Effect of postweaning implantation of zeranol and dietary energy level on growth and reproductive performance of replacement beef heifers

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Makarechian, M., Arthur, P. F. and Price, M. A. 1991. **Effect of postweaning implantation of zeranol and dietary energy level on growth and reproductive performance of replacement beef heifers.** Can. J. Anim. Sci. **71**: 265–270. Eighty-one heifer calves weaned at an average age of 6 mo were used to study the effect of postweaning zeranol implantation, on the growth and reproductive performance of heifers fed to grow slowly on three dietary energy levels. Forty heifers were implanted with 36 mg of zeranol at 30 d and again at 120 d postweaning. The remaining heifers were used as unimplanted controls. Within the implanted and control groups, heifers were subdivided into three groups and fed either a low, medium or high energy diet, which provided approximately 105, 130 and 160%, respectively, of NRC maintenance energy requirement, until 1 yr of age. The heifers were then turned out to pasture with hay supplementation. Heifers were exposed to bulls for 35 d at approximately 14 mo of age. Zeranol had no significant effect on growth. The effect of zeranol on the reproductive traits studied was not significant, although the trend was that the zeranol implanted heifers had lower calf crop born (52.3 vs. 63.6%) and lower incidence of calving difficulty (18.5 vs. 32.1%) than control heifers. The level of energy in the diet had a significant ($P<0.01$) effect on growth of the heifers, with those on the high energy diet having the highest mean growth rate, but no significant effect on reproductive performance.

Key words: Zeranol, dietary energy, growth, reproduction, heifers

Makarechian, M., Arthur, P. F. et Price, M. A. 1991. **Conséquences de l'implantation de zéranol après le sevrage et de la concentration d'énergie dans les aliments sur la croissance et les aptitudes à la reproduction des génisses de boucherie de remplacement.** Can. J. Anim. Sci. **71**: 265–270. On a étudié les conséquences de l'implantation post-sevrage de zéranol sur la croissance et les aptitudes à la reproduction de 81 génisses sevrées à l'âge moyen de six mois. Les animaux ont reçu trois régimes à teneur énergétique variable, mais favorisant une croissance lente. Quarante génisses ont reçu un implant de zéranol de 36 mg 30 jours puis de nouveau 120 jours après le sevrage. Les autres sujets ont été utilisés comme témoins. Dans chaque groupe, les génisses ont été réparties en trois sous-groupes et ont reçu un régime à faible, à moyenne ou à haute teneur en énergie (environ 105, 130 et 160% respectivement des recommandations du CNRC pour le maintien du poids), jusqu'à l'âge d'un an. On les a ensuite laissé paître en leur donnant du foin comme supplément. Les génisses ont été mises en présence d'un taureau pendant 35 jours vers l'âge de 14 mois. Le zéranol n'a eu aucun effet sensible sur la croissance, ni sur les aptitudes à la reproduction, quoique les génisses portant l'implant aient donné naissance à moins de veaux (52,3 c. 65,6%) et aient montré moins de difficultés au vêlage (18,5 c. 32,1%) que les témoins. La quantité d'énergie dans le régime a un effet significatif ($P<0,01$) sur la croissance, les animaux soumis au régime le plus énergétique affichant le croît moyen le plus élevé, sans incidence toutefois sur les aptitudes à la reproduction.

Mots clés: Zéranol, énergie alimentaire, croissance, reproduction, génisses

Proper management of replacement heifers is vital to the development of a productive cow herd. This entails heifers achieving adequate growth, reaching puberty early and conceiving within a short breeding season. Zeranol is an anabolic agent which has been shown to enhance growth in cattle (Sharp and Dyer 1971; Basarab et al. 1984). However, while zeranol is used extensively in steers, it has had limited use in heifers because of its possible interference with sexual development. Selection of replacement heifers normally occurs after weaning, hence if implanting heifers following weaning would accelerate growth without negative effect on reproduction, zeranol implantation could be considered as a beneficial management practice.

There are some indications that plane of nutrition influences the degree to which zeranol affects growth and reproduction in heifers (Deutscher et al. 1986). Most of the heifers used in such studies are fed to grow fast, with gains greater than 500 g a day. Replacement heifers, however, are traditionally fed to grow more slowly over the winter until they are turned out to pasture in the spring. Information on the effect of zeranol on growth and reproduction under such a system is limited. The objective of this study was to investigate the effect of zeranol implantation 30 d and 120 d postweaning on growth and reproductive performance of replacement heifers fed to grow slowly up to 1 yr of age on three levels of dietary energy.

MATERIALS AND METHODS

Eighty-one heifer calves, weaned in October at approximately 6 mo of age at the University of Alberta ranch at Kinsella, Alberta, were used in this study. The heifers were from the Beef Synthetic no. 1, Beef Synthetic no. 2 and Dairy Synthetic breed groups, and the details on the formation and breed composition of the breed groups have been provided by Berg et al. (1990). Approximately half of the heifer calves (40) were implanted with 36 mg of Ralgro® (a commercial form of zeranol) at 30 d and again at 120 d after weaning (Fig. 1). The remaining 41 heifer calves were used as unimplanted controls. Within the implanted and control groups, heifer calves were randomly subdivided into three similar groups, and fed a low, medium or high energy diet for a period of 140 d after a 28-d feedlot adjustment period. Heifers were fed alfalfa/brome hay and a grain mixture (Table 1). The hay, which contained 10.9 MJ kg^{-1} DE, 12.9% CP and 38.1% ADF on DM basis, was provided at 2.3 kg $head^{-1}$ d^{-1}. The amount of grain mixture given was based on monthly body weight measurements, such that the total digestible energy in the diet (hay plus grain mixture) was approximately 105, 130 and 160% of National Research Council (NRC 1984) maintenance energy requirement of heifers on the low, medium- and high-energy diets, respectively. Straw was provided as bedding and the amount consumed was not recorded. Heifers received their respective diets until about 1 yr of age when the diets were discontinued and they were turned out to pasture, with occasional hay supplementation as required by weather and pasture conditions. Heifers were exposed to bulls of proven fertility at a ratio of 25 randomly selected heifers to a bull for 35 d at approximately 14 mo of age (Fig. 1).

Traits studied included weight and hip height, calving date, calving performance, body condition at calving, calf crop born and weaned, preweaning body weights of the progeny, and heifer productivity, defined as the weight of calf weaned per heifer exposed to bull. Body condition, evaluated by visual appraisal and palpation, was scored on a scale of 1 to 5, with a score of 5 representing an extremely fat cow. All calving requiring assistance was coded as 1 and unassisted calving coded as 0. Heifers which calved were given a code of 1 and those which did not calve a code of 0. Similarly, any heifer which weaned a calf was given a code of 1 and those which did not wean a calf a code of 0. After statistical analysis of the coded data, the resulting proportions were multiplied by 100 to express calving difficulty as percentage of total calvings and calf crop born or weaned as percentage of the heifers exposed to bulls.

The data were analyzed by least squares procedures (Harvey 1985). The model included the fixed effects of treatment (zeranol vs. control), level of energy in the diet, breed group and all possible two-way interactions. For preweaning growth traits of the progeny, sex of calf and its interactions with the other factors were included in the model. Differences between means of traits which showed significant differences were tested using Student Newman Keul's test (Steel and Torrie 1980).

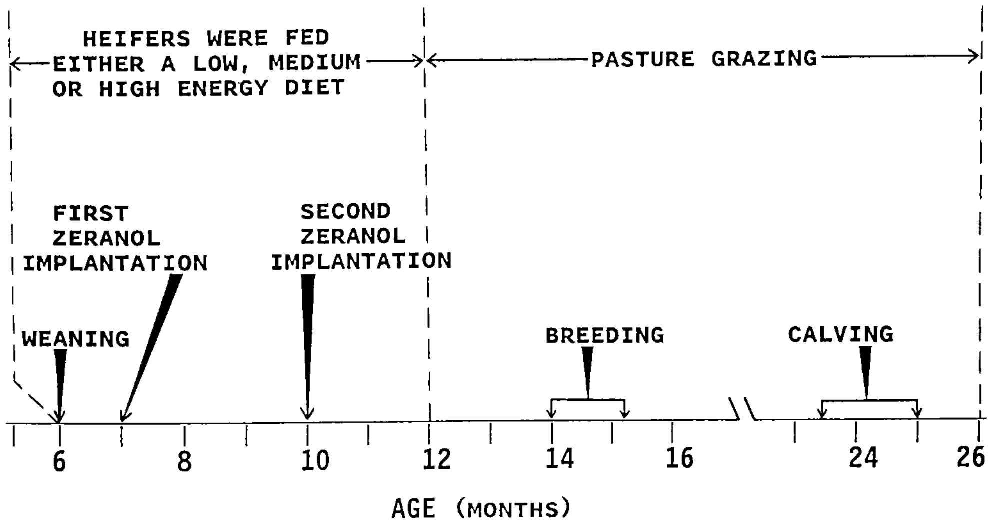

Fig. 1. Time scale of the various phases of the experiment.

Table 1. Composition of grain mixture

Ingredients	Air-dry composition
Barley (%)	63
Oats (%)	22
Alfalfa pellets (%)	10
Premix[z] (%)	5
Total (%)	100
Chemical composition	per kg DM
DM (%)	90.0
Digestible energy (MJ)	14.2
Protein (g)	133.9
Acid detergent fibre (g)	122.0
Calcium (g)	5.7
Phosphorus (g)	4.7

[z]Contained canola meal 72.2%, barley 2.6%, molasses 2%, limestone 12.9%, dicalcium phosphate 6.5%, vitamin mixture (guaranteed analysis: 10 000 000 IU kg^{-1} vitamin A, 1 000 000 IU kg^{-1} vitamin D and 75 000 IU kg^{-1} vitamin E) 0.6% and trace mineralized salt (guaranteed analysis: salt 86%, iodine 87 mg kg^{-1}, cobalt 35 mg kg^{-1}, iron 3600 mg kg^{-1}, copper 290 mg kg^{-1}, manganese 1050 mg kg^{-1}, zinc 3500 mg kg^{-1} and selenium 10 mg kg^{-1}) 3.2%.

RESULTS AND DISCUSSION

Zeranol implantation did not have significant effects on body weight gain (Table 2) and growth height (Table 3) of the heifers during the feedlot period. Most of the zeranol studies with heifers have reported improvements in growth rate in implanted heifers compared to control heifers (Deutscher et al. 1986; Cohen et al. 1987; Sawyer et al. 1988). In all of these studies the heifers were either on ad libitum feeding or on a high plane of nutrition with rates of gain exceeding 500 g d^{-1}. However, in studies where the amount of energy in the diet was restricted resulting in rates of gain of less than 500 g d^{-1}, differences in rate of gain between implanted and control heifers have been small or nonsignificant (Hodge et al. 1983; Staigmiller et al. 1983; Turner and Raleigh 1984). In this study the level of energy in the diet was restricted, and even in the group which received the highest level of energy (160% of maintenance requirement), average daily gain was only 516 g d^{-1}. Raising replacement heifers on a high plane of nutrition has been found to increase body fat, to interfere with normal mammary development and to decrease lifetime milk production (Sejrsen 1978; Little and Kay 1979; Sejrsen et al. 1983; Johnsson and Obst 1984). Traditionally, therefore, growing replacement heifers are fed a plane of nutrition lower than that fed to cattle intended for slaughter. While the level of energy fed the heifers in this study was within the range typically fed growing replacement beef heifers, it is possible that this level was not high enough to allow the heifers to respond to the growth-promoting effect of zeranol.

Although there was a trend towards zeranol-implanted heifers being slightly heavier at calving, having lower percent calf crop born and weaned and lower incidence of calving difficulty than control heifers, these differences were not significant (Table 4). The difference between the two treatment groups for calving date was also not significant. Heifer productivity, as defined by the weight of calf weaned per heifer exposed to bull, could not be tested statistically as only group means were available for a particular group. Comparison of the means, however, indicated that heifers implanted with zeranol weaned 23.4 kg less calf compared to control heifers. Research results on the effect of zeranol on reproduction in heifers have not been conclusive. While in some studies zeranol did not significantly affect reproductive performance (Staigmiller et al. 1983; Deutscher et al. 1986), in other studies it was found to depress some reproductive traits (Nelson et al. 1972; Staigmiller et al. 1983; Turner and Raleigh 1984; Deutscher et al. 1986; Cohen et al. 1987). Factors such as age at implantation, dosage, reimplantation, plane of nutrition and length of breeding season appear to influence

Table 2. Least squares means and standard errors for the effect of zeranol implantation (treatment) and level of energy in the diet on body weight gain of heifers in feedlot

Item	Treatment		Energy level in diet		
	Control	Zeranol	Low	Medium	High
No. of calves	41	40	27	28	26
Body weight (kg)					
Day 1[z]	218.9±4.4	220.5±4.4	223.4±5.4	217.5±5.3	218.2±5.5
Day 83[y]	245.4±5.3	244.8±5.4	229.4±6.5*a*	246.2±6.4*ab*	259.6±6.6*b*
Day 140	269.7±5.9	267.3±6.0	246.3±7.3*a*	268.7±7.1*b*	290.5±7.4*c*
Average daily gain (g d^{-1})					
Day 1–83	319±21	292±21	72±26*a*	347±26*b*	498±27*c*
Day 83–140	427±23	396±23	297±28*a*	395±28*b*	543±29*c*
Day 1–140	363±18	335±19	164±23*a*	366±22*b*	516±23*c*

[z] First implantation was done 7 d (30 d postweaning) before start of feedlot test (day 1).
[y] Second implantation was done 83 d (120 d postweaning) after start of feedlot test.
a–c Means for energy level in diet, within the same row, with different letters differ ($P<0.05$).

Table 3. Least squares means and standard errors for the effect of zeranol implantation (treatment) and level of energy in the diet on growth in height of heifers in feedlot

Item	Treatment		Energy level in diet		
	Control	Zeranol	Low	Medium	High
No. of calves	41	40	27	28	26
Height (cm)					
Day 1[z]	108.4±0.7	108.7±0.7	109.4±0.9	107.5±0.9	108.7±0.9
Day 83[y]	111.9±0.8	111.5±0.8	111.4±1.0	110.4±1.0	113.3±1.0
Day 140	117.8±0.8	117.5±0.8	117.1±0.9	116.8±0.9	119.0±1.0
Daily gain in height (mm d^{-1})					
Day 1–83	0.4±0.04	0.3±0.04	0.3±0.05*a*	0.3±0.05*a*	0.6±0.08*b*
Day 83–140	1.0±0.06	1.1±0.07	1.0±0.08	1.1±0.08	1.0±0.08
Day 1–140	0.7±0.02	0.6±0.02	0.6±0.03*a*	0.7±0.03*b*	0.7±0.03*b*

[z] First implantation was done 7 d (30 d postweaning) before start of feedlot test (day 1).
[y] Second implantation was done 83 d (120 d postweaning) after start of feedlot test.
a–b Means for energy level in diet, within the same row, with different letters differ ($P<0.05$).

Table 4. Least squares means and standard errors for the effect of zeranol implantation (treatment) and level of energy in the diet on reproductive performance of heifers

	Treatment		Energy level in diet		
Item	Control	Zeranol	Low	Medium	High
No. of heifers exposed to bull	41	40	27	28	26
Calving date[z]	111 ± 2	110 ± 2	109 ± 2	108 ± 2	112 ± 2
Wt. at calving (kg)	364.1±11.0	385.8±12.4	379.6±14.7	374.0±13.5	371.2±14.9
Body condition score[y]	2.8± 0.1	2.9± 0.1	2.9± 0.1	2.8± 0.1	2.7± 0.1
Calving difficulty (%)	32.1± 8.8	18.5± 9.9	29.0±11.8	16.9±10.8	30.0±11.9
Calf crop born (%)	63.6± 7.9	52.3± 8.0	60.1± 9.8	60.8± 9.6	52.9± 9.9
Calf crop weaned (%)	56.3± 8.4	47.2± 8.3	55.9±10.3	50.0±10.1	49.3±10.5
Calf birth wt. (kg)	30.7± 1.6	31.5± 1.4	32.0± 2.0	30.2± 1.6	31.0± 1.6
Calf weaning wt. (kg)	220.6± 6.6	222.2± 5.7	219.5± 8.4	217.5± 6.6	226.3± 6.7
Calf preweaning ADG (g d^{-1})	1051 ±34	1060 ±29	1042 ±44	1040 ±34	1085 ±35
Heifer productivity (kg)[x]	139.9	116.7	121.9	132.1	121.9

[z]Number of days from 1 Jan. to calving day.
[y]Appraised at calving on a scale of 1 to 5; 5 = extremely fat cow.
[x]Weight of calf weaned/heifer exposed to bull.

the effect of zeranol on reproductive performance. The low calf crops obtained in this study for both treatment groups were expected as a result of the restricted breeding season of 35 d.

Zeranol implantation did not affect the preweaning performance of the progeny of the heifers. Similar results were obtained by Deutscher et al. (1986). This suggests that postweaning zeranol implantation of heifers prior to a year of age did not have any effect on embryonic and fetal development of their calves or the heifers' milk production.

The amount of energy in the diet during the feedlot period (6–12 mo of age) had a significant ($P<0.05$) effect on body weight gain (Table 2) as well as on growth in height (Table 3). For both traits heifers on the high energy diet had higher gains than those on the medium energy diet, which in turn, had higher gains than those on the low energy diet. This pattern was similar to results on the effect of dietary energy level on growth in cattle obtained in other studies (Price et al. 1980, 1984; Houseknecht et al. 1988).

Although differences in growth rate were observed among heifers on the different diets during the feedlot period (Tables 2 and 3), these differences gradually disappeared as the heifers approached the calving season with similar weights at calving and similar body condition (Table 4). It appears that the heifers which were on the low and medium energy diets had experienced compensatory growth after the feedlot period, and by the time of calving had attained body weights and body condition similar to those raised on the high energy diet. All the heifers were kept on pasture following the feedlot period and therefore the lighter heifers might have grazed more than the heavier heifers to catch up, in terms of body weight and body condition.

The incidence of calving difficulty among the heifers raised on the different diets was similar. The level of energy in the diet during the feedlot period did not have any effect on calf crop born or weaned and mean conception date of the heifers bred, as reflected in the calving dates. There were also no significant differences in the preweaning growth performance among the progeny of the heifers raised on the different feedlot period diets.

No significant interaction between postweaning zeranol implantation and level of energy in the feedlot period diet was observed for any of the traits studied. Other two-way interactions were also not significant.

At the level of energy provided in the diet (highest being 160% of NRC maintenance energy requirement) from weaning to 1 yr of age, it can be concluded that implantation of heifers with zeranol, 30 d and 120 d postweaning did not have any effect on their growth and reproduction, or on the preweaning performance of their progeny. There is no evidence of any benefit from zeranol implantation in replacement heifers under such conditions. Heifers fed low and medium energy diets up to a year of age experienced compensatory (catch-up) growth while on pasture, to attain weights at calving similar to those fed high energy diet.

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