Video image analysis of live lambs to predict live weight, carcass composition and meat quality

N.R. Lambe[1], C.P. Schofield[2], E.A. Navajas[1], R. Roehe[1], L. Bünger[1]
[1]SAC, Edinburgh, United Kingdom, [2]Silsoe Livestock Systems Ltd, Silsoe, United Kingdom
Email:Nicola.Lambe@sac.ac.uk

Introduction Predictors of carcass and meat quality are sought that can be measured in the live animal, preferably at a young age, on-farm, and with minimum stress to the growing animal. Several *in vivo* methods of assessing these traits indirectly in lambs have been developed, most of which are expensive and require restraint/handling of animals, which can cause stress and affect growth rate. This study investigates the use of linear dimensions obtained from video image analysis (VIA) to assess live weight, carcass composition and meat quality (MQ) in lambs of two divergent breeds, in a non-disruptive way.

Materials and methods Mixed batches of male and female Texel (TEX; n=113) and Scottish Blackface (SBF; n=103) lambs were photographed at finishing (commercial slaughter weight and condition score), after being shorn. Age ranged from 101-205d and live weight from 29-47 kg. The digital images were processed to collect a synchronised set of linear dimensions taken from 3 views: the rear - highest point of rump to hock, averaged over both sides (AvQL), width of rear end (HW); the side - shoulder height (SH), rump height (HH), body depth from shoulder (SB), body depth from point of rump (HB), body length shoulder to end of rump (BL); the top - shoulder width (W1), width at narrow point behind shoulders (W2), width at widest mid-point (W3), width at narrow point in from of rump (W4), rump width (W5), length from mid-point of W1 to mid point of W5 (L1), length from mid-point of W1 to tail (L2). Multiple linear regression was used to determine the relationships of these dimensions with conformation and MQ data collected post slaughter, including total dissected weights of muscle (DMWT) and fat (DFWT) in one carcass side, chemically extracted intramuscular fat in the loin (IMF), shear force of leg (ShFLEG) and loin (ShFLOIN) muscles, and ultimate pH in leg (pHLEG) and loin (pHLOIN) muscles. The models fitted included either age (model 1) or live weight (LWT; model 2) at VIA as a covariate, as well as sex and days between VIA and slaughter. Additionally, the best combinations of VIA dimensions (chosen by comparing residual standard deviations, Mallows Cp and adjusted R^2) were included, and these models were compared to models using covariates and sex only to predict product quality traits ('No VIA').

Table 1: Adjusted R^2 of models for product quality traits

Model	Trait	TEX No VIA	TEX Best model	SBF No VIA	SBF Best model
Model 1 (incl. age)	LWT	0.36	0.84	0.34	0.67
	DMWT	0.36	0.73	0.13	0.64
	DFWT	0.27	0.54	0.23	0.69
	IMF	0.19	0.38	0.10	0.40
	pHLEG	0.02	0.20	0.04	0.13
	pHLOIN	0.03	0.22	0.07	0.09
	ShFLEG	0.17	0.19	0.01	0.10
	ShFLOIN	0.29	0.32	0.08	0.19
Model 2 (incl. LWT)	DMWT	0.66	0.76	0.18	0.63
	DFWT	0.53	0.62	0.26	0.69
	IMF	0.33	0.43	0.12	0.36
	pHLEG	0.07	0.26	0.09	0.13
	pHLOIN	0.07	0.24	0.05	0.12
	ShFLEG	0.17	0.19	0	0.09
	ShFLOIN	0.30	0.31	0.01	0.18

Results Weight traits (LWT, DMWT, DFWT) were predicted with moderate to high accuracy using VIA linear dimensions, age and sex (Table 1), with some inter-breed differences. Prediction accuracies were higher for LWT and DMWT in TEX (a leaner breed) and for DFWT in SBF (a fatter breed). Moderate (IMF) to low (pH and ShF) predictions of the MQ traits were achieved in both breeds. In most traits, accuracies were more than doubled by including VIA dimensions in the model, compared to only sex and age ("No VIA", Table 1). VIA predictors explained approximately 10% additional variation in DMWT, DFWT and IMF, once LWT and sex were accounted for in TEX, and a larger percentage in SBF. In TEX, VIA linear dimensions explained more variation in ultimate pH in the leg or loin muscles than age, LWT or sex. However, only a relatively small amount of the total variation was explained by all factors. VIA had little association with ShF in the leg or loin. Traits positively associated with LWT were HW, SB, HB, L1, W1 (in TEX), W2 and W3 (in SBF). DMWT was higher in males and positively associated with lengths, widths and SB, but negatively associated with rear height (HH, AvQL) and W3 (perhaps reflecting gut-fill). DFWT and IMF were highly correlated (r = 0.79 in TEX, 0.67 in SBF), were higher in females, and were also positively associated with lengths, widths and SB, and negatively associated with W3 and with depth of the hind body in SBF (AvQL, HB) and SH in TEX. The most valuable set of VIA dimensions for predicting LWT and tissue weights was that measured from the top view. Adjusted R^2 values for models including dimensions from only the top view were <0.1 below those for the best model (Table 1) for each trait. For most traits (except age-adjusted LWT, DMWT and pH), including only the best single VIA dimension, with sex and age or LWT, reduced adjusted R^2 values by <0.1.

Conclusions VIA is valuable for accurately predicting weight and composition of finished shorn lambs, in a non-disruptive manner, and substantially improves the estimation of IMF. The VIA dimensions predicting composition in the two divergent breeds reflect changes in tissue proportions and distribution that are known to occur with maturity (Hammond, 1940). One potential use for this measurement method may be to select lambs with preferred weights and composition for slaughter, using a camera above a feeder or drinker in a finishing shed.

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References

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