ESTIMATION OF CATTLE AGE USING VISIBLE-NEAR-INFRARED SCANS OF HIDES

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I. INTRODUCTION

Animal age and maturity have an important effect on carcass and meat quality [1, 2]. Current methods to determine age and maturity, using dentition and ossification, are not without flaws yet contribute as indicators of meat quality. This description however has the potential to be improved. A study using a visible-near-infrared (Vis-NIR) system has shown the potential of this non-invasive technology to predict human age by scanning the skin [3]. Determining the age of animals using visible-NIR (Vis-NIR) spectroscopy has the advantage that it could be developed to be implemented a) on-farm helping breeders to estimate genetic merit of animals, b) for commercial animals as a reference population in genomic predictions, and c) to automate carcass measurements and meat tenderness predictions at slaughter. The current study examines whether a fiber-optic probe-based system for making diffuse reflectance measurements in the Vis-NIR region can be used to accurately predict the age of slaughtered cattle by scanning the hides.

II. MATERIALS AND METHODS

The hides of eighty Angus cattle with accurate date of birth (from 26 to 142 months old) were scanned using a spatially resolved spectroscopy (SRS) system. Spectra of the hides were collected on the day of slaughter. Prior to scanning, hair from 4 areas (neck, armpit, rib region and under hind leg) on the left side of the hide was removed for measurement using clippers and metal safety razor, after the hides were removed from the carcass. To ensure consistency, the SRS Vis-NIR measurements were undertaken with the hide sample placed on a single piece of muscle. The instrument probe was placed on the external surface of the hide. The SRS probe consists of a source fibre at the centre and 5 rings of detection fibres surrounding it with rings 1-5 placed at increasing radial distances from the source fibre. Data analysis in this study considered only reflectance measurements from ring 5, which consists of fibres placed at a radial source-detector distance of 2.5 mm. The scan setting for the Vis-NIR instrument was set to wavelength range 380 – 1000 nm with three scans taken at each location. The three scans at each location were done automatically by utilizing the internal settings of the device. The scanning time for the 3 replicate measurements was around 1 minute per location.

Calibration models for predicting age using ring 5 were built using Partial Least Squares (PLS) regression. Spectra were pre-processed using an Automatic Whittaker Filter baseline correction and mean centred. As part of the calibration step, wavelength selection using a genetic algorithm was applied. Leave-one-out cross-validation was applied and the root mean-square error of cross-validation (RMSECV) and the coefficient of determination for the cross-validation R^2_{cv} were used to compare performance of models. R^2 was obtained from CV by using R^2_{cv}. All calculations were carried out using MATLAB (64-bit (win64)) [4] and the PLS Toolbox [5].

III. RESULTS AND DISCUSSION

Preliminary analysis to predict chronological age indicates that there is potential to predict chronological age by using the SRS Vis-NIR system as shown in Table 1. Hide scans of the neck location (A) provided the best model calibration to predict animal age (RMSECV = 1.6 years, R^2_{cv} = 0.75). Whilst scans under hind leg location (D) demonstrated the least accurate and precise prediction of age (RMSECV = 2.4 years, R^2_{cv} = 0.44).

These models were developed with animals ranging from 26 to 142 months of age with the majority of measurements on animals around 26 months old. The predictive error for all of these models is likely to be reduced if further animals are included in the calibration model to achieve a wider age range and uniform age distribution in the data set. Although ossification is not distinctive for animals older than 5-6 years old it has been established that eating quality differs within this age category [6]. Therefore it is crucial to have enough data for animals older than 5-6 years old in a wide spread up to around 13 years old for a better prediction of animal age using SRS Vis-NIR.

Table 1 Model performance based on reflectance measurements at four locations of hides from 80 cattle ranging from 2 to 12 years old to predict chronological age.

Location	RMSECV (years)	R^2_{cv}	Latent variable
Neck	1.6	0.75	7
Armpit	1.5	0.47	6
Rib region	1.8	0.69	6
Under Hind Leg	2.4	0.44	3

IV. CONCLUSION

This study suggests that chronological age of cattle is best predicted by scanning the hides in the neck region with a predictive error of 1.6 years and an R^2_{cv} = 0.75. It must be acknowledged that this dataset is limited by the large proportion of 2 year olds represented in the age categories which reduces the accuracy and increases the error associated with the models. Thus, it is important that further cattle younger than 2 years and older than 3 years are sampled to improve calibration models before further steps towards industry adoption are taken. This will include actually validating the calibration models on independent animals to determine the true prediction error.

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