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GDF8 C.1232 *G>A* MUTATION EFFECT CONSISTENT IN AN INDUSTRY COLLECTED RESOURCE

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SUMMARY

VIAscan® carcass lean meat yield data was available on 1160 non-experimental industry lambs genotyped for the Texel derived GDF8 c.1232 *G>A* mutation. The genetic background of the lambs was unknown. Under experimental conditions the mutation is associated with increased carcass lean meat yield. Four percent of the lambs genotyped were homozygous for the GDF8 c.1232 *G>A* mutation, with 21% heterozygous, with the balance non-carriers. The *A* allele was significantly associated with increased carcass lean in all three of the carcass regions assessed, resulting in lambs carrying the *AA, AG,* and *GG* genotypes having total lean meat yields of 58.0% ± 0.51 , 55.3% ± 0.27 and 52.9% ± 0.21 respectively. The majority of lambs carrying at least one copy of the *A* allele achieved lean meat yield premium thresholds set by Alliance Group Ltd where the lambs were slaughtered, however, this was not exclusive demonstrating that the genetic background on which the mutation is introgressed is important in determining the ultimate lean meat yield of a lamb.

INTRODUCTION

The effects of the transition from *G* to *A* in the 3' untranslated region of the GDF8 gene (c.1232 *G>A*); derived from Texel sheep, has been documented as associated with increased lean meat yield in controlled experiments (Johnson *et al.* 2009; Johnson *et al.*, 2005a; Johnson *et al.*, 2005b)(Johnson et al., 2005); Masri *et al.* 2011; Kijas *et al.* 2007). Producers in New Zealand are now able to capture financial premiums for producing lambs with improved lean meat yield through some meat companies. Currently based on the VIAscan® (Hopkins *et al.* 2004) imaging system, the Alliance Group Ltd is offering financial premiums for lambs that achieve a minimum of 21.4%, 13.7% and 16.4% of carcass lean meat yield in the leg, loin and shoulder regions of the carcasses respectively.

The opportunity arose with the collection of an industry data set to investigate whether or not the effect could be detected in a non-controlled experiment, that is whether the effect is significant enough to overcome environmental noise and therefore be of relevance to the industry through increasing the likelihood of lambs achieving premium targets for lean meat yield.

MATERIALS AND METHODS

Data collection was carried out between January and April over two consecutive years (2008 and 2009). Mobs of lambs were observed at Alliance Group Ltd Mataura and Lorneville meat processing plants as they travelled through the VIAscan® (Hopkins *et al.* 2004) imaging system. Lambs were selected from large mobs >200 lambs, with carcass weights between 15.5 and 19kg. One to three most extreme yielding pairs (high and low, matched for carcass weight) were identified from the selected mobs. No information about breed, age or origin was available on the lambs. Measurements recorded on the whole carcass were cold carcass weight (CW), the depth of tissue at the GR site 110mm off the mid- line in the region of the 12th rib. VIAscan® carcass measurements of the lean meat yield of the leg, loin, and shoulder expressed as a percentage of the carcass weight were recorded together with their sum total. Carcass length was measured from between the hind legs to the front of the neck using a set of callipers with 50mm 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.

The lambs were genotyped for the GDF8 c.1232 *G>A* mutation using the method described by van Stijn *et al*. (2007) using an iPLEX primer using a Mass Spectroscopy-based technique. Given that other SNPs were also being genotyped, Primer Design software was used to design primers that would multiplex with the other SNPs. The sequence surrounding the SNP provided to the primer design programme was taken from GenBank accession number DQ530260.

The data were analyzed using the mixed model procedure in SAS (SAS 2004). The models fitted included fixed effects of year (2008 or 2009) sex (female or male), and GDF8 c.1232 *G>A* genotype (AA, AG, or GG), mob was fitted as a random effect and carcass weight was fitted as a covariate for all traits except carcass weight.

RESULTS AND DISCUSSION

Data and genotype information was available on 1167 lambs, representing 343 mobs (genotypes were not available for all lambs on which data was collected). The genotype status of any mob carrying at least one copy of the mutation was generally not fixed, with a mixture of genotypes within each mob, however, 162 mobs consisted of lambs that were all non-carriers.

An across year evaluation is presented in Table 1, similar results were obtained in both years. (data not presented). The average carcass weight was not significantly different between the three genotypes which is consistent with previous studies (Johnson *et al.* 2009; Johnson *et al.* 2005). In this industry data set there was significant differences between the three genotypes for all of the ViaScan lean meat yield traits assessed with the lambs homozygous for the mutation significantly leaner. There were also significant differences between lambs homozygous for the mutation vs non-carriers for GR, but with heterozygous lambs not significantly different to either homozygous group. The size of the effect is generally consistent with those reported by Johnson *et al.* (2009) for ViaScan measurements of total carcass yield.

Table 1. Differences in carcass traits for industry lambs carrying zero, one or two copies of the GDF8 c.1232 *G>A* mutation[1].

	Genotype		
	AA	AG	GG
Number of Lambs	51	249	867
Carcass Weight (kg)	17.1 ± 0.10	16.9 ± 0.06	16.9 ± 0.04
GR (mm)	4.8 ± 0.30^{a}	5.5 ± 0.17^{ab}	6.3 ± 0.13^{b}
ViaScan Leg Yield (%)	23.8 ± 0.25^{a}	22.5 ± 0.13^{b}	21.5 ± 0.10^{c}
ViaScan Loin Yield (%)	15.3 ± 0.15^{a}	14.7 ± 0.08^{b}	14.2 ± 0.06^{c}
ViaScan Shoulder Yield (%)	18.9 ± 0.17^{a}	18.1 ± 0.09^{b}	17.2 ± 0.07^{c}
ViaScan Total Yield (%)	58.0 ± 0.51^{a}	55.3 ± 0.27^{b}	52.9 ± 0.21^{c}

[1]In previous studies the A SNP has been associated with increased muscling.

Although previous studies have concluded that the mutation is associated with increased muscling, the effect has not always been significant for all methods of muscling assessed (Johnson *et al.* 2009; Masri *et al.* 2011; Kijas *et al.* 2007, in particular for ultrasound measurements made on the loin, although also for video image analysis, the measurements used in this current analysis. With the exception of Johnson *et al.* (2009), however, all other studies have only compared heterozygotes with non-carriers and there is indication that the mode of inheritance may not strictly be additive for all traits, rather partially recessive which limits its detection in heterozygotes (Johnson *et al.* 2009) as two copies of the mutation are required to observe the effect.

Thus from the analysis it would appear that introgression of the GDF8 c.1232 *G>A* mutation does result in increased lean meat yield within the carcass as assessed by VIAscan®. However, for the results of introgression to be realised by producers the increase must result in the carcasses achieving the lean meat yield percentage that results in a premium being received. Figure 1 shows the percentage of lambs, from this data set, with the different genotypes that reach the target premium thresholds for each of the three regions assessed. The impact of the GDF8 c.1232 *G>A* mutation is evident. However, it is also shows that not all lambs carrying one or even two copies of the mutation met the targets for lean meat yield. This clearly demonstrates the principles of introgression of such a mutation, in that the ultimate level of lean meat yield achieved is dependent on the base level of lean meat yield as influenced by the potentially dozens of other genes controlling lean meat yield. That is, if the mutation is introgressed into a flock with very poor lean meat yield, although it will increase the level of lean meat yield by known levels (Johnson *et al.* 2009) it will not lift the overall lean meat yield to levels required to achieve premiums. The lambs used in this study have also been genotyped using the ovine 50K sheep chip, the results of which will be combined with other meat yield resources to allow development of genome wide selection for lean meat yield which will improve the ability to increase the base level of lean meat yield. In the mean time emphasis still needs to be placed on quantitative selection for lean meat yield in breeding programmes to improve the base level of lean meat yield to maximise the benefits of the introgression of the GDF8 c.1232 *G>A* mutation. Meat quality also needs to be monitored to ensure no negative effects on meat quality from selection for increased lean meat yield, as although the GDF8 c.1232 *G>A* mutation does not negatively affect meat quality (Johnson *et al.* 2009), negative relations between selection for increased lean meat yield and meat quality can exist, dependent on the physiological mechanisms through which the increased yield is achieved.

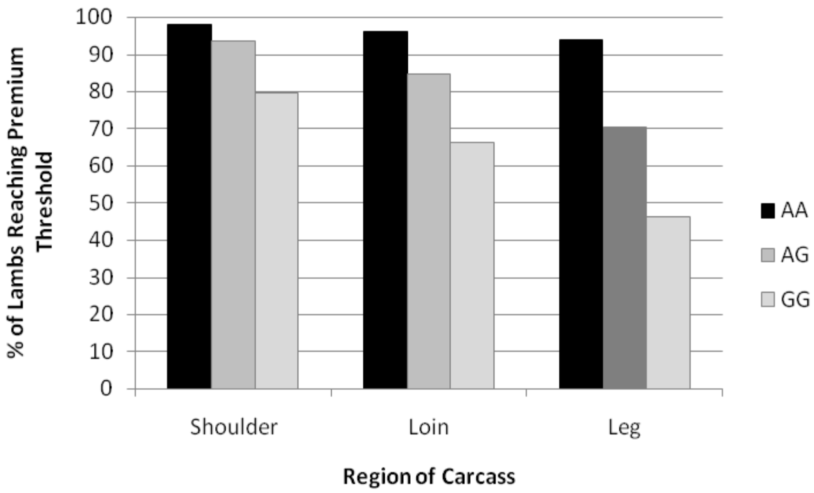

Figure 1. Percentage of lambs that met the premium thresholds of 16.4%, 13.5% and 20.7% of carcass lean meat yield in shoulder, loin and leg regions of the carcass for the three GDF8 c.1232 *G>A* genotypes.

CONCLUSIONS

An increase in carcass lean meat yield as a result of the GDF8 c.1232 *G>A* mutation was observed in non-experimental industry lambs. The size of the effect is similar to that reported under controlled experimental conditions. That not all lambs carrying the mutation achieved high enough lean meat yields to reach meat processor premium targets emphasises the need for quantitative selection for lean meat yield in breeding programmes to continue to improve the base level of lean meat yield.

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