The Professional Animal Scientist 19 (2003):159–170

Effects of Final Implant Type and Supplementation of Melengestrol Acetate® on Finishing Feedlot Heifer Performance, Carcass Characteristics, and Feeding Economics[1]

C. N. MACKEN*, PAS, C. T. MILTON*,2, PAS, T. J. KLOPFENSTEIN*,3, B. D. DICKE†, PAS, and D. E. McCLELLAN‡, PAS

*Department of Animal Science, University of Nebraska, Lincoln, NE 68583-0908; †Cattlemen's Counsulting Services, LLC, Lincoln, NE 68516; and ‡McClellan Consulting Services, Fremont, NE 68025

Abstract

*Three finishing experiments were conducted in commercial feedlots to determine effects of implant programs on finishing heifer performance, carcass characteristics, and economics. A total of 3,307 heifers were used in the three experiments. Overall, four treatment comparisons were tested within the three separate experiments. Treatment groups included the following: 1) heifers implanted with Synovex® Plus (Fort Dodge Animal Health; Fort Dodge, IA) but not fed melengestrol acetate (**MGA®**; Pharmacia and Upjohn Company; Kalamazoo, MI) , 2) heifers implanted with Synovex® Plus and fed MGA®, 3) heifer implanted with Revalor®-H (Intervet Inc.; Millsboro, DE) and fed MGA®, and 4) heifers implanted with Finaplix®-H (Intervet Inc.) and fed MGA®. Common treatments of Synovex® Plus and dietary MGA® as well as Finaplix®-H and dietary MGA® were used in each of the three experiments. Finishing heifers fed MGA® and implanted with Synovex® Plus had 3.9 and 4.1% greater (P<0.10) ADG than did heifers implanted with Revalor®-H or Finaplix®-H and fed MGA®, respectively. Daily gain did not differ for heifers implanted with Revalor®-H or Finaplix®-H. Feeding MGA® to heifers implanted with Synovex® Plus increased ADG and decreased deleterious effects on quality grade; however; carcasses had greater fat thickness. Fewer carcasses of heifers fed MGA® and implanted with Synovex® Plus or Revalor®-H were graded Choice in comparison with the carcasses of those implanted with Finaplix®-H. When selling heifers on a carcass-merit basis, net returns did not differ among heifers implanted with Synovex® Plus, Revalor®-H, or Finaplix®-H when fed MGA®. When selling heifers on a dressed basis, net return was maximized (P<0.10) with the use of Synovex® Plus and supplementation with MGA® compared with Synovex® Plus and no MGA® supplementation, Revalor®-H and MGA® supplementation, and Finaplix®-H and MGA® supplementation.*

(Key Words: Beef Cattle, Finishing, Heifers, Implants, Melengestrol Acetate®.)

Introduction

Growth-promoting implants are widely accepted for use in the finishing phase of beef production to improve ADG and feed efficiency. Implants contain a single dose or a combination dose of active compounds that influence growth of beef

[1]A contribution of the University of Nebraska Agricultural Research Division, Lincoln, NE 68583. Journal Series No. 13671.

[2]Present address: Midwest PMS, 10249 W. Loup River Rd., Danneborg, NE 68831.

[3]To whom correspondence should be addressed: tklopfenstein1@unl.edu

cattle. Although the exact mechanism is not thoroughly understood, products containing estrogens, androgens, or both have been demonstrated to be efficacious under a variety of feedlot conditions (Herschler Et al., 1995). Design of an implant program for finishing heifers can be challenging and involves numerous decisions (level of ingredients, time of implants, number of implant times, etc.). Another major decision involves inclusion of melengestrol acetate (MGA®; Pharamacia and Upjohn Company; Kalamazoo, MI) in the diet. Melengestrol acetate affects endogenous estrogen levels (Henricks et al., 1997). Combining trenbolone acetate (**TBA**) with an estradiol (**E_2**) implant (Trenkle, 1994) or feeding MGA® (Montgomery et al., 1992) increased efficacy of TBA in feedlot heifers. This relationship has brought products such as Synovex® Plus [Fort Dodge Animal Health; Fort Dodge, IA; 28 mg of estradiol benzoate (20 mg E_2) and 200 mg of TBA] and Revalor®-H (Intervet Inc.; Millsboro, DE; 14 mg of E_2 and 140 mg of TBA) to the market. The use of TBA, as a single active compound, and supplemental MGA® has been a common practice used by feedlots (Galyean, 1997). Finaplix®-H (Intervet Inc.) is an implant that contains only 200 mg of TBA. Based on the potential interactions of exogenous and endogenous increases of E_2, there is justification for larger replicated studies involving these sources. The objectives of these experiments were 1) to compare performance, carcass characteristics, and feeding economics in heifers implanted with Synovex® Plus, Revalor®-H, or Finaplix®-H as the final implant and 2) to determine whether MGA® supplementation is beneficial in finishing heifers implanted with Synovex® Plus.

Materials and Methods

Experiment 1. The experiment was conducted in a commercial feedyard in central Nebraska between December 23 and July 20 using 879 yearling crossbred beef heifers (330 ± 23 kg) in a randomized block design. Blocks (n = 5) were based on arrival date. Heifers that were used were of *Bos taurus* breeds. Within the five blocks of heifers, one block was predominately British breeds, one block was predominately Continental breeds, and three blocks were British ´ Continental breeds. Heifers arriving at the feedyard were kept separated by truckload following unloading and were weighed. Heifers from the separate truckloads were assigned randomly to one of three implant programs in groups of two heifers by a gate sort into one of three arrival pens and then assigned to one of 15 pens (5 pens per treatment). Treatment groups included 1) heifers implanted with Synovex® Plus and fed MGA®, 2) heifers implanted with Synovex® Plus and not fed MGA®, or 3) heifers implanted with Finaplix®-H and fed MGA®. The finishing diet that contained MGA® was formulated to provide 0.45 mg of MGA®/d per heifer. Within a block, all heifers arrived at the feedyard at the same time. After sorting, heifers (by pen) were reweighed, processed, and moved to their home pen. During processing, heifers were vaccinated for viral diseases (BoviShield 4®; Pfizer Inc., New York City, NY), treated for internal and external parasites (Dectomax®; Pfizer Inc.), implanted with Ralgro® (36 mg of zeranol; Schering-Plough Inc.; New York City, NY), and given a lot-tag for identification. Blocks of heifers were reimplanted a second time with either Synovex® Plus or Finaplix®-H, on average, 90 d (range, 84 to 101 d) before harvest. Heifers assigned to Finaplix®-H were fed MGA® following adaptation to the final diet (18 to 20 d on feed). Additionally, one treatment of heifers implanted with Synovex® Plus was fed MGA® following adaptation to the final diet (18 to 20 d on feed). Blocks of heifers were fed an average of 150 d; the range was 128 to 172 d because of initial BW and frame type of the different blocks of heifers entering the feedlot.

Initial BW was determined using the BW recorded by a pen scale when the heifers arrived at the feedlot (entire block) and the BW recorded by a pen scale after the treatment groups were sorted. The second BW record for the treatment group was used to prorate the entire block weight to determine the initial BW of each treatment pen. Final live BW were determined by a pen scale for a treatment pen just before shipment and pencil shrunk 4%. Carcass weights were also used to determine final BW by adjusting to a common dressing percentage of 63% to calculate ADG and feed efficiency on a carcass-adjusted basis. Dry matter of the diet was determined from samples of the ingredients analyzed by a commercial lab.

All pens within a block were harvested on the same day at the same abattoir. Harvest date was determined by the feedlot manager based on days on final implant, cattle performance, estimated fatness, and ability to market the cattle. Hot carcass weights were recorded on the day of harvest. Carcass 12th rib fat thickness; marbling score; kidney, pelvic, heart (**KPH**) fat; longissimus area; and USDA quality grade were recorded following a 24- to 36-h chill.

Experiment 2. Experiment 2 was conducted in the same feedyard as Experiment 1 between January 11 and August 3 using 1,558 yearling crossbred beef heifers (345 ± 30 kg) in a randomized block design. Blocks (n = 6) were based on arrival date. Heifers used were of *Bos taurus* breeds. Within the six blocks of heifers, one block was predominately British breeds, three blocks were predominately Continental breeds, and two blocks were British × Continental type breeds. Heifers were kept separate by truckload following unloading and were weighed. Heifers from the separate truckloads were assigned randomly to one of three implant programs one by one using a gate sort into one of three arrival pens; then, heifers were assigned to one of 18 pens (6 pens per treatment).

TABLE 1. Finishing diet composition (100% DM basis)

Composition	Exp. 1	Exp. 2	Exp. 3
Ingredient			
Steam-flaked corn	57.0	48.0	—-
Dry-rolled corn	16.9	27.0	79.0
Alfalfa hay	7.5	7.5	7.5
Corn steep liquor	6.5	5.5	9.5
Liquid supplement	5.8	5.8	—-
Dry supplement	1.9	1.9	3.0
Liquid MGA®[a] supplement	1.4	1.3	—-
Tallow	3.0	3.0	—-
Micro ingredients	—-	—-	1.0
Calculated nutrient			
DM, %	76.3	77.5	82.3
Crude protein, %	13.6	13.7	13.3
Calcium, %	0.8	0.8	0.8
Potassium, %	0.8	0.8	0.8
Phosphorus, %	0.4	0.4	0.4

[a]MGA® = Melengestrol acetate (Pharmacia and Upjohn Company, Kalamazoo, MI).

Treatment groups included: 1) heifers implanted with Synovex® Plus, 2) heifers implanted with Revalor®-H, or 3) heifers implanted with Finaplix®-H at re-implant time. All treatments included dietary MGA® supplementation (0.45 mg of MGA®/d per heifer).

Within a block, all heifers arrived at the feedyard at the same time. After sorting, pens of heifers were reweighed, processed, and moved to their home pen. During processing, heifers were vaccinated for viral diseases (BoviShield 4®), treated for internal and external parasites (Dectomax®), implanted with Ralgro®, and given a lot-tag for identification.

Heifers were re-implanted with their respective treatment of Synovex® Plus, Revalor®-H, or Finaplix®-H following 45 d (range, 35 to 58 d) on feed. Heifers were exposed to their final implant for an average of 95 d across blocks (range, 84 to 108 d). Heifers were fed MGA® following adaptation to the final diet (18 to 20 d on feed). Heifers were fed an average of 139 d with a range of 127 to 166 d because of differences in initial BW and frame type of the different blocks entering the feedlot.

Initial BW were determined by prorating each treatment pen's weight back to the total of the entire block of heifers' weight as in Experiment 1. Final live BW were determined by a pen scale for a treatment pen just before shipment and pencil

TABLE 2. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) with or without MGA® (melengestrol; acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) or Finaplix®-H (Intervet Inc., Millsboro, DE) with MGA® supplementation on heifer performance (Exp. 1).

Item	Synovex® plus no MGA®	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE
Pens, no.	5	5	5	
Heifers, no.	294	292	293	
Days on feed	150	150	150	
Live performance[a]				
Initial BW, kg	329	327	332	1.4
Final BW, kg	534	537	536	2.7
DMI, kg/d	8.6	8.7	8.7	0.07
ADG, kg	1.37	1.40	1.36	0.01
Gain/feed	0.159	0.161	0.157	0.002
Carcass-adjusted performance[b]				
Final BW, kg	551	555	548	3.5
ADG, kg/d	1.48[c]	1.52[d]	1.45[e]	0.01
Gain/feed	0.172[f]	0.174[f]	0.167[g]	0.002

[a]Final BW shrunk 4%.

[b]Final BW calculated as hot carcass weight divided by 0.63 (common dressing percentage).

[c,d,e]Means within a row with different superscripts differ ($P<0.10$).

[f,g]Means within a row with different superscripts differ ($P<0.05$).

shrunk 4%. Carcass weights were also used and adjusted to a common dressing percentage of 63% to calculate ADG and feed efficiency on a carcass-adjusted basis. Dry matter of the diet was determined from samples of the ingredients analyzed by a commercial lab.

All pens within a block were harvested on the same day at the same abattoir. Harvest date was determined by the feedlot manager based on days on final implant, cattle performance, estimated fatness, and ability to market the cattle. Hot carcass weights were recorded on the day of harvest. Carcass 12th rib fat thickness, marbling score, KPH fat, longissimus area, and USDA quality grade were recorded following a 24- to 48-h chill.

Experiment 3. This experiment was conducted in eastern Nebraska at a commercial feedyard between January 12 and June 26 using 870 yearling British × Continental bred heifers (376 ± 13 kg) in a randomized block design. Heifers were blocked by arrival date into the feedyard. Heifers were processed on arrival, and a block (n = 3) was maintained in one large pen until re-implanting. At re-implanting, a block of heifers was allotted randomly to one of two treatments by sorting individual heifers at chute-side and then assigning each heifer to one of two pens (3 pens per treatment). Treatments were Synovex® Plus or Finaplix®-H plus MGA® supplementation formulated to provide 0.4 mg/d per heifer. Thus, if the first heifer received Synovex® Plus, the second heifer through the chute would have been implanted with Finaplix®-H, and so on. Initial BW was determined on individual heifers at the time of reprocessing. Final BW was determined by adjusting hot carcass weight to a common 63% dressing percentage. Dry matter of the diet was determined from samples of the ingredients analyzed by a commercial lab.

All pens within a block were harvested on the same day at the same abattoir. Harvest date was determined by the feedlot manager based on days on final implant, cattle performance, and ability to market the cattle. Hot carcass weights were recorded on the day of harvest. Carcass 12th-rib fat thickness, marbling score, KPH fat, longissimus

TABLE 3. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) with or without MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) or Finaplix®-H (Intervet Inc., Millsboro, DE) with MGA® supplementation on heifer carcass characteristics (Exp. 1).

Item	Synovex® plus no MGA®	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE
Hot carcass weight, kg	347	350	346	1.8
Dressing percentage	65.0[a]	65.1[a]	64.6[b]	0.1
Fat thickness, cm	1.22[a]	1.38[b]	1.30[c]	0.02
Longissimus area, cm^2	92.3	90.6	87.5	1.4
KPH[d] fat, %	2.06	2.08	2.06	0.02
Calculated yield grade	2.44[a]	2.72[b]	2.75[b]	0.07
Yield grade distribution, %				
1	30.0[e]	17.7[f]	14.6[f]	4.0
2	47.2	45.3	50.7	3.4
3	19.8	31.3	29.8	3.7
4 and 5	3.0	5.6	5.0	1.1
Marbling score[g]	5.19[h]	5.47[i]	5.43[i]	0.04
Quality grade distribution, %				
Prime	1.0	3.5	1.0	0.8
Upper 2/3 Choice	16.3	20.3	18.8	1.3
Low Choice	37.8[a]	43.3[a]	52.2[b]	2.3
≥Low Choice	55.1[g]	67.1[h]	72.0[h]	3.2
Select	44.4[d]	32.0[e]	27.6[e]	2.3
Standard	0.5	0.8	0.4	0.7
Dark cutters, %	2.0	1.3	0.0	0.8

[a,b,c]Means within a row with different superscripts differ ($P<0.05$).

[d]KPH = Kidney, pelvic, heart.

[e,f]Means within a row with different superscripts differ ($P<0.10$).

[g]Marbling score: 4.0 = Slight 00, 4.5 = Slight 50, 5.0 = Small 00, 5.5 Small 50, etc.

[h,i]Means within a row with different superscripts differ ($P<0.01$).

TABLE 4. Economic analysis of using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) with or without MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) or Finaplix®-H (Intervet, Millsboro, DE) with MGA® supplementation as final implants in finishing heifers (Exp. 1).

Item	Synovex® plus no MGA®	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE
Diet cost[a], $/100 kg	14.43	14.59	14.59	
Cost of feed, $ per heifer	185.78	190.05	189.58	1.4
Total feeding cost, $ per heifer	195.69	199.96	198.90	1.4
Live cost of gain, $/100 kg	95.75	95.70	97.84	0.95
Carcass-adjusted cost of gain, $/100 kg	88.35[b]	88.17[b]	91.89[c]	0.77
Carcass value[d], $/100 kg	238.96[e]	240.79[f]	242.33[g]	0.55
Profit[h], $ per heifer				
Live basis	68.35[bc]	73.97[b]	58.74[c]	3.8
Dressed basis	88.19[b]	92.62[b]	76.12[c]	3.0
Carcass-merit basis	69.60[e]	80.57[f]	68.02[e]	3.7

[a]Includes feed mark-up.

[b,c]Means within a row with different superscripts differ ($P<0.05$).

[d]Calculated using a $244/100 kg carcass base price. Discounts = $22, Select; $44, Standard; $33, Yield Grade 4 and 5; and $66, dark cutter. Premiums = $18, Prime; $7, upper 2/3 Choice; and $7, Yield Grades 1 and 2.

[e,f,g]Means within a row with different superscripts differ ($P<0.10$).

[h]Initial animal cost = $172/100 kg; animal returns based on $154/100 kg live price, $244/100 kg carcass price, or calculated carcass value; interest not included.

TABLE 5. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE) with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer performance (Exp. 2).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	Revalor®-H plus MGA®	SE
Pens, no.	6	6	6	
Heifers, no.	523	516	519	
Days on feed	139	139	139	
Live performance[a]				
Initial BW, kg	345	345	345	1.4
Final BW, kg	551	546	545	2.3
DMI, kg/d	9.2[b]	8.8[c]	9.1[b]	0.09
ADG, kg	1.48	1.44	1.43	0.05
Gain/feed	0.161	0.163	0.157	0.003
Carcass-adjusted performance[f]				
Final BW, kg	567[b]	559[c]	560[c]	1.9
ADG, kg	1.60[d]	1.53[e]	1.54[e]	0.02
Gain/feed	0.174	0.174	0.169	0.003

[a]Final BW shrunk 4%.

[b,c]Means within a row with different superscripts differ ($P<0.05$).

[d,e]Means within a row with different superscripts differ ($P<0.10$).

[f]Final BW calculated as hot carcass weight divided by 0.63 (common dressing percentage).

TABLE 6. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA)or Finaplix®-H (Intervet, Millsboro, DE) with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer carcass characteristics (Exp. 2).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	Revalor®-H plus MGA®	SE
Hot carcass weight, kg	357[a]	351[b]	353[b]	1.2
Dressing percentage	64.8	64.5	64.7	0.1
Fat thickness, cm	1.36	1.37	1.38	0.02
Longissimus area, cm^2	93.4[c]	90.2[d]	91.8[cd]	0.67
KPH[f] fat, %	2.10	2.14	2.09	0.03
Calculated yield grade	2.61	2.74	2.68	0.05
Yield grade distribution, %				
1	23.4	16.1	21.9	2.6
2	45.0[ab]	49.6[a]	41.6[b]	2.1
3	26.7	27.9	31.7	2.6
4 and 5	4.8	6.3	4.8	1.4
Marbling score[g]	5.26[c]	5.48[d]	5.38[e]	0.04
Quality grade distribution, %				
Prime	1.9	2.8	1.4	0.5
Upper 2/3 Choice	16.1[a]	24.0[b]	21.7[b]	3.2
Low Choice	37.1	40.5	42.4	3.1
≥Low Choice	55.1[a]	67.3[b]	65.5[b]	4.2
Select	41.7[c]	31.2[d]	33.1[d]	2.9
Standard	3.1	1.4	1.4	0.7
Dark cutters, %	1.2	0.0	2.0	0.8

[a,b]Means within a row with different superscripts differ ($P<0.05$).

[c,d,e]Means within a row with different superscripts differ ($P<0.10$).

[f]KPH = Kidney, pelvic, heart.

[g]Marbling score: 4.0 = Slight 00, 4.5 = Slight 50, 5.0 = Small 00, 5.5 Small 50, etc.

muscle area, and USDA quality grade were recorded following a 36- to 48-h chill.

In all experiments, data are presented with dead (1.0% overall) and chronic (0.4% overall) cattle removed from the analysis. Feed intake and total head days were adjusted on a pen basis 1 d prior to the removal of the animal from the pen as either dead or chronic. Finishing diets fed during the experiments are presented in Table 1.

Economic Analysis. The economic influence of the implant treatments was determined using the diet cost at the feedyard during the period the experiment was conducted. The diet cost used in the analysis includes feedlot markup in Experiments 1 and 2. In Experiment 3, yardage was charged on a daily basis. Non-feed costs (medicine, processing, etc.) were calculated for each pen of heifers in the experiment and averaged. This average non-feed cost was applied to each pen of heifers for calculation of cost of gain and net return. Initial heifer cost was calculated by using the price of $171.81/100 kg, the approximate 10-yr average for Nebraska (Fuez et al., 2000). Final heifer value was calculated by using a live price of $154.19/100 kg of live weight (10-yr average) (Fuez et al., 2000), a dressed price of $244.50/100 kg of carcass weight (10-yr average) (Fuez et al., 2000), or a carcass-merit price based on individual heifer carcass value. Carcass value was calculated based on USDA quality grade, calculated yield grade, carcass weight, and nonconformance (i.e., dark cutters). A carcass base price of $244.50/100 kg was used for low Choice, Yield Grade 3 carcasses weighing 249 to 431 kg. Discounts were calculated as follows: $22.03 for Select grade, $44.05 for Standard grade, $66.08 for dark cutters, and $33.04/100 kg for Yield

Grades 4 and 5. Premiums were calculated as follows: $17.62 for Prime grade, $6.61 for upper 2/3 Choice grade, and $6.61/100 kg for Yield Grades 1 and 2.

Statistical Analysis. For the three experiments, performance, carcass, and economic data were analyzed as a randomized block design using SAS® (SAS Inst. Inc., Cary, NC). Treatment and block were included in the model. Least squares means were separated using the least significance difference method when a significant ($P<0.10$) F test was detected. Data from common treatments (Synovex® Plus and MGA® and Finaplix®-H and MGA®) across experiments were pooled and analyzed with PROC

TABLE 7. Economic analysis of using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA); Revalor®-H (Intervet, Millsboro, DE), Finaplix®-H (Intervet Inc.) with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation as final implants in finishing heifers (Exp. 2).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	Revalor®-H plus MGA®	SE
Diet cost[a], $/100 kg	14.48	14.48	14.48	
Cost of feed, $ per heifer	185.36[b]	178.27[c]	183.59[b]	1.6
Total feeding cost, $ per heifer	194.24[b]	187.32[c]	192.95[b]	1.6
Live cost of gain, $/100 kg	94.56	93.30	97.40	1.70
Carcass-adjusted cost of gain, $/100 kg	87.53	87.78	90.51	1.43
Carcass value[d], $/100 kg	236.92[b]	241.21[c]	239.25[bc]	1.10
Profit[e], $ per heifer				
Live basis	62.77	61.73	54.15	5.0
Dressed basis	86.91	81.11	76.42	4.7
Carcass-merit basis	59.90	70.37	58.19	5.3

[a]Includes feed mark-up.

[b,c]Means within a row with different superscripts differ ($P<0.05$).

[d]Calculated using a $244/100 kg carcass base price. Discounts = $22, Select; $44, Standard; $33, Yield Grade 4 and 5; and $66, dark cutter. Premiums = $18, Prime; $7, upper 2/3 Choice; and $7, Yield Grades 1 and 2.

[e]Initial animal cost = $172/100 kg; animal returns based on $154/100 kg live price, $244/100 kg carcass price or calculated carcass value; interest not included.

MIXED in SAS. Kenward-Roger degrees of freedom correction was used in the analysis (Kenward and Rodger, 1997). Experiment, blocks nested within experiment, and experiment by treatment interaction were considered random effects. In all experimental analyses, experimental unit was pen of heifers.

Results and Discussion

Experiment 1. Treatment effects on finishing heifers' performance are shown in Table 2. Overall DMI did not differ ($P=0.52$) among treatments. On a carcass-adjusted basis, heifers implanted with Synovex® Plus with or without dietary MGA® gained 4.8 and 2.1% faster ($P<0.05$) and were 4.3 and 3.2% more efficient ($P<0.01$) than those implanted with Finaplix®-H, respectively. Live performance was not significantly different; however, numerical differences in live performance tended to be similar to carcass-adjusted performance. Mader et al. (1998) reported 7.1% greater ADG for heifers implanted with Synovex® Plus than for heifers implanted with 200 mg of TBA (equivalent to Finaplix®-H). Mader et al. (1998) did not use supplemental MGA®. However, heifers implanted with TBA and fed MGA® had 4.7% greater ADG than did heifers implanted with TBA and not fed MGA® (Trenkle, 1994).

TABLE 8. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer performance (Exp. 3).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Pens, no.	3	3		
Heifers, no.	432	438		
Days on feed	107	107		
Initial BW, kg	376	375	2.5	0.77
Final BW[a], kg	537	529	1.9	0.09
DMI, kg/d	9.82	9.51	0.17	0.32
ADG, kg	1.50	1.44	0.007	0.02
Gain/feed	0.153	0.152	0.003	0.85

[a]Final BW calculated as hot carcass weight divided by 0.63 (common dressing percentage).

TABLE 9. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer carcass characteristics (Exp. 3).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Hot carcass weight, kg	338	333	1.1	0.09
Fat thickness, cm	1.38	1.39	0.04	0.95
Longissimus area, cm^2	87.1	86.0	0.27	0.10
KPH[a] fat, %	0.14	2.47	2.52	0.01
Calculated yield grade	2.87	2.90	0.05	0.76
Yield grade distribution, %				
1	10.0	12.0	3.2	0.72
2	49.0	41.9	2.8	0.22
3	33.7	38.6	2.4	0.27
4 and 5	7.3	7.6	1.5	0.89
Marbling score[b]	5.65	5.69	0.11	0.83
Quality grade distribution, %				
Prime	3.8	4.0	1.1	0.94
Upper 2/3 Choice	27.9	30.2	2.6	0.59
Low Choice	43.4	41.9	2.1	0.67
≥Low Choice	75.1	76.1	2.7	0.76
Select	23.5	23.2	1.8	0.93
Standard	1.4	0.7	0.8	0.61

[a]KPH = Kidney, pelvic, heart.

[b]Marbling score: 4.0 = Slight 00; 4.5 = Slight 50; 5.0 = Small 00; 5.5 Small 50; etc.

In heifers implanted with Synovex® Plus, those fed MGA® had greater ($P<0.10$) carcass-adjusted ADG but similar feed efficiency to heifers not fed MGA® (Table 2). Brandt et al. (1996) reported that supplementation of MGA® along with Revalor®-H (combination of E_2 and TBA) numerically increased ADG by 1.5% compared with Revalor®-H-implanted heifers not fed supplemental MGA®. Using the combination of Heiferoid® (20 mg of estradiol benzoate and 200 mg testosterone) and Finaplix®-H implants to achieve a combination of E_2 and TBA, heifers fed MGA® gained 3.0% faster than did heifers not fed MGA® (Montgomery et al., 1992).

Dressing percentage was greater ($P<0.05$) for heifers that were implanted with Synovex® Plus than for those implanted with Finaplix®-H (Table 3). Heifers implanted with Synovex® Plus and not fed MGA® had reduced ($P<0.05$) calculated yield grades and a greater ($P<0.10$) percentage of carcasses grading Yield Grade 1 compared with those fed MGA® and implanted with either Synovex® Plus or Finaplix®-H. Heifers fed MGA® and implanted with Synovex® Plus had greater ($P<0.01$) fat thickness compared with heifers implanted with Synovex® Plus but not fed MGA® or those implanted with Finaplix®-H. Heifers implanted with Finaplix®-H had greater ($P<0.01$) fat thickness measurement compared with heifers implanted with the Synovex® Plus but not fed MGA®. The current experiment supports previous studies in which supplemental MGA® in the diets of finishing heifers increased fat thickness and yield grade (Nichols et al., 1996; Lubberstedt et al., 1999). Longissimus area did not differ ($P>0.13$) among treatments.

Marbling scores and the percentage of carcasses grading USDA Choice were less ($P<0.01$) for heifers implanted with Synovex® Plus and not fed MGA® in comparison with those implanted with Synovex® Plus and fed MGA® (Table 3). Marbling scores

TABLE 10. Economic analysis of using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation as final implants in finishing heifers (Exp. 3).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Diet cost, $/100 kg	9.34	9.34		
Cost of feed, $ per heifer	98.25	95.11	1.7	0.32
Total feeding cost, $ per heifer	149.25	146.11	1.7	0.32
Cost of gain, $/100 kg	93.00	95.02	1.39	0.41
Carcass value[a], $/100 kg	242.58	242.80	0.81	0.87
Profit[b], $ per heifer				
Dressed basis	31.71	25.09	2.9	0.25
Carcass-merit basis	25.03	19.23	2.8	0.28

[a]Calculated using a $244/100 kg carcass base price. Discounts = $22, Select; $44, Standard; $33, Yield Grade 4 and 5; and $66, dark cutter. Premiums = $18, Prime; $7, upper 2/3 Choice; and $7, Yield Grades 1 and 2.

[b]Initial animal cost = $172/100 kg; animal returns based on $154/100 kg live price, $244/100 kg carcass price, or calculated carcass value; interest not included.

TABLE 11. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer performance (pooled data).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Live performance[ab]				
Pens, no.	10	10		
Heifers, no.	815	812		
Days on feed	149	149		
Initial BW, kg	337	349	2.2	0.49
Final BW, kg	544	541	2.6	0.22
DMI, kg/d	8.96	8.75	0.16	0.43
ADG, kg	1.44	1.40	0.02	0.09
Gain/feed	0.161	0.160	0.003	0.84
Carcass-adjusted performance[c]				
Pens, no.	14	14		
Heifers, no.	1247	1247		
Days on feed	136	136		
Initial BW, kg	348	349	1.8	0.55
Final BW, kg	554	547	1.7	<0.01
DMI, kg/d	9.23	9.00	0.11	0.16
ADG, kg	1.54	1.48	0.01	<0.01
Gain/feed	0.167	0.164	0.007	0.38

[a]Final BW shrunk 4%.

[b]Contains data only from Exp. 1 and 2.

[c]Final BW calculated as hot carcass weight divided by 0.63 (common dressing percentage).

and the percentage of carcasses grading USDA Choice did not differ (*P*=0.17) for heifers fed MGA® and implanted with either Synovex® Plus or Finaplix®-H. Mader et al. (1998) reported that marbling scores and percentages of cattle grading USDA Choice or above were not significantly affected by treatments of Synovex® Plus or 200 mg of TBA without MGA® supplementation, although numerically heifers implanted with Synovex® Plus had lower marbling scores (5.18 *vs* 5.34) and decreased percentages of heifers grading USDA Choice or above (51.8% *vs* 59.6%). Supplemental dietary MGA® with the use of Synovex® Plus as the final implant tended to lessen any deleterious effects of the implant on carcass quality grade, as suggested by the small change in the percentage of USDA Choice or above carcasses (67.2% *vs* 71.9%; *P*=0.17) and similar marbling scores (5.47 *vs* 5.43; *P*=0.48) compared with the implantation of Finaplix®-H plus dietary MGA®. There was no effect of treatment on the percentage of Standard carcasses or the incidence of dark cutting carcasses.

A summary of the economic analysis is provided in Table 4. Heifers supplemented with MGA® had greater (*P*<0.10) costs associated with feed and total feeding compared with those that were not supplemented with MGA®. This increased cost is the result of the higher ration price of $0.16/100 kg for the MGA® -supplemented finishing diet. Carcass-adjusted cost of gain was less (*P*<0.05) in heifers implanted with Synovex® Plus than in those implanted with Finaplix®-H. Heifers implanted with Synovex® Plus and fed MGA® returned more dollars per heifer than did heifers implanted with Finaplix®-H and fed MGA® on a live basis price (*P*<0.10); heifers implanted with Synovex® Plus and fed no MGA® showed an intermediate return on dollars per heifer. On a dressed-basis price, net return was greater (*P*<0.05) when heifers were implanted with Synovex® Plus than when implanted with Finaplix®-H. When carcass discounts and premiums were applied to calculate carcass price, heifers implanted with Synovex® Plus and fed no MGA® had the least (*P*<0.01) calculated carcass value compared with the other two treatments. Heifers implanted with Synovex® Plus and fed MGA® had lesser calculated carcass value ($/100 kg) than did those implanted with Finaplix®-H. However, the additive effects (gain of efficiency) of Synovex® Plus with supplementation of MGA® created greater (*P*<0.10) carcass-merit basis net return than that for heifers implanted with Synovex® Plus without MGA® supplementation or heifers implanted with Finaplix®-H with MGA® supplementation by $10.97 or $12.55 per heifer, respectively.

Experiment 2. Effects of implant programs on performance of finishing heifers implanted with Synovex® Plus, Finaplix®-H, or Revalor®-H and fed supplemental dietary MGA® are presented in Table 5. Dry matter intake was greater (*P*<0.05) for heifers implanted with Synovex® Plus or Revalor®-H compared with those implanted with Finaplix®-H. Daily gain, final BW, and feed efficiency did not differ (*P*>0.21) among implant treatments based on live weight performance. On a carcass-adjusted basis, heifers implanted with Synovex® Plus as the final implant gained 3.9 or 4.0% (*P*<0.10) faster than did heifers implanted with Revalor®-H or Finaplix®-H as the final implant, respectively. This resulted in heavier (*P*<0.05) carcass-adjusted final weight for heifers implanted with Synovex® Plus than for those implanted with Revalor®-H and Finaplix®-H. Carcass-adjusted ADG of

TABLE 12. Effects of implant programs using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation on heifer carcass characteristics (pooled data).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Hot carcass weight, kg	349	345	1.1	<0.01
Dressing percentage[a]	65.0	64.5	0.1	<0.01
Fat thickness, cm	1.37	1.35	0.03	0.54
Longissimus area, cm^2	90.9	88.2	0.8	<0.01
KPH[b] fat, %	2.21	2.23	0.02	0.48
Calculated yield grade	2.70	2.78	0.06	0.23
Yield grade distribution, %				
1	18.5	14.7	3.3	0.27
2	46.0	48.3	2.9	0.44
3	29.8	30.9	2.6	0.70
4 and 5	5.6	6.1	1.1	0.68
Marbling score[c]	5.42	5.50	0.08	0.42
Quality grade distribution, %				
Prime	2.9	2.4	1.0	0.66
Upper 2/3 Choice	20.2	23.4	1.8	0.38
Low Choice	40.7	45.0	2.8	0.15
≥Low Choice	63.9	70.7	3.4	0.18
Select	34.3	28.3	3.0	0.19
Standard	1.9	0.9	0.6	0.12
Dark cutters, %	0.8	0.0	0.4	0.06

[a]Contains data only from Exp. 1 and 2.

[b]KPH = Kidney, pelvic, heart.

[c]Marbling score: 4.0 = Slight 00, 4.5 = Slight 50, 5.0 = Small 00, 5.5 Small 50, etc.

heifers implanted with Revalor®-H or Finaplix®-H did not differ.

The results of the use of Synovex® Plus or Revalor®-H in Experiment 2 tend to agree with Jim et al. (1998a, b), who showed that Synovex® Plus increased ADG by 3.3 and 5.1%, respectively. In contrast to our experiment, Jim et al. (1998a, b) observed a 2.4 and 2.3% greater DMI for heifers implanted with Synovex® Plus than for heifers implanted with Revalor®-H, respectively. Brandt et al. (1996) reported a 4.6% greater ADG for heifers implanted with Revalor®-H and fed supplemental MGA® compared with heifers implanted with Finaplix®-H and fed supplemental MGA®. In contrast, ADG was not different between Revalor®-H and Finaplix®-H in this experiment and others (Nichols et al., 1996). Brandt et al. (1996) and Nichols et al. (1996) both reported that there was no significant difference in DMI or feed efficiency between the Revalor®-H and Finaplix®-H and supplemented MGA®.

Hot carcass weight was 4.4 or 5.1 kg heavier ($P<0.05$; Table 6) for heifers implanted with Synovex® Plus than for heifers implanted with Revalor®-H or Finaplix®-H, respectively. Hot carcass weight did not differ ($P=0.67$) for heifers implanted with Revalor®-H or Finaplix®-H. Dressing percentage tended ($P=0.13$) to be different among treatments. Longissimus area was larger ($P<0.05$) for heifers implanted with Synovex® Plus than for heifers implanted with Finaplix®-H; heifers implanted with Revalor®-H had intermediate longissimus area. Fat thickness and KPH fat were similar among treatments. Calculated yield grade was similar among treatments; however, the percentage of Yield Grade 2 carcasses was greater for heifers implanted with Finaplix®-H than for heifers implanted with Revalor®-H; heifers implanted with Synovex® Plus had intermediate percentages of Yield Grade 2 carcasses. Marbling score was less ($P<0.10$) for heifers implanted with Synovex® Plus than for those implanted with either Revalor®-H or Finaplix®-H. Heifers implanted with Revalor-H had a lower ($P<0.10$) marbling score than heifers implanted with Finaplix®-H. The percentage of carcasses grading upper 2/3 USDA Choice was less ($P<0.05$) and the percentage of carcasses grading USDA Select was greater ($P<0.10$) for heifers implanted with Synovex® Plus in comparison with those implanted with Revalor®-H or Finaplix®-H. The percentage of carcasses grading USDA Standard and the incidence of dark cutting carcasses did not differ ($P>0.18$) among treatments.

Jim et al. (1998a, b) reported the percentage of heifers grading USDA Choice or above was not significantly different between heifers implanted with Synovex® Plus and those implanted with Revalor®-H. In the studies of Jim et al. (1998a, b), days heifers were exposed to the final implant were greater (115 *vs* 95 d) than in this study, which might have affected marbling score and percentage of heifers grading USDA Choice or above. Increasing the days heifers are exposed to the final implant before harvest may decrease the difference in quality grade.

A summary of the economic analysis is provided in Table 7. Cost of gain was similar among treatments. Cost of feed and total feeding costs were ($P<0.05$) less for heifers implanted with Finaplix®-H than for heifers implanted with Synovex® Plus or Revalor®-H, which is due to the decreased DMI by Finaplix®-H implanted heifers. Carcass value, figured on individual carcasses for premiums and discounts, for heifers implanted with Finaplix®-H were greater ($P<0.05$)

TABLE 13. Economic analysis of using Synovex® Plus (Fort Dodge Animal Health, Fort Dodge, IA) or Finaplix®-H (Intervet, Millsboro, DE), with MGA® (melengestrol acetate; Pharmacia and Upjohn Company, Kalamazoo, MI) supplementation as final implants in finishing heifers (pooled data).

Item	Synovex® plus MGA®	Finaplix®-H plus MGA®	SE	*P*
Cost of feed, $ per heifer	158.43	154.72	2.17	0.21
Total feeding cost, $ per heifer	182.11	178.23	1.98	0.17
Live cost of gain, $/100 kg[a]	95.09	95.46	1.70	0.86
Carcass-adjusted cost of gain, $/100 kg	89.32	91.26	1.12	0.21
Carcass value, $/100 kg[b]	239.58	241.92	1.21	0.19
Profit, $ per heifer[c]				
Live basis[a]	58.60	50.77	7.19	0.47
Dressed basis	71.86	62.06	3.78	0.11
Carcass-merit basis	57.57	55.41	7.42	0.80

[a]Contains data from only Exp. 1 and 2.

[b]Calculated using a $244/100 kg carcass base price. Discounts = $22, Select; $44, Standard; $33, Yield Grade 4 and 5; and $66, dark cutter. Premiums = $18, Prime; $7, upper 2/3 Choice; and $7, Yield Grades 1 and 2.

[c]Initial animal cost = $172/100 kg; animal returns based on $154/100 kg live price, $244/100 kg carcass price, or calculated carcass value; interest not included.

than those for those heifers implanted with Synovex® Plus; Revalor®-H-implanted heifers had intermediate carcass values. Net return on a dressed-basis value tended (*P*=0.15) to be $10.49 greater per heifer for heifers implanted with Synovex® Plus than for heifers implanted with Revalor®-H.

Experiment 3. Effects of implant program on performance of finishing heifers that were implanted with Synovex® Plus or Finaplix®-H and fed supplemental MGA® are presented in Table 8. Dry matter intake did not differ (*P*=0.32) between the implant strategies. Heifers implanted with Synovex® Plus gained 4.2% (*P*=0.02) faster than those implanted with Finaplix®-H. This resulted in 8-kg heavier (*P*=0.09) carcass-adjusted final weights. Feed efficiency did not differ (*P*=0.85) between implant strategies.

Hot carcass weight was 5 kg heavier (*P*=0.09; Table 9), and longissimus area was 1.3% larger (*P*=0.10), for heifers implanted with Synovex® Plus compared with heifers implanted with Finaplix®-H. Calculated yield grade, fat thickness, and marbling score did not differ (*P*>0.76) between heifers implanted with Synovex® Plus or Finaplix®-H. Additionally, the distribution of USDA quality grade and calculated yield grade did not differ between implant treatments. All economic variables measured did not differ (*P*>0.25) between implant treatments (Table 10).

Pooled Data. Effects of Synovex® Plus and supplement with MGA® compared with Finaplix®-H and supplemental MGA® on finishing heifer performance across three experiments are summarized in Table 11 (14 pens per treatment). Only data from Experiments 1 and 2 were pooled for performance on a live basis, because in Experiment 3, final live BW were not recorded. Initial BW averaged 348 kg for 2,494 heifers. On a live basis, ADG was 2.8% greater (*P*<0.10) for heifers implanted with Synovex® Plus than for heifers implanted with Finaplix®-H. Carcass-adjusted ADG was 4.4% greater (*P*<0.01) for heifers that received Synovex® Plus implants than for those that received Finaplix®-H implants, which resulted in carcass-adjusted final BW that were 7.4 kg heavier (*P*<0.01) for heifers implanted with Synovex® Plus than for heifers implanted with Finaplix®-H. Dry matter intake tended to be increased by 2.7% (*P*=0.16) for those heifers receiving Synovex® Plus implants compared with those receiving Finaplix®-H implants; feed efficiencies were similar between treatments. On a live basis, final BW and feed efficiency did not differ between treatments.

Carcass characteristics for pooled data are presented in Table 12. Heifers implanted with Synovex® Plus had 4.7 kg heavier (*P*<0.01) carcasses compared with heifers implanted with Finaplix®-H. Dressing percentage was 0.5% units greater (*P*<0.01) for heifers implanted with Synovex® Plus (65.0%) than for heifers implanted with Finaplix®-H (64.5%). Calculated yield grade, fat thickness, and KPH fat did not differ between treatments. Longissimus area was larger (*P*<0.01) for heifers implanted with Synovex® Plus than for heifers implanted with Finaplix®-H. The percentage of carcasses grading USDA Low Choice or greater tended to be greater (*P*=0.18) for heifers implanted with Finaplix®-H than for those implanted with Synovex® Plus, although marbling score was not affected (*P*=0.42) by treatments. The distribution of calculated yield grade was similar between treatments. The incidence of dark cutting was greater (*P*<0.10) for heifers implanted with Synovex® Plus than for heifers implanted with Finaplix®-H.

A summary of the economic pooled data is presented in Table 13. Live cost of gain, carcass-adjusted cost of gain, feeding cost, carcass value, and carcass-merit net return were similar between treatments. Dressed basis net return tended to be in-

creased (P=0.11) by $9.80 per heifer for heifers implanted with Synovex® Plus compared with those implanted with Finaplix®-H.

Implications

Implanting finishing heifers with Synovex® Plus as a final implant in combination with supplemental dietary MGA® increased ADG and carcass weight. However, there appears to be some reduction in percentage of carcasses grading USDA Choice when comparing heifers implanted with Synovex® Plus with those implanted with Revalor®-H or Finaplix®-H and fed MGA®. Feedlot performance was enhanced and offset any economic losses caused by a decrease in carcasses grading Choice when using Synovex® Plus and MGA® relative to the other implant regimens. The Choice–Select spread would need to be >$22/100 kg ($10/cwt) of carcass weight before improved performance would be negated when using Synovex® Plus and MGA®. Clearly, feedlot performance has major implications on economic returns for the various implant regimens.

Literature Cited

Brandt, R. T., W. T. Nichols, F. D. Lehman, and D. P. Hutcheson. 1996. Effect of anabolic agents alone or in combination on performance and carcass characteristics of finishing heifers: A pooled summary of two experiments. Revalor® Tech. Bull. TB-1. Hoechst-Roussel Agri-Vet Company, Somerville, NJ.

Feuz, D. M., P. A. Burgener, and T. Holman. 2000. Historical cattle prices, seasonal patterns, and futures basis for the Nebraska Panhandle 1970-1999. PHREC 00-21. Univ. of Nebraska, Lincoln, NE.

Galyean, M. L. 1997. Implant practices by nutritional consultants: Survey results. In Symposium: Impact of Implants on Performance and Carcass Value of Beef Cattle. Tulsa, OK P 957. p 204. Oklahoma State Univ., Stillwater, OK.

Henricks, D. M., R. T. Brandt, Jr., E. C. Titgemeyer, and C. T. Milton. 1997. Serum concentrations of trenbolone-17â and estradiol-17â and performance of heifers treated with trenbolone acetate, melengestrol acetate, or estradiol-17â. J. Anim. Sci. 75:2627.

Herschler, R. C., A. W. Olmsted, A. J. Edwards, R. L. Hale, T. Montgomery, R. L. Preston, S. J. Bartle, and J. J. Sheldon. 1995. Production response to various doses and ratios of estradiol benzoate and trenbolone acetate implants in steers and heifers. J. Anim. Sci. 73:2873.

Jim, K., T. Guichon, C. Booker, O. Schunicht, and B. Wildman. 1998a. Comparison of four initial and two terminal implant strategies in feedlot heifer calves in western Canada. Synovex® Plus Tech. Rep. TR-27. Fort Dodge Animal Health, Overland Park, KS.

Jim, K., T. Guichon, C. Booker, O. Schunicht, and B. Wildman. 1998b. Comparison of Synovex® Plus and Revalor®-H implant programs in yearling feedlot heifers in western Canada. Synovex® Plus Tech. Rep. TR-28. Fort Dodge Animal Health, Overland Park, KS.

Kenward, M. G., and J. H. Rodger. 1997. Small sample inference for fixed effects from restricted maximum likelihood. Biometrics 53:983.

Lubberstedt, M., T. Mader, J. Heemstra, and K. Lechtenberg. 1999. Evaluation of growth-promoting systems for heifer calves finished in the feedlot. In Nebraska Beef Cattle Report MP 71-A. p 51. Univ. of Nebraska, Lincoln, NE.

Mader, T. L., E. G. Johnson, T. TerHume, and G. K. Jim. 1998. Efficacy of estradiol benzoate and trenbolone acetate, alone or in combination, on feedlot performance by heifers. Synovex® Plus Tech. Rep. TR-29. Fort Dodge Animal Health, Overland Park, KS.

Montgomery, T., P. Camfield, M. Beck, J. Van Buren, and W. Nichols. 1992. The effect of different combinations of estradiol benzoate, trenbolone acetate melengestrol acetate upon the carcass characteristics of commercially fed heifers. Proc. West. Sec. Am. Soc. Anim. Sci. 43:232.

Nichols, W. T., E. Larson, and D. LaChance. 1996. Comparison of three implant strategies for finishing heifers. Revalor® Tech. Bull. TB-7. Hoechst-Roussel Agri-Vet Co., Somerville, NJ.

Trenkle, A. 1994. Summary of implant strategies for finishing heifers. Iowa St. Beef Res. Rep. A. S. Leaflet R1142:46. Iowa State Univ., Ames, IA.