along with automated data display and recording make the unit easy to use in a research laboratory or as part of a process audit procedure.

Acknowledgements

This device was developed under contract to Meat & Wool New Zealand and Meat & Livestock Australia.

References

Bouton,P,E. & Harris, P.V. (1972). A Comparison of Some Objective Methods used to Assess Meat Tenderness. *Journal of Food Science, 37* 218-221.

Bratzler, L. J. (1932). Measuring the tenderness of meat by means of a mechanical shear. *Master of Science Thesis*. Kansas State College (KA), USA.

Destefanis, G., Brugiapaglia, A., Barge, M.T. & Dal Molin, E. (2008). Relationship between beef consumer tenderness perception and Warner–Bratzler shear force, *Meat Science, 78*, pp. 153–156

Frazerhurst, L.F. & MacFarlane, P. (1983). A device for measuring the tenderness of meat. Patent 190945. Hamilton.

Graafhuis, A.E., Honikel, K.O., Devine, C.E. & Chrystall, B.B. (1991). Tenderness of different muscles cooked to different temperatures and assessed by different methods. In *Proceedings of the 37th ICoMST,* pp 365-368 Kulmbach, Germany.

Peachey, B.M., Purchas, R.W. & Duizer, L.M. (2002). Relationships between sensory and objective measures of meat tenderness of beef m. longissimus thoracis from bulls and steers. *Meat Science, 60 (3),* 211-218.

Perry, D., Rymill, S.R., Hearnshaw, H., Ferguson, D.M. & Thompson, J.M. (1998). The Relationship between consumer scores, trained taste panel scores and objective measurements of tenderness. In *Proceedings of the 44th ICoMST, B.159* 814-815.

Perry, D., Thompson, J.M., Hwang, I.H., Butchers, A. & Egan, A.F. (2001). Relationship between objective measurements and taste panel assessment of beef quality. *Australian Journal of Experimental Agriculture, 41,* 981-989.

Shackleford, S.D., Wheeler, R.L. & Koohmaraie, M. (1995). Relationship between shear force and trained sensory panel tenderness ratings of 10 major muscles from bos indicus and bos taurus cattle. *Journal of Animal Science, 73,* 3333-3340.

Warner, K.F. (1928). Progress report of the mechanical test for tenderness of meat. In *Proceedings of the American Society of Animal Production, 21*, p. 114.