ACCREDITATION OF DUAL ENERGY X-RAY ABSORPTIOMETRY CARCASS FAT % PREDICTION AS A TRADABLE TRAIT IN THE AUSTRALIAN SHEEP MEAT INDUSTRY

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I. INTRODUCTION

Dual Energy X-ray Absorptiometry (DXA) scanning of lamb carcasses at chain speed within an abattoir is precise and accurate when predicting carcass computed tomography (CT) fat % (R^2=0.91, RMSE=1.19%) [1,2,3]. The existing accredited method of trading sheep meat carcasses by their fatness in Australia is by fat scoring, a process of palpating and predicting the thickness of tissue at the grade-rule site along the 12th rib. To accredit DXA as an alternative to this, it must achieve predictions of CT fat % that are superior in precision and accuracy, over a large range of fatness and hot carcass weight values, with both greater than 67% of all predictions less than 3 fat % units from the true CT fat %, and 95% of all predictions less than 6 fat % units from the true CT fat %. We hypothesise that a DXA operating at chain speed in an Australian abattoir would achieve these accreditation requirements over a range of fatness and hot carcass weights comparable to the range found across the industry.

II. MATERIALS AND METHODS

Lamb carcasses (n=375) were selected in 5 kill groups over 5 months from a sheep meat abattoir in Western Australia with an on-line DXA scanner installed at the conclusion of the slaughter floor. Lambs were selected based on hot carcass weight and predicted fatness to maximise the range of both traits. The DXA images were processed in accordance with the algorithm that was being tested for accreditation to output a prediction of fat %, by first excluding all bone-containing pixels and predicting the percentage of fat within the remaining soft tissue. All carcasses were sectioned into three components (fore, saddle, and hind), then scanned by CT at Murdoch University to output the gold standard values for carcass composition, including CT fat %, using a 5mm slice width at 120kV. A threshold of the voxel's Hounsfield unit was applied to distinguish fat, lean muscle, and bone tissue, which was adjusted based on the results of a phantom scan at the commencement and conclusion of CT scanning [4]. Carcasses were divided into three bands of hot carcass weight (<22kg, 22-28kg, and >28kg), and to ensure that the accuracy threshold is met across each quarter of the accreditation range, a Markov Chain Monte Carlo (MCMC) stochastic simulation was applied to the data to characterise the distribution of residuals (observed by CT – predicted by DXA). Accuracy was then assessed within quarters of the data range that the technology is seeking accreditation for.

III. RESULTS AND DISCUSSION

The precision of CT fat % predictions by DXA for the low weight (<22kg, R^2=0.93, RMSE=1.44%), mid weight (22-28kg, R^2=0.95, RMSE=1.23%), and high weight (>28kg, R^2=0.90, RMSE=1.63%) carcasses were comparable to findings in previous experimentation

with this device. There was a sufficient number of carcasses within each quartile of each weight band for the MCMC stochastic simulation to be considered reliable. The required thresholds for accreditation as a device predicting fat % were achieved, with all quartiles of all weight bands meeting and exceeding the minimum of 67% of predictions within 3% of the true value, and 95% of predictions within 6% of the true value (Table 1). As the sectioning of data into quartiles constrained the upper and lower limits of carcass fat % in the statistical modelling, accreditation can only be claimed within these limits. As such, this DXA device surpasses the accreditation requirement for low weight lamb carcasses between 10.9-30.3% fat, mid weight lamb carcasses between 14.0-35.0% fat, and high weight lambs between 22.0-37.1% fat.

Table 1 Results within the required thresholds for accreditation by quartiles of weight bands

	Low Weight (<22kg)			**Mid Weight (22-28kg)**			**High Weight (>28kg)**		
	% within 3 % fat	% within 6 fat %	n	% within 3 fat %	% within 6 fat %	n	% within 3 fat %	% within 6 fat %	n
Q 1	95.71	99.99	38	96.94	100	18	87.45	99.75	12
Q 2	88.8	99.95	72	97.29	100	40	84.16	99.52	21
Q 3	86.79	99.9	23	97.15	100	34	88.21	99.78	24
Q 4	94.98	99.99	21	96.6	100	14	87.7	99.77	21

IV. CONCLUSION

This DXA device has surpassed all accreditation requirements for the prediction of carcass fat % for use as a tradable trait within the Australian sheep meat industry and provides a far superior alternative to the existing method. The implementation of the accredited algorithm tested on this device to any other comparable DXA systems around Australia will be possible, with the accreditation of carcass lean % and bone % predictions by DXA to follow.

ACKNOWLEDGEMENTS

The authors thank Scott Automation and Robotics and the Western Australia Meat Marketing Co-operative for the assistance with conducting experimentation of the DXA device.

REFERENCES

1. Connaughton, S. L., A. Williams, F. Anderson, K. R. Kelman & G. E. Gardner (2020). Dual energy X-ray absorptiometry precisely and accurately predicts lamb carcass composition at abattoir chain speed across a range of phenotypic and genotypic variables. animal: 1-9.
2. Connaughton, S. L., A. Williams, F. Anderson, K. R. Kelman, J. Peterse & G. E. Gardner (2020). Dual energy X-ray absorptiometry predicts lamb carcass composition at abattoir chain speed with high repeatability across varying processing factors. Meat Science: 108413.
3. Gardner, G., S. Starling, J. Charnley, J. Hocking-Edwards, J. Peterse & A. Williams (2018). Calibration of an on-line dual energy X-ray absorptiometer for estimating carcase composition in lamb at abattoir chain-speed. Meat Science 144(October): 91-99.
4. Williams, A.J., K.L. Mata & G.E. Gardner (2022). Aligning CT Scanner data used in determining carcass composition via the XTE-CT phantom. In Proceedings 73rd Annual Meeting of the European Federation of Animal Science (p 514), 5-9 September 2022, Porto, Portugal.