THE IMPACT OF GROWTH RATE ON INTRAMUSCULAR FAT OF LAMBS

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I. INTRODUCTION

The intramuscular fat (IMF%) or marbling, is an important meat quality trait. IMF% and plays a critical role in the sheep-eating experience [1] include juiciness and flavour. IMF% has been found to contribute a minimum of 4-5 % of the variance in lamb loin for Australian customers [2]. Consequently, the selection of animals with higher IMF% has the potential to impact lamb purchases and willingness to pay decisions [3]. Little is known about the impact of growth rate on the expression of IMF% in lambs, however, the cells that express themselves as IMF% are influenced by maternal nutrition during the period from birth to weaning [4]. Given the importance of IMF%, this study aimed to examine if early life growth rate (first 100 days) of lambs has a higher impact on IMF% than later growth.

II. MATERIALS AND METHODS

The animals used in this study were from Meat and Livestock Australia resource flock [5]. Briefly, 12,139 lambs were produced over 13 years (2007–2019) at eight research sites across Australia, which represent a broad cross-section of Australian production systems. The lambs were the progeny of 1,229 key industry sires out of Merino, Maternal and Terminal representing the major production types in the Australian sheep industry. Lambs were slaughtered at a commercial abattoir, chilled overnight at 4°C and then carcass traits were measured. At approximately 24 h post-mortem, the *M. longissimus lumborum* (loin) was removed to estimate the IMF% as described by Anderson et.al [6]. Data was analysed using a generalised linear effects model using the lme package in R using one-way ANOVA anlysis of variance. The response variable was intramuscular fat (IMF%), cohort and sire type were included as fixed effects, while age at slaughter, hot standard carcase weight (HCWT), tissue depth (HGRFAT), and eye muscle depth (CEMD) were included as covariates. Lambs were weighed at birth, weaning and slaughter then the growth rate was calculated for growth rate 1 (GR1) and growth rate 2 (GR2) using the formula GR = (lamb weight) / (lamb age).

III. RESULTS AND DISCUSSION

This study showed that there was a significant ($P<0.001$, Table 1) effect of both growth rates on IMF%. The growth from birth to weaning (GR1) had a negative impact on IMF%. Increasing GR1 from 0 to 300g/d, decreases IMF% by 1.07%. In contrast with GR2, increasing GR2 from 0 to 300g/d, increasing IMF% by 0.78%. There is unknown mechanisim caused the differences between the two growth rates might be related to the maternal effect pre-weaning which increases muscle proportion. However, when lambs are weaned and the early maturity pattern starts with access to pasture and feed supplementary, if available then fat proportion increases with a positive effect on IMF%. The current study reporting an increase of 5mm of CEMD reducing IMF% by 0.13%. The genetic correlation between CEMD, IMF% and growth rate for early growth was reported to be higher than late growth (200-250 days) [7], supporting this study's findings which is what GR1 may also be explaining. There was a significant ($P<0.001$, Table 1) impact of HCWT on IMF% in this study was expected at constant slaughter age. Increases in the HCWT from 12 to 40kg increased IMF% by 0.5%. It is known that younger animals will have lower IMF% compared to older animals, thus the inclusion of animal age at slaughter in this study may be the reason for the reduced response in IMF% as HCWT increased. It is well known that HCWT is a reflection of an animal's growth rate. Lambs with lower muscle proportion will have more IMF% in contrast with heavier lambs. This shows that there is a potential to influence meat quality by breeding to change the growth curveand both fat and muscle proportion, taken into account that an increase of GR fat from 10 to 30 mm, IMF% increase by 0.42%.

Table 1: Statistical output for the effect of growth rate on intramuscular fat (IMF%) from the base model included, carcass eye muscle depth of the *M. longissimus lumborum,* fat measurement (GRFAT).

		Model corrected for GR1 (g/d)		Model corrected for GR2 (g/d)	
Effect	DF	F-value	P-value	F-value	P-value
Cohort	143	31.9	<0.001	33.2	<0.001
Sire type	2	23.1	<0.001	10.4	<0.001
Slaughter age	1	2.68	<0.001	6.69	0.03
HCWT	1	238	<0.001	67.1	<0.001
GR FAT	1	288	<0.001	305	<0.001
CEMD	1	93.2	<0.001	36.9	<0.001
GR1*	1	580	<0.001	-	-
GR2*	1	-	-	44.2	<0.001
R^2		0.392		0.373	
RSE		0.785		0.859	

* GR1 is the calculated growth rate from birth to weaning, and GR2 is the growth rate from weaning to slaughter.

IV. CONCLUSION

While the mechanism driving the difference in effect of growth rate for the pre and post-weaning periods, the following is speculated. Animals with high growth rates pre-weaning are likely to be high lean meat yield animals which very efficient at converting feed to weight due to minimal fat deposition. Meanwhile the high growth rates post-weaning may better reflect dietary energy intake, which allows for better growth and increased fat deposition.

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REFERENCES

1. Bonny, S. P., O'Reilly, R. A., Pethick, D. W., Gardner, G. E., Hocquette, J. F. & Pannier, L. (2018). Update of Meat Standards Australia and the cuts based grading scheme for beef and sheepmeat. Journal of Integrative Agriculture 17: 1641-1654.
2. Watson, R., Gee, A., Polkinghorne, R. & Porter, M. (2008). Consumer assessment of eating quality– development of protocols for Meat Standards Australia (MSA) testing. Australian Journal of Experimental Agriculture 48: 1360-1367.
3. Pethick, D., Banks, R., Hales, J. & Ross, I. (2006). Australian prime lamb–a vision for 2020. International Journal of Sheep and Wool Science 54: 66-73.
4. Yao, D., Su, R., Zhang, Y., Wang, B., Hou, Y., Luo, Y., Sun, L., Guo, Y. & Jin, Y. (2022). Impact of dietary Lactobacillus supplementation on intramuscular fat deposition and meat quality of Sunit sheep. Journal of Food Biochemistry 46: e14207.
5. Pannier, L., Pethick, D. W., Geesink, G., Ball, A., Jacob, R. & Gardner, G. (2014). Intramuscular fat in the longissimus muscle is reduced in lambs from sires selected for leanness. Meat Science 96: 1068-1075.
6. Anderson, F., Pannier, L., Pethick D. W. & Gardner, G. (2015). Intramuscular fat in lamb muscle and the impact of selection for improved carcass lean meat yield. Animal 9: 1081-1090.
7. de Hollander, C., Moghaddar, N., Kelman, K., Gardner, G., & van der Werf, J. (2014). Is variation in growth trajectories genetically correlated with meat quality traits in Australian terminal lambs. In Proceedings 10th World Congeress of Genetic Applied to Livstock Production (pp.346-349), 17-22 Augest 2014, Vancouver, BC, Canada.