FAT DISTRIBUTION IN ANGUS STEERS IS RELATED TO RESIDUAL FEED INTAKE ESTIMATED BREEDING VALUE

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SUMMARY

The association between fat distribution and feed efficiency was investigated using Angus steers divergent in residual feed intake (RFI) estimated breeding values (EBV). The 208 steers were fed in a commercial feedlot in NSW for 250 days, entering at 13 – 16 months of age. Hot standard carcass weight, eye muscle area, marble score, intramuscular fat content, rib fat (subcutaneous) depth and seam (intermuscular) fat area were measured and regressed against the mid-parent RFI EBV of the steers. The results showed that rib fat depth was more strongly associated with RFI EBV than were the other fat depots.

INTRODUCTION

Feed costs comprise a significant part of the cost of beef production. In order to reduce these costs, research has been undertaken to identify cattle with genetically higher net feed efficiency measured as low residual feed intake (RFI), i.e. animals that consume less feed (energy) than would be expected for an animal at a particular live weight and growth rate. However, the impact on individual fat depots when breeding for increased net feed efficiency warrants further investigation as there have been reports of an association between feed efficiency and fat deposition (Richardson *et al.* 2001; Basarab *et al*. 2003; Bulle *et al*. 2007).

Pitchford (2004) reviewed selection for feed efficiency in other species and concluded that 'while improvements in feed efficiency can be made, they come at a cost. In poultry and mice, increased net feed efficiency has been associated with increased fatness but in pigs and beef cattle there is some evidence of the reverse. While a number of studies have predicted that selection for efficiency may result in lower proportions of crucial, metabolically active organs, there are few studies to support this.' Richardson *et al.* (2001) determined that cattle with genetically lower RFI also had a lower proportion of body fat, but there was no difference in subcutaneous fat or eye muscle area (EMA). Basarab *et al*. (2003) found a similar phenotypic relationship between RFI and general fatness, with an increase in RFI associated with increased marble score, removable fat and subcutaneous fat, but no relationship with muscle area (*longissimus thoracis).* In an intensive trial using 24 steers, Bulle *et al.* (2007) demonstrated that phenotypically low RFI steers tended to gain less fat than their high RFI counterparts, yet there was no significant difference in carcass weight, marbling score, subcutaneous fat or internal fat between high and low RFI animals. This was also the finding of Baker *et al.* (2006).

The purpose of this work was to examine potential associations between genetic variation in RFI and phenotypic data for different fat depots (subcutaneous, intramuscular and intermuscular fat), in comparison to muscle traits, in a larger number of steers fed in a commercial feedlot trial.

MATERIALS AND METHODS

Cattle. 208 Angus steers from the NSW Department of Primary Industries Trangie RFI selection line with a large divergence in mid-parent residual feed intake estimated breeding values (RFI EBVs) were used in this trial to show that differences in residual feed intake can be achieved in a commercial setting. The steers were progeny of 26 sires with numbers of progeny ranging from 1 to 21. The feedlot trial comprised 3 pens, with steers allocated to the pens based on mid-parent RFI EBV (low RFI EBV = -0.85 to -0.52, n = 68; medium RFI EBV = -0.29 to 0.14, n = 72; high RFI EBV = 0.16 to 0.98, n = 68) and fed for 250 days in a large commercial feedlot in NSW. The steers had been managed together from birth until they entered the feedlot. Age at feedlot entry ranged from 13 to 16 months. Each pen was supplied with the same ration, *ad libitum,* adjusted weekly for over/under feeding. All steers were slaughtered on the same day.

Data. Aus-meat abattoir measurements and Meat Standards Australia chiller assessments were performed on the carcasses by accredited graders (Table 1). Traits included hot standard carcass weight (HSCW), rib fat thickness (RFT), eye muscle area (EMA) and marble score (MSAMB). EMA and MSAMB were assessed at the $5^{th}/6^{th}$ rib. In addition, a 15mm thick sample incorporating the *M. longissimus dorsi, Spinalis dorsi and Semi-spinalis dorsi* muscles was collected for calculation of seam fat area (SF) via image analysis and measurement of intramuscular fat content (IMF%) via chemical extraction according to the protocol described by Siebert *et al.* (2006).

Image analysis. All samples were photographed and images stored as separate jpeg files with a resolution of 180dpi. Subsequent image manipulation involved using Adobe® Photoshop® CS2 to trim the seam fat from the surrounding muscles and saving these as individual images, again at 180dpi. The seam fat area (SF) was measured using Matlab R2007a, an interactive software system.

Data analysis. All data were analysed using general linear regression (GenStat 10.1) with effects of age at slaughter (range 646 to 746 days), RFI EBV (range -0.85 to +0.98 kg/d), pen (high, medium, low), and the RFI EBV by pen interaction. Regression coefficients of RFI EBV are reported and percent change in each trait per kg/day change in RFI EBV was calculated by dividing the regression coefficient by the mean of that trait. Significance was defined as P<0.05.

RESULTS AND DISCUSSION

The range in mid-parent RFI EBV was 1.83kg/day. Substantial variation was observed for all traits (Table 1), but was most noticeable for rib fat depth, seam fat area and marble score.

Table 1. Summary of trait data.

	HSCW (kg)	*EMA (cm²)*	*RFT (mm)*	*SF (cm²)*	*IMF%*	*MSAMB*
Mean	415	77	17.9	24.2	14.5	504
Min	354	68	6	9.67	8.29	350
Max	494	85	34	44.2	22.7	830
St Dev	27.4	3.28	5.62	6.21	3.12	107

HSCW = hot standard carcass weight, EMA = eye muscle area, RFT = rib fat thickness, SF = seam fat area, IMF% = percent of chemically extracted intramuscular fat, MSAMB = Meat Standards Australia marble score.

Because of the experimental design, pen was completely confounded with RFI EBV group. However, as there was variation in the mid-parent RFI EBVs within the pens, each trait was regressed against the mid-parent EBV, pen, and the mid-parent EBV by pen interaction. Mid-parent EBV and pen were significant for most fat and muscle traits (Table 2). Mid-parent EBV by pen interaction was marginally significant for the eye muscle area but not for any of the other traits and was removed from the model (Table 2).

Of the 26 sires of steers in this trial, 10 had progeny in two pens. Therefore, an additional model was fitted with sire as random effect. This only reduced the significance levels slightly and did not remove the pen effect. Therefore, the mixed model results are not reported herein.

Table 2. Tests of significance for traits (F-probabilities).

	HSCW	***EMA***	***Rib fat***	***Seam fat***	***IMF %***	***MSAMB***
Model 1: final age + mid-parent RFI EBV + pen + mid-parent RFI EBV x pen interaction						
RFI EBV	0.026	0.550	<0.001	0.013	0.093	0.146
Pen	<0.01	<0.001	0.363	0.018	<0.001	<0.001
RFI EBV x pen	0.078	0.039	0.885	0.447	0.889	0.248
Model 2: final age + mid-parent RFI EBV and final age + pen						
RFI EBV	0.030	0.579	<0.001	0.015	0.103	0.191
Pen	0.004	<0.001	<0.001	0.001	<0.001	<0.001

Terms as defined in Table 1.

The relationship between mid-parent RFI EBV and rib fat was highly significant (<0.001); with HSCW and seam fat marginally significant (0.030 and 0.015, respectively), while other traits had no significant association with mid-parent RFI EBV (Table 2, Model 2). This result does not agree with the work by Bulle *et al.* (2007), who found no significant differences in subcutaneous fat or carcass weight. However, it is consistent with the subcutaneous fat results of Basarab *et al.* (2003) and Richardson *et al.* (2001). There are a number of differences in these experiments that might account for the conflicting results. Two of the previous experiments involved crossbred steers which may have influenced the result, as the genetics underlying the variation in RFI may differ between breeds. Indeed, Basarab *et al.* (2003) selected animals from five foundation breeds because of the large variation in genetic backgrounds. In addition to this, there was variation in the age at feedlot entry, length of time on feed and the number of animals in each trial. The trial reported here involved a larger number of steers that were fed a high energy diet for a longer period than the previous studies. In addition, the steers were older than all previous studies with the exception of the animals in the Bulle *et al.* (2007) trial. The variation in the results may reflect the added maturity of the steers and the longer time on a high energy diet, both of which are likely to increase the amount of fat deposited and therefore, increase the variation between the animals, as has been discussed in a review by Herd and Arthur (2009).

As pen was significant for the traits measured in this trial, it would suggest that there were important environmental effects involved. The most likely explanation in this instance would be differences in the feeding regimens between the pens. Therefore, careful analysis and interpretation of the data is required in order to draw conclusions regarding body composition and selection for RFI.

The regression coefficients (Table 3) indicate the measured change in the traits that was observed with a one kilogram/day increase in RFI EBV. The percentage change enables a comparison of the magnitude of the effect on each trait from the genetic change in RFI under the conditions of this experiment. The association between RFI EBV and the fat traits implies that selection for lower RFI would decrease fatness. However, the change in rib fat thickness was much larger than the change in seam fat area, and the change in intramuscular fat content was statistically insignificant. This suggests that while improving (decreasing) RFI could reduce fatness, the magnitude of the effect differs between the adipose depots.

Table 3. Regression coefficients of RFI EBV with the standard errors and percent changes of traits.

	HSCW	*EMA*	*Rib fat*	*Seam fat*	*IMF %*	*MSAMB*
Regression coefficient	19.9 ± 12.0	1.04 ± 1.44	7.97 ± 2.4	2.17 ± 2.85	2.12 ±1.39	42.9 ± 44.5
Percentage change (% trait / unit RFI EBV)	5	1	45	9	15	9

Terms as defined in Table 1.

CONCLUSIONS

This experiment showed that rib fat thickness and seam fat area were associated with RFI EBV in these Angus steers. Rib fat thickness often has tight market specification and showed the most variation linked with genetic change in RFI. There was a significant relationship between genetic variation in RFI and area of seam fat, a previously unreported fatness trait, but the magnitude of the association was not nearly as large as that for rib fat thickness. The results confirm previously reported associations between improved RFI and decreased fatness. However, the results also show that substantial changes in fat deposition following selection for RFI will not necessarily affect all adipose depots equally. Reducing residual feed intake, and therefore, reducing a major cost of production, may change carcass fat composition but the consequences may not be as severe as previously thought as not all fat depots appear to be affected.

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