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BRIEF COMMUNICATION: Carcass linear measurements as predictors of meat yield in lambs determined by VIAscan

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INTRODUCTION

Lambs yielding proportionally more lean meat are desirable to processing companies as they have a greater quantity of saleable product which also meets market demand without the need for further processing. The quest for higher yielding lean lambs has seen a change in the lamb carcass grading system from classification on carcass weight and the GR measurement (total tissue depth above the 12th rib, 110 mm from the midline) (Kirton, 1989) to using imaging systems such as VIAscan®. VIAscan® is a two dimensional imaging system that estimates lean content of the carcass (Hopkins *et al.*, 2004). Hopkins *et al.* (2004) have shown that using VIAscan® versus the traditional carcass weight and GR measurements increases the prediction accuracy of estimating the lean meat yield of a carcass (R^2 = 0.52 versus R^2 = 0.19). The introduction of VIAscan® in some meat plants has enabled online predictions of the proportion of lean meat in the total carcass as well as the leg, loin and shoulder regions. This technology allows meat companies to reward producers for meat yield within a carcass region, an incentive for farmers to produce higher lean meat yielding lambs (Jopson *et al.*, 2009).

A data set was collected to search for genetic markers for lean meat yield, using high and low yielding carcasses, based on VIAscan® estimates of total yield. This provided an opportunity to also investigate relationships between linear carcass measurements and lean meat yield as assessed by the VIAscan® grading. This work is the focus of this report. A transition from *G* to *A* in the 3' untranslated region of the GDF8 gene (c.1232 *G>A*; (Hickford *et al.*, 2009)), derived from Texels, is associated with increased lean meat yield and is also associated with increased buttock circumference (Johnson *et al.*, 2009). The relationship between increased lean meat yield and butt circumference both with and without adjustment for this mutation is also investigated.

MATERIALS AND METHODS

Data collection was carried out between January and April in 2008 and 2009. Mobs of lambs were observed at Alliance Mataura meat processing plant as they travelled through the VIAscan®. To reduce variation in the results, criteria included carcasses from ram lambs only, selected from large mobs of greater than 200 lambs, with a carcass weight between 15.5 and 19.0 kg. One to three most extreme yielding pairs with a high and a low carcass yield, matched for carcass weight, were identified from the selected mobs. This Brief Communication looks at a subset of 834 carcasses, from the 2008 data set which had been genotyped for the GDF8 c.1232 *G>A* mutation and represented 209 different mobs. Measurements recorded on the whole carcass were cold carcass weight (CW), GR depth and carcass linear measurements of buttocks circumference (BC), carcass length (CL), and leg length (LL). VIAscan® carcass measurements of leg yield, loin yield, shoulder yield, and total yield were recorded and expressed as a percentage of the carcass weight. Carcass length was measured from between the hind legs to the front of the neck using a set of callipers with 50 mm wide bars at each end. Leg length was measured from the crotch to the end of the hind leg, which was cut though the tarsal joint. The circumference of the buttocks was measured using a flexible tape measure on the dressed carcasses hanging from their hindquarters and represented the circumference when taken in a parallel plane immediately above the anal opening.

A meat sample was collected from all lambs measured for DNA. These meat samples were genotyped for the GDF8 c.1232 *G>A* mutation. The A allele is associated with the increased lean meat yield phenotype. The protocol of Johnson *et al.* (2009) was used, with 611, 194, 29 carcasses carrying 0 (*GG*), 1 (*AG*) or 2 (*AA*) copies of the A allele respectively. Data were analysed using a stepwise regression procedure in SAS (SAS, 2004) to determine which measurements best predicted VIAScan® estimated yield. The three carcass regions of leg yield, loin yield, shoulder yield and total yield were the dependant variables, within each of the *A* allele groups (*GG, AG* or *AA*). Variables, BC, GR, CW, LL, and CL were included in the stepwise analysis.

RESULTS AND DISCUSSION

Summary statistics for the measurements made in the meat processing plant are given in Table 1.

TABLE 1: Overall mean ± standard deviation and range for carcass weight, GR measurement, total yield, leg yield, loin yield, shoulder yield, carcass length, leg length, and butt circumference. Number of carcasses = 834.

Variable	Mean	Range
Carcass weight (kg)	17.1 ± 0.6	15.6 – 19.7
GR[1] (mm)	6.2 ± 2.2	2.0 – 13.0
Total yield (%)	53.8 ± 3.3	47.3 – 62.0
Leg yield (%)	21.7 ± 1.5	18.0 – 25.7
Loin yield (%)	14.4 ± 0.9	12.1 – 16.6
Shoulder yield (%)	17.7 ± 1.1	13.9 – 20.6
Carcass length (cm)	77.9 ± 2.3	71.0 – 84.0
Leg length (cm)	28.4 ± 1.3	24.9 – 32.0
Butt circumference (cm)	62.1 ± 1.5	57.0 – 66.7

[1]Depth of tissue 110 mm off the mid-line in the region of the 12th rib.

The results of fitting a variety of linear carcass measurements in a stepwise model to predict VIAscan® lean meat yield in the three primal regions of leg, loin and shoulder, within the *A* allele groups are shown in Table 2. Overall the models fitted for each carcass region/*A* allele combination were consistent, although absolute partial R^2 values did vary. Butt circumference was the largest explanatory variable entered in all of the stepwise models with partial R^2 values ranging between 0.25 for *AG* animals for the shoulder region through to 0.45 for the shoulder and total regions for *AA* animals. The next variable fitted in all models was GR with partial R^2 values ranging from 0.04 for the loin region for *GG* animals through to 0.14 for the shoulder region and total regions for *AA* animals. The stepwise model only fitted leg length for *AG* and *GG* animals with all partial R^2 less than 0.04. Carcass weight and carcass length, were not consistently fitted across the models, and when fitted explained less than 0.05 of the variation, and were excluded from the final analysis.

Lambe *et al.* (2009) have reported higher correlations between butt circumference and dissected lean meat yield of 0.72 and 0.62 for Texel and Scottish Blackface sheep respectively. However, their data was pre-adjusted for fixed effects including birth rank and dam age, information that was not available for this data set. In addition they correlated butt circumference to actual lean meat yield, rather than an indirect predictor of yield, such as VIAscan®, as was the case in this trial.

In the work of Hopkins *et al.* (2004), width measurements in the region of the buttocks were selected from the many linear dimensions available from VIAscan® to combine with estimates of carcass colour to predict lean meat yield. No published information exists, on the weightings that were used in the estimation of lean meat yield from the VIAscan® measurements. Other authors have found correlations between subjective visual scores of leg conformation and lean meat yield (Wolf *et al.*, 2006) and linear measurements of leg length and width, measured from CT images and lean meat yield (Jones *et al.*, 2004).

The relationship between butt circumference and VIAscan® lean meat yield is independent of the

TABLE 2: Parameter estimate ± standard error with partial R^2 value in brackets, from a stepwise model fitting butt circumference, GR and leg length to predict VIAscan® lean meat yield (%) of different carcass regions for GDF8 c.1232 *G>A* genotypes where the *A* allele is associated with increased muscling in Texels. Number of carcasses for the *AA*, *AG* and *GG* groups = 29,194 and 611 respectively.

Region of carcass	Genotype	Parameter estimate			
		Butt circumference (cm)	GR (mm)	Leg length (cm)	Intercept
Leg	*AA*	0.62 ± 0.16 (0.41)	-0.26 ± 0.11 (0.10)		-15.0 ± 0.62
	AG	0.45 ± 0.05 (0.39)	-0.28 ± 0.03 (0.13)	-0.2 ± 0.06 (0.03)	1.3 ± 0.45
	GG	0.57 ± 0.03 (0.40)	-0.25 ± 0.02 (0.12)	-0.1 ± 0.03 (0.01)	-9.0 ± 0.57
Loin	*AA*	0.29 ± 0.10 (0.28)	-0.17 ± 0.07 (0.12)		-2.8 ± 0.29
	AG	0.35 ± 0.03 (0.43)	-0.11 ± 0.03 (0.05)	-0.1 ± 0.04 (0.02)	-3.5 ± 0.35
	GG	0.34 ± 0.02 (0.37)	-0.1 ± 0.01 (0.04)	-0.1 ± 0.02 (0.01)	-4.2 ± 0.34
Shoulder	*AA*	0.53 ± 0.12 (0.45)	-0.25 ± 0.08 (0.14)		-13.2 ± 0.53
	AG	0.25 ± 0.04 (0.25)	-0.14 ± 0.03 (0.07)	-0.1 ± 0.05 (0.01)	5.3 ± 0.25
	GG	0.38 ± 0.02 (0.32)	-0.12 ± 0.02 (0.05)	-0.1 ± 0.03 (0.02)	-1.6 ± 0.38
Total	*AA*	1.44 ± 0.32 (0.45)	-0.69 ± 0.23 (0.14)		-30.8 ± 1.44
	AG	1.06 ± 0.10 (0.42)	-0.54 ± 0.08 (0.10)	-0.4 ± 0.13 (0.02)	3.1 ± 1.06
	GG	1.29 ± 0.06 (0.44)	-0.47 ± 0.04 (0.08)	-0.3 ± 0.07 (0.01)	-14.9 ± 1.29

GDF8 c.1232 *G>A* mutation status, with a trend of increasing butt circumference and increasing ViaScan® lean meat yield even within the non-carrier (*GG*) carcasses (Table 2). This conclusion is consistent with the work of Lambe *et al.* (2009) who saw similar relationships for Texels and Scottish Blackface, with the later breed not carrying the GDF8 c.1232 *G>A* mutation.

These results show that of the measurements assessed, butt circumference was the best individual measurement for predicting VIAscan® carcass lean meat yield.

Whilst it is acknowledged that VIAscan® only provides an estimate of carcass lean meat yield (Hopkins *et al,*. 2004) it is the basis of premium payments in many New Zealand and Australian meat plants. These results provide insight into what area live animal measurement developments should be targeted to identify a low-cost live animal predictor of VIAscan® estimated carcass lean meat yield.

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