LAMB GROWTH INCREASES INTRAMUSCULAR FAT IN THE LONGISSIMUS MUSCLE

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Intramuscular fat is an important indicator of lamb eating quality. It is increased in lambs with heavier hot carcass weights, which have heavier average growth rates throughout life. Growth rates vary during different phases of growth however no differential effect of growth rate on intramuscular fat has been shown in beef. Therefore it was hypothesized that the association between intramuscular fat and growth would not vary between different phases of growth. Weight data totaling 164, 797 observations was collected from 17, 525 lambs across eight sites and five years of the Sheep Cooperative Research Centre Information Nucleus Flock experiment. A Bayesian random regression model was fitted to the live weight data to estimate live weight at 100 and 150 days for each lamb. Intramuscular fat was measured in the loin of 8, 254 lambs. Intramuscular fat was analysed in a linear mixed model to determine the association with birth weight and estimated weight at 100 and 150 days. Contrary to our hypothesis, the association between intramuscular fat and growth varied with the phase of growth being negative at birth and positive at 100 and 150 days. Thus the key period for intramuscular fat modulation is between birth and weaning.

Key Words – breeding value, consumer, eating quality

I. INTRODUCTION

Consumers are becoming increasingly concerned with lamb eating quality [1] which is assessed using consumer sensory scores. Intramuscular fat influences consumer sensory scores [2] therefore changes in intramuscular fat may impact eating quality. Intramuscular fat can be influenced by production factors including lamb growth, although this has not been fully investigated in sheep. Hot carcass weight has been used to crudely estimate growth and has shown a positive association with intramuscular fat [3]. However, the limitation is that hot carcass weight can only reflect the average growth rate between birth and slaughter. As growth varies with time the association between intramuscular fat and growth may also vary with time. The change in association between different phases of growth has not previously been explored in lamb. Alternatively, a study in beef demonstrated no differential effect of intramuscular fat development due to variation in either birth weight or growth rate to weaning [4]. Therefore we hypothesise that intramuscular fat will increase with higher growth rates, and that this effect will not vary between different phases of growth.

II. MATERIALS AND METHODS

Weight data was collected from 17,525 lambs across eight sites and five years of the Sheep Cooperative Research Centre Information Nucleus Flock experiment. Lambs were weighed at birth and at monthly intervals throughout their grow-out period, resulting in 164,797 observations. A Bayesian method was used to fit a random regression linear mixed model to the live weight data with fixed effects (interacted with a cubic polynomial for age) for site, year, gender, birth type-rear type, age of dam, sire type, dam breed within sire type. Random terms included sire, dam by year and animal identification, which were each interacted with a cubic polynomial for age. This model was used to estimate lamb weights at weaning (100 days) and post weaning (150 days).

At slaughter, loin fat was weighed and a 40g sample of loin muscle was excised from 8, 254 lambs. Intramuscular fat was subsequently determined using a near infrared procedure and these readings were validated with chemical fat determination using solvent extraction. Data was analysed using a linear mixed effects model in SAS with fixed effects for site, year of birth, sex, birth type-rear type, age of dam, sire type, dam

breed within sire type and kill group within site, with actual weight at birth and estimated weight at 100 and 150 days included separately as covariates. Sire identification and dam identification by year were included as random terms. The intramuscular fat models were analysed both with and without short loin fat weight as a covariate.

III. RESULTS AND DISCUSSION

Weight at birth, 100 days and 150 days each had an influence on intramuscular fat. Increasing birth weight was associated with a reduction in intramuscular fat. The magnitude of the reduction in intramuscular fat was 0.85% across the 8.1 kg birth weight range. Between birth and 100 days this association inverted, with intramuscular fat increasing with increasing weight. Thus at 100 days of age, the magnitude of this effect across the 57 kg weight range was equivalent to 1.09% intramuscular fat. This was more than double the magnitude of the association at 150 days which demonstrated an increase in intramuscular fat of only 0.49% across the 57 kg weight range (Table 1).

Table 1 The magnitude of effect of lamb weight (Kg) on intramuscular fat %

Weight	Magnitude (%)	Range (Kg)
Birth	0.85	8
100 days	1.09	57
150 days	0.49	57

The general association between increasing weight at 100 days and 150 days and greater intramuscular fat % aligned well with the earlier work in lambs [3]. However the differential nature of this effect, being greater at 100 days than at 150, and showing the opposite response at birth, is contrary to our hypothesis that these effects would be consistent.

Although it has not previously been reported in lambs, the negative association between intramuscular fat and birth weight was not unexpected as a similar occurrence has been shown in pigs [5]. The inversion of the association between birth and 100 days highlights the pre-weaning phase of growth as a key period in which growth modulates the development of intramuscular fat. These findings align with previous research indicating that adipocyte development is fixed relatively early in life [6]. The main source of lamb nutrition pre-weaning is via the ewe suggesting that there is potential to modulate lamb intramuscular fat by manipulation of ewe nutrition.

The inclusion of short loin fat weight in the models reduced the association between birth weight and weight at 150 days with intramuscular fat by approximately 50% while it completely accounted for the association at 100 days. This suggests that the increase in intramuscular fat with growth is well correlated with an increase in whole body adiposity with age, although a significant proportion of variation in intramuscular fat % is also due to growth independent of whole body fatness.

IV. CONCLUSION

The association between lamb growth and intramuscular fat varies with the period of growth. The strongest association is at 100 days after which the association diminishes. As the association inverts between birth and weaning this is the key time period during which intramuscular fat is modulated. Around half of the variation in intramuscular fat with growth is explained by the change in whole body adiposity with growth however the remainder is an association with growth itself.

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