THE INFLUENCE OF REPEATED TREATMENT WITH A HORMONAL GROWTH PROMOTANT ON TENDERNESS AND INTRAMUSCULAR FAT IN TROPICAL BEEF CATTLE

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SUMMARY

The effect of reimplantation with a hormonal growth promotant (HGP) on meat tenderness was investigated using steers generated from the northern crossbreeding program of the Cooperative Research Centre for the Cattle and Beef Quality. For the 1996 and 1997 calf crops, straightbred Brahman and F_1 Brahman cross steers were allocated to finish at pasture or in a feedlot, to target slaughter liveweights of 400 (Domestic Market), 520 (Korean Market) or 640kg (Japanese Market) and remained either untreated (Control) or treated every 100 days with 20mg Oestradiol-17β (Compudose® 100). The average age at first implantation was 14.2 months for the 1996 calf crop and 12.3 months for the 1997 calf crop. A least-squares analysis of the tenderness scores of the *m. longissimus dorsi* indicated that the taste panelist could detect a small reduction (P<0.05) in tenderness from the aggressive strategy (up to 725 days exposure to HGP) of implantation with an oestrogen. The effect of HGP treatment for the Pasture-finished group was 6.3 units (P<0.05) and from the Feedlot-finished group was 4.9 units (P<0.05). The reduction was greater in straightbred Brahman (13.4 units) than the F_1 Brahman cross (average of the F_1's, 3.9 units). The positive linear relationship between taste panel tenderness and intramuscular fat was significant for Pasture finish (P<0.05) and tended to significance (P<0.10) for Feedlot finish. An aggressive sustained growth promotion strategy has been shown to increase the toughness of beef, however it is unlikely that such an implant strategy will be used in commercial practice.

*Keyword*s: oestrogen, taste panel tenderness, intramuscular fat, Brahman, cattle

INTRODUCTION

Cattle hormonal growth promotants (HGP's), including the sex steroid oestrogen and androgen (a class of testosterone), lead to increased muscle mass and enhanced feed conversion efficiency (Heitzman 1980). A strategy of repeated implantation of HGP's, involving a small number of implants (up to 4 implants), will continue to boost growth in steers (Hunter *et al.* 2000) with minimal negative impacts on carcass quality (Wilson *et al.* 1999; Hunter *et al.* 2000). However, Hunter *et al.* (2001a) have shown that an aggressive reimplantation strategy with Oestradiol-17β (up to 8 implants) reduced the percentage of intramuscular fat in the *m. longissimus dorsi*. Given the complex relationships between sex steroids, growth, genotype, carcass traits and the meat quality of particular muscles (see van Weerden 1984; Bass *et al.* 1990; Harper 1999), the effects of sustained hormonal growth promotion on meat quality of tropical breeds of cattle remain to be evaluated. The objective of this experiment was to identify the consequences of using Oestradiol-17β as an aggressive growth promoter on a subjective measure of meat quality, namely taste panel tenderness, of the *m. longissimus dorsi*.

MATERIALS AND METHODS
Experimental animals and protocols
The 234 steers used in this study were obtained from the northern crossbreeding program of the Cooperative Research Centre (CRC) for Cattle and Beef Quality (Upton *et al*. 2000) in 1996 and 1997. The experimental animals, finishing treatments (Pasture, Feedlot), market destinations (Domestic, Korean, Japanese) and hormonal growth promotant strategies (control (no implant), 20mg Oestradiol-17β (Compudose® 100) every 100 days) are described in detail by Hunter *et al*. (2001b). The average age at first implantation was 14.2 months for the 1996 calf crop and 12.3 months for the 1997 calf crop. Steers allocated to the growth promotant treatment were implanted up to 8 times with exposure to the hormone of up to 725 days (steers born 1997 and finished at pasture for the Japanese market). Hunter *et al*. (2001a,b) and Thompson (2001) describe details of electrical stimulation and the

protocols that were used in carcass and eating quality assessment. All carcasses that were recorded as not being electrically stimulated were removed from the analysis. As there was no carcass with a Warner-Bratzler shear force value above 9kg the electrical stimulation of carcasses was considered to be effective. However, there were 3 records with values of 8kg that were included in the analysis.

Genotype

The steers consisted of straightbred Brahman and 4 F_1 Brahman cross genotypes. The crossbred genotypes had been born to Brahman dams and sired by bulls of the following breeds: Santa Gertrudis, Belmont Red, British (either Hereford, Shorthorn or Angus) and Continental (either Limousin or Charolais).

Intramuscular Fat and Tenderness

Intramuscular fat of the *m. longissimus dorsi* (striploin) was determined by either chemical extraction with diethyl ether in a Soxhlet apparatus or by near infrared spectroscopy (NIR). A sample of the anterior half of the *m. longissimus dorsi* was submitted to Meat Standards Australia (MSA) for estimation of tenderness by untrained consumer panels. Cooked samples were scored on a scale of 0 – 100 where 0 was the least acceptable and 100 was most acceptable.

Statistical analysis

Analysis of covariance (Statistical Analysis Systems Institute 1999 - 2000) was used to investigate the effect of HGP treatment on scores of taste panel tenderness and the relationship between taste panel tenderness and intramuscular fat. Since there was confounding between year/abattoir/estimation of intramuscular fat, the Pasture-finished and Feedlot-finished groups were analysed separately. The model consisted of fixed effects of year (1996, 1997), market destination (Domestic, Korean, Japanese), genotype (Brahman, F_1 Brahman x Santa Gertrudis, F_1 Brahman x Belmont Red, F_1 Brahman x British (Hereford, Shorthorn, Angus), F_1 Brahman x Continental (Limousin, Charolais) and hormonal implant treatment (control, HGP treatment) and covariates of intramuscular fat and carcass weight within market. In the Pasture-finished group, year was confounded with method of estimation of intramuscular fat (Soxhlet, NIR) and method was not included in the model as a fixed effect. In the Feedlot-finished group, method (Soxhlet, NIR) was included as a fixed effect with the difference between the two methods being non-significant (P>0.10). The evidence that we have is that the confounding was negligible and does not affect the conclusions we make here. Means and terms of the models were considered to be significantly different at P<0.05. Non-significant (P>0.05) interaction terms were removed from the models.

RESULTS

Average values of the taste panel scores of tenderness of cooked samples of *m. longissimus dorsi* from control and HGP treated steers for each genotype are presented in Table 1. Overall, after treatment with the oestrogenic compound, the increase in toughness of meat samples of all the F_1 steers averaged 3.9 units whilst the increase in toughness of straightbred Brahman steers was 3.4 times greater at 13.4 units (Table1).

Table 1. **Arithmetic means (± sem) for taste panel tenderness scores, where 0 was least tender and 100 most tender, of each genotype either treated with Oestradiol or not treated with Oestradiol (control)**

Treatment	Brahman	F_1 Santa Gertrudis	F_1 Belmont Red	F_1 British	F_1 Continental
Control [A]	43.6 ± 3.07 (16) [B]	46.7 ± 4.10 (11)	47.9 ± 2.15 (34)	48.8 ± 2.53 (32)	46.9 ± 2.23 (32)
Oestradiol [A]	30.2 ± 3.14 (15)	41.4 ± 4.73 (9)	44.9 ± 2.48 (30)	43.4 ± 2.65 (25)	45.0 ± 2.31 (30)

[A] Combined data from Feedlot-finished and Pasture-finished steers
[B] Number of animals in parentheses

The least-squares analysis of the taste panel scores, adjusting scores for carcass weight within market, showed that HGP treatment resulted in a small but significant (P<0.05) reduction in tenderness for both Pasture-finished (6.3 units) and Feedlot-finished (4.9 units) groups. Although the reduction was consistent for each market (Domestic, Korean, Japanese), and occurred in all genotypes, the reduction was not uniform across all genotypes. Unlike Brahmans, whose reduction was significant (P<0.05), the reduction for F_1 Belmont Red tended towards significance (P<0.10) and the reduction for the remaining 3 genotypes was not significant (P>0.10). Genotype was also a significant fixed effect for taste panel tenderness in both Pasture (P<0.05) and Feedlot-finished (P<0.01) groups. Brahmans had consistently the lowest scores for taste panel tenderness whilst F_1 Continental and F_1 British the highest scores in Pasture and Feedlot finish respectively.

The regression coefficients for the effects of both carcass weight within market and intramuscular fat are presented in Table 2. The R^2 value for the Pasture-finished and Feedlot-finished models was 45.7 and 29.5% respectively. Carcass weight within market was not significant ($P>0.10$) for either Pasture or Feedlot finish. The adjustment of tenderness for intramuscular fat was significant ($P<0.05$) for Pasture finish and tended to significance ($P<0.10$) for Feedlot finish. The positive linear relationship between taste panel tenderness and intramuscular fat accounted for an additional 5.5% and 1.8% of the variation for tenderness score for Pasture and Feedlot finish respectively. Moreover, adjusting for intramuscular fat generally resulted in less difference between the control and treatment within the genotypes, with all F_1s being non-significant at $P>0.10$, leaving only Brahmans with a significant ($P<0.05$) increase in toughness after treatment with oestradiol.

Table 2. Regression coefficients (± sem) for the effects of carcass weight within market and intramuscular fat on taste panel tenderness.

		Pasture finish		Feedlot finish	
		Tenderness score	Significance level, P	Tenderness score	Significance level, P
Carcass weight (kg)	Within market:				
	Domestic	-0.08 ± 0.108	>0.10	-0.11 ± 0.095	>0.10
	Korean	0.11 ± 0.106	>0.10	-0.01 ± 0.043	>0.10
	Japanese	0.02 ± 0.064	>0.10	-0.01 ± 0.044	>0.10
Intramuscular fat (%)		4.70 ± 2.030	<0.05	2.28 ± 1.218	<0.10

DISCUSSION

The beneficial effects of hormonal growth promotants within the beef production process are well documented, although there is some concern for the negative impact of growth promotants on intramuscular fat and meat tenderness (see review by Duckett *et al.* 1997). After reviewing the scientific literature, Harper (1999) concluded that the negative effect of implants, as they are used commonly in Australia, on tenderness was minimal. However, the majority of scientific literature deals with *Bos taurus* breeds. The present study reports the first data for *Bos indicus* and F_1 *Bos indicus* crossbreds. The data presented indicate that finishing strategies for Brahman and F_1 Brahman crossbreds, involving repeated use of implants of Oestradiol-17β, results in a small but significant ($P<0.05$) increase in meat toughness. That the analysis of the first year (1996) of the data from the CRC experiment (Hunter *et al.* 2001b) did not reveal a significant reduction in tenderness scores can be attributed to the small number of animals (n=69) in the initial analysis compared to the number of animals (n=234) in the current analysis. Gerken *et al.* (1995) also documented a significant ($P<0.05$) reduction in taste panel scores for tenderness of top sirloin steaks from cloned Brahman x Angus (Brangus) steers that had received a single implant of an oestogenic compound. The data in Table 1 and Gerken *et al.* (1995) suggest that consumers can detect increased toughness of meat from steers of high Brahman content that have undergone oestrogenic growth promotion.

The larger reduction in tenderness score of the *m. longissimus dorsi* from straightbred Brahman compared to F_1 Brahmans (Table 1) is also consistent with the relationship between taste panel tenderness and intramuscular fat presented in Table 2. The positive relationship between tenderness and intramuscular fat (Table 2) augments the understanding of the connection between meat quality and muscle fat as a positive, although curvilinear, relationship has also been found between intramuscular fat and taste panel scores of flavour and juiciness (Thompson 2001). As Brahmans have been shown to be the least tender (Crouse *et al.* 1989) and have the least intramuscular fat (see Burrow 2001) of the 5 genotypes, the compounding effect of reduced levels of intramuscular fat from HPG treatment (Duckett *et al.* 1997; Hunter *et al.* 2001a) result in the relatively larger reductions in tenderness score of Brahmans from the implantation strategy (Table 1). Moreover, after treating vealers with an oestradiol growth promotant, van Weerden (1984) found that, at least for the *m. longissimus dorsi* and not two other muscles, there was a small but negative ($P<0.05$) response in the scores of tenderness from a taste panel. Thus, there is evidence that the negative response in tenderness from treatment with oestradiol was muscle specific and was associated with leaner carcasses, as in Brahmans and vealer calves.

Given that oestrogen has an anabolic action on growth that is antagonistic (eg. stimulating cell growth, inhibiting somatomedins) (Spencer 1985) it follows that any negative impact on carcass and meat quality may also be inconsistent. Harper's (1999) conclusion, from a review of the scientific literature, that fat content contributed little to tenderness may only apply to less aggressive strategies of oestradiol treatment and/or to carcasses of higher levels of fat and/or to muscles other than the *m. longissimus dorsi*. The evidence from Tables 1 and 2 suggests that intramuscular fat takes on greater importance for taste panel measures of tenderness of the striploin at reduced levels of intramuscular fat, as with prolonged oestradiol treatment, and in those genotypes known to yield relatively leaner carcasses.

The sustained growth promotion strategy (4 implants per year) used in this experiment is greater than would be used in commercial practice. In another study at this laboratory (Hunter *et al*. unpublished) it was found that implantation with Oestradiol-17β twice a year was not associated with a reduction of tenderness of meat of high-grade Brahman steers, measured objectively by the Warner-Bratzler shear force. Nevertheless, the current study adds to the body of knowledge about HGP's that producers with high content Brahmans can use to prepare their cattle for target markets.

ACKNOWLEDGEMENTS

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