Can a smartphone near-infrared spectroscopy sensor predict days on feed and marbling score?

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Near-infrared reflectance spectroscopy (NIRS) is commonly used in research and industry to determine meat quality in a non-destructive and real-time manner, with recent studies focusing on smaller, more portable NIRS sensors with greater industry usability (Dixit *et al.*, 2017; Fowler *et al.*, 2020). These handheld NIRS sensors have shown the potential to provide accurate and rapid determination into the nutritional background and eating quality of meat, prevent mislabelling and provide an automatic marbling grading. The ability to predict chemical fat and protein from various meats has been prevalent over several decades to varying degrees of success (Lanza, 1983; Prieto *et al.*, 2017). However, no studies have looked into predicting days on feed (DOF) of grain-fed beef. It is therefore hypothesised that NIRS can predict DOF as well as visual marbling score in commercial beef cuts.

One hundred and eight beef steaks were purchased, comprising store-labelled grass-fed (0 DOF, n=54) and grain-fed for 100 (n=12), 150 (n=23) and 300 (n=19) DOF. The marbling scores of these steaks were visually measured (MLA, 2017), followed by scanning using a handheld smartphone NIRS sensor (900-1600 nm; NIRvascan) on the lean and fat surfaces of each steak. Spectral data (lean and fat surface spectra) were inverse-log transformed and subjected to partial least squares discriminant analysis (PLSDA) modelled with 75% training and 25% test data (cross-validation of repeated coefficient of variation – 10 buckets repeated 5 times) using the *Caret* package (Kuhn, 2020) in RStudio. Following this, the *Spectracus* package (Fajardo *et al.*, 2019) was used to determine the goodness of fit of the PLSDA models to predict marbling and DOF based on coefficient of determination (R^2), lowest root mean square error (RMSE), highest residual prediction deviation (RPD) and lowest absolute value of bias.

Table 1. Goodness of fit PLSDA predictions of marbling score (Marbling) and days on feed (DOF) by NIRS scanning of lean and fat surfaces.

Model	R^2	RMSE	RPD	Bias
Lean Marbling	0.491	200.5	1.163	96.39
Lean DOF	-0.041	732.9	0.164	679.5
Fat Marbling	0.201	209.1	1.128	52.19
Fat DOF	0.464	91.30	1.351	-7.009

The handheld smartphone NIRS sensor showed moderate precision in predicting marbling score using the spectral data collected from the lean surface ($R^2 = 0.49$) and predicting DOF from the fat surface ($R^2 = 0.46$; Table 1). Scanning of lean surface to predict DOF and fat surface to predict marbling yielded poor precision ($R^2 < 0.25$; Table 1). The precision for visual marbling score prediction in the present study was higher than that reported by Coombs *et al.* (2019) and higher than a recent study predicting chemical fat using a similar NIR wavelength range (Dixit *et al.*, 2020). Precision was similar to other studies using larger visible-NIRS wavelength ranges of 350-2500 nm (Coombs et al., 2019; Fowler et al., 2020). The prediction of DOF using fat surface scans had the highest RPD and lowest RMSE and bias. More thorough testing with equal numbers of staggered DOF data and more DOF treatments is required. These results were promising for a pilot experiment, however further testing including chemical fat analysis, is required before successful deployment of NIRS sensors for this purpose in meat processing and retail industries.

References

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