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# Hormones and Antibiotics for Fattening Yearling Steers

By Conrad J. Kercher, Carroll Schoonover, and Robert C. Thompson<sup>1</sup>

**M**ANY INVESTIGATORS have studied the value of hormones, hormone-like substances, and antibiotics for fattening cattle. The implantation of female sex hormones will increase the rate of gain and the efficiency of feed utilization in beef cattle of various weights and under different systems of management (Dinussou et al., 1948; Clegg and Cole, 1954; Andrews et al., 1954; O'Mary et al., 1956; Deans et al., 1956; Koch et al., 1959). The feeding of stilbestrol has improved performance similarly (Burroughs et al., 1954; Perry et al., 1955; Beeson et al., 1956; Andrews et al., 1956; Kastelic et al., 1956).

Some investigators have reported that antibiotics improve the performance of beef cattle in the feedlot (Beeson et al., 1957; Kolari et al., 1960; Perry et al., 1958; Sherman et al., 1959; Dyer et al., 1957). Others have reported no benefit from the use of antibiotics in a fattening ration for beef cattle (Bohman et al., 1947; Heaney and Thomas, 1956; Richard et al., 1956; Anonymous, 1956).

In this study, yearling steers received oral stilbestrol with and without aureomycin, stilbestrol implants, or Synovex implants. The influence of these drugs upon feedlot performance and carcass qualities was studied.

## Experimental Procedure

*Trial 1.* Forty-two yearling Hereford steers at the Powell Agricultural Substation were weighed, tattooed, and randomly assigned to the treatments which consisted of (1) controls, (2) 10 mg. stilbestrol per day in the feed,<sup>2</sup> (3) 36 mg. stilbestrol<sup>3</sup> im-

planted subcutaneously in the ear, (4) Synovex (20 mg. estradiol, 1000 mg. progesterone)<sup>4</sup> implanted subcutaneously in the ear, (5) 75 mg. aureomycin<sup>5</sup> per day in the feed, and (6) 75 mg. aureomycin plus 10 mg. stilbestrol per day in the feed.

<sup>1</sup> The authors—Professor of Animal Nutrition, Associate Professor of Meats, and Instructor in Animal Science, respectively—acknowledge the help of Dale Fritz, Jay Partridge, and Warren Smith, Powell Agricultural Substation Superintendents; M. W. Glenn, Veterinary Science Division; G. J. Miller, Agricultural Biochemistry Division; Emma J. Thiessen, formerly of the Home Economics Division; James Legg, Assistant County Agent—Fremont County; and Jerry and Lewis Medows, Riverton, Wyoming.

<sup>2</sup> Furnished by Elanco Products Co., a division of Eli Lilly & Co.

<sup>3</sup> Furnished by Charles Pfizer & Co., Inc.

<sup>4</sup> Furnished by E. R. Squibb and Sons Division, Olin Mathieson Chemical Corp.

<sup>5</sup> Furnished by American Cyanamid Co.

The steers were fed long alfalfa hay and a grain mix comprised of 70 percent steam-rolled barley, 20 percent dried beet pulp, and 10 percent steam-rolled oats *ad libitum*. All steers received one pound of ground corn daily. The corn also served as the carrier for the stilbestrol and aureomycin. Salt and bonemeal were provided free-choice throughout the feeding period.

At the end of the 152-day feeding period, the two heaviest steers from each group were trucked to Laramie for slaughter at the University Meats Laboratory. The remainder of the steers were slaughtered at a packing house in Worland, Wyoming.

The steers were weighed immediately before slaughter. At the time of slaughter, the seminal vesicles were removed for weighing, and evidence of teat development was recorded. All carcasses were weighed immediately after slaughter and approximately 48 hours later to determine cooler shrink. The chilled carcasses were measured according to the procedure described by Naumann (1951) with slight modifications currently employed by Schoonover (1957). The left side of all carcasses was ribbed and color photographs taken of the cross-sectional area of the rib eye (*longissimus dorsi* muscle) at the 12th rib, using the method outlined by Schoonover and Stratton (1957). The 12th rib eye muscle was removed from the right side of the two heaviest steers slaughtered at Laramie and analyzed for moisture, fat, protein, and ash according to A.O.A.C. (1955) methods. Steaks

two inches thick were removed adjacent to the 12th rib, frozen, and retained for organoleptic tests. Carcass grades were obtained for all steers.

Liver, kidney fat, and diaphragm muscle samples were removed for residual-estrogen assays. The method used was essentially the same as the method outlined by Stob *et al.* (1954a), except that immature female mice were used.

*Trial 2.* Thirty-six yearling Hereford steers were weighed, tattooed, and randomly assigned to the same treatments as in trial 1. The steers were fed at Powell.

The steers were fed long alfalfa hay and a grain mix comprised of 40 percent dried beet pulp, 40 percent steam-rolled barley, and 20 percent steam-rolled oats *ad libitum*. Five percent molasses was added to the latter two feeds during the rolling process. All steers received one pound of ground corn daily which served as a carrier for stilbestrol and aureomycin. Salt and bonemeal were provided free-choice.

At the end of the 124-day feeding period, the two heaviest steers from each group were trucked to Laramie for slaughter at the University Meats Laboratory. The remainder of the steers were slaughtered at a packing house in Worland. The steers were individually weighed immediately before slaughter. Warm-carcass weights, chilled-carcass weights, carcass grades, carcass measurements, and rib-eye photographs were recorded as in trial 1.

The eye muscle at the 12th rib on

the right side was removed from the two heaviest steers slaughtered at Laramie and subjected to chemical analyses as in trial 1.

*Trial 3.* Fifty-four yearling Hereford steers at Powell were weighed, tattooed, and randomly assigned to the same treatments as in trial 1 and 2 except that Synovex-S (20 mg. estradiol and 200 mg. progesterone) was used instead of Synovex (20 mg. estradiol, 1000 mg. progesterone). The steers were fed the same feeds and proportions of feed as in trial 2. Salt and bonemeal were provided free-choice.

At the end of the 138-day feeding period, the steers were trucked approximately 425 miles to Scottsbluff, Nebraska, where they were slaughtered at a commercial packing house. The steers were weighed individually before loading on the trucks, as they were unloaded, and approximately 14 hours later just before slaughter. Warm-carcass weights, cold-carcass weights, carcass measurements, carcass grades before and after ribbing, and rib-eye photographs were obtained as in trials 1 and 2. A weighted line was suspended from the middle of the aitch bone. The distance from the line to the fifth lumbar vertebra was recorded as a measure of depression in the loin area.

*Trial 4.* Eighty-two yearling steers of mixed breeding (4 Shorthorns, 1 Holstein, 5 crossbred, and 72 Herefords), owned by a cooperator near Riverton, were individually weighed,

tattooed, and randomly assigned to the following treatments: (1) controls, (2) 36 mg. stilbestrol, and (3) Synovex (20 mg. estradiol, 1000 mg. progesterone). The steers were group-fed in one lot. They were fed chopped alfalfa hay, corn silage, ground corn, ground oats, ground wheat, and ground barley. During the first 82 days of the test the steers received one-half barley, one-quarter oats, and one-quarter wheat *ad libitum* as the grain ration. For the balance of the 107-day feeding period, the grain ration was one-half corn and one-half barley with approximately one-half pound of a commercial protein, vitamin, and mineral supplement per head daily. At the end of the feeding period, the steers were individually weighed. Carcass data were not obtained.

In all trials, initial and final weights were taken early in the morning after the animals had been deprived of feed and water overnight. The animals were weighed at 28-day intervals except for those in trial 4, where only initial and final weights were obtained. Feed was weighed as the animals were fed twice daily. The refused feed was weighed back as needed.

All data were subjected to analysis of variance. Where treatment effects were significant, the significant differences in means were detected with Hartley's sequential method of testing means (Snedecor, 1956).

## RESULTS

*Trial 1.* Approximately two weeks after the steers were started on feed, they refused to eat and suffered from bloat. Four steers died from this condition. To correct the digestive problems, dried beet pulp was fed to replace about one-half of the grain mix for two weeks, and alfalfa hay from another source was fed to the steers. This seemed to eliminate most of the feeding problem.

A summary of the feedlot results is given in Table 1. The feeding or implanting of hormones increased gains

from 3.8 to 11.4 percent; however, the differences were not significant statistically. Stilbestrol (DES), either as a 36 mg. implant or fed at the rate of 10 mg. per day, was not as effective in stimulating growth as was the Synovex implant. The feeding of aureomycin depressed gains 6.4 percent, although this difference was not significant.

The use of hormones increased feed intake, whereas the feeding of aureomycin depressed it. Except for the steers fed 10 mg. stilbestrol, those ad-

**TABLE 1—Summary of Feedlot Results: Trial 1, Powell Agricultural Substation, 1956-57**

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
No. of yearling steers	6	6	7	6	7	5
Av. initial wt.—lb.	673	696	699	664	683	712
Av. final wt.—lb.	953	987	989	976	945	1023
Av. 152-day gains—lb.	280	291	290	312	262	311
Standard error	47.1	24.9	21.9	11.9	15.9	21.3
Av. daily gain—lb.	1.84	1.91	1.91	2.05	1.73	2.05
Increase or decrease—%	.....	+3.8	+3.8	+11.4	-6.4	+11.4
<i>Av. daily Ration—lb.</i>						
Alfalfa hay	7.7	8.2	7.7	8.4	6.8	7.7
Steam-rolled barley	7.1	7.5	7.4	8.0	6.6	7.2
Dried beet pulp	2.5	2.6	2.3	2.8	2.3	2.4
Steam-rolled oats	1.0	1.1	1.1	1.2	0.9	1.0
Ground corn	1.0	1.0	1.0	1.0	1.0	1.0
<i>Lb. Feed per cwt. of gain</i>						
Alfalfa hay	418	427	401	407	400	370
Concentrates	611	612	569	604	570	535
Total	1029	1039	970	1011	970	905
Increase or decrease ... %	.....	+1	-6	-2	-6	-12
Feed cost per cwt. of gain <sup>1</sup>	\$18.08	\$18.22	\$17.80	\$17.87	\$17.69	\$16.17

<sup>1</sup> Feed costs per ton: Alfalfa hay—\$16, steam-rolled barley—\$43, dried beet pulp—\$48, steam-rolled oats—\$45, ground corn—\$70. The cost of the hormones and of antibiotic was not included.

ministered hormones required from 2 to 6 percent less feed per unit of gain. The steers fed aureomycin also gained more efficiently than the control steers (6%). The steers fed the combination of stilbestrol and aureomycin were the most efficient, requiring 12 percent less feed per unit of gain than the control steers.

Before slaughter few, if any, side effects could be noted. A slight elevation of the tailhead may have resulted from hormone treatment, but this was not evident visually. Mammary stimulation was observed in some of the steers; however, this was not excessive and could easily have passed unnoticed when observing the steers on the hoof. When the steers were slaughtered, mammary stimulation was observed to be present in some. This was common to all the hormone treatments; however, not all of the steers in any one treatment showed signs of mammary development. The 36 mg. of stilbestrol implant and the Synovex implant appeared to result in greater mammary development: a watery fluid could be expelled from the teats of some of the steers receiving these treatments. This condition was not observed in any of the steers fed stilbestrol. The differences in mammary stimulation were slight and would be negligible from a practical standpoint.

The cattle used in this study were slaughtered at light weights to satisfy the demands of the local market; thus the steers were not carrying a high degree of finish; however, the majority of the carcasses graded choice (by local

graders). The carcass and slaughter data are summarized in Table 2.

The treatments did not significantly affect the weight loss of the carcasses during the first 48 hours they were in the cooler. The carcasses of steers implanted with stilbestrol lost the most weight, while those fed aureomycin lost the least weight in the cooler.

The steers fed 10 mg. of stilbestrol or implanted with Synovex yielded less carcass ( $p < .01$ ) than the steers fed the other rations. There were no significant differences among the other treatments in carcass yield.

The treatments did not significantly influence carcass grades. All carcasses from animals in the control and stilbestrol-fed groups graded choice. However, the stilbestrol-fed cattle had carcasses with a larger amount of subcutaneous fat as indicated by the area of fat over the rib eye when compared with control carcasses. The aureomycin-fed steers also had a larger area of subcutaneous fat over the rib than did the controls. These differences in fat area over the 12th rib and crude-fat content of the rib-eye muscle were not significant.

As indicated by the crude-fat content of the rib-eye muscle, the control steers, the aureomycin-fed, and the stilbestrol-aureomycin-fed steers appeared to contain more intramuscular fat than the other groups. Inspection of colored slides of the 12th rib area did not reveal any observable differences in the amount of marbling.

The use of hormones increased the size of the rib-eye muscle and the amount of moisture, crude protein,

TABLE 2—Slaughter and Carcass Data: Trial 1, Powell Agricultural Substation, 1956-57

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
Cooler shrink—% <sup>1</sup>	1.69	1.71	1.66	1.80	1.62	1.68
Standard error	0.13	0.27	0.18	0.25	0.19	0.23
Carcass yield—% <sup>2</sup>	61.18 <sup>b</sup>	58.97 <sup>a</sup>	61.25 <sup>b</sup>	59.44 <sup>a</sup>	61.14 <sup>b</sup>	61.24 <sup>b</sup>
Standard error	0.38	0.36	0.75	0.36	0.53	0.28
Carcass grade <sup>3</sup>	20.0	20.0	19.1	19.5	19.1	19.4
Standard error	0.00	0.00	0.55	0.61	0.55	0.57
<i>12th Rib-eye muscle measurements</i>						
Muscle area—sq. in.	10.25	10.89	11.23	10.70	10.01	10.90
Standard error	0.24	0.39	0.42	0.47	0.43	0.36
Fat area—sq. in.	2.70	3.09	2.48	2.45	3.13	2.75
Standard error	0.22	0.35	0.20	0.15	0.18	0.12
Moisture—%	70.7	71.7	72.8	72.7	71.8	70.4
Standard error	0.9	1.0	0.5	0.8	0.5	0.4
Crude fat—%	6.6	4.7	4.4	3.5	6.2	5.2
Standard error	0.4	0.8	0.3	0.7	0.1	0.3
Crude protein—%	22.5	23.2	22.8	24.1	23.8	23.2
Standard error	0.0	0.7	0.3	0.3	0.7	0.7
Ash—%	1.04	1.08	1.07	1.09	1.05	1.04
Standard error	0.02	0.06	0.05	0.04	0.02	0.01
<i>Organoleptic tests—</i>						
<i>Longissimus dorsi muscle</i>						
Warner-Bratzler						
shear test (lb.)	16.6	16.9	14.9	15.3	15.5	15.4
Taste-panel evaluation <sup>4</sup>						
Tenderness	4.5	5.8	7.4	7.1	6.5	5.9
Juiciness	5.7	6.5	6.8	6.3	5.9	5.1
Flavor	5.7	6.4	6.6	6.3	5.9	5.0
Seminal vesicle wt.—gm. <sup>5</sup>	6.7(5)	33.3(3)	37.5(4)	47.3(5)	8.4(7)	31.8(4)
<i>Mouse-uterine wt.—mg.</i>						
Kidney fat <sup>6</sup>	18.7	19.3	20.0	14.5	17.3	15.6
Standard error	0.5	1.8	1.7	0.7	1.0	0.7
Liver <sup>7</sup>	11.0	10.9	.....	7.9	.....	10.8
Standard error	1.0	1.0	.....	0.6	.....	1.3
Diaphragm muscle <sup>8</sup>	21.4	26.9	17.5	16.1	16.7	24.3
Standard error	1.6	4.4	0.7	1.7	2.8	3.6
Mouse diet <sup>9</sup>		23.1				
Standard error		2.5				

<sup>1</sup> 48-hour cooler shrink.

<sup>2</sup> Based on cold carcass weights and prekill weights. Figures having the same superscripts are not significantly different.

<sup>3</sup> Carcass grade: Av. choice—20, Av. good—17.

and ash in the rib-eye muscle; however, the increases were not significant. The feeding of aureomycin decreased the rib-eye muscle area and increased the amount of moisture, crude protein, and ash in the rib-eye muscle non-significantly.

Each rib-eye muscle was cored three times, and each core was sheared three times for tenderness with the Warner-Bratzler shear machine. As measured in this manner, the treatments did not influence the tenderness of the rib-eye muscle. However, there was a significant ( $p < .01$ ) difference in tenderness due to cores, shears, and cores X treatment interaction.

The taste panel was unable to detect differences in juiciness or flavor of the rib-eye muscle of the steers treated with hormones or antibiotics compared with the muscles from the control steers. Kendall's (1948) procedure for computing tau values was used for ranking the muscles for tenderness, juiciness, and flavor by each taste-panel member.

Administration of hormones markedly increased the weight of the seminal vesicles. Apparently the levels were high enough to exert a physiological response. Seminal vesicles obtained from six 650 to 825-lb. normal yearling bulls in another study were found to have an average weight

of 39.8 gm. (Thompson *et al.*, 1958). The hormones used in the present study stimulated seminal-vesicle growth to a point approaching that of these intact males. No histological studies were conducted, but the glands from treated steers appeared quite similar to those from intact males.

Table 2 shows the results of the mouse assay for residual estrogens in kidney fat, liver, and diaphragm muscle. The hormone treatments did not result in deposition of residual estrogens in the fat, liver, or muscle of the treated steers as measured by comparing each tissue from the treated steers with the corresponding tissue from the control steers. Except for two groups of mice—those fed diaphragm muscle from carcasses of steers fed stilbestrol or stilbestrol plus aureomycin—the mice fed the mouse diet devoid of hormones had heavier uteri than the mice fed the experimental tissues. It is interesting to note that the muscle tissue contains the most estrogenic activity, followed closely by liver tissue, with the kidney fat lowest in that activity.

*Trial 2.* In view of the feeding problems associated with trial 1, the grain ration was modified in trial 2 so that the steers were fed more dried beet pulp and less steam-rolled barley. Molasses was also added to the steam-rolled oats and barley at the time of

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<sup>4</sup> 1—dislike extremely, 3—dislike moderately, 5—neither like nor dislike, 7—like moderately, and 9—like extremely.

<sup>5</sup> Numbers within parentheses refer to the number of animals sampled.

<sup>6</sup> 30% fat, 70% mouse diet.

<sup>7</sup> 80% liver, 20% mouse diet.

<sup>8</sup> 80% muscle, 20% mouse diet.

<sup>9</sup> Commercial mouse diet devoid of hormones.

rolling. One steer fed the combination of stilbestrol and aureomycin foundered about six weeks after the trial began and had to be removed. The summary of the feedlot phase of this study is given in Table 3.

The administration of hormones increased gains from 10 to 17 percent, whereas the use of aureomycin, or a combination of aureomycin and stilbestrol, reduced gains from 5 to 10 percent. According to Hartley's sequential method of testing means, the gains of the steers fed no hormones,

aureomycin, or a combination of stilbestrol and aureomycin were not significantly different. The gains of the steers fed 10 mg. stilbestrol orally or a combination of stilbestrol and aureomycin, or implanted with Synovex, were not significantly different. The gains of the steers fed stilbestrol or those implanted with stilbestrol or Synovex were not significantly different. However, the partition of the treatment sum of squares into individual comparisons revealed the following significant differences in feed-

TABLE 3—Feedlot Results: Trial 2, Powell Agricultural Substation, 1957-58

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
No. of yearling steers	6	6	6	6	6	5
Av. initial wt.—lb.	699	654	656	698	661	699
Av. final wt.—lb.	1027	1026	1039	1059	956	1010
Av. 124-day gain—lb. <sup>1</sup>	328 <sup>abc</sup>	372 <sup>ab</sup>	383 <sup>a</sup>	361 <sup>ab</sup>	295 <sup>c</sup>	311 <sup>bc</sup>
Standard error	17.6	25.6	10.3	15.8	14.8	8.6
Av. daily gain—lb.	2.65	3.00	3.09	2.91	2.38	2.51
Increase or decrease—%	.....	+13	+17	+10	-10	-5
<i>Av. daily ration—lb.</i>						
Alfalfa hay	5.0	5.0	5.0	5.0	5.0	5.2
Dried beet pulp	6.0	6.0	6.3	6.2	5.6	5.4
Steam-rolled barley	5.7	5.7	6.0	5.9	5.3	5.2
Steam-rolled oats	2.9	2.9	3.0	2.9	2.6	2.6
Molasses	0.5	0.5	0.5	0.5	0.4	0.4
Ground corn	1.0	1.0	1.0	1.0	1.0	1.0
<i>Lb. Feed per cwt. of gain</i>						
Alfalfa hay	189	167	162	172	210	207
Concentrates	604	537	540	564	626	582
Total	793	704	702	736	836	789
Increase or decrease—%	.....	-11	-11	-7	+5	-0.5
Feed cost per cwt. of gain <sup>2</sup>	\$14.98	\$13.33	\$13.30	\$13.95	\$15.63	\$14.62

<sup>1</sup> Figures having the same superscripts are not statistically different.

<sup>2</sup> Feed prices per ton: Alfalfa hay—\$12, beet pulp—\$44, steam-rolled oats—\$45, steam-rolled barley—\$42, molasses—\$60, ground corn—\$74. The cost of the hormones and of antibiotic was not included.

lot gains: Hormone-treated steers gained significantly faster ( $p = < .01$ ) than those not administered hormones. Steers fed aureomycin gained significantly slower ( $p = < .01$ ) than steers fed no aureomycin. Steers fed the combination of stilbestrol and aureomycin gained significantly more slowly ( $p = < .05$ ) than steers fed stilbestrol. The total gains of the steers administered the various hormones were not significantly different.

As in trial 1, the use of hormones increased feed intake somewhat, whereas the feeding of aureomycin depressed it. The use of hormones decreased the feed required per unit of gain from 7 to 11 percent, while aureomycin-fed steers required 5 percent more feed per unit of gain compared with the control steers. Steers fed the combination of aureomycin and stilbestrol required about as much feed per unit of gain as the control steers.

Side effects were not readily apparent in the live animals; however, mammary stimulation was noted in some of the hormone-treated steers on the slaughter floor. The carcass and slaughter data are presented in Table 4.

Hartley's sequential method of testing means revealed that steers implanted with stilbestrol lost significantly less weight in transit to slaughter, a distance of 100 miles. Steers implanted with Synovex or fed aureomycin did not differ significantly in in-transit shrink. The shrink of steers implanted with Synovex or fed the combination of stilbestrol and aureo-

mycin were not significantly different. Those fed stilbestrol, implanted with Synovex, or fed the combination, lost similar amounts of weight in transit. The control steers and those fed stilbestrol did not differ significantly in in-transit weight loss.

Except for the steers implanted with Synovex, the hormone-treated steer carcasses lost somewhat more weight the first 48 hours in the cooler, and the aureomycin-fed steer carcasses lost somewhat less weight than the control steers. These differences were not significant.

Steers fed stilbestrol or implanted with Synovex yielded somewhat more carcass, and steers implanted with stilbestrol, fed aureomycin, or fed a combination of aureomycin and stilbestrol, yielded somewhat less carcass than the control steers. However, these differences were small and non-significant.

All carcasses but one (aureomycin group) graded choice (local graders). Hormone-treated animals graded equally as well as the control steers.

The use of hormones increased the size of the rib-eye muscle; however, these differences were non-significant. Interestingly, the control steers contained more water and less crude protein, crude fat, and ash in the 12th rib-eye muscle than hormone-treated or aureomycin-fed steers. These differences were not significant. The treatments did not significantly influence the length of body, length of hind leg, total length, length of loin, depth of round, width of round, depth of body, or width of shoulder.

**TABLE 4—Slaughter and Carcass Data: Trial 2, Powell Agricultural Substation, 1957-58**

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
In-transit shrink—% <sup>1</sup>	4.90 <sup>e</sup>	4.41 <sup>de</sup>	2.89 <sup>a</sup>	4.10 <sup>bed</sup>	3.83 <sup>b</sup>	4.30 <sup>ed</sup>
Standard error	0.51	0.37	0.94	0.99	0.90	0.67
Cooler shrink—% <sup>2</sup>	2.32	2.37	2.49	1.99	2.20	2.11
Standard error	0.31	0.29	0.25	0.12	0.09	0.26
Carcass yield—% <sup>3</sup>	62.23	62.67	61.72	62.81	61.95	62.07
Standard error	0.49	0.36	0.47	0.47	0.21	0.71
Carcass grade <sup>4</sup>	20	20	20	20	19.5	20
Standard error	0	0	0	0	0.5	0
<i>12th Rib-eye muscle measurements</i>						
Area—sq. in.	8.17	9.34	9.08	9.44	8.07	8.29
Standard error	0.41	0.49	0.43	0.39	0.23	0.38
Water—%	73.6	70.7	73.2	71.4	72.1	71.8
Standard error	1.05	2.30	0.90	0.24	0.80	0.20
Crude protein—% <sup>5</sup>	22.7	23.2	22.9	23.3	24.1	23.0
Standard error	0.40	1.20	0.10	1.15	1.50	0.10
Crude fat—% <sup>5</sup>	1.83	4.13	1.87	4.59	2.56	3.17
Standard error	0.58	1.18	0.62	1.64	0.60	0.22
Ash—% <sup>5</sup>	1.21	1.28	1.36	1.21	1.23	1.26
Standard error	0.07	0.07	0.05	0.04	0.08	0.01
Length of body—cm.	118.0	117.1	117.1	119.1	116.6	118.2
Standard error	0.92	2.03	1.61	1.76	1.66	1.87
Length of hind leg—cm.	74.1	73.5	72.8	75.0	73.0	72.9
Standard error	0.64	1.33	1.12	0.69	0.94	0.88
Total length—cm.	192.1	190.7	189.9	194.2	189.6	191.1
Standard error	1.49	3.22	2.67	2.40	2.52	2.63
Length of loin—cm.	63.4	62.9	62.5	62.8	61.4	62.4
Standard error	0.73	1.10	1.02	1.15	1.22	1.12
Depth of round—cm.	33.5	33.5	34.6	35.4	32.9	32.9
Standard error	0.79	1.03	1.10	0.98	1.02	1.33
Width of round—cm.	23.0	23.4	23.8	23.1	22.8	23.2
Standard error	0.37	0.35	0.56	0.32	0.43	0.39
Depth of body—cm.	39.8	39.5	38.9	39.7	38.4	39.1
Standard error	0.69	0.76	0.46	0.76	0.61	0.67
Width of shoulder—cm.	20.5	21.7	21.3	21.4	20.5	21.2
Standard error	0.33	0.48	0.52	0.63	0.34	0.45

<sup>1</sup> Trucked 100 miles to slaughter. Figures having the same superscripts are not statistically different.

<sup>2</sup> 48-hour cooler shrink.

<sup>3</sup> Based on prekill weights and cold carcass weights.

<sup>4</sup> Carcass grades: Av. choice—20, Av. good—17.

<sup>5</sup> Fresh basis.

*Trial 3.* No feeding problems were encountered during this trial. The summary of the feedlot phase is given in Table 5. The feeding of stilbestrol or aureomycin reduced gains 6 percent compared with the controls. No apparent reason can be given for the depression of growth from feeding stilbestrol. The implanting of stilbestrol, the implanting of Synovex-S, or the feeding of aureomycin and stilbestrol increased gains 15, 20, and 7 percent, respectively, compared with the controls. Hartley's sequential method of testing means indicated that the fol-

lowing groups of steers made similar gains: (1) controls, 10 mg. stilbestrol in the feed, and 75 mg. aureomycin in the feed; (2) 36 mg. stilbestrol implant, Synovex-S implant, and a combination of stilbestrol and aureomycin in the feed; (3) controls, 36 mg. stilbestrol implant, and the combination of stilbestrol and aureomycin in the feed; (4) Synovex-S implant.

Stilbestrol-fed steers consumed less feed and required 2 percent more feed per unit of gain than the control steers. Stilbestrol-implanted steers ate

**TABLE 5—Feedlot Results: Trial 3, Powell Agricultural Substation, 1958-59**

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex-S implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
No. of yearling steers	9	9	9	9	9	9
Av. initial wt.—lb.	788	766	762	757	772	762
Av. final wt.—lb.	1132	1089	1158	1169	1096	1131
Av. 138-day gain—lb. <sup>1</sup>	344 <sup>ac</sup>	323 <sup>a</sup>	396 <sup>bc</sup>	412 <sup>b</sup>	324 <sup>a</sup>	369 <sup>bc</sup>
Standard error	9.7	19.0	14.2	19.3	18.0	18.7
Av. daily gain—lb.	2.49	2.34	2.87	2.98	2.34	2.67
Increase or decrease—%	.....	-6	+15	+20	-6	+7
<i>Av. daily ration—lb.</i>						
Alfalfa hay	6.0	5.9	6.0	6.1	5.9	6.0
Dried beet pulp	6.6	6.2	6.6	6.8	6.6	6.5
Steam-rolled barley	6.3	5.9	6.2	6.4	6.2	6.2
Steam-rolled oats	3.1	3.0	3.1	3.2	3.1	3.1
Molasses	0.5	0.5	0.5	0.5	0.5	0.5
Ground corn	1.0	1.0	1.0	1.0	1.0	1.0
<i>Lb. Feed per cwt. of gain</i>						
Alfalfa hay	241	253	209	203	254	224
Concentrates	701	708	607	601	744	649
Total	942	961	816	804	998	873
Increase or decrease—%	.....	+2	-13	-15	+6	-7
Feed cost per cwt. of gain <sup>2</sup>	\$16.17	\$16.40	\$14.00	\$13.84	\$17.15	\$14.98

<sup>1</sup> Figures having the same superscripts are not significantly different.

<sup>2</sup> Feed prices per ton: Alfalfa hay—\$12, steam-rolled barley—\$47, steam-rolled oats—\$43, dried beet pulp—\$33.50, ground corn—\$55, and molasses—\$60. The cost of the hormones and antibiotic was not included.

about as much feed as the control steers and required 13 percent less feed per unit of gain. Synovex-S implanted steers ate more feed than the control steers and required 15 percent less feed per unit of gain. Aureomycin-fed steers ate somewhat less feed than the controls and required 6 percent more feed per unit of gain. Those steers fed the combination of stilbestrol and aureomycin ate somewhat less feed than the controls and required 7 percent less feed per unit of gain.

As shown in Table 6, steers treated with hormones lost somewhat more weight in transit to slaughter (425 miles) than the control steers, whereas aureomycin-treated steers lost somewhat less weight. These differences were not significant.

All of the treated steers lost somewhat less weight (non-significant) than the control steers during the first 48 hours in the cooler. Carcass yield was not significantly affected by the treatments. Although the differences in carcass grades (plant grader) before and after ribbing were not significant, the stilbestrol-implanted steers graded the lowest. The stilbestrol-fed and the Synovex-S implanted steers graded higher than the control steers, as did the aureomycin-fed steers.

The administration of hormones increased the size of the rib-eye muscle at the 12th rib and the feeding of aureomycin decreased the size of the rib-eye muscle compared with the controls. These differences were not significant. Except for the Synovex-S implanted steers, the use of hormones

decreased the width of the fat covering over the 12th rib-eye muscle and the area of fat over this muscle. Aureomycin-fed steers had a fat covering and area of fat over the 12th rib similar to the controls. The steers implanted with Synovex-S or fed the combination of aureomycin and stilbestrol had a thicker rind over the 12th rib and a greater area of fat over the 12th rib-eye muscle than the control steers. However, these differences in fat thickness or fat area were not significant.

The feeding regimes did not significantly alter the length of body, length of hind leg, total length, length of loin, or depth of round. The distance from the middle of the aitch bone to the 5th lumbar vertebra was shorter for hormone-treated steers than for aureomycin-fed or the control steers. This would indicate a depression in the loin area of the hormone-treated steers, but it was not apparent in the live animal. However, it seems unlikely that a depression of 0.55 cm. or less could be detected by the naked eye. These differences were not significant.

*Trial 4.* In this trial with a cooperator in the upper Big Horn Basin, the implantation of 36 mg. of stilbestrol and the implantation of synovex increased gains 36 and 26 percent, respectively (Table 7). As these steers were group-fed, it was not possible to measure feed intake or feed efficiency by treatment groups. The gains of the hormone-treated steers were significantly greater ( $p > .01$ ) than the controls. The differences between

TABLE 6—Slaughter and Carcass Data: Trial 3, Powell Agricultural Substation, 1958-59

	Controls	10 mg. DES orally	36 mg. DES implant	Synovex-S implant	75 mg. Aureo. orally	75 mg. Aureo. 10 mg. DES orally
In-transit shrink—% <sup>1</sup>	4.83	5.43	5.58	5.34	4.33	4.57
Standard error	0.57	0.31	0.42	0.34	0.45	0.46
Cooler shrink—% <sup>2</sup>	1.65	1.48	1.60	1.48	1.52	1.56
Standard error	0.17	0.08	0.07	0.07	0.05	0.06
Carcass yield—% <sup>3</sup>	61.57	61.59	62.13	61.82	62.81	62.05
Standard error	0.33	0.42	0.35	0.30	0.37	0.35
Carcass grade before ribbing <sup>4</sup>	7.33	7.67	6.33	7.67	7.67	7.33
Standard error	0.44	0.33	0.73	0.33	0.33	0.44
Carcass grade after ribbing <sup>4</sup>	7.11	7.33	6.33	7.44	7.78	7.89
Standard error	0.48	0.29	0.50	0.58	0.16	0.20
No. of carcasses up-graded after ribbing	0	1	2	0	1	2
No. of carcasses down-graded after ribbing	1	2	1	1	0	0
<i>12th Rib-eye muscle measurements</i>						
Muscle area—sq. in.	10.45	10.66	11.05	10.66	10.00	9.83
Standard error	0.38	0.29	0.32	0.42	0.25	0.32
Fat area—sq. in.	3.48	3.30	3.20	3.99	3.45	4.22
Standard error	0.47	0.31	0.31	0.39	0.30	0.38
Width of fat covering—in.	0.61	0.57	0.53	0.70	0.62	0.72
Standard error	0.08	0.05	0.06	0.07	0.05	0.07
Length of body—cm.	121.5	119.3	122.2	123.3	120.8	120.6
Standard error	1.28	1.49	0.96	0.77	1.15	1.10
Length of hind leg—cm.	74.4	73.9	75.1	74.0	73.5	74.9
Standard error	0.85	1.07	0.72	0.80	0.96	0.37
Total length—cm.	195.9	193.2	197.4	197.2	194.3	195.5
Standard error	2.03	2.53	1.62	1.50	1.99	1.41
Length of loin—cm.	63.7	63.5	64.4	64.9	63.9	63.6
Standard error	0.35	0.96	0.82	0.72	0.60	0.78
Depth of round—cm.	35.3	35.0	36.5	35.9	35.2	35.4
Standard error	0.70	0.63	0.57	0.57	0.67	0.55
Midline of aitch bone to ventral edge of lumbar vertebra—cm.	2.61	2.28	2.06	2.17	2.67	2.67
Standard error	0.16	0.32	0.38	0.37	0.20	0.20

<sup>1</sup> Trucked 425 miles to slaughter.

<sup>2</sup> 48-hour cooler shrink.

<sup>3</sup> Based on prekill weights and cold carcass weights.

<sup>4</sup> Carcass grades: Av. choice—8, Low choice—5, High good—2.

the stilbestrol- or Synovex-implanted steers were not significant.

It was not possible to obtain carcass data, since the steers were sorted for slaughter over a period of time and sent to different markets. None

of the steers exhibited very noticeable side effects. An occasional high tailhead and some mammary stimulation were apparent in the hormone-treated steers.

**TABLE 7—Feedlot Results: Riverton Cooperative Study—1957**

	Controls	36 mg. Stilbestrol implant	Synovex implant
No. of yearling steers	27	27	28
Av. initial wt.—lb.	808.0	825.3	855.7
Av. final wt.—lb.	996.9	1078.3	1097.0
Av. gain (107 days)—lb.	188.9	253.0	241.3
Av. daily gain—lb. <sup>1</sup>	1.79 ± 0.08	2.36 ± 0.06	2.25 ± 0.06
% increase in gain	.....	32	26
Feed cost/100 lbs. of gain <sup>2</sup>	\$19.16	\$14.53	\$15.24
<i>Daily ration—lb./day</i>			
Corn silage	11.4	} Av. for all 82 steers	
Chopped alfalfa hay	5.3		
Cracked corn	1.9		
Ground barley	5.0		
Ground oats	1.6		
Ground wheat	1.6		
Commercial supplement	0.2		

<sup>1</sup> Gain ± standard error.

<sup>2</sup> Feed prices/ton: Alfalfa hay—\$15, corn silage—\$7, corn—\$58.40, barley—\$45, oats—\$45, wheat—\$56, and commercial protein, vitamin, and mineral supplement—\$150.

## DISCUSSION

When the data from the three trials are summarized, it is noted that the use of hormones increased the rate of gain of yearling steers in the feedlot and reduced the amount of feed required to put on a unit of gain. The data for the three trials at the Powell Substation have been summarized in Figure 1. Feeding 10 mg. of stilbestrol per head daily increased gains 2.2

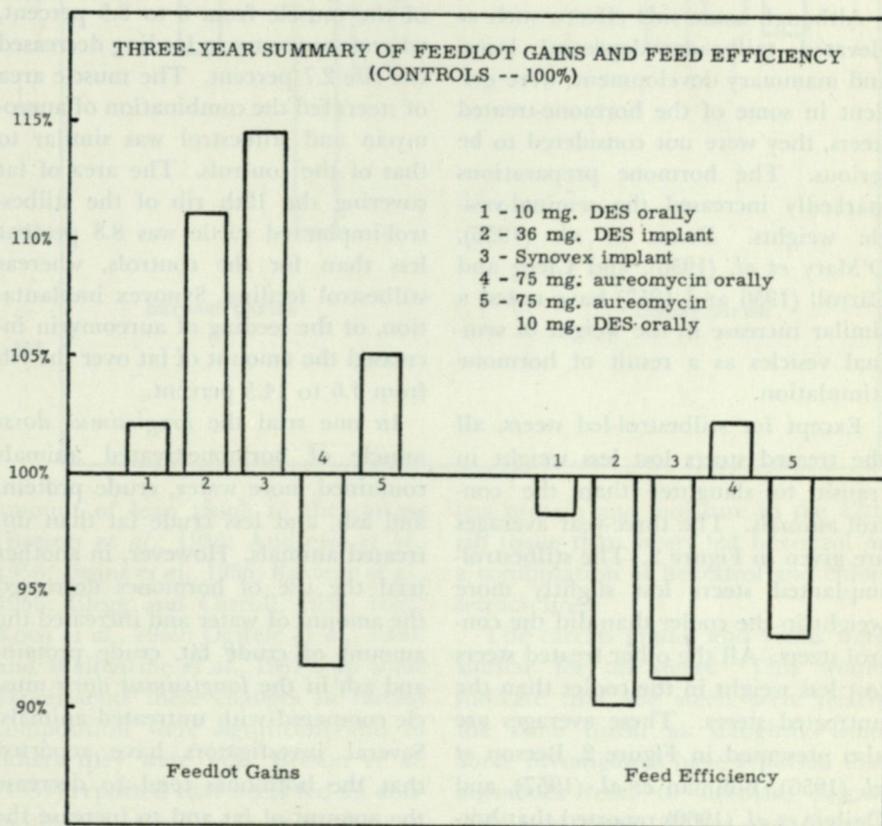
percent, whereas the implanting of 36 mg. of stilbestrol or Synovex increased feedlot gains 11.2 and 14.6 percent, respectively.

In each trial, the feeding of 75 mg. of aureomycin depressed gains, resulting in 8.2 percent slower gains for the three tests. More feed was also required to gain 100 lbs. Steers fed the combination of stilbestrol and aureo-

mycin gained 5.2 percent faster on 6.8 percent less feed than the untreated steers. In 1955, Hentges *et al.* reported that the combination of stilbestrol and aureomycin in the feed increased daily gain and efficiency of gain more than either treatment applied singly during the first 35 days of the trial. However, after 10 weeks the gains of the stilbestrol-fed steers and those receiving the combination were similar. Perry *et al.* (1958) also

reported that feeding of stilbestrol and aureomycin did not improve the feedlot gains or efficiency of gains of steer calves compared with the feeding of stilbestrol alone. Dyer *et al.* (1957), Bohman *et al.* (1957), Beeson *et al.* (1957), Sherman *et al.* (1959), and Kolari *et al.* (1960) all reported that the feeding of stilbestrol and an antibiotic in combination resulted in at least additive gains and improved feed efficiency compared with cattle

FIGURE 1



fed either stilbestrol or antibiotics alone.

In our trials, steers implanted with stilbestrol or Synovex gained faster on less feed per unit of gain than steers fed stilbestrol. Perry *et al.* (1958), Clegg and Carroll (1957), and Deans *et al.* (1956) reported that hormone-implanted cattle gained as well as or better than stilbestrol-fed cattle.

Hormones stimulated the appetite, whereas antibiotic-fed steers always consumed less feed than untreated steers. This phenomenon has also been reported by many other investigators.

Although some side effects, such as elevated tailheads, depressed loins, and mammary development, were evident in some of the hormone-treated steers, they were not considered to be serious. The hormone preparations markedly increased the seminal-vesicle weights. Deans *et al.* (1956), O'Mary *et al.* (1956), and Clegg and Carroll (1956 and 1957) have noted a similar increase in the weight of seminal vesicles as a result of hormone stimulation.

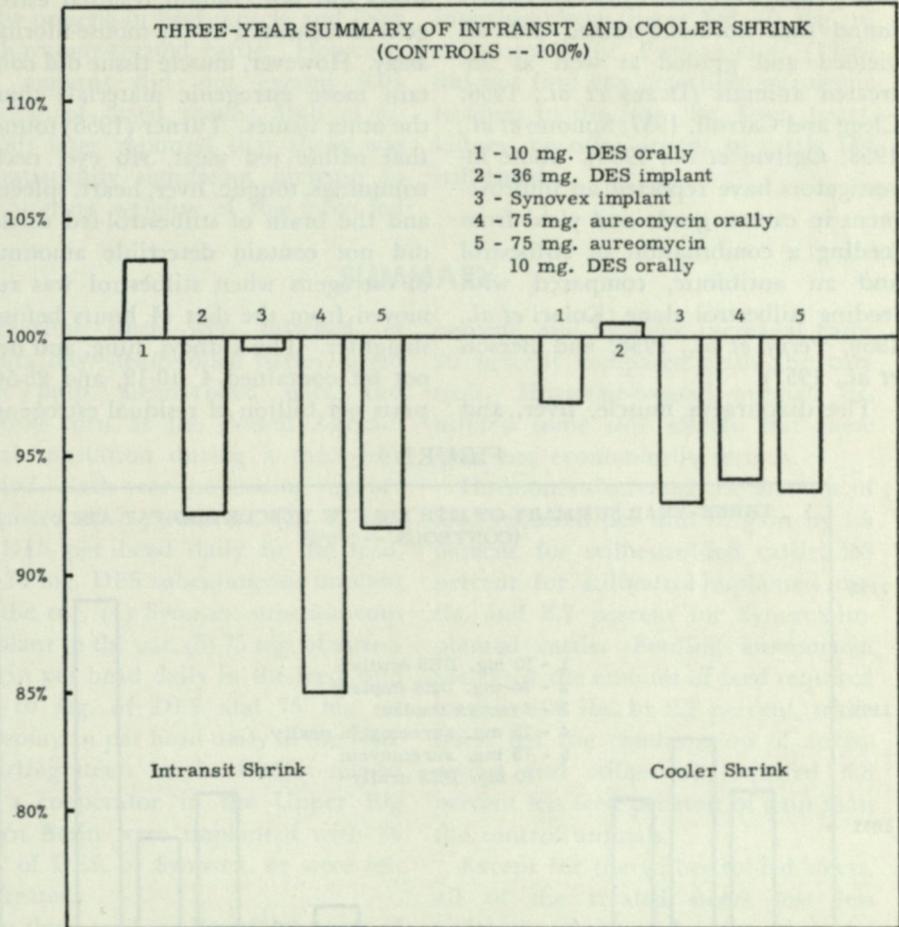
Except for stilbestrol-fed steers, all the treated steers lost less weight in transit to slaughter than the control animals. The three-year averages are given in Figure 2. The stilbestrol-implanted steers lost slightly more weight in the cooler than did the control steers. All the other treated steers lost less weight in the cooler than the untreated steers. These averages are also presented in Figure 2. Beeson *et al.* (1956), Bohman *et al.* (1957), and Ogilvie *et al.* (1960) reported that hor-

mone-treated cattle did not lose more weight in transit to slaughter than untreated cattle. However, Andrews *et al.* (1956) reported that stilbestrol-fed cattle lost significantly more weight in transit than control cattle. Deans *et al.* (1956), Sherman *et al.* (1959), and Bohman *et al.* (1957) found that carcasses from hormone-treated steers did not lose any more weight in the cooler than carcasses from untreated steers.

The average *longissimus dorsi* muscle area and the area of fat covering the muscle at the 12th rib are given in Figure 3. Hormones increased the size of the muscle from 6 to 8.5 percent, whereas aureomycin feeding decreased the size 2.7 percent. The muscle area of steers fed the combination of aureomycin and stilbestrol was similar to that of the controls. The area of fat covering the 12th rib of the stilbestrol-implanted cattle was 8.8 percent less than for the controls, whereas stilbestrol feeding, Synovex implantation, or the feeding of aureomycin increased the amount of fat over the rib from 1.6 to 14.5 percent.

In one trial the *longissimus dorsi* muscle of hormone-treated animals contained more water, crude protein, and ash, and less crude fat than untreated animals. However, in another trial the use of hormones decreased the amount of water and increased the amount of crude fat, crude protein, and ash in the *longissimus dorsi* muscle compared with untreated animals. Several investigators have reported that the hormones tend to decrease the amount of fat and to increase the

FIGURE 2



amount of lean tissue in the carcass (Beeson *et al.*, 1956; Andrews *et al.*, 1956; Deans *et al.*, 1956; Kastelic *et al.*, 1956; Clegg and Carroll, 1956, 1957; Koch *et al.*, 1959; Ogilvie *et al.*, 1960; and Wallentine *et al.*, 1961). In some experiments these changes in carcass composition were significant and in others they were not. Beeson *et al.* (1957) reported that steers fed an antibiotic had significantly more fat and

less protein and moisture in the 12th rib tissue than steers fed hexestrol or a combination of hexestrol and chlor-tetracycline.

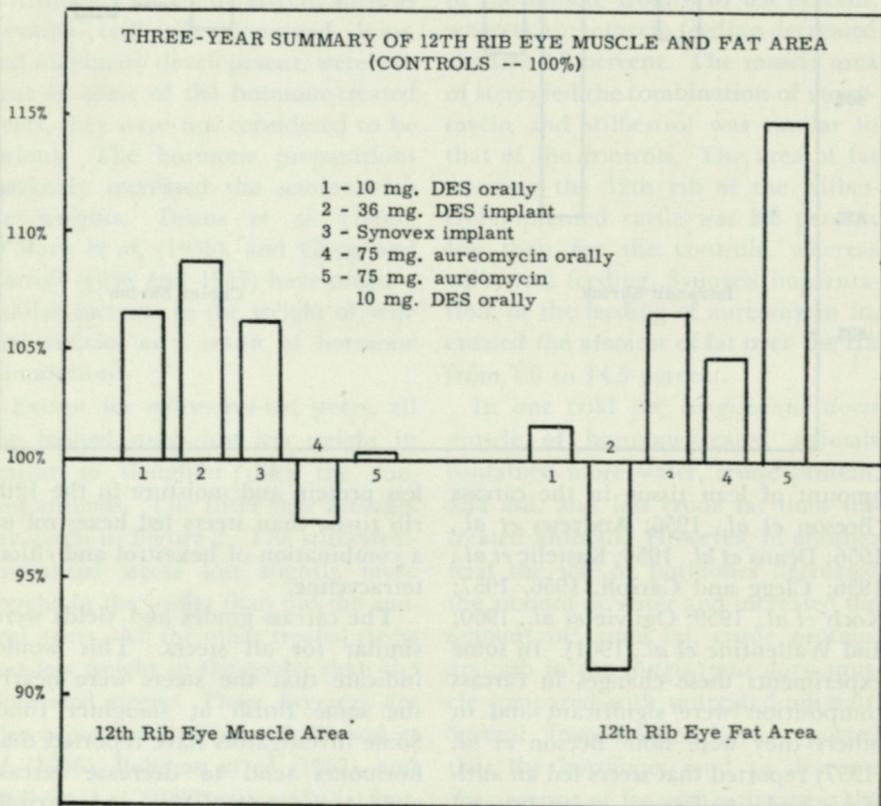
The carcass grades and yields were similar for all steers. This would indicate that the steers were nearly the same finish at slaughter time. Some investigators have reported that hormones tend to decrease carcass yield and grade (Clegg and Carroll,

1956; Beeson *et al.*, 1956; Kastelic *et al.*, 1956; Perry *et al.*, 1959). Others found that hormone-treated animals yielded and graded as well as untreated animals (Deans *et al.*, 1956; Clegg and Carroll, 1957; Simone *et al.*, 1958; Ogilvie *et al.*, 1960). Some investigators have reported an improvement in carcass grade and yield from feeding a combination of stilbestrol and an antibiotic, compared with feeding stilbestrol alone (Kolari *et al.*, 1960; Perry *et al.*, 1958; and Beeson *et al.*, 1957).

The diaphragm muscle, liver, and

kidney fat from hormone-treated steers did not contain residual estrogens as measured by the mouse-uterine assay. However, muscle tissue did contain more estrogenic materials than the other tissues. Turner (1956) found that edible red meat, rib eye, neck trimmings, tongue, liver, heart, spleen, and the brain of stilbestrol-fed cattle did not contain detectible amounts of estrogens when stilbestrol was removed from the diet 44 hours before slaughter. The kidneys, lung, and depot fat contained 4, 10-12, and 25-50 parts per billion of residual estrogens.

FIGURE 3



Stob *et al.* (1954b) reported estrogen to be present in beef muscle and liver of hormone-treated cattle. However, the amount did not exceed 0.01 mcg./g. of dried tissue. Stob *et al.* (1956) later reported that there was a statistically significant increase in the uterine weights of the mice fed

muscle, kidney fat, liver, kidney, and intestines from steers fed 10 mg. of stilbestrol daily. Preston *et al.* (1956) did not find any detectable estrogenic residues in the lean, fat, liver, heart, kidney, or offal organs of cattle fed stilbestrol.

## SUMMARY

Yearling steers were fattened on alfalfa hay, steam-rolled barley, dried beet pulp, steam-rolled oats, and ground corn at the Powell Agricultural substation during a three-year period. Each year the feeding regimes consisted of (1) controls, (2) 10 mg. of DES per head daily in the feed, (3) 36 mg. DES subcutaneous implant in the ear, (4) Synovex subcutaneous implant in the ear, (5) 75 mg. of aureomycin per head daily in the feed, and (6) 10 mg. of DES and 75 mg. of aureomycin per head daily in the feed. Yearling steers in the feedlot owned by a cooperator in the Upper Big Horn Basin were implanted with 36 mg. of DES, or Synovex, or were left untreated.

In these trials at Powell, the rate of gain was increased by hormone administration. Synovex implants increased gains 14.6 percent, 36 mg. stilbestrol implants, 11.2 percent, and 10 mg. of stilbestrol orally, 2.2 percent. The feeding of aureomycin depressed gains 8.2 percent, whereas the combination of stilbestrol and aureomycin in the feed improved gains 5.2 percent, compared with the control animals. In the field trial, the 36 mg. stilbestrol implant increased gains 32

percent, and Synovex increased gains 26 percent compared with the controls. Hormone-treated animals exhibited some side effects, but these were not economically serious.

Hormones decreased the amount of feed required per unit of gain by 1.6 percent for stilbestrol-fed cattle, 9.8 percent for stilbestrol-implanted cattle, and 8.7 percent for Synovex-implanted cattle. Feeding aureomycin increased the amount of feed required to gain 100 lbs. by 2.2 percent, while steers fed the combination of aureomycin and stilbestrol required 6.8 percent less feed per unit of gain than the control animals.

Except for the stilbestrol-fed steers, all of the treated steers lost less weight in transit to slaughter than the untreated steers. In one trial these differences were significant. Except for the stilbestrol-implanted cattle, the treated steers lost less weight in the cooler (48 hours) compared with the untreated steers. The stilbestrol-implanted cattle lost about as much weight in the cooler as the controls.

The treatments did not appreciably alter carcass grades or yield. The area of the *longissimus dorsi* at the 12th rib was increased by hormone

treatment and decreased by aureomycin feeding. None of the differences was significant, but they were apparent in each trial. The amount of fat covering the 12th rib was decreased by stilbestrol implantation and increased by all other treatments compared with the controls. The treatments did not consistently affect the chemical analysis of the *longissimus dorsi* muscle at the 12th rib, or carcass measurements such as length of body, length of hind leg, length of loin, depth of round, width of round,

depth of body, or width of shoulder. The use of hormones or antibiotics did not influence the tenderness of the rib-eye muscle as measured by the Warner-Bratzler shear test or by taste-panel evaluation. The taste panel was also unable to detect differences in juiciness or flavor of the rib-eye muscle of the treated steers compared with untreated steers. There were no residual estrogens in the diaphragm muscle, kidney fat, or liver of hormone-treated animals as determined by the mouse-uterine assay.

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