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Identification of a Brahman sire whose progeny have high marbling scores and high intramuscular fat content

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Summary. A Brahman sire (Select Brahman) whose steer progeny had both high marbling scores and high intramuscular fat content has been identified. The effect was independent of dam breed (5 different dam breeds were analysed), was present in both grain-finished and pasture-finished progeny, and was independent of hormone growth promotant treatment. From pasture, over twice as many progeny from the Select sire (62.5%) had high marbling scores as progeny from 10 other Brahman sires (25.9%). The effect was not as marked in grain-finished steers but the Select sire still produced one-third more high marbling progeny (84.6%) than the other sires (63.6%). The Select sire's progeny were equal to or better than progeny from Tuli sires in producing high marbling scores. The intramuscular fat content (3.5 ± 0.3 g/100 g) of the progeny from the Select sire was greater than double that of progeny from other Brahman sires (1.9 ± 0.2 g/100 g; P<0.0001) and higher than progeny from Tuli sires (2.3 ± 0.1 g/100 g; P<0.0001). The increased marbling and intramuscular fat content were not associated with increased subcutaneous fat deposition, decreased muscle deposition, lower growth rate or smaller mature size since there were no differences in age, hot standard carcass weight, rump fat depth and rib eye muscle area between the Select sire's progeny and those of other Brahman sires. The identification of a high marbling trait in a *Bos indicus* sire is of considerable significance to the northern Australian beef industry because it enables markets requiring marbled carcasses to be targeted while maintaining the advantages of tropical adaptation.

Introduction

The Japanese grain-fed and pasture-fed beef market, which shows a preference for greater marbling, is Australia's most valuable beef export market. Since much of Australia's export beef is produced in the harsh production environment of northern Australia (Bindon *et al.* 1995), it would be economically advantageous to have lines of tropically adapted cattle that marbled readily. Most beef cattle in northern Australia contain a high proportion of the Brahman genotype because it is adapted to the production environment. Numerous studies have indicated that this genotype has inherently low marbling capacity relative to *Bos taurus* breeds (Crouse *et al.* 1989; Cundiff *et al.* 1996; Chappell 1997). Cross-breeding of Brahmans with *Bos taurus* breeds has many production advantages through combining resistance to tropical stressors with high growth potential and high fertility. However, cross-breeding has little effect on marbling because of negligible heterosis for this character (Comerford *et al.* 1988). Selection for marbling within breeds has been seen as a long-term process with limited economic viability unless a 'prepotent marbling score sire' is identified (Francis 1996). This study investigated the possibility that such sires might exist, particularly in the Brahman breed, among a range of tropically adapted breeds (Frisch and O'Neill 1998). Preliminary identification of such a sire, here identified as the Select sire, allowed comparison of marbling and intramuscular fat content from progeny of this sire to that from progeny of other Brahman sires and progeny from Tuli sires. Comparison with the Tuli breed, which has typical *Bos taurus* marbling characteristics (Cundiff *et al.* 1996), was undertaken as a preliminary step to benchmark the Select sire against *B. taurus* breeds.

Materials and methods

Animals and measurements

The experimental animals were 89 steers produced from 11 Brahman (B) sires (includes the 'Select' sire) and 77 steers from 11 Tuli (Tu) sires mated with Belmont Red (BR), B, Brahman cross (BX), Brahman x

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Table 1. Number of progeny finished on pasture or on grain across sire group and dam breed

BR, Belmont Red; B, Brahman; BX, Brahman cross; F1, Brahman x Hereford–Shorthorn first cross; HS, Hereford–Shorthorn

Sire	Dam breed					Total
	BR	B	BX	F1	HS	
			Grain-finished steers			
Select Brahman	2	3	3	2	3	13
Other Brahman	9	7	7	4	6	33
Tuli	8	9	8	7	6	38
Total	19	19	18	13	15	84
			Pasture-finished steers			
Select Brahman	1	10	3	2	0	16
Other Brahman	9	3	4	7	4	27
Tuli	11	10	9	5	4	39
Total	21	23	16	14	8	82

Hereford–Shorthorn first cross (F1) or Hereford–Shorthorn (HS) dams (Table 1) in 1993 and 1994 at The National Cattle Breeding Station, Belmont, Queensland. More detailed descriptions of the breeds and the growth and finishing procedures can be found in Frisch and O'Neill (1998). The 'Select' sire was one of a group of randomly sampled commercial seed stock sires selected for inclusion in a cross-breeding study (Frisch and O'Neill 1998).

Within each year, all animals were born and reared together until they reached the finishing phase. From 8 to 16 months of age, half the animals were treated for external and internal parasites (treated) and half were left untreated (control). They were castrated at about 16 months of age. At 18 months of age, the steers were randomly divided into 2 groups for pasture finishing and grain finishing in a feedlot and were treated with a hormone growth promotant (HGP). Grain-finished animals received Compudose 200 and pasture-finished animals received Compudose 400.

Steers were slaughtered when the average liveweight of groups (e.g. feedlot pen of 22 animals) was 625 kg which was set so that all animals would meet the requirements of the Japanese Ox market for carcasses >300 kg. The age of the animals at slaughter (AGE; months) was calculated from production records. Hot standard carcass weight (HSCW; kg) and hot P8 fat depth (P8FAT; mm) were recorded at slaughter (AUS-MEAT 1996). After chilling the carcasses overnight, rib eye muscle area at the 10/11th rib (REMA) was measured. Striploin samples were aged for 8 days and then frozen. Marbling score (AUS-MEAT 1996) was assessed after thawing and samples were analysed for intramuscular fat content by solvent extraction (IMFAT; g/100 g). Marbling score was divided into 2 categories—low (score of 0 or 1), and high (score of 2 or 3).

Statistical analyses

The aim of the analysis was to compare the progeny from the Select Brahman sire with progeny from a random sample of other Brahman sires and progeny from Tuli sires. The design of the experiment allowed for accumulation of data over 2 years with the Select sire linking the years to account for year effects. Results from the Select sire's progeny did not differ significantly between years suggesting that the effect of years was not important but progeny were too few to ascertain this definitively. One of the other Brahman sires and 5 of the 11 Tuli sires were represented in both years. There were no significant differences due to year in that group and there was no sire x year interaction. Therefore, to increase the total number of progeny from the Select Brahman sire in each cell, year was not included as an effect in the analysis.

Although there was no replication of finishing groups, the 2 finishing methods were treated as a fixed effect for the purpose of statistical analysis. The HGP treatment was categorised as active if the animal had an active implant at slaughter. Animals that had lost the implant before slaughter or were slaughtered after the expiry date of the implant were categorised as having inactive HGP treatment.

Continuous variables (IMFAT, P8FAT, AGE, HSCW, REMA) were modelled by the GLM procedure of SAS (SAS Institute, Cary, USA). Models tested included the fixed effects of sire (Select Brahman, other Brahman, Tuli), dam breed (BR, B, BX, F1, HS), finish method (grain, pasture), parasite treatment (treated, control) and HGP status (active, inactive). A systematic procedure was used to eliminate non-significant effects and 2-way interactions between significant effects were tested. Pairwise comparisons of means, where appropriate, were conducted by the least significant difference method (SAS Institute, Cary, USA). The proportion of high marbling progeny was modelled using the GENMOD procedure of SAS (SAS Institute, Cary, USA) with sire and finish method as main effects.

Results

Table 1 shows the distribution of animals by sire, dam breed and finishing regime. The total number of animals was 166. Overall means for the measured variables are presented in Table 2. Sire, finishing regime and HGP status were significant for the variables measured. Parasite treatment and dam breed were not significant. No interactions were significant. Intramuscular fat content for the progeny from the Select sire was higher than that for other Brahman-sired progeny [l.s.d. (P = 0.0001); Table 2] while there was no difference in P8 fat depths. The Tuli-sired progeny also had less intramuscular fat than the Select sire progeny [l.s.d.

Table 2. Effect of sire, finish type and hormone growth promotant treatment on intramuscular fat content, P8 fat depth, age, standard hot carcass weight and rib eye muscle area

Values are least squares means ± s.e.
Means within sire effect followed by the same letter are not significantly different at *P* = 0.05

	IMFAT (g/100 g)	P8FAT (mm)	AGE (days)	HSCW (kg)	REMA (cm^2)
Overall means	2.3 ± 0.1	14.6 ± 0.4	989 ± 11	335 ± 2	72 ± 1
			Sire		
Select Brahman	3.5 (± 0.3)a	16.9 (± 0.8)a	1008 (± 12)ab	338 ± 4	67 (± 2)a
Other Brahman	1.9 (± 0.2)b	16.3 (± 0.6)a	991 (± 9)a	339 ± 3	69 (± 2)a
Tuli	2.3 (± 0.1)b	13.4 (± 0.5)b	1031 (± 9)b	336 ± 3	76 (± 2)b
Significance	*P*<0.0001	*P*<0.0001	*P*<0.005	n.s.	*P*<0.001
			Finish		
Grain	3.1 ± 0.2	17.9 ± 0.5	940 ± 8	342 ± 3	71 ± 1
Pasture	2.0 ± 0.2	13.1 ± 0.5	1081 ± 7	334 ± 3	70 ± 2
Significance	*P*<0.0001	*P*<0.0001	*P*<0.0001	*P*<0.05	n.s.
			Hormone growth promotant		
Active	2.3 ± 0.1	14.0 ± 0.5	927 ± 7	329 ± 2	71 ± 1
Inactive	2.8 ± 0.2	17.0 ± 0.6	1094 ± 9	346 ± 2	70 ± 2
Significance	*P*<0.01	*P*<0.0001	*P*<0.0001	*P*<0.0001	n.s.

(*P* = 0.0001)] but this was accompanied by a significantly lower P8 fat depth [l.s.d. (*P* = 0.0003)]. Fat content in both depots was greater (*P*<0.0001) for grain-finished progeny than pasture-finished progeny. Active HGP implants reduced fat content in both depots but was accompanied by lower carcass weight and younger slaughter age (Table 2).

There were no significant differences in AGE, HSCW or REMA between steers sired by the Select sire and those sired by the other Brahman sires (Table 2). There were no differences between Select sire progeny and Tuli progeny in AGE or HSCW but the Tuli progeny had significantly higher REMA than Brahman progeny (Table 2). Carcasses finished on grain were younger, heavier and fatter than carcasses finished on pasture but there were no differences in REMA. Active HGP implants also had no effect on REMA. Although active HGP implants resulted in lighter carcasses, this occurred at a much lower slaughter age than for the inactive implants (Table 2).

There was a significant (*P*<0.0001) difference in the proportion of steers with high marbling score (score of 2 or 3) between progeny from the Select sire and progeny from the other Brahman sires (Table 3). The effect was consistent in both finishing methods but most prominent in the pasture-finished steers. Similar proportions of Select-sired progeny and Tuli-sired progeny had high marbling scores both for grain-finished and pasture-finished steers (*P*<0.05). Only 4 progeny had marbling scores of 3. Two were progeny from the Select sire, one each from pasture and grain, and the other 2 were Tuli steers, both from grain.

Table 3. Effect of sire on the proportion (%) of progeny with high marbling scores [scores of 2 or 3 on the AUS-MEAT (1996) scale]

Sire	Grain-finished steers *n*	Progeny with high marbling score (%)	Pasture-finished steers *n*	Progeny with high marbling score (%)
Select Brahman	13	84.6	16	62.5
Other Brahman	33	63.6	27	25.9
Tuli	38	78.9	39	66.7
Significance of main effects				
Sire	*P*<0.0001			
Finish type	*P*<0.05			

Discussion

A Brahman sire that produces progeny with relatively high marbling scores and high intramuscular fat content has been identified. Previous studies demonstrated that the Tuli breed, a tropically adapted *B. taurus* breed with typical *B. taurus* marbling characteristics, has significantly higher marbling scores than Brahman when both breeds had similar rump fat depths (Cundiff *et al*. 1996). In the present study, Tuli-sired progeny had similar intramuscular fat content at a lower rump fat depth and a greater proportion of progeny with high marbling score than progeny sired by typical industry Brahman bulls (other Brahman). However, the Select sire progeny had higher intramuscular fat content than both the Tuli-sired progeny and the other Brahman-sired progeny. Moreover the proportion of Select-sired progeny with high marbling scores was greater than for progeny of industry bulls and equal to Tuli-sired progeny.

The Select sire therefore offers a way of introducing desirable carcass characteristics into the Brahman breed in a simple, cost effective manner. Increased intramuscular fat deposition can be achieved in all cattle at a price. Increased intramuscular fat deposition achieved by increased nutritional input, by allowing animals to grow older or by selecting smaller maturing breeds, produces undesirable increases in subcutaneous fat deposition. However, progeny from the Select sire had increased marbling scores and increased intramuscular fat levels that were not accompanied by any increase in rump fat depth. Other factors to be considered when seeking increased marbling or intramuscular fat deposition are whether the increased marbling is associated with smaller mature size, lower growth rate or reduced muscle growth. The progeny from the Select sire had similar growth potential and muscle growth relative to the progeny from other sires as demonstrated by lack of sire effects on AGE, HSCW and REMA. Furthermore, heifer progeny from the Select sire had normal reproductive performance (C. J. O'Neill and J. E. Frisch unpublished data). There are, therefore, no apparent disadvantages in using the Select sire to introduce higher marbling into the Brahman breed.

Implications

Steer progeny from the Select sire had normal Brahman growth and resistance characteristics associated with increased marbling. The possibility exists that one or a few major genes are responsible for this high marbling trait and that the genes are different from those in high marbling *B. taurus* breeds. If the genes can be identified it will make selection easier and quicker. There is scope, not only for introducing the trait into other Brahmans but also for forming tropically adapted, high marbling crossbreds or composites based on the Select sire and other high marbling breeds such as Angus.

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