Prediction of Intermuscular Fat of lamb topside *in-situ* using Near Infrared Spectroscopy

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I. INTRODUCTION

Fat content, in either subcutaneous or intramuscular fat (IMF) deposits, is a trait which is important to red meat processors in Australia as it contributes to the nutritive value and eating quality of meats. Therefore, red meat processors need to be able to identify the fat content of retail meat cuts which suits consumers' looking for leaner cuts as well as those which will meet premium eating quality grades [1]. This is particularly important for lamb processors given that the current lamb carcase assessment method does not include a visual marbling score.

Near Infrared (NIR) spectroscopy has been extensively used as a method for measuring the fat content of foods as the long chain fatty acids give rise to distinct peaks However, much research has been completed on samples which have been freeze dried and homogenised prior to analysis.

Therefore, the aim of the current study was to determine the potential for a hand held NIR devices to measure the IMF of lamb carcases in at-line and on-line situations.

II. MATERIALS AND METHODS

The *m. semimembranosus* (SM) of 100 carcases randomly selected from a commercial abattoir were measured *in-situ* at 25 min and 24 h post slaughter using a TerraSpec Halo® NIR hand held device (ASD Inc.). Carcases were selected to represent those which are typically processed in Australia. Five measurements of the SM were conducted on the muscle with the subcutaneous fat removed. Once measurements were completed with the NIR spectroscopic device, the SM was removed and a 25 – 30g section of the muscle at the NIR measurement site was taken and frozen. IMF analysis was completed using the Soxhlet method [2] adapted to remove the sand and cotton during determination using 40 mL of hexane as the extraction solvent. Spectra for each sample were averaged and reduced to wavelengths 545 nm to 1217 nm before being preprocessed with a Savitzky-Golay filter and analysed using partial least squares (PLS) analysis. Cross validation for each model was completed using the leave one out (LOO) method. All analysis was completed using MatLab® software [3].

III. RESULTS AND DISCUSSION

The SM measured for this study had a mean IMF content of 3.2% (s.d. = 0.86) and a range from 1.3 – 5.9%. Prediction of the IMF content using spectra collected at 25 min post slaughter yielded an R^2 = 0.50 and R^2_{cv} = 0.37 (6LV; RMSECV = 0.78; Fig 1). While prediction of the IMF content using spectra collected at 24 h post mortem resulted in an R^2 value of 0.37 and an R^2_{cv} equal to 0.27 (6 LV; RMSECV = 0.85), which suggests that there is some ability predict the IMF content at 25 min post slaughter.

Although much research has been completed on the use of NIR as a technology to measure the IMF content of homogenised and freeze dried meat [4], there are few studies completed which measure the IMF content of fresh intact muscle with a method which is suitable for use by commercial meat processors. There are two studies which have investigated the use of a diode array VIS/NIR fibre optic probe [5] and a EPP2000-CXR-Srs connected by a bifurcated optical cable [6] to predict the IMF content of pork muscles.

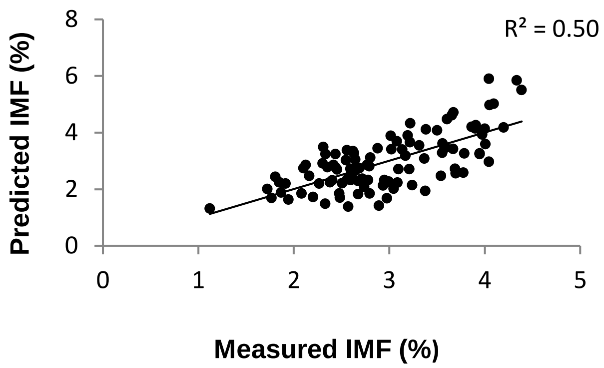

Figure 1. Prediction of IMF of the topside using spectra measured at 25 min post mortem (R^2 = 0.50, R^2_{cv} = 0.21, 4 LV, RMSECV = 0.78).

Comparing the results of the current study with these studies indicates that there is a greater potential to measure the IMF content of lamb compared to pork as neither of the cited studies shown the ability to predict IMF values with a suitable accuracy, as R^2 values of 0.35 [5] and 0.28 [6] were achieved. It is hypothesised that the low range of IMF values measured by these studies was a limiting factor. As pork is considerably leaner in comparison to lamb, the IMF values reported in the cited studies are significantly smaller than those of the present study. Indeed, ranges in IMF content of between 0.51 – 2.7% [5] and 0.02 – 0.7% [6] were reported. Given that the accuracy of regression models, including partial least squares regression, is dependent on the range of the data set [7], and it was hypothesised that this small range of IMF values limited the accuracy of the calibration models. Thus, the models presented here may be further improved by increasing the range of IMF values of carcases measured to create calibration models to include a larger number of carcases with low and high IMF contents.

IV. CONCLUSION

While this study demonstrated the potential to predict the IMF content of lamb topsides using the hand held NIR device, there is still considerable research which needs to be completed before the technology can be made available to commercial lamb processing plants. Further research includes increasing the range of the samples used to create calibration models and validating the prediction models over a longer term and on independent samples to ensure the models are repeatable and robust. Given the lack of current lamb carcase assessment methods, future research should also include consultation with industry to determine the accuracy and error of the models deemed acceptable for use in industry, especially when for IMF there is no current system or an alternative that can be used *in situ.*

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REFERENCES

1. Font-i-Furnols, M. and Guerrero, L. (2014). Consumer preference, behavior and perception about meat and meat products: An overview. Meat Science, 98: 361-371.
2. AOAC (1992). *AOAC Official Method 991.36 Fat (Crude) in Meat and Meat Products*. p. 289.
3. The Mathworks Inc. (2013). *MATLAB*.
4. Weeranantanaphan, J., Downey, G., Allen, P., and Da -Wen, S. (2011). A review of near infrared spectroscopy in muscle food analysis: 2005-2010. Journal of Infrared Spectroscopy, 19: 61-104.
5. Hoving-Bolink, A., Vedder, H., Merks, J., de Klein, W., Reimert, H., Frankhuizen, R., van den Broek, W., and Lambooij, E. (2005). Perspective of NIRS measurements early post mortem for prediction of pork quality. Meat Science, 69: 417-423.
6. Balage, J.M., da Luz e Silva, S., Gomide, C.A., Bonin, M.d.N., and Figueira, A.C. (2015). Predicting pork quality using Vis/NIR spectroscopy. Meat Science, 108: 37-43.
7. Davies, A.M. and Fearn, T. (2006). Back to Basics: calibration statistics. Spectroscopy Europe, 18: 31-32.