CAN SCANNING LIVE LAMBS WITH A PROTOTYPE RAPID DEXA PREDICT CT CARCASE COMPOSITION?

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I. INTRODUCTION

Carcase muscling and fatness are important profit drivers in the lamb meat industry. In Australia, processors generally pay producers for animals based on measures of carcase weight and fatness. However, producers do not currently have an objective means of determining the muscle and fat content of their animals on farm. This limits the capacity of producers to determine the best time to process their animals for optimal carcase composition and profit. Medical dual energy X-ray absorptiometry (DEXA) scanners have previously been used to predict the muscling and fatness of livestock [1], however their slow speed has impeded their adoption within the commercial livestock industry. A prototype DEXA system has been developed to predict lamb carcase composition with high accuracy and precision at abattoir chain-speed [2], training the device on computed tomography (CT) as the gold standard. This carcase DEXA system could be of great value to livestock industries if adapted to rapidly measure the composition of live animals in a “walk-through” setting. This experiment evaluates the potential of the prototype carcase DEXA scanner to determine carcase composition in live lambs, and thereby if further investment is warranted to develop this technology for use in livestock. We hypothesise that scanning live lambs with the prototype carcase DEXA can predict the CT composition of their carcases with moderate precision.

II. MATERIALS AND METHODS

Twenty lambs were selected from a flock for maximal phenotypic range in weight and fatness. Lambs were fasted overnight, weighed, sedated with 0.2mg/kg of acepromazine and restrained in dorsal recumbency for DEXA scanning. The DEXA scanner generated images using a single emission 140kV X-ray tube, at 10mA, captured on two photodiodes containing ZnSe and CSi scintillants, separated by a copper filter. Three days later lambs were processed at a commercial abattoir, weighed, and chilled overnight before being re-weighed and CT scanned using a GE Lightspeed QXi, in 5mm slices, at 100kVp and150mA. DEXA images were analysed by calculating the R-value for each pixel in the selected fore and hind regions. The head and distal limbs were excluded from analysis to simulate a standard carcase, while the mid-section was excluded as the internal organs were likely to mask any estimation of carcase composition. Established DEXA R-value thresholds were used to estimate the lean, fat and bone % of the animal [2]. CT images were analysed as described by [3] for determination of carcase CT lean, fat and bone %. General linear models (SAS) were used to analyse the association between CT lean, fat and bone %, with DEXA value fitted as a covariate.

III. RESULTS AND DISCUSSION

The range in hot carcase weight, CT carcase fat, lean and bone % of the lambs are shown in Table 1.

Table 1 Carcase traits of the lambs scanned (n=20)

Carcase trait	Mean	Std Deviation	Range
Hot carcase weight (kg)	24.3	3.2	20 - 31.6
CT lean %	57.2	3.22	51.7 – 64.3
CT fat %	25.7	4.2	17 - 32
CT bone %	17.1	1.6	14.5 – 20

In line with our hypothesis, scanning lambs with the prototype DEXA scanner predicted the CT composition of the lamb carcases with moderate precision. The DEXA system was able to predict carcase CT lean % of live lambs with an R^2 of 0.64 and root meat square error (RMSE) of 2.05, and was able to predict carcase CT fat % with an R^2 of 0.68 and RMSE of 2.52 (Fig. 1a, 1b). However, DEXA scanning of the live lambs predicted CT bone % of carcases with much lower precision (R^2 = 0.38, RMSE =1.35) (Fig. 1c).

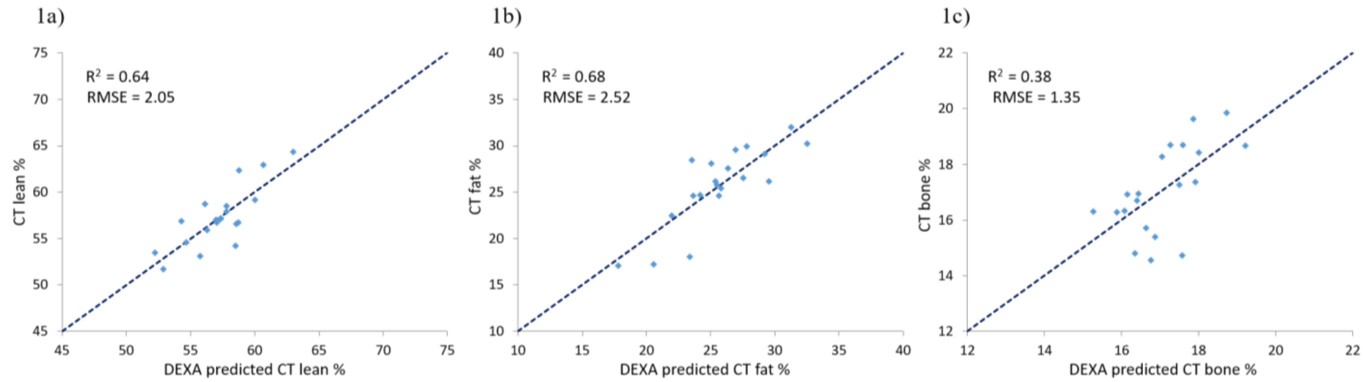

Figure 1. Relationship between a) actual CT lean % and DEXA predicted CT lean %, b) actual CT fat % and DEXA predicted CT fat %, and c) actual CT bone % and predicted CT bone %, from a model containing only DEXA values. The R-squared (R^2) and root mean square error (RMSE) of each relationship is shown, dashed lines represent a perfect prediction.

These results support the potential of the prototype DEXA scanner to predict the composition of live animals. Though the DEXA scans of the lambs could only predict carcase bone with low precision, predicting the proportion of muscle and fat tissue is far more valuable given that producers have the capacity to alter these traits. This technology would be particularly valuable to the seedstock sector and to the feedlot sector, where ideally animals would be DEXA scanned on entry to feedlot to inform a tailored feeding regime for optimal profit at processing. However, the positioning and immobilization of the lambs in this study does not reflect how a DEXA scanner would be used to scan live animals in practice, where animals would ideally be scanned as they “walk-through” an adapted race. Therefore the next step in developing a DEXA scanner to predict the composition of live animals is to construct a prototype walk-through DEXA system that could be evaluated under conditions closer to those practicable in industry.

IV. CONCLUSION

This experiment demonstrates that the prototype DEXA developed for determining the composition of lamb carcases has the potential to predict the composition of livestock. If this DEXA system can be adapted to predict CT composition with similar precision when scanning lambs as they moved through a race, it would present a valuable opportunity for producers to improve the efficiency of selective breeding, finishing their livestock and thus the profitability of their business.

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