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The Effects of Nutrition and Genotype on the Growth and Development, Muscle Biochemistry and Consumer Response to Lamb Meat

David Pethick[1], Roger Heggarty[2] and **David Hopkins[3]**
[1]Department of Veterinary Science, Murdoch University, WA
[2,3]New South Wales Agriculture, Armidale[2] or Cowra[3], NSW

ABSTRACT

A lamb growth experiment was conducted with the objective of understanding the genetic and nutritional influences on growth and development, and on the biochemical and sensory attributes of muscle and meat. Growth and carcass traits showed significant positive effects when lambs were raised on a high plane of nutrition. The expression of greater genetic potential for growth was facilitated by nutrition with the genetic effect being reduced by 60% in the low nutrition group. By contrast, the expression of genetic potential for eye muscle development was not reduced by nutrition. Slower rates of growth as a result of low nutrition reduced fat deposition beyond that attributable to weight indicating slow growth *per se* will reduce carcass fatness. The amount of fat in the carcass of the lambs in the high nutrition treatment was reduced in the lambs from highly muscled sires strongly indicating that selection for eye muscle depth biologically programs the partition of nutrients toward muscle. Muscle biochemistry was strongly influenced to become more anaerobic and less aerobic in the animals sired by the muscle selected lines suggesting that selection at this axis strongly impacts on the biological makeup of muscle. There is a suggestion that selection for muscling reduces the consumer appreciation of grilled lambs steaks but this needs further analysis and testing especially given the very large financial incentives to both producers, processors and retailers of highly muscled prime lambs.

AIMS

A lamb growth experiment was conducted with the objective of establishing the effect of plane of nutrition on the expression of genetic potential for growth and muscling in second cross prime lambs. In addition the study was used to understand both genetic and nutritional influences on biochemical and sensory attributes of muscle and meat.

METHODS

This study, run in Armidale NSW, provided growth and devepment data for 387 lambs generated by sires with genetic capacity for high muscling (M), high growth (G) or industry standard performance (C) based on the Lambplan system of estimated breeding values (EBV) for post eaning weight (PWWT) and post weaning eye muscle depth (PEMD). The sires were choosen to minimise differences in the estimated breeding value for fat depth. The range of EBV's for PWWT and PEMD was 1.4-13.8 kg and –1.8-3.4 mm respectively. Lambs were reared on either 'low' or 'high' all of life nutrient availability, with nutrition being regulated from 10 d of age by pasture availability and supplementation. The resulting average growth rate to slaughter was approximately 130 and 190g/d for the low and high nutrition groups respectively. At 8 months of age the lambs were slaughtered with a resulting hot carcass weight of 16.3 and 26.6kg (sem=0.81) and GR tissure depth of 6.6 and 21.3 mm (sem=0.70) for the low and high nutrition groups respectively. At slaughter 140 female lamb carcasses from across all treatment groups received electrical stimulation after which the loins were collected for consumer evaluation at 5 days of aging as part of Meat and Livesock Australia's sheepmeat eating quality program. An additional 56 lambs collected across all treatment goups were used for generation of carcass bone out data and also for the collection of samples to evaluate muscle biochemistry.

RESULTS

<u>Growth</u>: All measured growth and carcass traits showed significant positive effects of high nutrition. Siretype affected pre- and post-weaning liveweight gain and preslaughter live weight (LW) of lambs such that the LW and live weifght gain of G lambs was greater than that of C or M lambs. However expression of greater gentic potential for growth was strongly facilitated by nutrition, with 1 unit of PWWT EBV delivering 275 g and 683 g of extra final weight under low and high nutrition respectively.

Fat Development and Distribution: The results for fat development were influenced by the method of fat determination. Based on 'GR' tissue depth, the G lambs had a reduced fat depth than for C or M lambs when adjusted for differences in liveweight. Under low nutrition, the GR tissue depth of the low nutrition lambs was less both as measured (by 9.4 mm) and when expressed at the same carcass weight, indicating nutrition had modified fat deposition beyond that attributable to weight. Carcass fat, determined via commercial bone out, when considered at a constant carcass weight, was similar in lambs from all siretypes under low nutrition. However under a high nutrition the G and C lambs had more dissectable fat than M lambs. The reduced propensity for M lambs to deposit carcass fat on a high plane of nutrition had not been anticipated and was not indicated by the carcass GR of these lambs, suggesting regional distribution of fat within the carcass differs between genotypes. The effect for reduced fatness on the higher plane of nutrition in the M lambs was evident in the saddle and loin area, and also tended to occur in the forequarter.

Loin Muscle Development: The expression of the PEMD EBV was consistent across nutrition levels, with 1 mm of PEMD EBV delivering 0.61 mm of extra eye muscle across both nutrition levels. The effect of the EBV for PEMD on eye muscle depth was much stronger than on carcass protein, indicating that selection for PEMD is not selecting on total protein mass.

Eating Quality: Nutritional treatment had no impact on the eating quality score of the grilled lamb loins. However there was a significant effect for the EBV for PEMD to decrease the consumer score. For each mm of PEMD EBV the consumer score was significantly decreased by 1.8 and 1.3 (sem = 0.6) points for tenderness and overall liking respectively. This equates to a decline of 6-7 overall liking points for grilled lamb steaks over the range of PEMD EBV's studied (lowest to highest PEMD). The true significance of this result is still uncertain given that there was a high standard error and that one the the M sires was homozygous for the Carwell gene which has been previously been shown to produce tough loin meat.

Muscle biochemistry: As the EVB for PEMD increased the muscle biochemistry of the progeny became less aerobic and more anaerobic. Similarly to eye muscle depth the increased expression of anaerobic activity in response to the EBV for PEMD was not influenced by nutrition. There was a strong correlation between anaerobic enzyme expression and muscle yield.

CONCLUSION

This work has highlighted the importance of adequate nutrition especially to fully capture the genetic benefits of selection for growth. Moreover the work suggests that selection for growth has little impact on muscle structure, biochemistry or eating quality and that this selection index results in animals with an increased body size. By contrast, selection for muscling has powerful metabolic effects on the muscle and fat metabolism within the prime lamb progeny. Animals selected for muscle development partition energy toward muscle regardless of nutritional regime. The resultant reduced fatness in prime lambs is of great importance to the prime lamb industry since this results in economic advantages to producers (better feed conversion), processors (better lean meat yield), retailers (better lean meat yield and product presentation). However newer technologies of carcass assessment, such as Viascan, will be necessary to segregrate the highly muscled animals as current Industry measures could not differentiate the carcasses. The powerful effects of selection for muscling on muscle biochemistry are also likely to translate into positive Industry outcomes such as better meat colour, improved colour shelf life, better response to electrical stimulation. The tentertive outcome that selection for muscling reducing the eating quality of lamb meat warrants further investigation.

KEY WORDS

Estimate breeding value, muscling, growth, nutrition, biochemistry, eating quality

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