A probe for measuring GR depth in Australian lamb carcases

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Abstract – Complementary studies were conducted at 3 abattoirs to determine the potential of a dual function GR/Impedance probe to measure GR tissue depth in lamb carcases online. Lamb carcases (1016) were measured approximately 25 min post slaughter with the probe and a GR knife as the gold standard. Modelling of the data demonstrated that the probe was underestimating the GR knife measurement when GR knife measured > 10 and increasingly so with increasing carcase weight and increasing fat score. Furthermore, error variation differed significantly across abattoirs with marginal R^2 ranging from 0.32 – 0.84. Consequently, the dual-function probe does not have the accuracy required by industry. Despite the poor predictions found, this study did highlight several improvements which could be made to the current probe, including reducing its size and weight, which would improve the accuracy of measurements.

Key Words – carcase assessment, carcase yield, fat depth

I. INTRODUCTION

GR or Greville tissue depth is the basis of the current fat scoring system commonly used in Australian abattoirs as an indicator of lamb and sheep carcase composition and meat yield. GR tissue depth is defined as the total tissue thickness over the 12th rib 110 mm from the midline.

Although technologies such as the AUS-MEAT sheep probe (ASP) have previously been employed to measure GR depth, these technologies are no longer available. Consequently, palpated fat scores is the most common method used by sheep and lamb processors in Australia to estimate tissue depth at the GR site as it is not feasible to measure GR depths using a GR knife, which is the gold standard, at chain speed. Therefore, a more accurate and robust method for measurement of the GR tissue depth is required.

The aim of this study was to determine the potential for a dual purpose GR/Impedance probe to measure GR depths of lamb carcases in commercial processing plants.

II. MATERIALS AND METHODS

Complementary experiments were conducted at 3 commercial abattoirs measuring 1016 randomly selected lamb carcases that were typical of lambs processed within Australia. Lamb carcases were measured approximately 25 – 30 min post slaughter with the probe (Fig 1.) and the GR knife.

Figure 1. Measurement of a lamb carcase 25 min post slaughter using the GR probe.

Carcase weight, palpated fat score (if available), the day of measurement, perspex plate type on the front of the probe (flat or round), carcase temperature (hot or cold) and operator were also recorded.

Models to predict the GR knife measurements using the depths measured by the GR probe were fitted using *asreml* [1] under R software [2] and marginal R^2 were calculated as previously described [3]. GR knife was modelled as linear regressions on GR probe, with the regressions allowed to differ across abattoirs. The models also included separate fixed effects for fat scores (including a separate effect for missing fat score) and a linear adjustment for carcase weight (where available). The model also included effects for each of the six unique dates on which measurements were taken and random error, with the random error allowed to differ across abattoir.

III. RESULTS AND DISCUSSION

Overall the lambs measured in this study represented those which are typically processed within Australia as demonstrated by the summary statistics for carcase weight, GR knife measurements and fat scores that are given in Table 1.

Table 1 Summary statistics for carcase weight, GR knife measurements and fat scores of lamb carcases measured.

Measurement	Mean (s.d)	Range (min- max)
Carcase Weight (kg)	21.6 (3.3)	10.7 – 33.3
GR knife measurement (mm)	11.0 (4.0)	1.5 - 25
Fat Scores	3 (0.8)	2 - 5

Modelling of the depths measured with the GR knife using the GR probe, fat score and carcase weight as well as random effects for abattoir and date indicated that fat score and carcase weight were significant effects ($P < 0.01$).

This indicates that the probe is unable to totally account for systematic differences in GR knife introduced with varying fat scores and / or carcase weights. In addition to differences across fat scores and carcase weights, there were systematic effects associated with abattoir and with date.

Variability in the conformation of lamb carcases is an ongoing challenge for the development of a probe to measure GR tissue depth, especially soon after slaughter when hot, given that they lack rigidity and are also slippery to handle. As the GR/Impendence probe is a similar design to the Fat-o-Meater developed for pork carcase assessment [4], the front of the probe is too large and does not sit entirely flat against the ribs of the carcase (Fig 2.).

The variability in the conformation of carcases may be more pronounced for carcases with a higher amount of subcutaneous fat as after adjusting for the GR probe measurement it was found that the GR knife measurements were increasingly underestimated as fat score increased. This resulted in a model adjustment of + 1.16 mm (s. e. = 0.40) for carcases with a palpated fat score of 3, + 3.52 mm (s. e. = 0.45) carcases with a palpated fat score of 4 and + 5.34 mm (s. e. = 0.62) for carcases with a palpated fat score of 5.

Figure 2. Measurement of a lamb carcase using the round plate on the GR probe highlighting the impact of carcase conformation.

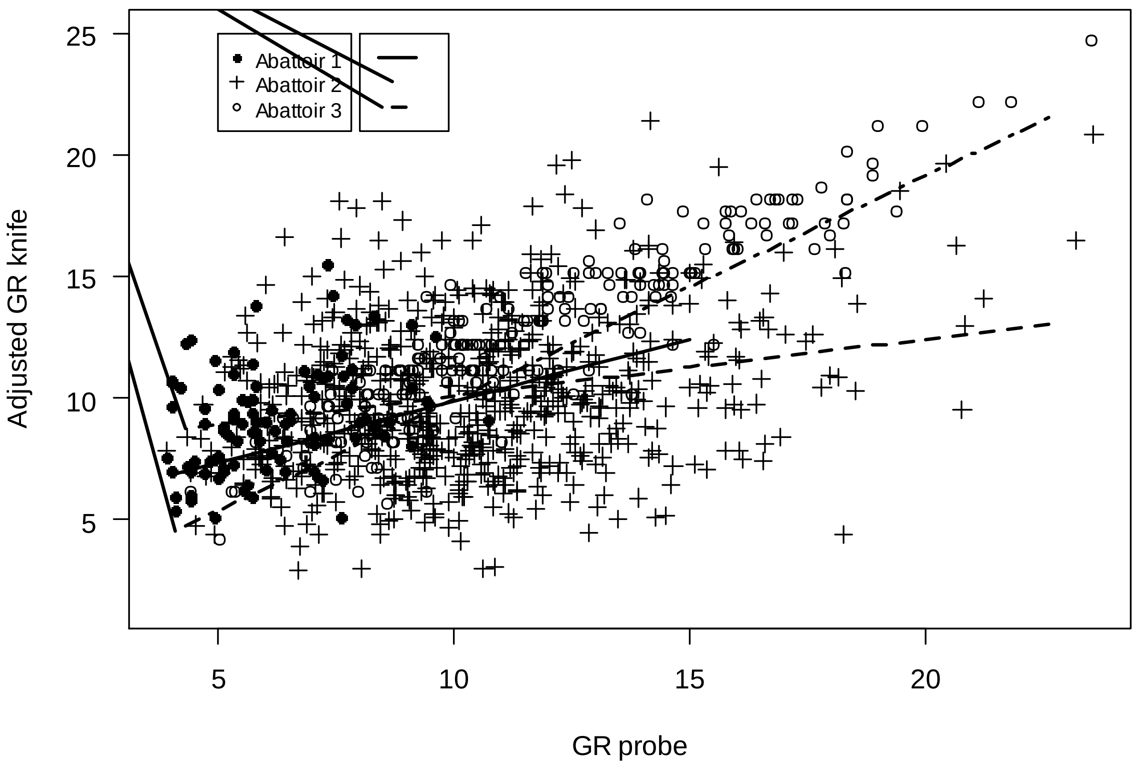

Figure 3. The adjusted GR knife predicted values (adjusted to a fat score =2 and a carcase weight = 21.5) plotted against the observed GR probe values with a fitted regression for predicting GR depth using the GR probe at each abattoir when fat score equals 2 and carcase weight equals 21.5kg.

A similar effect was also found for heavier carcases as after adjusting for the GR probe, GR knife measurements were underestimated by an increasing amount as carcase weight increased. Consequently, for each kilo (kg) increase in carcase weight, the GR knife measurement was underestimated by 0.28 mm (s. e. = 0.04). Over the 22.6 kg carcase weight range this would equate to a 6.3 mm difference between the GR depth measured with the probe and the knife.

Abattoir was also a source of variation within the model, as highlighted by Figure 3. Subsequently, the equation for the regression line varied between the abattoirs. The Predicted(GR knife) regressions on GR probe for carcases with fat score 2 and weight 21.5 kg are:

Abattoir 1 = 4.80 (s. e. = 1.39) + 0.51 (s. e. = 0.14) x GR probe

Abattoir 2 = 6.58 (s. e. = 0.72) + 0.24 (s. e. = 0.04) x GR probe

Abattoir 3 = 0.78 (s. e. = 1.09) + 0.92 (s. e. = 0.03) x GR probe

The above regression model for abattoir 2 is the average across four separate dates, with significant variation across dates, whereas observations at abattoirs 1 and 3 were on single but separate dates. The R^2 for the regressions within each of the six sampling dates ranged from 0.32 to 0.84, with a mean value equal 0.50.

The corresponding error variances for the 3 abattoirs are 4.21 (s. e. = 0.61), 8.10 (s. e. = 0.44) and 2.0 (s. e. = 0.19) for abattoirs 1, 2 and 3 respectively. This variance emphasises the significance of operator training and operator monitoring to ensure that suitable protocols for measurement are developed and employed, as the abattoir error includes the contributions to measurement error associated with operator.

This agrees with previous studies which focused on the development and validation of the Hennessy Grading Probe and ASP [5, 6] as it was found that the ability to measure GR depth varied over measurement days and operator.

IV. CONCLUSION

Based on the results of this study, the dual function GR/Impedence probe is unable to a provide the repeatable measure of GR tissue depth which is required for industrial application as there was significant variation in results both across and within abattoirs. However, this finding is limited to the current design of the GR/Impedance probe as this study identified several modifications, including miniturisation of components, which would enable accurate measurements at chain speed.

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