The influence of hormonal growth promotants on marbling

R.A. Hunter, G.J. McCrabb and C.J. O'Neill

CRC for Cattle and Beef Quality

CSIRO Livestock Industries

J.M. Rendel Laboratories

Rockhampton Queensland

Phone: 07 4923 8142; Email: Bob.Hunter@li.csiro.au

Abstract. The paper lists 15 different commercial products containing hormonal growth promotants (HGPs). HGPs contain synthetic forms of the steroids oestrogens, androgens or progestins. Results from the USA confirm that there are small but variable reductions in marbling associated with HGP treatment of grain-finished cattle. Experiments in the CRC's Northern Crossbreeding study confirm that significant reduction in marbling (25%) occurred only in pasture-finished steers treated with oestradiol-based HGPs for prolonged periods (minimum 367 days).

Introduction

The hormonal growth promotants (HGPs) registered for use in the Australian beef industry have physiological properties similar to those of sex steroids. Their action is anabolic in that they increase nitrogen retention and protein deposition in animals (Heitzman 1980). The effects they may have when administered to cattle are:

- increased growth rate
- increased muscle mass
- improved feed conversion efficiency
- changes in lean fat to ratio

Hormonal growth promotants are either androgens, oestrogens or progestins. The androgens include testosterone and trenbolone acetate, the oestrogens oestradiol and zeranol, while the only progestin in use in Australia is progesterone. The HGP products registered for use in Australia in cattle are listed in Table 1. There is scope for confusion because the same hormones or combination of hormones are used in a number of proprietary products. This list can be simplified if the products are classified by their functional hormones rather than their brand names (Table 2). The choice of which HGP to use in which beef production system becomes less confusing.

Table 1. Implant Products currently available in Australia.

Overview of HGP treatment and

Implant name	Functional life (days)	Active oestrogen	Active androgen	Other hormone	Class
Compudose 100	100-120	20 mg oe	nil	nil	Steers and heifers
Compudose 200	~200	24 mg oe	nil	nil	Steers and heifers
Compudose 400	~400	45 mg oe	nil	nil	Steers and heifers
Progro H	100-120	20 mg oe benzoate	200 mg test prop	nil	Heifers
Progro S	100-120	20 mg oe benzoate	nil	200 mg prog	Steers
Progro TE-S	100-120	24 mg oe	120 mg tba	nil	Steers
Ralgro	100-120	36 mg zeranol	nil	nil	Steers
Revalor S	100-120	24 mg oe	120 mg tba	nil	Steers
Revalor H	100-120	20 mg oe	200 mg tba	nil	Heifers
Revalor G	100-120	[illegible] mg oe	[illegible] mg tba	nil	Steers and heifers
Synovex with TBA	100-120	24 mg oe benzoate	200 mg tba	nil	Steers and heifers
Synovex H	100-120	20 mg oe benzoate	200 mg test prop	nil	Heifers
Synovex S	100-120	20 mg oe benzoate	nil	200 mg prog	Steers
Synovex C	100-120	10 mg oe benzoate	nil	100 mg prog	Calves
Ralgro	100-120	36 mg zeranol	nil	nil	Steers, heifers, calves

oe, oestradiol-17β; test prop, testosterone propionate; tba, trenbolone acetate; prog, progesterone

Table 2. Implants for steers and heifers classified by functional hormones.

Growth promoting hormone	Functional life (days)	Product
Zeranol	100-120	Ralgro
Oestradiol	100-120	Compudose100, Synovex S, Synovex C, Progro S
Oestradiol	~200	Compudose 200
Oestradiol	~400	Compudose 400
Oestradiol + trenbolone acetate	100-120	Progro TE-S, Synovex Plus, Revalor G, Revalor S, Revalor H
Oestradiol + testosterone	100-120	Progro H Synovex H

marbling

The one statement that can be made with some degree of confidence is that treatment of cattle with an HGP does not increase marbling. This effect is consistent with the anabolic nature of HGPs and their propensity to increase muscle deposition rather than fat deposition. The other statement that has some validity is that treatment with an HGP is likely to result in a small decrease in marbling. In a review of 37 experiments in the USA in which steers were finished on grain-based diets, Duckett *et al.* (1997) detected a mean reduction of 24% in marbling associated with use of a variety of HGPs. The difference between implanted and non-implanted cattle ranged from -72% to +31%. This range presumably reflected the lack of precision in marbling score assessed visually in abattoirs. The lines of best fit which describe the relationship between marbling score and final yield grade in the data summarised by Duckett *et al.* (1997) are shown in Figure 1. These data were collected from individual experiments. A variety of implant strategies which ranged from multiple implantations with combinations of oestrogens and androgens to single implantations with oestrogens were used. All implanted and non-implanted cattle in the individual experiments were fed for the same number of days, rather than to the same market weight. Implanted cattle were heavier. The figure clearly demonstrates that at any USA yield grade, cattle treated with growth promoting hormones are likely to have lower marbling score than cattle not treated with HGP's.

Different hormones and combinations of hormones have a differential effect on the extent of marbling. Duckett *et al.* (1997) have subdivided the oestrogenic implants into

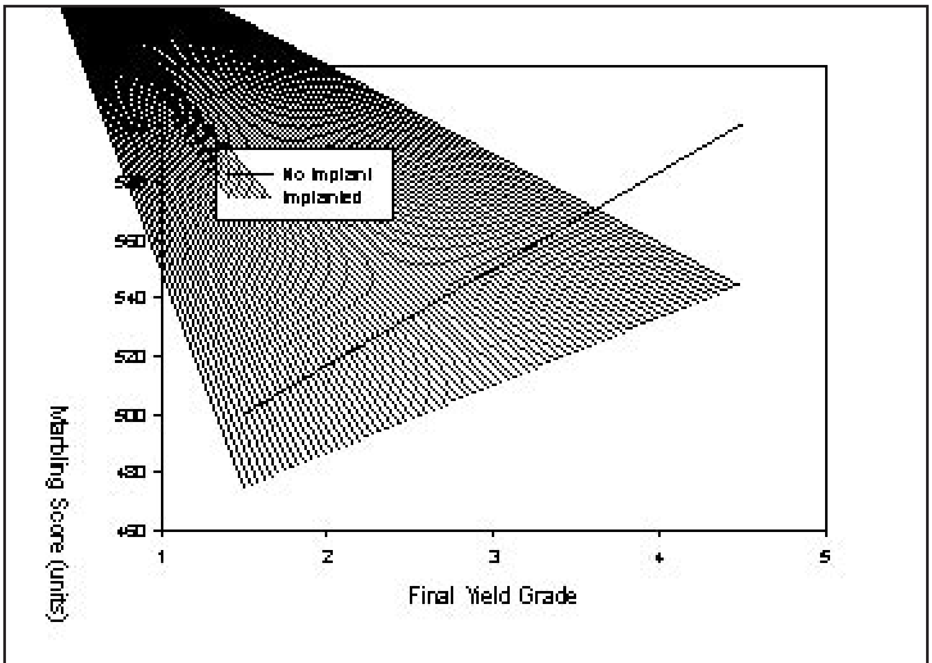

Figure 1. Lines of best fit to describe the relationship between marbling score and final yielld grade (Duckett *et al.* 1997).

strong and mild. Implants containing both oestradiol and progesterone, such as Synovex S are classified as strong oestrogens whereas implants such as Compudose and Ralgro which contain only oestradiol or zeranol are classified as mild oestrogens. The analysis of experimental data found that mild oestrogens depress marbling to a lesser extent than strong oestrogens or combinations of a mild oestrogen with an androgen.

There is evidence that the HGP induced decrease in marbling is associated with a dilution of intramuscular fat in a larger muscle. In studies in the USA ribeye area has been increased from 4% to 7% by implantation (Milton *et al.* 1996; Duckett *et al.* 1999). This suggests that the main effect of HGP treatment is to increase protein deposition while not having a profound effect on fat deposition.

Aggressive oestrogen treatment and marbling

Experimentation in the CRC for the Cattle and Beef Industry (Meat Quality) developed a strategy for sustained growth promotion from the first wet season after weaning until slaughter. The implantation strategy was aggressive. Half the steer progeny in a crossbreeding programme with tropical genotypes were treated with 20mg oestradiol -17ß (Compudose 100) every 100 days. Steers finished on pasture for the Japanese market (640 kg liveweight) received as many as 7 implants. The methodological details of this study are given elsewhere (Hunter *et al.* 2001). Intramuscular fat deposition on different cohorts of steers that went to slaughter in different years was measured by one of two procedures; solvent extraction and near infrared spectroscopy (NIR).

Table 3 gives the eye muscle area, depth of subcutaneous fat at the P8 rump site and marbling fat in the *longissimus dorsi* muscle. Because HGP treated animals were substantially heavier at slaughter, the comparison presented in the table is at the same carcass weight.

The aggressive oestradiol treatment had no significant effect on the extent of intramuscular fat deposition in steers finished in a feedlot for the domestic (400 kg liveweight), Korean (550 kg liveweight) and Japanese markets. These steers had been implanted up to 4 times and were exposed to the hormone for up to 367 days. Only in steers finished at pasture for the Japanese market was the decrease in intramuscular fat deposition statistically significant. The magnitude of the decrease was about 25 %. There were implanted up to 8 times and the minimum exposure to the hormone was for 367 days. For the other groups in which statistical significance was not reached, the change in marbling associated with HGP treatment ranged from -13% to +9%. This variation in the direction of the effect, albeit with small groups of animals, is similar to that reported in individual experiments by Duckett *et al.* (1997).

It is interesting to note that the effect of HGP treatment on depth of subcutaneous fat at the P8 rump site was similar to that for intramuscular fat (Table 3). Only in steers finished at pasture for the Japanese market with long exposure to aggressive oestradiol treatment was the decrease in fat depth associated with HGP treatment statistically significant. These findings suggest that even aggressive treatment with oestradiol has a minimal effect on fat deposition within the various fat depots of the carcass, unless treatment is for a very prolonged period.

The CRC experiment in which Brahman cows were mated to bulls of different genotype allows the effect of repeated oestradiol treatment on marbling in steers of different genotypes to be determined. Table 4 gives the intramuscular (*Longissimus dorsi*) fat of steers finished at pasture or in a feedlot for all 3 markets (Domestic, Korean, Japanese). Not surprisingly the deposition of marbling fat was greatest in the F_1 Brahman x British (Hereford, Shorthorn, Angus) and F_1 Brahman x Belmont Red genotypes and least in the pure bred Brahmans and F_1 Brahman x European (Charolais, Limousin) genotypes. The effect of oestradiol treatment was significant ($P<0.05$) when data from both solvent extraction and NIR procedures were combined and number of observations more than doubled. The treatment by genotype interaction remained non-significant. The latter means that the effect of the hormone on the deposition of intramuscular fat was similar in each genotype.

Conclusions

The evidence from both the USA and Australia is that treatment of cattle with oestradiol (mild oestrogent) results in only a small, and perhaps undetectable, decrease in marbling. Only when an aggressive implant strategy is continuously imposed for a prolonged time is the decrease in marbling noticeable. Use of androgens in implants with a combination of oestrogens and androgens is likely to lead to a greater decrease in marbling than when oestrogens are used alone.

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Table 3. Effects of aggressive oestradiol treatment on fat deposition in straightbred Brahman and F, Brahman crossbred steers

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(Data were adjusted by covariance for carcass weight within market.) (Values are mean (s.e.m.)
NIR, near infrared
* Solvent extraction and NIR procedures were conducted on samples of muscle from different animals.

Table 4. Effect of aggressive oestradiol treatment on intramuscular fat deposition in different genotypes

Genotype	Intramuscular fat (%)* (solvent extraction)			Intramuscular fat (%)* (solvent extraction + NIR)		
	Control	Oestradiol	Genotype overall	Control	Oestradiol	Genotype overall
Brahman	2.0 0.21 (n=24)	2.0 0.21 (n=19)	2.0 0.17 (n=43)	2.4 0.14 (n=41)	2.2 0.15 (n=36)	2.3 0.11 (n=77)
F1 Santa Gertrudis	2.3 0.25 (n=12)	1.9 0.27 (n=9)	2.1 0.20 (n=21)	2.4 0.18 (n=20)	2.0 0.19 (n=16)	2.2 0.14 (n=36)
F1 Belmont Red	2.7 0.17 (n=29)	2.5 0.19 (n=26)	2.6 0.14 (n=55)	3.0 0.10 (n=67)	2.7 0.13 (n=54)	2.8 0.09 (n=121)
F1 [illegible]	2.6 0.20 (n=21)	2.5 0.20 (n=19)	2.6 0.16 (n=40)	2.8 0.11 (n=63)	2.8 0.12 (n=50)	2.8 0.09 (n=113)
F1 [illegible]	2.2 0.19 (n=21)	1.9 0.21 (n=19)	2.0 0.16 (n=40)	2.3 0.11 (n=74)	2.3 0.12 (n=64)	2.3 0.10 (n=138)
Treatment overall	2.4 0.13 (n=107)	2.2 0.14 (n=92)		2.6 0.08 (n=265)	2.4 0.09 (n=220)	
Significance overall	P=0.10		P<0.0001	P<0.05		P<0.0001

(Data were adjusted by covariance for carcass weight within market.)(Values are mean (s.e.m.) NIR, near infrared
* Solvent extraction and NIR procedures were conducted on samples of muscle from different animals.