CAN A NitFom NEAR INFRARED SYSTEM PREDICT LABORATORY INTRAMUSCULAR FAT VALUES?

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Abstract – This study investigated the potential to predict laboratory intramuscular fat (IMF) content of lamb loins (n = 486) and topsides (n = 287) using a NitFom near infrared (NIR) system. Modelling of NitFom spectra against IMF content determined using an NIR laboratory method revealed a poor ability to predict IMF in both muscles (R^2_{cv} = 0.15 and R^2_{cv} = 0.05 for loin and topside respectively). It is hypothesised that the poor prediction may be due to the development of the technology originally as a tool to determine fatty acid composition of pork subcutaneous fat and the use of an NIR reference measurement which results in additional error within predictive models compared to wet chemistry.

Key Words – near infrared, intramuscular fat, carcase assessment

I. INTRODUCTION

As lamb carcases in Australia are not split for carcase grading and visual assessment of intramuscular fat (IMF), wet chemistry methods for IMF determination are required which are resource intensive and destructive. Consequently, more rapid non-destructive and non-invasive methods for determining IMF levels are required by the sheep meat industry. Given that NIR has been successfully used to predict IMF under laboratory conditions [1], and the NitFom NIR device is a semi portable system [2], it may be able to predict IMF of lamb loins *in-situ*. However, the potential to predict IMF of lamb has not yet been investigated using the NitFom. Therefore, the aim of this research was to determine the potential for the NITFom NIR system to predict the intramuscular fat percentage of ovine *m. longissimus thoracis* and *m. semimembranosus in-situ* with a view to adoption by commercial lamb processors.

II. MATERIALS AND METHODS

Between 96 – 168 hours post mortem, NIR spectra were collected from 486 lamb loins (*m. longissiumus lumborum;* LL) and 287 lamb topsides (*m. semimembranosus*; SM) using a Carometec NitFom system. The Carometec NitFom probe was inserted once into each muscle through the subcutaneous adipose tissue at the C site on the LL (45 mm from the centre of the spine at the 12/13th rib) and on the external face in the medial section of the SM *in-situ*. A 40 g sample from the caudal portion of the LL and the medial portion of the SM were excised and the held at -20 °C until further analysis for IMF. The IMF content was determined using an NIR method; muscle was freeze dried using a Cuddon FD 1015 freeze dryer (Cuddon Freeze Dry, Blenheim, New Zealand) and homogenised prior to NIR measurements using a Spectro Star 2400 calibrated against chloroform solvent extraction [1].

Prior to statistical analysis, the spectra for each LL and SM were reduced to use spectra from depths between 15 mm to 33 mm due to issues with saturated spectra outside these depths. Spectra were then averaged for each carcase and transformed using the negative log of transmission, into absorbance spectra [2] and Partial Least Squares (PLS) regression was undertaken. The number of latent variables (LV) selected for each PLS model was based on the greatest reduction in Root Mean Square Error of Cross Validation (RMSECV) compared to the null model.

III. RESULTS AND DISCUSSION

The IMF content of muscles measured in this study ranged from 2.5 – 8.2% (mean = 4.7, ± s. d. = 0.97) for the LL and from 2.4 – 7.5% (mean = 4.3, ± s. d. = 0.89) for the SM. Fitting a PLS model indicated there is a poor ability to predict the IMF percentage of LL using the NitFom NIR spectra (6.3% reduction in RMSECV, R^2 = 0.12, R^2_{cv} = 0.15, 5 LV; Fig 1). Furthermore, the model to predict IMF percentage of SM yielded similar results (1.1% reduction in RMSECV, R^2 = 0.05, R^2_{cv} = 0.03, 2 LV). A comparison of this result to literature is difficult as the sampling protocols, reference measurement methods, range of the data sets and the numbers of independent samples measured all vary between studies which affect the repeatability and robustness of chemometric models reported.

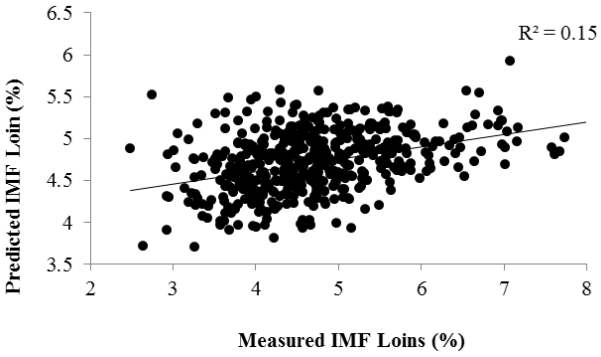

Figure 1. The percentage of intramuscular fat predicted using NitFom spectra from 486 lamb loins.

Other studies which use few independent samples sub-sectioned into a larger number of samples prior to being measured are at risk of being biased and reporting increased prediction accuracies which may not be applicable to other data sets. This is due to chemometric analysis methods including PLS and Principal Component Analysis (PCA), which use the variance within the data to describe the relationship between the observed values and the values predicted using the spectra. Consequently, the average spectra in studies with few independent samples may under represent subtle differences between regions in the spectra [3]. Therefore, further NIR research needs to be completed on larger data sets to investigate the potential to alter sampling and measurement parameters to improve the predictions found in this study.

The impact of using an NIR based laboratory method to determine IMF reference measurement compared to the wet chemistry method is also unknown. Using the NIR method as the reference measurements as the observed values may also reduce the predictive ability of the models as the equation to measure IMF using the laboratory method introduces further error in addition to the error of the wet chemistry method. Although previous research has demonstrated the laboratory NIR IMF method is able to accurately determine the value measured using the wet chemistry method [1], no analysis has been conducted to determine the difference in error between the NIR and wet chemistry methods. Consequently, it is difficult to determine how the difference in the error of the method affects the prediction models. Therefore, future work is needed to determine the errors associated with the different reference measurements and assess the potential of NIR devices to predict IMF of intact muscle using wet chemistry methods.

IV. CONCLUSION

A poor relationship between NitFom NIR predicted intramuscular fat level of intact lamb LL and SM and IMF determined by an NIR laboratory reference method was found in the present study. However, several limitations with this study were identified including the use of a device which has been developed to measure pork adipose tissue and NIR laboratory based measurement as the IMF reference measurement.

ACKNOWLEDGEMENTS

The authors would like to thank the Sheep CRC for funding this research.

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