GENETICS OF MEAT QUALITY TRAITS IN TWO TROPICALLY ADAPTED GENOTYPES OF BEEF CATTLE: 1. GENETIC PARAMETERS AND CORRELATIONS

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SUMMARY

Meat quality traits are instrumental in determining consumer satisfaction with beef meat products, and in defining the value of carcasses. Measurements of tenderness (as peak force: PF and compression: CMP), percent cooking loss (CLoss), meat color (ColL) and percent intramuscular fat (IMF) were recorded for meat samples from 2178 feedlot finished tropically adapted steers of two genotypes (Brahman: BRAH and Tropical Composite: TCOMP). Tenderness traits were moderately heritable in BRAH (PF = 0.33; CMP = 0.19) and TCOMP (PF = 0.32; CMP = 0.20). CLoss, ColL and IMF traits were more heritable in TCOMP (0.22, 0.42 and 0.60 respectively) than BRAH (0.09, 0.20 and 0.42 respectively). Genetic correlations between meat quality traits indicated that selection for individual traits would not negatively impact other meat quality measures. The genetic relationships between ColL and PF in BRAH, and between ColL and CMP, and IMF and CMP in TCOMP, suggest that opportunities may exist for indirect selection for tenderness in tropically adapted cattle.

INTRODUCTION

Tenderness is the most important factor in determining consumer satisfaction with cooked beef products (Egan, *et al.* 2001), Meat quality is, however, a multifaceted trait, influenced by a number of components. Bouton *et al.* (1975) showed that a combination of tenderness (measured objectively as both shear force and compression) and moisture loss during cooking, explained approximately 85% of the variation in sensory tenderness scores given by a taste panel. The visual appearance of meat represents an important quality trait in determining consumer decisions to purchase beef (Wulf and Wise 1999), and researchers have demonstrated a relationship between meat colour and tenderness.

Thompson (2004) demonstrated that percent intramuscular fat (IMF) had moderate, positive phenotypic correlations (r = 0.35 to 0.41) with taste panel assessed meat quality traits (tenderness, juiciness, flavor and overall liking). Johnston (2001) examined the genetic components of these relationships, and reported that IMF was heritable in tropically adapted animals ($h^2 = 0.39$), and that moderate favorable genetic correlations existed between IMF and taste panel scores for tenderness, juiciness, flavor and overall liking in tropically adapted genotypes ($r_g = 0.29$ to 0.54).

This study aimed to estimate the genetic parameters of objectively measured meat quality traits in tropically adapted cattle, and to examine the genetic relationships between these measurements, This represents the initial work in a larger study of the impact of selection for meat quality on production, adaptation and fertility traits in tropically adapted cattle.

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MATERIALS AND METHODS

Animals. The experiment involved steers of two tropically adapted genotypes: Brahman and Tropical Composite (which comprised 50% *Bos indicus* or African Sanga, and 50% non-adapted *Bos Taurus* genetics). The cattle were bred on 8 co-operating properties in Queensland and the Northern Territory with calving taking place over 4 years from 1999 to 2002.

After weaning, steers (986 BRAH and 1192 TCOMP) were relocated to one of five backgrounding properties, where they were grown out to feedlot entry, at a mean group target liveweight of 400kg. Steers were implanted with a hormonal growth promotant (COMPUDOSE®) at an average age of 10 months. Implants were replaced to maintain treatment levels until feedlot exit. Steers were slaughtered after an average 119 days in the feedlot.

Measurements. Animals were slaughtered and the right sides were hung by the Achilles tendon. Sides were chilled overnight, and at 24 hours post mortem, a 15cm sample of the *M. Longissimus thoracis et lumborum* (LD) muscle was collected caudal to the $12/13^{th}$ rib, and frozen for later meat quality measurements. These included peak force (PF), compression (CMP), cooking loss (CLoss) and meat colour (ColL: using a Minolta Chroma Meter, which assessed the brightness of samples on a unit-less scale, with higher results indicating a brighter, lighter meat colour). Samples were thawed, cooked in a water bath (70^0C for 60min) and chilled overnight, prior to PF and CMP measurement. CLoss was computed as the difference in the weight of the sample pre- and post- cooking. A second sub-sample of the LD was used to measure percent intramuscular fat (IMF) using a near infra-red spectrophotometry method. See Perry *et al*. (2001) for a complete description of methodologies regarding meat sample preparation and trait measurement.

Statistical analysis. Records more than 3 standard deviations from the contemporary group (defined by the animal's property of origin, year of birth and growout location) mean were identified as outliers and removed from the analysis. For BRAH this removed 1 ColL and 1 IMF record from the analysis, and for TCOMP: 2 ColL and 18 IMF records. Fixed effect models for each trait by genotype combination (including a pooled dataset which included records for both genotypes) tested the significance of: year, month and location of birth, growout location, feedlot management groups and date of kill. Terms to account for possible heterosis were tested in models for TCOMP, and genotype was tested for the combined dataset. Genetic parameters and predicted means were estimated using an animal model in ASReml (Gilmour *et al.* 1999), and with a relationship matrix based on a 3 generation pedigree. Genetic correlations were estimated (for traits with heritabilities greater than 0.10) from bivariate analyses, and predicted means were calculated based on the results for 320 BRAH and 362 TCOMP from the same location, and managed together since birth.

RESULTS AND DISCUSSION

Table 1 presents the number of records for each trait (n), model predicted means (PMeans), phenotypic variances (V_p) and heritabilities (h^2), for meat quality traits. PMeans for BRAH and TCOMP were comparable to those reported by Johnston *et al.* (2003) and Reverter *et al.* (2003), for animals of similar genotypes. TCOMP were significantly more tender than BRAH for PF (TCOMP = 4.70, BRAH = 5.48) and CMP (TCOMP = 1.80, BRAH = 2.01), and displayed more IMF (TCOMP = 3.13, BRAH = 2.34). No significant differences in ColL or CLoss were observed between the genotypes in this experiment. Heritabilities for tenderness were comparable to those reported by Johnston *et al.* (2003), where PF and CMP measurements had a heritability of 0.30 and 0.19 respectively for a pooled analysis of tropically adapted genotypes.

The heritabilities for IMF were significantly different for BRAH (h^2 = 0.24) and TCOMP (h^2 = 0.60), and were respectively lower, and higher than the result of 0.39 presented by Reverter *et al.* (2003) in an analysis of pooled IMF data from tropically adapted genotypes.

Table 1. Number of measurements (n), predicted means (PMean) phenotypic variances (σ_P^2), and heritabilities (h^2), for meat quality traits in Brahman and Tropical Composite steers

Trait	Brahmans				Tropical Composite			
	n	PMean*	σ_P^2	h^2 (SE)	n	PMean*	σ_P^2	h^2 (SE)
PF (kg)	955	5.48^A	1.12	0.33 (0.10)	1,174	4.70^B	1.09	0.32 (0.10)
CMP (kg)	977	2.01^A	0.07	0.19 (0.08)	1,183	1.80^B	0.06	0.20 (0.08)
CLoss (%)	971	23.2^A	5.3	0.09 (0.07)	1,117	22.5^A	4.8	0.22 (0.08)
ColL	928	38.9^A	6.7	0.20 (0.10)	1,049	39.0^A	6.6	0.42 (0.11)
IMF (%)	840	2.34^A	0.50	0.24 (0.09)	1,165	3.13^B	0.95	0.60 (0.15)

* Predicted genotype means for 320 BRAH and 362 TCOMP steers managed together since birth.
[A,B]Predicted means with different superscripts, in the same row, were significantly different (P<0.05).

The heritability (Table 1) for BRAH ColL (h^2 = 0.20) was consistent with the results reviewed by Marshall (1999) (average h^2 = 0.29), but for TCOMP, heritability (h^2 = 0.42) was higher than most estimates reported in the literature. Similarly, Johnston *et al.* (2003), reported a heritability of 0.18 for ColL measured, in tropically adapted animals. Heritabilities for cooking loss were lower for BRAH (h^2 = 0.09) than TCOMP (h^2 = 0.22), similar to the results of Johnston *et al.* (2003) (h^2 = 0.22).

Table 2 presents genetic and phenotypic correlations between meat quality traits. For both genotypes, there were positive genetic correlations between measures of tenderness (r_g between PF and CMP = 0.78 for BRAH and 0.64 for TCOMP). IMF had consistent negative genetic relationships with measures of tenderness, suggesting that selection for increased marbling would improve PF and CMP in tropically adapted animals.

Table 2. Genetic (above diagonal) and phenotypic (below diagonal) correlations between meat quality traits in Brahman (BRAH) and Tropical Composite (TCOMP) steers

Trait		PF	CMP	CLoss	ColL	IMF
BRAH:	PF (kg)	-	0.78 (0.33)	.	-0.66 (0.23)	-0.24 (0.25)
	CMP (kg)	0.33 (0.03)	-	.	-0.54 (0.30)	-0.08 (0.32)
	CLoss (%)*	.	.	-	.	.
	ColL	-0.28 (0.03)	-0.22 (0.03)	.	-	0.78 (0.25)
	IMF (%)	-0.17 (0.04)	-0.22 (0.04)	.	0.25 (0.04)	-
TCOMP:	PF (kg)	-	0.64 (0.17)	0.06 (0.26)	-0.26 (0.21)	-0.35 (0.18)
	CMP (kg)	0.41 (0.03)	-	0.37 (0.26)	-0.80 (0.17)	-0.72 (0.16)
	CLoss (%)	0.16 (0.03)	0.27 (0.03)	-	-0.12 (0.24)	-0.57 (0.17)
	ColL	-0.16 (0.03)	-0.16 (0.03)	-0.11 (0.03)	-	0.42 (0.16)
	IMF (%)	-0.13 (0.04)	-0.24 (0.04)	-0.22 (0.04)	0.18 (0.04)	-

* Genetic correlations for CLoss in BRAH not presented as heritability < 0.10

Meat color had a positive genetic relationship with IMF in both genotypes, and a consistently negative correlation with both measures of tenderness, indicating that selection for higher ColL could produce significant genetic improvements for PF (r_g = -0.66) and IMF (r_g = 0.78) in BRAH and CMP (r_g = -0.80) and IMF (r_g = 0.42) in TCOMP. CLoss, measured in TCOMP, had a significant negative genetic correlation with IMF (r_g = -0.57), while relationships between CLoss and other meat quality traits were small and non-significant.

Phenotypic correlations were consistently of a lower magnitude than the genetic though the directions were comparable. The phenotypic correlation between PF and CMP (r_P = 0.33 and 0.41 for BRAH and TCOMP respectively) were moderate, but with this exception, the potential for indirect phenotypic assessment of meat quality traits, seems limited in tropically adapted animals.

CONCLUSIONS

Meat quality traits examined in this experiment (with the exception of CLoss in BRAH) were heritable in tropically adapted cattle. Genetic and phenotypic correlations were universally in a favorable direction, such that selection to improve one trait would not adversely affect others. The magnitude of the genetic correlations between ColL and PF (BRAH), ColL and CMP (TCOMP), and IMF and CMP (TCOMP), suggest that opportunities may exist for more easily measured traits to act as indirect genetic indicators of tenderness in tropically adapted cattle. Having established that selection to improve meat quality is possible in tropically adapted cattle; future research will examine the genetic relationships between these and early production, adaptation and fertility traits which dictate the ability of these genotypes to perform in Australia's northern environments.

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