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RELATIONSHIP BETWEEN SIRE EBV'S AND CARCASE AND MEAT QUALITY TRAITS

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Introduction

As a part of the meat science program of the Australian Sheep Industry CRC (www.sheep.crc.org.au) a resource flock was established to generate progeny to be used in strategic studies on fat and muscle development. One aspect that is under investigation in the multifaceted program is the relationship between the estimated breeding value of sires for specific traits and the performance of their progeny. Hopkins et al. (2004) recently reported that the lightness of the m. *longissimus thoracis* (LL) increased as the estimated breeding value (EBV) for post weaning weight (PWWT) increased and intramuscular fat content in the LL decreased as sire EBV for post weaning muscle depth (PEMD) increased. It was suggested that this latter effect partially explained the finding of a decrease in eating quality in the LL, but this remains to be validated. In the same work Hegarty et al. (2005b) found that selection for increased PEMD decreased carcass fat and increased carcase lean. Whether this effect is maintained as animals grow is unknown.

Objective

To examine the impact of sire EBV's for fat, muscling and growth on carcase composition and meat quality traits in lambs of varying age.

Methodology

Animals

In 2002 a flock of 450 Merino ewes and 120 Border Leicester x Merino (BLM) ewes was created. Using LAMBPLAN (Banks 1994) databases a number of sires were selected based on their EBV's for growth and muscle development. The lamb types generated were as follows; Poll Dorset x Border Leicester x Merino (with a focus on growth in the

sires), Poll Dorset x Merino (with a focus on muscling in the sires), Poll Dorset x Merino (with a focus on growth in the sires), Merino x Merino (with a focus on growth in the sires), Border Leicester x Merino (with a focus on growth in the sires). There were 4 different sires per group. Only progeny sired by Poll Dorset rams and representing 3 of the genotypes will be considered in this paper.

Experimental Design

All lambs were weighed pre-weaning in September 2003 and based on this weight lambs were randomly allocated in a stratified way to one of the 4 slaughter times, balanced for rearing type, gender and sire. The experiment was designed for slaughters across the age range of 4 to 20 months. Data for 4 and 8 month old lambs is presented here these representing unweaned and weaned lambs, respectively.

Slaughter Protocol and Measurements

Lambs to be slaughtered at each age were allocated to 2 slaughter days and 2 slaughter groups within slaughter days based on stratified weight and balanced for sire. All lambs were electrically stunned (head only) and carcases were trimmed according to the specifications of AUS-MEAT (Anon, 1992). Hot carcase weights were recorded and the GR measured (total tissue depth over the 12^{th} rib, 110 mm from the midline) using a GR knife and the carcases chilled. The pH was measured in the left-hand portion of the m. *longissimus thoracis et lumborum* (LL) at the caudal end over the lumbar/sacral junction at 24 hours. A section of subcutaneous fat and the m. *gluteus medius* was cut away to expose the LL. pH of the m. *semitendinosus* (ST) was measured at 24 using WPS meters with temperature compensation (TPS, WP-80, PTS Pty Ltd) and a polypropylene spear-type gel electrode (Ionode IJ 44), calibrated at ambient temperature. The left hindleg was removed from the loin section by a cut 30 mm distal to the lumbar/sacral junction and the muscle depth of the rump (m. *gluteus medius*) and of the subcutaneous fat was measured. A section of the LL (~50 grams) from the caudal end was collected for determination of intramuscular fat (IMF) and frozen at -20°C. The percentage of intramuscular fat was determined using a near infrared procedure (NIR) in a Technicon Infralyser 450. NIR readings were calibrated with chemical fat using solvent extraction. The method is further described by Perry *et al.* (2001). The caudal end of the LL was exposed to the air at ambient temperature for 30-40 min and the meat colour measured on the cut surface using a Minolta Chroma meter (Model CR-300) set on the *L**, *a**, *b** system (where *L** measures relative lightness, *a** relative redness and *b** relative yellowness). The chroma meter was operated using Illuminant C and a white tile standard (Y = 93.1, x = 0.3135, y = 0.3197). Three replicate measurements were taken at the same position with special effort to avoid areas of connective tissue or intramuscular fat. A thin (1-2 mm) slice of frozen LL muscle (-20°C) from 1 day aged portions was used for determination of sarcomere length using laser light diffraction as reported by Bouton *et al.* (1973). Muscle samples (2 g) taken from 1 day aged LL were held at -20°C and subsequently used for determination of 'free' calcium concentration. The calcium concentration was determined using a Ca^{2+} electrode (Cole-Parmer, Niles Illinois, USA) as described by Hopkins and Thompson (2001). Subsequent to boning of the left side, the remaining bone was removed by sawing the carcase down the middle of the vertebral

column. The entire right sides were transported chilled by road to Werribee (DPI, Vic) where they were weighed and carcase length measured between the anterior edge of the first rib and the anterior end of the pubic symphysis. The sides were scanned by dual energy X-ray absorptiometry (DXA) using a Hologic QDR 4500A fan beam X-ray bone densitometer (Hologic, Waltham, MA, USA). The half carcases were positioned flat down on the DXA table with the cut surface down and the percentage of fat, lean and bone estimated. After scanning the entire backstrap (Anon. 1998 product identification number HAM 5100) was removed with overlaying subcutaneous fat and the fat depth over the LL at the 12th rib measured (Fat C), as was the depth and length of the LL cross section (EMD and EML respectively). The weight of both the LL and ST was determined.

Statistical Analysis

Traits were analysed using a REML procedure (Genstat 7.1, 2004), which contained the fixed effects of post-weaning eye muscle depth EBV, (PEMD), post-weaning weight EBV (PWWT) and post-weaning weight fat EBV (PFAT), dam breed (BLM or Merino), slaughter group (suckers or weaned), gender (wether or ewe) and significant interactions if appropriate. Non-significant fixed effects were removed accordingly. Sire and slaughter day (1-4) x slaughter time within day (1 or 2) were included as random effects and for carcase measures weight of the carcase was included as a covariate, except for compositional data.

Results & Discussion

In total 198 mixed sex lambs were slaughtered representing 8 different sires. In table 1 the traits, which were significantly related to sire EBV's are shown excluding any significant effects of gender, slaughter age or dam breed. For the following traits there was no relationship to sire EBV's (LL weight, depth, width and cross sectional area, rump fat and muscle depth, carcase length, muscle calcium concentration or sarcomere length). Not surprisingly as the value of the EBV PFAT increased the percentage of carcase lean decreased and carcase fat increased. There was a consistent increase in measures of fat depth as the PFAT EBV increased as would be expected and as verified by the reports of Hall et al. (2002) and Hegarty et al. (2005a). This response indicates that changes in both FatC and GR are reflecting changes in the percentage of fat and lean in the carcase. The increase in intramuscular fat (IMF) percentage with an increase in the PFAT EBV is consistent with the response in carcase fatness indicators. However the fact there was no decrease in IMF as the PEMD EBV increased was contrary to the findings of both Hopkins et al. (2005) and Hegarty et al. (2005) which may be due to the wider age span used in the current study. As both the EBV's for PEMD and PWWT increase the weight of the ST increased and both EBV's are required for this effect to be significant. This indicates that selection for muscling may have a positive effect on hind leg muscle content.

The effect of PEMD EBV on muscle pH was notable indicating that as muscling increases, pH at least at 24 hours after death will also increase in both the LL and ST. However both the EBV for PEMD and PFAT are required for the effect on LL pH ($P = 0.06$), and this effect did not persist when ultimate pH was examined. The response in the

ST is not consistent with muscling leading to increased anaerobic capacity. An increase in the lightness of loin meat with increasing PWWT EBV was also found by Hegarty et al. (2005a), and in this study both the EBV's for PEMD and PWWT were required for there to be a significant relationship with lightness (L^*) and yellowness (b^*).

Conclusions

Results presented here demonstrate that selection emphasis in terminal sires will impact on the carcase and meat quality traits of their crossbred progeny. These effects are not all beneficial (eg higher muscle pH), whereas other effects such as the ability to reduce carcase fat could be considered beneficial. These outcomes demand that the interaction between traits and the absolute effects of sire selection on traits need to be quantified so informed decisions can be made about selection decisions.

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Tables and Figures

Table 1. Effect of Poll Dorset sire EBV's on carcase and meat quality traits

Traits	**PEMD**	**PEMD**	**PFAT**	**PFAT**	**PWWT**	**PWWT**
	Sign.	**Coefficient (s.e.)**	**Sign.**	**Coefficient (s.e.)**	**Sign.**	**Coefficient (s.e.)**
Lean %	NS		0.001	-1.87 (0.32)	NS	
Bone %	NS		NS		NS	
Fat %	NS		0.001	1.93 (0.33)	NS	
Intramuscular fat %	NS		0.05	0.36 (0.16)	NS	
ST weight* (g)	0.05	5.51 (2.73)	NS		0.05	1.99 (0.93)
Hot carcase weight (kg)	NS		0.05	0.98 (0.44)	0.05	0.15 (0.07)
GR*	NS		0.001	1.49 (0.45)	NS	
FatC*	NS		0.05	0.61 (0.25)	NS	
LL pH – 24 hour	0.06	0.01 (0.006)	0.05	-0.03 (0.012)	NS	
LL pH - ultimate	NS		NS		NS	
ST pH – 24 hour	0.05	0.04 (0.015)	NS		NS	
L	0.05	0.79 (0.36)	NS		0.05	0.37 (0.12)
a^+	0.05	0.32 (0.16)	NS		NS	
b^+	0.05	0.20 (0.10)	NS		0.05	0.07 (0.03)

*****Adjusted to a carcase weight of 21.1 kg. $^+$Adjusted to a mean pH of 5.67.