THE EFFECTS OF ZERANOL ON THE FEEDLOT PERFORMANCE OF BEEF BULLS

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Fifty-three cross-bred bulls, aged 5–7 mo, were divided at random into a nonimplanted control group of 26 bulls and a treatment group of 27 bulls, which were each implanted with 36 mg of zeranol on the 1st, 81st, and 155th day of the experiment. They were fed a high energy diet ad libitum for 168 days during which time liveweight and feed consumption were recorded at 2-wk intervals. Occasional measurements of scrotal circumference and serum T_3 and T_4 concentration were taken on 26 bulls (12 control, 14 implanted). At the end of 168 days the same 26 bulls were halter-broken in preparation for libido testing and semen evaluation. All bulls were slaughtered 236 days after the initial implanting, at which time a study was made of the behavior of 20 control and 20 treated bulls during the 6–7 h leading up to slaughter. There was a large (6.1%) but nonsignificant difference in rate of gain, with no difference in feed efficiency due to the implant. Zeranol was found to have no significant effect on sexual development, thyroid hormone concentration, behavior or carcass characteristics. There was, however, a four-times greater incidence (nonsignificant) of dark-cutting carcasses among the control bulls, than the treated bulls.

Key words: Zeranol, beef cattle, feedlot performance, sexual development, behavior

[Effets du zéranol sur le rendement de bovins de boucherie en parc d'engraissement.]

Titre abrégé: Zéranol pour bovins en parc d'engraissement.

Nous avons séparé au hasard 53 bovins croisés âgés de cinq à sept mois en deux groupes comme suit: un groupe témoin de 26 sujets non implantés; un groupe de 27 sujets recevant chacun un implant de 36 mg de zéranol au premier, au 81e et au 155e jour de l'expérience. Les animaux ont été nourris à volonté d'un régime à haute teneur énergétique pendant 168 jours et on a noté leur poids vif et leur consommation à toutes les deux semaines. Des mesures occasionnelles de la circonférence du scrotum et des teneurs en serum T_3 et T_4 ont aussi été effectuées sur 26 bovins (12 témoins et 14 implantés). À la fin des 168 jours, les 26 mêmes sujets ont été accoutumés au licou en prévision d'une évaluation de la libido et du sperme. Tous les sujets ont été abattus 236 jours après la première implantation. On a procédé, pendant les six ou sept heures précédant l'abattage, à une étude du comportement de 20 témoins et de 20 sujets implantés. Nous avons observé une différence importante (6,1%) mais non significative du taux de croissance des bovins implantés par rapport aux témoins, mais aucune différence de l'indice de transformation. Le zéranol n'a pas non plus d'effet significatif sur le développement sexuel, la concentration des hormones thyroïdiennes, le comportement ni sur les caractéristiques des carcasses. La viande à coupe sombre était cependant quatre fois plus fréquente (différence non significative) chez les bovins témoins que chez les bovins implantés.

Mots clés: Zéranol, bovins de boucherie, rendement en parc d'engraisement, développement sexuel, comportement

Zeranol (a resorcylic acid lactone) is an anabolic agent which causes increased growth rates when implanted into young ruminants (Sharp and Dyer 1971; Wilson et al. 1972). The mechanism of this growth stimulation is incompletely understood, though it is reported to increase serum growth hormone and insulin levels (Olsen et al. 1977). It has also been suggested that it may reduce thyroid function and hence metabolic rates and physical activity in lambs (Rothenbacher et al. 1975; Wiggins et al. 1979).

In recent years there has been an increasing interest in the use of young bulls in feedlot. However, among the problems encountered by bull feeders are aggressive behavior and riding in the feedlot and en route to slaughter, and an increased incidence of dark, firm, dry (DFD or dark cutting) carcasses compared to steers. These problems would probably be ameliorated by a reduction in metabolic rate and sexual activity if they could be induced by zeranol implantation.

Because of the inherently greater growth rates and feed efficiency of bulls compared to steers (Price et al. 1978), their responses to biostimulators, including zeranol, have not been studied extensively. However, it has been shown (Riesen et al. 1977) that zeranol implanted prepubertally has an estrogenic effect which interferes with normal sexual development. If zeranol is implanted after puberty it has no such effect (Juniewicz et al. 1981). Under North American conditions, most bulls being fed for beef would enter the feedlot at about puberty 6–9 mo) and it is not clear from the literature what influence implanting at this age would have on sexual development, or on growth rate and feed efficiency. One of the advantages of feeding bulls rather than steers for beef is the opportunity to conduct an 'on-site' performance test, allowing the best of the bulls to be identified and used as herd sires. Clearly, if zeranol interferes with sexual development it would have to be avoided by feeders using such a system.

The following experiment was conducted to test the hypotheses that zeranol, first implanted at about the time of puberty would have no effect on the growth rate, feed efficiency or carcass traits of bulls; that it would not affect behavior in the feedlot or en route to slaughter; that it would not influence sexual development or reproductive performance and that it would not change the incidence of dark-cutting carcasses.

MATERIALS AND METHODS

Fifty-six crossbred bulls aged about 6 mo were assigned at random to 14 pens of four bulls each. The 28 bulls in seven of the pens were each implanted with 36 mg of zeranol in the form of three 12-mg pellets of Ralgro® placed in the subcutaneous fat pad at the base of the left ear; the remaining 28 bulls served as controls. The bulls were gradually switched from a diet of long hay to an all-concentrate diet (Table 1), achieved by increasing the concentrate portion of the diet by 20% every 4 days. The initial weight was taken with water withheld for 16 h but feed continuously available. Ad libitum intake was reached 3 wk after the animals were first implanted. Individual liveweights and pen feed intakes were subsequently recorded every 2 wk. The implanted bulls were reimplanted on day 81 and day 155.

At the initial allocation, two bulls in each pen were selected for thyroid hormone monitoring. At intervals, jugular blood samples were drawn from these bulls and analyzed for triiodothyronine (T_3) and thyroxine (T_4) using a commercial radioimmunoassay technique (T_3 and T_4 RIA Kits, Inter Medico, Toronto, Ont.). At the same time the scrotal circumferences of these bulls at the widest part of the testes were measured and recorded.

At 197 days after the initial implanting, the 28 bulls selected for thyroid hormone and scrotal circumference monitoring began to be halterbroken in preparation for libido and semen eval-

Table 1. Diet fed to 53 feedlot bulls throughout the experiment

Ingredients	kg·tonne^{-1}
Barley, dry rolled	924
Canola meal	30
Calcium carbonate, 38% Ca	12
Calcium phosphate 15–18% Ca; 21% P	4
Trace-mineralized salt†	2.5
Molasses, wet	25
Vitamin-selenium mix‡	2.5
Analysis	*% DM basis*
Dry matter	83.0
Crude protein	12.6
Calcium	0.74
Phosphorus	0.46

†Trace-mineralized salt contained 96.5% sodium chloride, 0.40% zinc, 0.16% iron, 0.12% manganese, 0.033% copper, 0.007% iodine and 0.004% cobalt.
‡To supply 5000, 825 and 5 IU of vitamins A, D_3 and E, respectively, per kilogram of diet as well as 0.075 mg of selenium (as selenite).

uations. Semen samples were collected from the bulls by artificial vagina using estrus-induced cows (Kiser 1977). For libido scoring, the estrus-induced cows were restrained in a service crate and, if the bull mounted, semen was collected in an artificial vagina. Libido was scored on a later occasion by observing the reaction of each bull to the restrained cows for a 10-min period as described by Chenoweth (1979). The scoring system was based on the degree of interest, number of mounts and services performed by a bull during a 10-min period with a minimum score of 0 (= no interest) and maximum score of 10 (= two services and continued interest).

During the period of halter-breaking and semen collection, an outbreak of coccidiosis occurred among the experimental bulls. This was treated by medicating their water with sulfamethazine (Dominion Vet Labs, Winnipeg, Man.) necessitating a delay of slaughter to comply with drug withdrawal regulations. The bulls were slaughtered 236 days after the initial implanting.

Thirty-three of the bulls were loaded, trucked 10 km to a packing plant and slaughtered within an hour of arrival. The remaining 20 bulls were mixed together in four groups of five bulls (two Ralgro® groups, two control groups), each group being made up of bulls from three different pens. These 20 bulls were held together in their mixed groups for 6 h, during which time each group was watched for seven, 15-min periods. Four classes of behavior were recorded: head-to-head bunts, bunts to other parts of the body, threats (i.e. a bunt was begun, but no contact was made) and mounting. After this observation period the bulls were loaded and trucked for slaughter in the same manner as the previous 33. They were slaughtered within an hour of arrival at the plant. In the packing plant, the testicles were collected from each bull, and weighed. Following overnight cooling, the 53 carcasses were appraised and graded by staff of the Food Production and Inspection Branch of the Livestock and Poultry Division of Agriculture Canada. The continuous variables were analyzed statistically by one-way analysis of variance (Steel and Torrie 1960). The incidence of DFD carcasses was analyzed by Fisher's Exact Method (Keeping 1962).

RESULTS AND DISCUSSION

Three bulls (one treated, two controls) were removed for a reason unrelated to the experiment during the course of the study, and their data were not used in any of the analyses. The growth performance data for the remaining 53 bulls were compared during the 168 days from the time they reached ad libitum intake until the beginning of the halter-breaking period. The implanted bulls gained 6.1% faster (1.74 vs. 1.64 kg day^{-1}; $P>0.05$) during this period than the control bulls, with no significant difference in feed efficiency (Table 2).

Scrotal circumference measurements (an estimate of testicular development) clearly indicated a lack of any atrophying effect of zeranol (Fig. 1), and even suggest a slightly hypertrophic effect. It should be noted, however, that the implanted bulls had greater scrotal circumferences than the controls at day 1 and that, expressed as a percentage of the initial scrotal circumference, the difference in gain was small (68.4% vs. 61.6% for the implanted and control bulls, respectively). Following slaughter, the actual weights of the implanted bulls' testes were found to be about

Table 2. Feedlot performance during the 168-day period from the start of full feeding to the start of halter-breaking

	n	Initial wt (kg)	Final wt (kg)	Gain (kg/day)	Daily feed (kg)	Feed/ gain
Implanted	27	213.5	506.2	1.74	9.54	5.50
± SE		5.27	8.92	0.04	0.41	0.24
Control	26	213.5	448.5	1.64	9.05	5.61
± SE		7.82	8.80	0.06	0.5	0.47
Difference		0.0NS	17.7NS	0.10NS	0.49NS	−0.11NS

NS, not significant.

12.6% greater than those of the controls (Table 3).

The tests of reproductive capacity were inconclusive (Table 3) since all the bulls tested showed low libido and the majority failed to produce an ejaculate. Among the bulls which did ejaculate (four out of 14 implanted and six out of 12 controls), volume and sperm counts were considered unsatisfactorily low in both the implanted and control groups. This is probably not unusual in sexually inexperienced bulls particularly following a long period of ad libitum grain feeding. Although these results indicate no significant effect of zeranol on sexual development, they cannot, therefore, be taken as an indication that peripubertal bulls could be implanted with zeranol with impunity.

No significant differences attributable to implantation were detected in the concentration of either T_3 or T_4, at any of the four

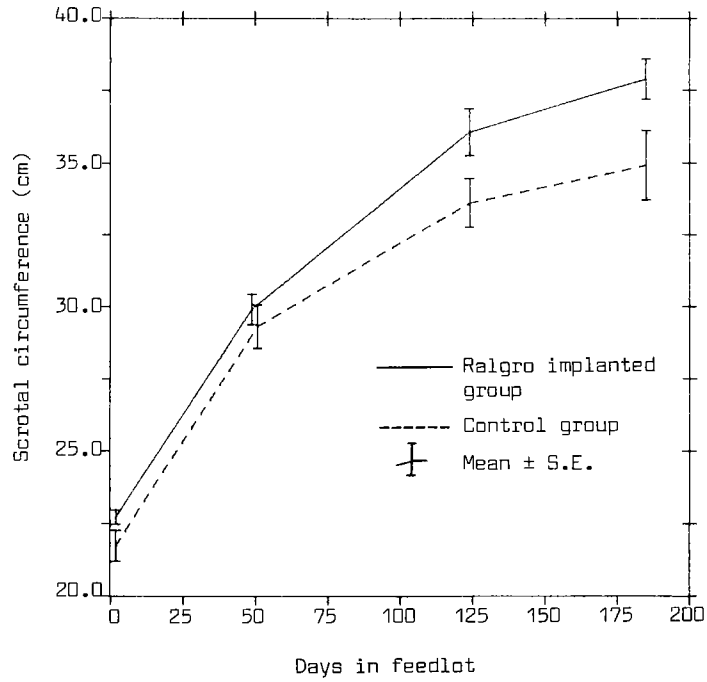

Fig. 1. Means and standard errors of scrotal circumference among Ralgro-implanted and control bulls at different stages in the feedlot.

Table 3. Effect of zeranol implanting on testicular and sexual development

				Semen quality†		
	n	Testes wt (g)	Libido score‡	Number of bulls	Volume (mL)	Sperm (count 10^6/mL)
Implanted	14	528.6	3.25	4	1.4	260
± SE		29.48	0.48	(28.6%)	0.78	159.2
Control	12	469.5	3.50	6	2.6	146
± SE		37.31	0.44	(50.0%)	0.53	23.0
Difference		59.1*	0.25NS	2	1.2NS	114NS

†Among the bulls which produced ejaculates.
‡Range 0–10, see text.
*Significant at $P<0.05$; NS, not significant.

sampling times during the 197 days after the initial implanting (Table 4). This trial, therefore, offers no evidence to support the view (Rothenbacher et al. 1975; Wiggins et al. 1979) that zeranol may lower thyroid production.

The behavioral observations were conducted on groups of bulls from several pens which had been mixed together. This treatment was designed to increase the number of agonistic interactions which would occur (Price and Tennessen 1981). No significant effect of the implant on any of the behavior traits was found (Table 5), and there was no significant effect of zeranol on the number of DFD (dark-cutting) car-

Table 4. Concentrations (ng·100 mL^{-1} blood) of T_3 and T_4 in experimental bulls

			Days after initial implanting							
	Treatment	*n*	19		81		155		197	
T_3 ± SE	Implanted	13	92.8± 6.2	14	200.7± 6.6	14	154.1± 8.1	14	161.7±17.0	
	Control	14	102.8± 7.3	14	185.6±11.6	11	172.9± 8.4	12	170.7±13.7	
	Difference		10.0NS		15.1NS		18.8NS		9.0NS	
T_4 ± SE	Implanted	14	5.77±0.36	14	9.63±0.32	14	8.95±0.51	14	10.80±0.54	
	Control	14	6.25±0.40	14	10.07±0.57	11	9.40±0.39	12	11.98±0.56	
	Difference		0.48NS		0.44NS		0.45NS		1.18NS	

Table 5. Influence of zeranol on preslaughter behavior and incidence of DFD meat

		Mean per 15-min observation period				
Treatment	*n*	Head bunts	Other bunts	Threats	Mounts	Dark cutters
Implanted						
Pen 1	5	15.3±1.9	20.4±1.3	8.0±3.0	6.4±1.3	1
Pen 2	5	7.0±1.2	15.9±2.1	11.0±2.5	11.7±2.0	0
Control						
Pen 3	5	15.9±3.6	24.0±4.4	8.0±1.4	13.1±2.8	3
Pen 4	5	3.0±0.5	7.1±1.4	7.0±2.0	9.6±2.1	1
Treatment effects		NS	NS	NS	NS	NS

Table 6. Effect of zeranol implantation on mean slaughter and carcass characteristics of 53 young feedlot bulls

	n	Slaughter wt (kg)	Carcass wt (kg)	Dressing (%)	Grade fat (cm)	Longissimus area (cm²)	Grade A4	A3	A2	A1	B1	B2	B3
Implanted	27	550.2	334.8	59.9	1.46	90.1	3	5	10	8	0	0	1†
± SE		11.72	5.9	0.32	0.10	1.75	(11.1%)	(18.5%)	(37.0%)	(29.6%)	(0.0%)	(0.0%)	(3.7%)
Control	26	548.8	322.8	59.7	1.23	87.8	1	4	7	10	2‡	2†	0
± SE		9.71	6.7	0.44	0.09	2.31	(3.8%)	(15.4%)	(26.9%)	(38.5%)	(7.7%)	(7.7%)	(0.0%)
Difference		1.4NS	2.2NS	0.2NS	0.23NS	2.4NS							

†DFD carcasses.
‡1 DFD, 1 underfat.

casses. It is, however, notable that only 10% of the implanted bulls were rated DFD by the graders, compared with 40% of the control bulls. Although this result was statistically nonsignificant ($P>0.05$) it may be biologically real.

The implanted bulls had similar dressing percentages to the control bulls (Table 6), allowing their similar liveweights to be reflected in similar carcass weights. There was little difference in the rib eye area, but the implanted bulls had slightly more subcutaneous fat and, as a result, showed a greater percentage of overfat (B3, A3 and A4) carcasses (33.3% vs. 19.2%).

The present investigation, therefore, suggests that peripubertal implantation of bulls with zeranol may cause increased feedlot gains, at least some of which are attributable to increased carcass fatness. It was not shown to have any marked effect on either level of thyroid hormone production, or aggressive behavior, but there is a suggestion, worthy of further research, that zeranol may reduce the incidence of dark-cutting in bull carcasses.

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