ANISOTROPY OF ULTRASONIC VELOCITY AS A METHOD OF TRACKING POSTMORTEM AGEING IN BEEF.

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Background

Tenderness of beef is one of the most important components of eating quality for the consumer. The structure of beef muscle and its physicochemical properties undergo many changes during postmortem ageing. These changes impact on the ultimate quality of the meat. A technique with significant potential in the study of these structural changes is ultrasonic spectroscopy, which is a tool based on the measurements of parameters of low-intensity ultrasonic waves propagated through materials. The propagation of ultrasound in a medium is closely dependent on its mechanical properties. Ultrasonic waves have the ability to propagate through optically non-transparent materials, and therefore they can be used to analyse muscle (Abouelkaram, 2000). The measurement of some pertinent acoustical parameters, which are sensitive to the muscle structure, can allow the mechanical properties of the medium to be characterised. Ultrasonic parameters, such as the velocity and attenuation, are sensitive to the muscle structure and hence can give important information about the potential eating quality. A high-resolution acoustical resonator technique has been developed by the authors and has been shown to be sensitive to the structure of meat. It therefore could potentially be used to follow the structural changes that occur in beef with ageing that ultimately determines the final eating quality.

Objective

The objective was to use the acoustical resonator technique to analyse and track structural changes in beef in order to enable the development of a method that could be used for the precise, objective and rapid characterisation of the eating quality of beef.

Methods

A resonator technique developed by one of the authors (Buckin and Smyth, 1999) was used to analyse the ageing-related structural changes in bovine M. *longissimus dorsi* (LD). This technique has previously been successfully applied in the analysis of biological polymers (see for review Buckin and Smyth, 1999 and Buckin and Kudryashov, 2000) and biocolloids (Kudryashov et al., 2000) and temperature-related transitions in beef (Dwyer et al., 2000). The ultrasonic parameters were measured in muscle samples at 25°C with their fibres aligned either parallel with or perpendicular to the direction of propagation of the ultrasonic waves. Initially, ultrasound measurements were recorded on samples excised directly from the carcass. The LD was excised at 1d, and stored (4°C) until 14d post-mortem. During this time samples were taken for ultrasound and quality measurements. The ultrasound measurements were recorded over the ageing period starting at 2h post-mortem. Five ultrasound measurements were recorded every day (excluding days 4 & 11) until the meat had aged for 14 days. Measurements were recorded both parallel with and perpendicular to the muscle fibre direction. Sensory assessment, using a trained 8-member panel, and Warner Bratzler shear force measurements were recorded at days 2, 7 and 14 post-mortem.

Results and discussion

The changes in the ultrasonic velocity, u, over the ageing period measured in muscle at 6.0 MHz are shown in Fig 1. Both the ultrasonic velocity and the attenuation were found to change with ageing for muscles of both parallel and perpendicular fibre alignments. The ultrasonic velocity for the samples with perpendicular fibre alignment was found to be higher at nearly all time points than for the samples with parallel-aligned fibres. The ultrasonic attenuation was initially higher in the parallel samples but as ageing continued the difference in attenuation between the sample types lessened. The changes in the ultrasonic velocity and attenuation coefficient, measured at 6 different frequencies were seen to reach a maximum after approximately 10 days of ageing. After this time the anisotropy of acoustical parameters was found to be negligible, possibly indicating a completion of the structural changes in the meat samples. It was also found that ultrasonic velocity was more sensitive than the ultrasonic attenuation to the ageing process. The results of the acoustical measurements were compared with results from standard analysis of sensory and physical properties of the meat (Figure 2). These results indicate that the acoustic velocity, measured by this technique, may be sensitive to the changes in the structure of meat. These structural changes may contribute to the ultimate quality of the meat. Therefore it is possible that this technique could be developed for application in the meat industry for the objective characterisation of eating quality.

Conclusion

These data demonstrate that anisotropy of ultrasonic velocity is capable of tracking structural changes in beef during the post-mortem ageing process and therefore has potential as an indicator of the eating quality of beef. However, further work on a broad range of meat samples is needed to validate this approach for predicting beef eating quality.

References

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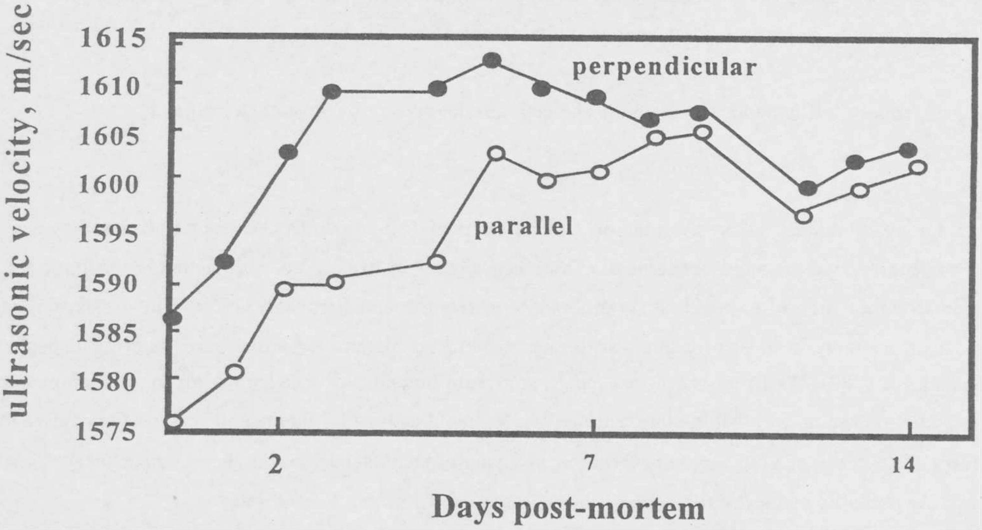

Figure 1. Ultrasonic velocity measured in anisotropic samples over the ageing period of 0 to 14 days post-mortem at 6 MHz. Ultrasonic parameters were measured fibres parallel and fibres perpendicular to the direction of propagation of the ultrasonic waves. Each point is an average of five measurements on the day of testing.

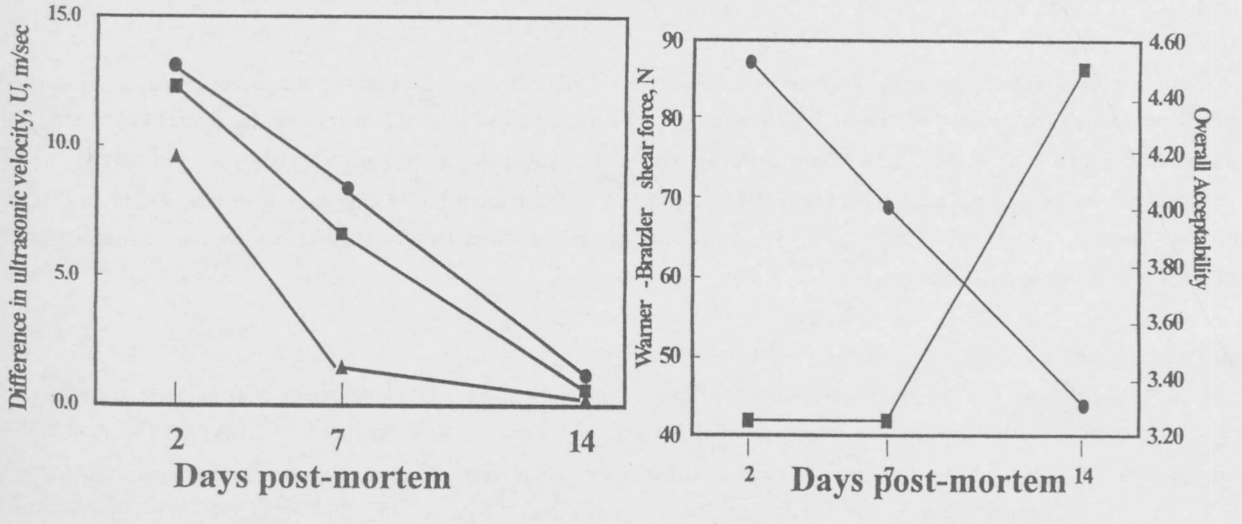

Figure 2. Anisotropy of ultrasonic velocity (U) showed in comparison with meat quality attributes over the ageing period. U was calculated by subtracting ultrasonic velocity measured parallel from ultrasonic velocity measured perpendicular to the muscle fibre.