P-07-23

Multi-parameter fusion of near infrared hyperspectral imaging data for rapid quantification of intramuscular fat in pork longissimus lumborum (#409)

Christopher Kucha[1], Li Liu[1], Michael Ngadi[1], Claude Gariepy[2]

[1] McGill University, Dept. of Bioresource Engineering, Ste-Anne-de-Bellevue, Canada; [2] Agriculture Agri-Food Canada, Ste-Hyacinthe, Canada

Introduction

Intramuscular fat (IMF), which impacts flavor and tenderness to meat, is still controlled in the meat industry by chemical-based methods such as Soxhlet extraction apparatus. These methods are slow and laborious and utilize a high amount of the chemical solvent reagents. Therefore, developing an efficient alternative IMF quantification technique is required.

Hyperspectral imaging (HSI) has emerged as a high-tech analytical tool in response to the needs of the meat industry. This device is yet another step targeted for automation in the meat industry. The evolution of this device is borne from its advantages of high speed, non-destructiveness, and chemical-free. Researches over the last decade has provided scientific evidence for adopting HSI for IMF assessment [1-3]. However, this evidence was based on longissimus lumborum (LL) cutlets, which would be imagined having a uniform distribution of IMF within the cutlet size. No attempt was made to estimate the IMF over a chuck of meat such as in the entire LL. LL is a valued primal cut in the entire carcass. LL is usually marketed intact (bone-in or deboned). Studies have suggested the last five ribs as representative grading site location on the LL [2]. However, besides the labor and waste that would be involved, the loss of any of the rib section to IMF analysis will mean a loss in the integrity of the LL and hence the market value. This study investigated the use HSI to quantify the average IMF within the LL using spectral information from the thoracic end.

Methods

Whole bone-in Pork LL (n = 48) were obtained over a period of three months from a butcher in Montreal, Canada. LL was prepared according to the pork carcass cut standard of the Canadian Pork buyer's Guide. A straight cut was made between the 4th and the 5th rib to obtain the scan cut. A typical surface of the scan surface is shown in Figure 1. Images were acquired on the cut using an HSI camera (Headwall Photonics, USA, 900–1700 nm) at the Department of Bioresource Engineering, McGill University. Spectral data was extracted from the main loin (LON), Serratus ventralis (STV) and Spinalis dorsi (SND), backfat (BFT), and the center rib bone (RBN) all at the thoracic end of the LL. IMF evaluation was carried out on the last three rib cuts using a Soxhlet extractor (SER 148-6; Velp Scientifica, Usmate, Italy). Fusion strategies were applied to fuse the spectral information from the different parameters. Partial least square regression was used to develop the calibration models (n = 34) and used for the prediction of the remaining samples (n= 14).

Results

Figure 2. shows the spectral characteristics of the spectral extracted from the five parameters on the LL. Results show that the coefficient of determination (R^2) and root mean square error (RMSE) in the calibration was 0.949 and 0.606 (%), respectively. Model performance evaluation on prediction samples revealed R^2 and RMSE of 0.898 and 0.940 %, respectively (Figure 3). We tested various models, individually and in their combination for predicting the average IMF of the entire LL. However, the models based on the fusion of the LON, SND, STV, BFT, and RBN provided the optimum result (Figure 2). We have used spectral information from the individual parameters, and none of them in isolation was able to accurately predict the average IMF of the entire LL. Even the loin muscle information obtained at the third rib surface gave a weak correlation with the average IMF of the entire loin This finding has revealed that there may be several carcass parts, tissues or group of tissues that spectral information could potentially be used in the prediction of the average IMF in the LL.

Conclusion

In this study we have used spectral information from different parameters on the LL to predict the average IMF. The result has demonstrated that HSI is an appropriate technique that could be applied for IMF quantification in the entire LL. Its application in the pork industry will not only safe labor cost but also keep away hazardous chemicals used for IMF quantification.

References

1. Barbin, D. F., ElMasry, G., Sun, D.-W., & Allen, P. (2013). Non-destructive determination of chemical composition in intact and minced pork using near-infrared hyperspectral imaging. Food Chemistry, 138(2), 1162-1171.

2. Huang, H., L. Liu, and M.O. Ngadi, Assessment of intramuscular fat content of pork using NIR hyperspectral images of rib end. Journal of Food Engineering, 2017. **193**: p. 29-41.

3. Huang, H., Liu, L., Ngadi, M. O., & Gariépy, C. (2014). Rapid and non-invasive quantification of intramuscular fat content of intact pork cuts. Talanta, 119, 385-395.

Notes

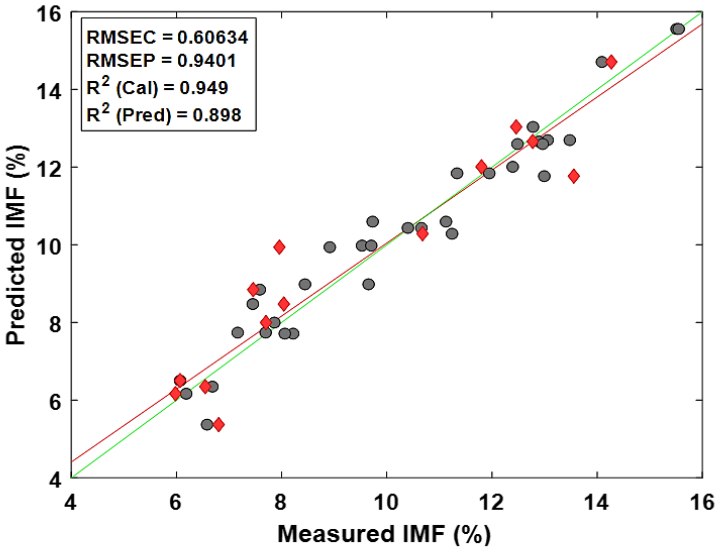

Figure 3. Plot of predicted and measured IMF (%) (red color) with calibration data (grey color).

Figure 3 Plot of predicted and measured IMF (%) (red color) with calibration data (grey color)

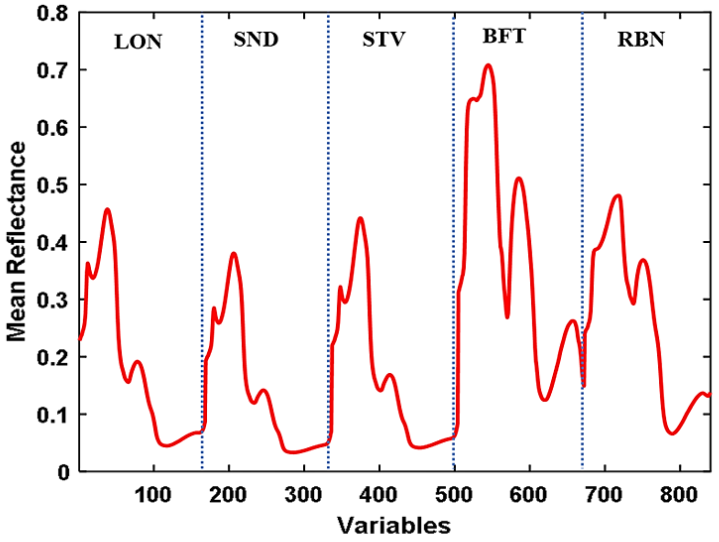

Figure 2. Spectra plot of the five parameters on the longissimus lumborum used to estimate the average IMF

Figure 2 Spectral plot of the five parameters on the longissimus lumborum used to estimate the average IMF

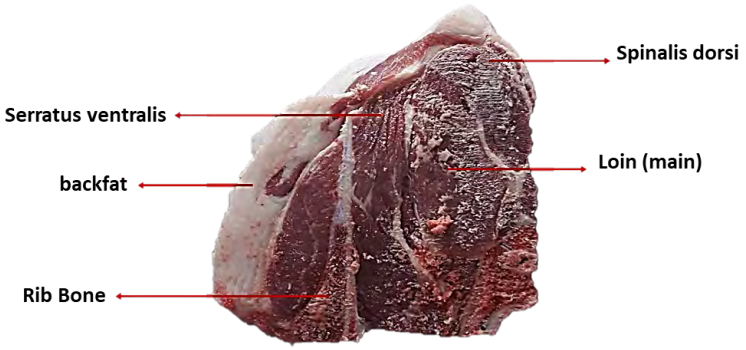

Figure 1. The original longissimus lumborum viewed at the thoracic end and showing the parameters from which spectral information was collected.

Figure 1 The original longissimus lumborum viewed at the thoracic end and showing the parameters from which information was collected

Notes