Effect of Diethylstilbestrol on Growth and Carcass Quality of Beef Cattle

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AUTHORS: A. T. Ralston is professor of animal nutrition, T. P. Davidson is superintendent of the Umatilla Experiment Station, and N. O. Taylor is Umatilla County extension agent, Oregon State University.

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LITERATURE REVIEW

The early work of Dinusson et al. (1950) and Andrews et al. (1950) showed that diethylstilbestrol (DES) implanted under the skin of beef cattle increased growth rate, feed efficiency, and feed consumption. The effectiveness of this product in stimulating growth when administered orally was reported by Burroughs (1954).

Many of the early side effects such as broken loins, raised tail heads, increased mammary development, and some reduction in carcass grade were eliminated when dosages were dropped to a 24 mg. implant in cattle as shown by O'Mary and Cullison (1956). That the level of implant could be reduced to 12 mg. and still have adequate growth response was shown by Fontenot et al., 1961; England, 1959; and Ralsion et al., 1965.

Chapman et al. (1964) reported that the animal response to stilbestrol was greatest on a full feed in dry lot with greater variability occurring on limited feed or pasture. However, research in energy concentration and the animal response to DES was limited and did not answer all feedlot problems.

Increased growth responses created by altering the hormonal balance of animals creates new nutritional stresses. Consequently, compounds usually synthesized within the animal body may become limiting to maximum production. Choline, a quaternary ammonium compound that some have classified as a B vitamin, falls in this category:

$$(CH_3)_3 \equiv \underset{\displaystyle OH}{\underset{|}{N}} - CH_2 - CH_2 - OH$$

Because of its three methyl groups, choline chloride can act as a methyl donor and may function in the synthesis of amino acids by bacteria (e.g., conversion of homocystine to methionine). It may also function in synthesis of phospholipids and is said to have lipotrophic and antihemmorhagic properties. Choline chloride, as well as other B vitamins, has been considered a dietary essential for monogastric animals (chick, pig, and laboratory animals). Its essentialness for young ruminants is assumed, although not conclusively proven (Davis et al., 1956; Waugh et al., 1956).

With the advent of less roughage in the ration and many rations finely ground for pelleting, the ruminant may be limited in areas of bacterial synthesis. Dyer (1961) has shown some response to choline chloride (25%) when fed at either 505 mg. per pound of feed or at 13 grams per head daily. The effectiveness of choline chloride in fattening rations was not clear cut even in earlier reports, and further investigations were indicated.

Beeson et al. (1962) reported a significant response to 100 ppm added zinc, and in 1963 Smith et al. of the same station got an increase of .19 and .20 pounds per head daily on steers supplemented with 1 and 2 grams of zinc, respectively. Wise and Barrick (1963) failed to show such a response. The lack of agreement seemed to justify further investigation with zinc.

OBJECTIVES

With the apparent lack of agreement in the literature, the objectives of the two experiments reported herein were to study animal response to DES under varying conditions, such as (1) method of application (implant, oral, or combined oral-implant); (2) interraction with the feed additives choline chloride or zinc oxide; (3) interraction with different diets; (4) interraction of choline chloride with concentration of energy in the diet; and (5) delayed or immediate finishing. In addition DES was compared with Rapigain.[1]

METHODS

Experiment 1. Two hundred fifty-two steers were stratified as to weight and source and randomly allotted to 21 pens of 12 per pen. The experimental design was a 2 x 3 x 3 factorial which consisted of two rations—a standard ration and a linear programmed finishing ration containing .71 and .70 mega calories of net energy per pound; three additives—3.25 g./head daily of choline chloride, 100 ppm zinc oxide, and a control; and three types of DES administration—implanted, 24 mg.; oral, 10 mg./head daily; and implanted 24 mg. + oral 10 mg./head daily. There were also three lots on a ration of low energy, .63 meg. cal./lb., with choline chloride added; one lot was on each of the three DES treatments. The ration ingredients appear in Table 1. Periodic weights were taken and equal numbers from each pen were marketed, enabling comparisons of marbling, back fat, and grade. Selection of animals to be marketed was based on live animal grade.

[1] Rapigain is a paste implant containing testosterone and diethylstilbestrol, sold by E. R. Squibb and Sons, Inc.

Table 1. Ration Ingredients by Percent

Feedstuff	Standard	Mega calories	
	%	.7/lb.	.63/lb.
Steam rolled barley	82.50	58.00	36.90
Beet pulp—dried	15.00	11.25	15.00
Molasses	2.50	5.00	7.50
Millrun	.....	23.25	27.50
Limestone	.....	1.65	.60
Alfalfa meal	.....	.....	7.50
Urea	.....	.85	.....
Cull pea meal	.....	.....	5.00

Experiment 2. One hundred and twenty steers were stratified as to weight and randomly allotted to one of ten pens. Five pens were placed on the finishing ration immediately, while the remaining five were carried on a growing ration for the first 49 days. Five hormonal treatments (12 mg. implant DES, 10 mg. DES oral/head daily, 12 mg. implant DES + 10 mg. DES oral/head daily, Rapigain implant, and Rapigain implant + 10 mg. DES oral/head daily) were used in early and late finishing pens. The cattle finished directly were on feed 141 days, whereas, those delayed 49 days were on finishing feed for 100 days for a total of 149 days.

The growing ration consisted of corn silage fed *ad libitum* and a concentrate mixture of 80% steam rolled barley, 15% dried beet pulp, and 5% molasses. This ration was fed at 1% of body weight per day. All cattle were finished on the same ration: 76.5% TDN, 10.1% crude protein, and 6.1% crude fiber. In addition, 1 pound of a 44% protein supplement, based on cull peas and containing 20,000 I. U. of vitamin A per pound was fed per head daily. This provided the steers an initial finishing ration containing above 13.2% protein, but gradually reduced to 11.5% protein at time of slaughter.

RESULTS AND DISCUSSION

Experiment 1

Hormonal treatment effect. There were 84 steers on each hormonal treatment; although the implant produced 4.87% greater gains than the oral administration of DES, these differences were not statistically significant at the 10% level of significance.

Feed conversions (pounds of feed per pound of live-weight gain) followed average daily gains quite closely, and this was reflected in feed costs per hundredweight of gain. The differences in marbling

scores and USDA grades were slight, with the oral DES producing the highest grading carcasses and the implant-oral combination producing the lower grading carcasses.

Table 2. Summary of Hormonal Treatment Effects on Feedlot Performance and Carcass Grades

Hormonal treatment	Average daily gain	Feed/lb. of gain	Marbling score[1]	Grade[2]	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*			
Implant	3.44	6.86	13	15.2	$16.20
Oral	3.28	7.25	12	15.4	17.26
Implant + oral	3.37	7.05	12	14.9	16.74

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Additives effect. The addition of zinc oxide or choline chloride to the standard ration or to the high energy linear programmed ration had very little effect upon any of the criteria measured (Table 3). Later work by Smith et al. (1965a, 1965b) also failed to show the responses that had previously been reported. It was interesting to note that the addition of choline chloride to a low energy ration produced an unexpected response in average daily gain. There were only minor variations in carcass quality and feed efficiency. However, this may have been due to a growth impetus which would result in greater gains without additional fattening of the animals.

Table 3. Summary of Effects of Feed Additives on Feedlot Performance and Carcass Grades

Treatment	Average daily gain	Feed/lb. of gain	Marbling score[1]	Grade[2]	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*			
Control	3.35	6.98	12	15.2	$16.58
Zinc oxide	3.37	7.01	13	15.6	16.69
Choline chloride	3.31	7.23	13	14.9	17.28
Choline chloride on low energy	3.47	6.93	12	14.9	16.04

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Ration effect. Since the standard and linear programmed rations were so close in estimated net energy (.71 to .7 meg. cal. per lb.), one would expect their contribution to variance to be small (Table 4). The

low energy linear programmed ration could only be compared with the other rations containing choline chloride.

Table 4. Summary of Ration Effect on Feedlot Performance and Carcass Grade

Ration	Average daily gain	Feed/lb. of gain	Marbling score[1]	Grade[2]	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*			
Standard	3.34	7.01	13	15.3	$16.69
.7 meg. cal./lb.	3.35	7.14	12	15.1	16.73

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Choline chloride x ration interraction. When choline chloride was added to the low energy ration, it produced the greatest average daily gain with less feed per pound of gain and at less cost without a drastic reduction in carcass quality (Table 5).

Table 5. Summary of Ration Effect Where Only Choline Chloride Was Added

Ration	Average daily gain	Feed/lb. of gain	Marbling score[1]	Grade[2]	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*			
Standard	3.27	7.21	13	15.4	$17.48
.7 meg. cal./lb...	3.36	7.25	12	14.3	17.07
.63 meg. cal./lb.	3.47	6.93	12	14.9	16.04

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Additive x hormonal treatment interaction. Although oral DES produced the greatest gain when added to the control ration, it produced the poorest gains when used in combination with ZnO or choline chloride. When additional feed additives were used, the implants produced the greatest gains, with the combination oral and implant producing intermediate gains. The use of certain feed additives may not be compatible with oral DES. Whether this is due to alteration or catabolism of DES prior to absorption is not understood.

The statement made earlier that oral DES produced higher grading carcasses seems to have been based on the interaction of DES with zinc oxide. The apparent inactivity of oral DES in the presence of zinc oxide would, of course, be reflected in somewhat higher grade.

Table 6. Interaction Effect of Feed Additive X Hormonal Treatment on Feedlot Performance and Carcass Grade

Interaction	Average daily gain	Feed/lb. of gain	Marbling score[1]	Grade[2]	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*			
Control x implant	3.31	7.08	13	15.4	$16.73
Control x oral	3.44	6.84	12	15.3	16.29
Control x implant + oral	3.32	7.02	12	14.8	16.72
ZnO x implant	3.54	6.69	13	15.3	15.88
ZnO x oral	3.18	7.43	13	15.8	17.71
ZnO x implant + oral	3.39	6.92	13	15.8	16.49
ChCh x implant	3.47	6.81	13	15.3	16.26
ChCh x oral	3.11	7.64	13	15.3	18.32
ChCh x implant + oral	3.36	7.25	12	14.2	17.25

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Experiment 2

If all of the steers on a hormonal treatment are averaged together, the DES implant produced slightly greater gains, followed by the combined oral plus implant and the oral estrogen, respectively (Tables 7 and 8). However, if the immediate-finish and delayed-finish cattle are separated, their performance data offer at least a possible explanation of why reports on implants versus combined oral plus implants do not agree. The response of animals to the implant was superior for both the 49-and the 141-day weights. When animals were delayed for 49 days prior to finishing, the advantage of the implant at 49 days was dissipated, and both the oral and combination treatments had surpassed the DES implant. This can be explained since pellets that have been recovered at slaughter usually have lost around 90% of their biopotency at the end of 90 days.

The same explanation can be given for the poorer overall performance of Rapigain implant compared to DES. In this case, the activity of the Rapigain implant was even shorter lived than that of the DES implant. In fact, recommendations of the manufacturer would call for two implants for a feeding period of this length.

In general, the feed per pound of gain and feed costs per hundredweight of gain were a direct reflection of the amount of gain made, in that the greater the gain, the less feed per unit of gain.

Table 7. Summary of Feedlot Performance

Hormonal treatment	ADG to 49 days	ADG to 141 days	Feed/lb. of gain	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*	*Lbs.*	
DES oral + implant	3.45	2.82	7.48	$18.03
DES oral	3.50	2.87	7.81	18.81
DES implant	3.53	3.10	7.36	17.70
Rapigain implant	3.72	2.73	7.85	18.91
Rapigain implant + DES oral	3.47	2.88	7.60	18.36
Average	3.35	2.87	7.62	18.36

Table 8. Summary of Delayed Feedlot Performance

Hormonal treatment	ADG to 49 days	ADG to 149 days	Feed/lb. of gain	Feed cost/ cwt. of gain
	Lbs.	*Lbs.*	*Lbs.*	
DES oral + implant	2.92	2.92	7.56	$17.50
DES oral	2.49	2.85	7.70	17.87
DES implant	2.99	2.79	7.78	17.97
Rapigain implant	2.85	2.49	8.46	19.50
Rapigain implant + DES oral	3.11	2.88	7.55	17.49
Average	2.87	2.79	7.81	18.07

Table 9. Summary of Carcass Characteristics From Immediate Finishing

Hormonal treatment	Warm carcass wt.	Marbling score[1]	Back fat	USDA grade[2]
	Lbs.		*In.*	
DES oral + implant	619	12.9	.59	16.3
DES oral	612	15.2	.50	16.9
DES implant	630	13.4	.50	16.4
Rapigain implant	595	14.3	.48	16.6
Rapigain implant + DES oral	598	14.8	.49	16.8
Average	611	14.1	.51	16.6

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

The differences in carcass quality were small, but in this trial the implant of DES seemed to restrict marbling to some extent. This was without an accompanying reduction in back fat (Tables 9 and 10).

Table 10. SUMMARY OF CARCASS CHARACTERISTICS FROM DELAYED FINISHING

Hormonal treatment	Warm carcass wt.	Marbling score[1]	Back fat	USDA grade[2]
	Lbs.		*In.*	
DES oral + implant	623	15.9	.46	17.5
DES oral	599	14.8	.49	17.1
DES implant	609	11.8	.44	16.3
Rapigain implant	577	14.0	.46	16.8
Rapigain implant + DES oral	625	14.8	.38	17.0
Average	607	14.3	.45	16.9

[1] Marbling score: 12 = small, 15 = modest.
[2] USDA grade: 14 = good and 17 = choice.

Due to weather conditions, it was impossible to market the animals that went directly on the finishing ration. Because of this delay, any comparison between these management practices would, of course, be biased.

SUMMARY

The results of these experiments cast some doubt on the advisability of the combined use of oral plus implant of DES. They do shed some light on the lack of agreement in reports covering such comparisons. Greater attention to the time animals are to remain on feed and the duration of activity of implants is necessary if the producer is to realize maximum returns. The estrogenic content of feeds and the hormonal balance of the feeder cattle also play an important part in determining the optimum hormonal treatment.

The feed additives, zinc oxide and choline chloride, failed to improve performance. Some interesting interactions were noted. The response to choline chloride on the low energy diet was greater than on the high energy or conventional diet. Both zinc oxide and choline chloride depressed gains in the presence of oral DES, indicating a possible antagonism. If this is truly an antagonistic effect, greater care in ration formulation must be exercised to assure compatability of all components of the ration.

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