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THE INFLUENCE OF THE ORAL ADMINISTRATION OF DIETHYLSTILBESTROL ON CERTAIN CARCASS CHARACTERISTICS OF BEEF CATTLE[1]

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THE effects of subcutaneous administrations of diethylstilbestrol on the rates of gain, the efficiency of feed utilization and the carcass quality of fattening cattle, lambs and poultry have been summarized in a report of the Committee on Animal Nutrition (1953). More recently a review of this subject appeared in Nutritional Reviews (1955). Diethylstilbestrol implantation experiments have provided evidence that the administration of the drug diethylstilbestrol results in increases in rates of gain in cattle and lambs. In most of the investigations it has been implied that the carcass grades of treated animals have been lower than that of control untreated animals. The most frequently reported explanation for assigning lower grades to the carcasses of treated animals is that the carcasses contain less subcutaneous fat and that there are changes in the pelvis, Clegg and Cole (1954).

Several experiments have been conducted at Iowa State College which indicate that oral administration is effective in increasing rate of gain in fattening cattle. The foregoing is a report of the results of investigations of the influence of orally administered diethylstilbestrol on certain carcass characteristics of the beef animals from 4 of the 5 experiments reported in the paper on gains, by Burroughs *et al.* (1955).

Experimental

A detailed description of the animals which served as subjects for this investigation and of the basal and diethylstilbestrol supplemented rations they were fed, are available in a report by Burroughs *et al.* (1955).

In the four, out of five feeding experiments, for which carcass data were obtained, from one to three levels of diethylstilbestrol were fed in addition to a control ration. Each ration was fed to a lot of eight cattle. Steers were used in experiments 1, 2, and 5 and heifers were

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used in experiment 3. The cattle in each experiment were allotted at random by outcome groups based on initial weight. No carcass data were obtained in feeding experiment 4. In experiment 3, carcass data are available for five heifers from each lot since three from each lot were used for a further investigation. A diseased condition developed among 3 animals in experiment 2 and they were removed before the feeding experiments were completed.

The average daily intake of diethylstilbestrol, the initial and final body weights and data for certain carcass characteristics averaged by lots for the 92 beef animals which served as subjects for four series of experiments are shown in table 1. The basal rations for experiments 1, 2 and 3 may be described at high-corn fattening rations. The animals in experiment 5 received a high roughage ration for 168 days but were fed a high-corn fattening ration during the last 75 days of the experiment. The steers (experiments 1 and 2) and the heifers in experiment 3 graded Good to Choice as feeders when placed on the experimental rations. The average feeder grade of the steers in experiment 5 was Good.

The final weights of the animals at the close of the feeding trials were determined by averaging the individual weights of the animals, allowed access to feed and water, taken on three consecutive days. The animals were then maintained on these rations for an additional time (1–14 days) and then denied feed and water for 12 hours, weighed again, graded and sold. The live grades, expected yields and selling prices for animals in experiments 1, 2, and 5 were established by appraisals which were made by a committee of three, representing two cattle buyers from two packing companies and a livestock commission agency. The cattle were then prepared for shipment to a federally inspected meat firm located in Iowa. In all instances, animals after grading and weighing were permitted access to their assigned rations and to water but were given water only after delivery to the slaughter plant.

The elapsed time between weighing, grading and sale and slaughter varied from less than one day to a maximum of two days.

The carcass yields for animals from experiments 1, 2 and 5 were determined by dividing the hot carcass weight taken immediately after slaughter, by the weight of the animal as determined at the end of a 12 hour off-feed and water period, when the grade and selling price appraisals were made. The carcass yields of cattle from experiment 3 were obtained by taking the hot carcass weight and dividing by the weight of cattle upon arrival at the plant.

TABLE 1. THE EFFECT OF ORALLY ADMINISTERED DIETHYLSTILBESTROL ON CERTAIN CARCASS CHARACTERISTICS OF BEEF ANIMALS: AVERAGES BY LOTS

Exp. No.	Level of stilbest. fed mg.	No. of animals	Body Weight		Av. daily gain[a]	Carcass			Fat depth	Rib eye area	Composition 9–10–11 rib		
			Initial	Final		Hot wt.	Yield	Grade[b]			Fat	Lean	Bone
	1 day		lb.	lb.	lb.	lb.	%		mm.	sq. in.	%	%	%
1[c]	0	8	691.5	929.4	2.23	571.8	61.6	6.5	13.9	10.6	30.0	51.8	18.1
	2.75	8	692.7	959.4	2.46	596.5	62.2	6.4	11.0	11.3	28.4	55.9	15.4
	5.50	8	696.2	983.1	2.64	607.2	61.8	7.0	12.0	11.6	28.8	55.3	15.7
	11.00	8	695.8	1023.8	3.06	635.2	62.0	6.4	15.9	12.4	27.6	55.0	17.1
		s[d]			0.39	25.94	1.17	1.19	4.95	1.17	3.69	3.68	1.76
2	0	8	823.5	1108	2.36	702	61.8	7.0	14.0	12.0	33.5	51.3	15.4
	5	8	822.5	1121	2.57	701	60.9	6.6	19.2	12.5	35.0	50.5	14.1
	10	6	830.8	1128	2.53	709	61.2	6.2	14.0	12.3	32.2	52.0	15.7
	20	7	826.0	1181	2.93	740	61.1	6.6	14.4	12.8	32.1	52.6	15.1
		s			0.42	41.09	1.34	1.03	6.19	1.19	5.13	4.44	1.64
3	0	5	640.2	850	2.06	507.2	59.6	7.0	15.4	11.1	35.2	51.0	14.4
	6	5	639.4	880	2.23	518.8	58.9	6.8	13.0	10.8	30.7	54.6	14.1
	12	5	643.0	892	2.30	525.4	58.8	7.2	15.2	10.9	34.0	49.6	15.7
		s			0.41	35.24	0.79	0.73	2.96	0.86	6.29	5.52	2.04
5	0	8	622.3	1039	1.75	653	61.2	7.0	10.7	12.1	27.4	55.7	17.2
	10	8	620.8	1104	2.04	696	61.4	6.6	11.5	13.1	29.1	54.0	16.9
		s			0.17	29.43	1.11	1.13	2.61	0.64	2.62	3.16	1.56

[a] Average daily gain based on weight before being off feed and water for 12 hours.
[b] Federal grade based upon prime plus=12, prime=11, prime minus=10, choice plus=9, choice=8, choice minus=7, good plus=6, good 5, good minus 4.
[c] Days on feed: 112, 120, 113 and 243 days for experiment Nos. 1, 2, 3, and 5, respectively.
[d] The standard deviations, s, are the square roots of the average within lot mean squares after removing the influence of outcome groups.

Individual carcass grades were determined by federal meat graders after the carcasses had been held in the cooler for 24 hours to 48 hours and quartered.

Tracings of the cross section of the longissimus dorsi muscle at the 12th rib, were made at this time. The 9–10–11 rib sections were removed from the carcasses and cut to a standard length. Subsequently, physical separations of the fat, the lean and the bone tissues were carried out, according to procedures similar to those described by Hopper (1944) and Hankins and Howe (1946). They reported that the physical composition of the 9–10–11 rib cut was an excellent indicator of the fat and lean composition of the beef carcass.

The proportions of separable lean, fat and bone are reported as percent of total 9–10–11 rib cut weight and the longissimus dorsi cross sectional areas are recorded as square inches of surface as determined by measurements made in duplicate with the aid of compensating planimeter. The degree of marbling of the longissimus dorsi muscle, the extent of internal and external finish were carefully observed but no systematic records of observations were kept since it was assumed that the difference in carcass grade would reflect variations in these carcass quality attributes.

The thickness of fat cover over the longissimus dorsi at the 12th rib was determined according to the procedure of Clifton and Shepherd (1953).

Since the length of feeding periods, the basal rations, and the periods of time between appraisals of grade and selling price and slaughter and shipping distances prior to slaughter were different for each experimental group of cattle, comparisons among the "dressing percentages" and carcass data are probably valid only when made between treatments within a single experiment.

A statistical study of the data to estimate the influence of level of orally fed diethylstilbestrol on certain carcass characteristics is limited by the fact that only a single lot of animals was fed each level of diethylstilbestrol in each experiment and by the fact that the levels of diethylstilbestrol, the type and weight of animals, and the basal ration and the length of feeding period varied among experiments. In addition, variation among carcass characteristics may have been increased due to variations in quantity of feed consumed by animals within lots and consequently quantity of diethylstilbestrol consumed by animals within lots may have been variable.

Therefore the mean square among carcass characteristics within lots,

after removing the influence of outcome groups, was used as an estimate of experimental error. Such an estimate in these experiments is unbiased only if the lot effects were negligible and if the carcass characteristics among animals within lots were independent of one another. Direct evidence on whether or not these two conditions are sufficiently met, in general, is not available. Indirect evidence can be inferred by considering the influence of these factors on cattle weight gains.

The lot effect on gain in weight in many cattle feeding experiments is probably small, but there are important exceptions. Competition among animals within lots, especially with limited feeding of concentrates, has been observed frequently. Quantitative estimates of the influence of these two factors on the experimental error in cattle feeding experiments is too limited to draw definite conclusions. The lot effect tends to make the mean square among gains within pens an underestimate of the true experimental error, while the competition effect tends to make this mean square an overestimate.

If variation in gains among animals within lots does not supply an unbiased estimate of experimental error, then the same is probably true for carcass characteristics. This is inferred because most carcass characteristics are correlated with gain. Initially similar cattle, fed the same ration, that gain at different rates for some fixed period of time produce carcasses of varying degrees of finish.

Results

The body weights, the average daily gains, the data for the carcass characteristics are summarized in table 1 by experiments and level of diethylstilbestrol fed. In studying the carcass data, attention is directed to the differences among experiments in average initial body weight, final body weight, and hot dressed weight of carcasses. Attention is also directed to the fact that in each experiment every lot of cattle fed diethylstilbestrol made a larger average daily gain than the control lot of cattle.

The mean differences in carcass yields between animals fed diethylstilbestrol and the control animals were small and were not consistant among experiments. For carcass yield the average was somewhat larger for diethylstilbestrol fed cattle than for controls in experiment 1 and 5 but was smaller in experiments 2 and 3. None of these mean differences came close to being statistically significant ($P<.05$).

Bar charts summarizing the data by rations and experiments for

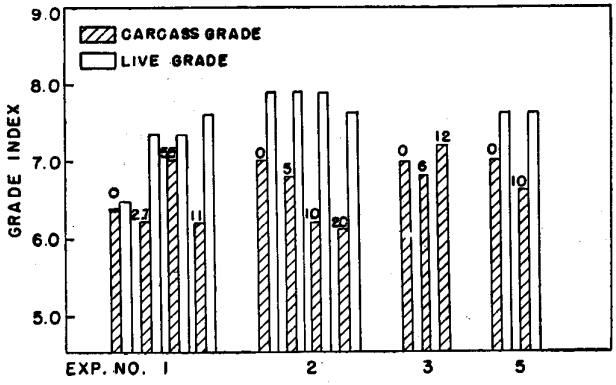

Figure 1. Live animal and carcass grades of cattle fed zero to 20 mg. diethylstilbestrol per head per day. (Grades computed using the following numerical system: Prime plus, 12; Prime, 11; Prime minus, 10; Choice plus, 9; Choice, 8; Choice minus, 7; Good plus, 6; Good, 5 and Good minus, 4.)

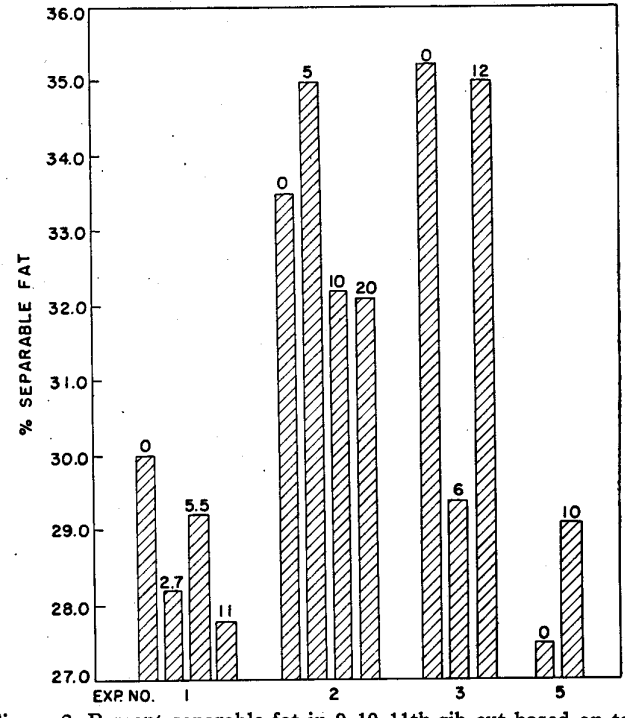

Figure 2. Percent separable fat in 9–10–11th rib cut based on total weight of cut.

carcass characteristics are given in figures 1–6. The number appearing above each bar indicates the average daily intake of diethylstilbestrol per animal. The number below each bar chart identifies the feeding experiment.

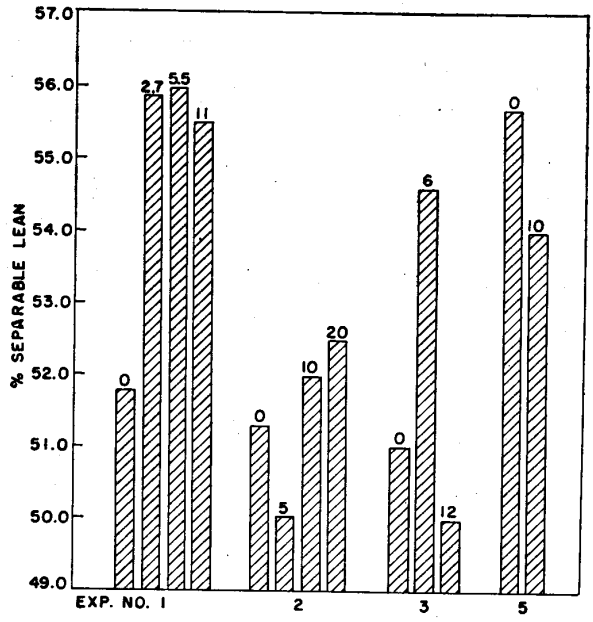

Figure 3. Percent separable lean in 9–10–11th rib cut based on total weight of cut.

These data show that the average live grades were higher than the carcass grades. The differences between grade were not consistent among lots or the experiments. The largest and most consistent differences between the live animal grades and carcass grades are to be found in the data for experiment 2 (figure 1). The graders expressed the opinion that the treated cattle had better looking hair coats than the controls, but no other outward differences in appearance of the animals were observed.

The bar charts in figures 2, 3, and 4 indicate that the fat, lean and bone composition of the rib cuts of carcasses of animals vary widely among experiments. These charts also indicate that the composition of

rib cut was not consistently related with amounts of diethylstilbestrol fed. The depth of fat over the 12th rib varied greatly among experiments, figure 5, and likewise was not consistently related with the feeding level of diethylstilbestrol. However, figure 6 shows that except for experiment 3 the cross sectional area of the longissimus dorsi muscles

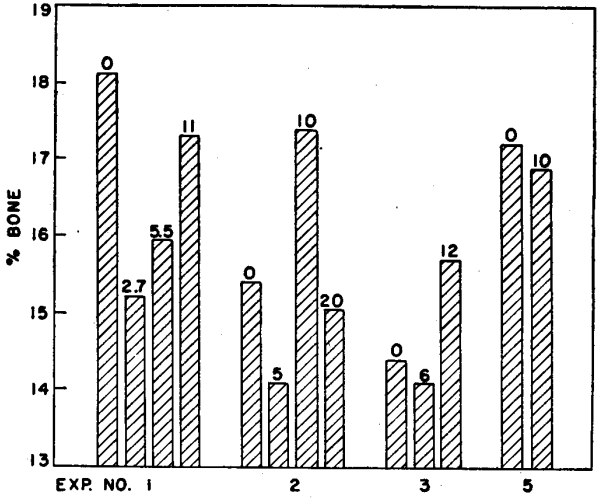

Figure 4. Percentage of bone in 9–10–11th rib cut based on total weight of cut.

of carcasses of treated animals were larger than that of the untreated animals. The standard deviations for the carcass data recorded in table 1 emphasize the large variability among carcasses of animals within lots.

An analysis of variance of the data was computed for each carcass characteristic for each experiment. The only mean differences among rations that were statistically significant, at the 5% level, were for bone content, rib-eye area, and hot dressed weight in experiment 1 and for rib-eye area and hot dressed weight in experiment 5. In addition, the mean difference between the control carcasses and the average of all carcasses from animals fed diethylstilbestrol was significant for lean content in experiment 1. None of the other mean carcass differences among rations approached statistical significance at the 5% level.

Since average daily gains were related with level of diethylstilbestrol fed in each experiment and since carcass characteristics were not con-

sistently related with level of diethylstilbestrol fed, a statistical study was made of the relationships between three carcass characteristics and rates of gain among animals within lots.

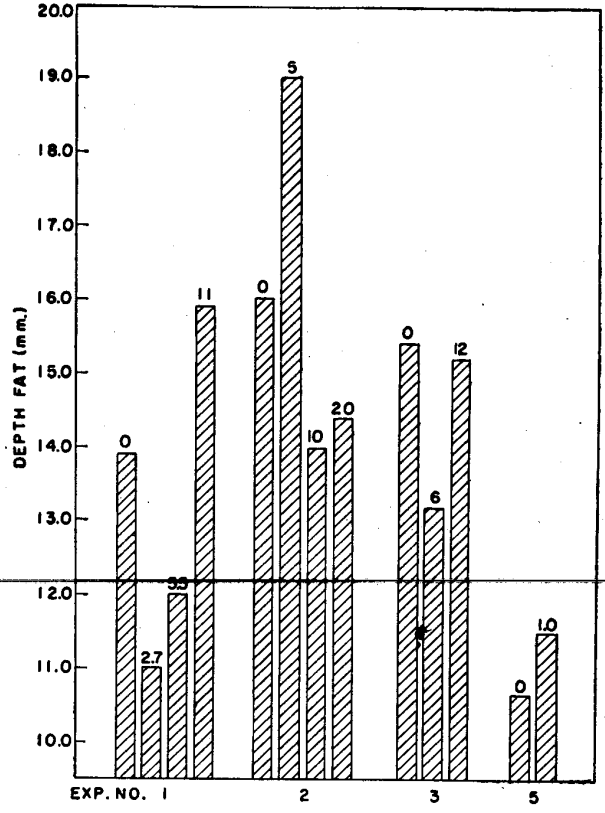

Figure 5. Depth of fat over the longissimus dorsi muscle at the 12th rib.

Correlation coefficients of average daily gain with carcass characteristics were computed for each lot in each experiment. They are presented in table 2. As a generalization, average daily gain was positively correlated with the fat content of the 9–10–11 rib cut and carcass grade.

The correlation coefficients of gain with carcass grade were all positive with one exception, lot 3, experiment 2, but only in one case was the correlation coefficient significant ($P<.05$) lot 1, experiment 5. Since

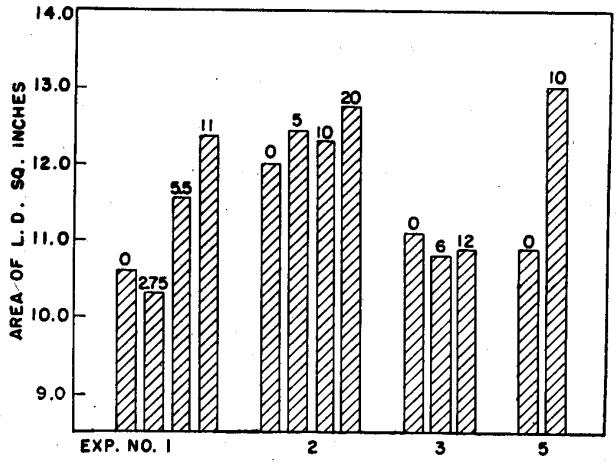

Figure 6. The cross sectional area of the longissimus dorsi muscle at the 12th rib.

similar basal rations were used in experiments 1 and 2, combined correlation coefficients of gain with these carcass characteristics were also computed. The correlation coefficients of gain with the fat content of the rib cut; with lean content of the rib cut and with grade for the controls were found to be 0.582, —0.534 and 0.450 respectively. The corresponding correlation coefficients for treated animals were 0.366,

TABLE 2. WITHIN LOT CORRELATION AND REGRESSION COEFFICIENTS OF CARCASS CHARACTERISTICS WITH GAIN

Exp. No.	Carcass charact.	Lot[a] 1		2		3		4	
		r	b	r	b	r	b	r	b
1	Fat	.492	4.72	.488	.437	—.442	—3.98	.775*	8.93*
	Lean	—.435	—4.21	.431	—.470	.543	3.73	—.137	—1.84
	Grade	.494	1.63	.027	.076	.010	0.03	.620	1.99
2	Fat	.666	6.15	.475	6.41	.550	6.02	.202	3.58
	Lean	—.680	—4.57	—.437	—5.74	—.513	—4.34	—.119	—1.19
	Grade	.409	1.04	.373	0.94	—.073	—0.34	.242	—0.50
3	Fat	—.064	—0.88	.522	2.65	.735	15.16		
	Lean	—.119	—1.41	—.427	—3.36	—.754	11.98		
	Grade	.457	0.89	.353	0.73	.493	0.98		
5	Fat	.060	0.67	.754*	11.67*				
	Lean	.049	—0.58	.599	—7.27				
	Grade	.771*	3.15	.518	3.09				

[a] Lot 1 is the control while lots 2, 3, and 4 identify the first, second and third levels of diethylstilbestrol fed (table 1).
* Significant at $P<.05$.

0.296 and 0.161. The correlation coefficients of gain with fat and with lean were significant ($P<.05$) for both controls and treated animals.

Discussion

The diethylstilbestrol implantation studies of Clegg and Cole (1954) on beef cattle suggest that animals receiving diethylstilbestrol may produce carcasses that are different in some respects at least, from those produced by animals not administered the drug. The present investigation failed to show that the feeding of diethylstilbestrol to beef cattle had any consistent effect upon carcass grades or the composition of the rib cut.

The correlations of carcass characteristics of animals within lots with rate of gain were higher than those for carcass characteristics with level of diethylstilbestrol fed. Whether this would be true for animals fattened for longer periods, i.e. fed to higher carcass grades or fattened to the same weight or for younger animals, cannot be predicted from these data.

An important observation was the large variation in carcass characteristics among animals within lots regardless of the amount of diethylstilbestrol fed. Furthermore those differences were in general larger than those among lots.

The conclusion drawn from these data does not infer that the feeding of diethylstilbestrol to beef animals produces no effect upon the carcass, for to accept this assumption is to conclude that effect upon the performance of the animal in the feed lot is without consequence to carcass tissues. In view of the large variations in the carcass characteristics among beef animals it would be necessary to study much larger numbers of animals in order to demonstrate whether or not diethylstilbestrol had any significant effect upon carcass composition.

Summary

Four investigations were made on 92 beef cattle in an attempt to determine whether orally administered diethylstilbestrol had any influence on carcass characteristics. The data failed to provide evidence that the feeding of diethylstilbestrol had any consistent influence on carcass characteristics as measured by carcass weight, grade, the fat, lean and bone content of the 9–10–11 rib cut, the area of the cross section of the longissimus dorsin muscle and thickness of fat over the rib-eye muscle. The variations in average daily gains of animals regardless of ration treatment were more consistently associated with

differences among a number of carcass characteristics. The correlation coefficients of carcass characteristics within lots with rate of gain were higher than those for carcass characteristics with level of diethylstilbestrol fed. The large differences observed among the various carcass attributes, while probably in part the consequence of nutritional treatments, appear to be related to some degree to inherent biological differences among animals which served as experimental subjects for these studies.

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