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ULTRASOUND ASSESSMENT OF MARBLING IN CATTLE

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INTRODUCTION

There is a growing commercial requirement in the Australian feedlot industry for objective measurements of intramuscular fat content (marbling) in live cattle. The benefits of such measurements are substantial for those who are breeding and lot-feeding cattle for the lucrative grain-fed export market in Japan. To date however, the efforts to measure marbling *in vivo* have generally been unsuccessful. The non-invasive technique of ultrasound has received most attention in this regard, but, as stated, the results have either been poor (Kauffman, 1991) or at best only moderate (Brethour, 1990). In the study by Brethour (1990), his subjective interpretation of the speckle patterns in ultrasound images taken on the live animal accounted for 25 to 30% of the variation in USDA marbling grades on the quartered side.

In 1989, a large scale research project, known as the Joint Ultrasound Project, was commissioned by the Australian Meat Research Corporation. Several collaborative research groups were involved and their principal aim was to investigate and exploit the potential of ultrasound for meat quality and carcass yield evaluation. As part of this project, the feasibility of ultrasound assessment of marbling in live cattle was determined.

MATERIALS AND METHODS

Two separate investigations were carried out during the course of this study. An initial investigation was performed to examine whether or not there were any measurable ultrasonic parameters which were correlated with intramuscular fat (IMF) in *m.longissimus* samples. This investigation was conducted in the laboratory under ideal conditions. Contingent on a successful outcome of the first investigation, a live animal field trial was undertaken to verify that the established ultrasonic parameter(s) would correlate to the same degree.

Laboratory Investigations

M.longissimus samples extending from the 5/6th ribs to the 12/13th ribs were collected from 14 beef sides. All overlying fat and epimysial tissues were removed prior to vacuum packaging each sample, which was then submerged in a water bath at 37°C. Transverse ultrasound scans were acquired close to the most cranial and caudal ends of the sample. The scan position was then marked on the plastic bag. The scans were conducted at a frequency of 3.5MHz using instrumentation and a signal processing package (Knight and Robinson 1987) developed by the CSIRO Ultrasonics Laboratory. Two 5mm transverse slices at the scan positions were removed from each sample for chemical fat analysis according to the procedures of the AOAC (1987).

RESULTS AND DISCUSSION

The percent IMF ranged from 3.6 to 16.1% with a mean value of 9%.

In the analysis of the data, the primary aim was to determine the degree of association between the various ultrasound parameters and percent IMF. Sound velocity was shown to be the best single predictor accounting for 84% of the variation in IMF percent. Unfortunately, measurement of sound velocity from pulse-echo image data, although possible under favourable conditions (Robinson *et al.*, 1982), would be inhibited by the geometry of the animal's anatomy. The results revealed that a number of other single and multiple parameters were also highly correlated (R^2 0.65-0.75) with percent IMF. Disclosure of the full details of these parameters is not possible as it is still subject to commercial confidentiality.

These encouraging results require some qualification. The measurements were carried out under ideal conditions where the distorting effect of the overlying tissues (e.g., fat, connective tissue and hide) on the ultrasonic beam were obviated. This effect manifests itself in the live animal and it was expected that the distortion, particularly in the case of sound velocity, would degrade the correlations established in the laboratory investigations.

Field Trial

In order to validate the results of the laboratory investigations, a field trial was conducted in a commercial feedlot. The data acquisition was carried out using a modified Hitachi EUB 310 scanner with a conventional 3.5MHz linear array transducer. The unit was modified to allow the transfer of signal data to the computer for further analysis.

Ultrasonic scans over the *m.longissimus* were taken at the 12/13th rib site on 20 Angus steers, which were fed for 250 days on a commercial feedlot ration. The scan site was brushed and liberal amounts of vegetable oil were applied. Following scanning, the cattle were despatched to a nearby abattoir for slaughter. The chilled sides were then quartered at the 12/13th rib site to determine the visual marbling score according to the procedures outlined by Anon. (1991). A 2cm transverse slice of the *m.longissimus* was then removed for analytical determination of the IMF percent.

Results

The results regarding the accuracy of the ultrasound predictions of percent IMF and marbling score are presented in Table 1.

Despite the effects of the overlying tissues, which were quite noticeable in this sample due to the excessive fatness of the cattle, a useful and reasonably accurate estimate of IMF percent was achieved. Predictive accuracy was lower for the prediction of marbling score, however, it is pertinent to bear in the mind that there is not a perfect correlation between marbling grade and actual IMF percent. In this study, marbling grade only accounted for 70% of the variation in percent IMF.

CONCLUSIONS

This finding verifies the possibility of assessing marbling in live cattle using ultrasound. The next stages in the development of this technique involve:

- verification on a larger sample
- refinement of data acquisition and image analysis
- determining the feasibility of applying the technique on the hot carcass

These aspects are to be addressed in an ongoing collaborative project.

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Table 1. Ultrasound predictions of IMF percent and marbling score.

Mean ± sd	IMF % 10.6 ± 3.2 R^2 SEE	Marbling Score 3.3 ± 1.3 R^2 SEE
Best two variables; model #	0.66 1.97	0.45 1.05

based on parameters established in the laboratory investigations.