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EFFECT OF A COMBINATION OF DIETHYLSTILBESTROL AND METHYLTESTOSTERONE AND PROTEIN LEVEL IN THE DIET ON PERFORMANCE AND CARCASS TRAITS IN AN UNSELECTED LINE OF SWINE¹

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Summary

TWO experiments involving 372 barrows were conducted to evaluate the effects of orally administered diethylstilbestrol (DES) and methyltestosterone (MT) with varying levels of dietary protein.

The DES+MT combination significantly increased carcass leanness regardless of dietary protein level. No significant effects of dietary protein levels on carcass leanness were observed with the barrows used in this study. It appears carcass leanness was maximized at the dietary protein level of 12%.

Daily gains were significantly reduced by DES+MT over all dietary protein levels. However, the amount of depression was reduced by adding the hormone to the diets at a heavier weight. Significant interactions were present between dietary protein levels and DES+MT on daily gain. Greater depression of gain occurred on the lower dietary protein levels when DES+MT was added to the diet.

The effect of DES+MT on feed efficiency was inconsistent between experiments. A small significant effect of dietary protein level on feed efficiency occurred in experiment 1. Feed efficiency appeared to be maximized at the 12% level in this study.

Introduction

The swine industry is challenged continually to produce a leaner, higher quality pork product for the consumer. Many factors including the genetics of the animal, sex and in some studies dietary protein levels have influenced the quantity of lean meat in the carcass.

Several workers have reported that sex differences do exist in carcass and production traits (Bruner *et al.*, 1958; Cahill *et al.*, 1960;

Bruner and Swiger, 1968). These workers have shown that barrows gain faster than gilts but gilts have leaner carcasses. Boar carcasses are leaner than either barrow or gilt carcasses.

Earlier workers postulated that hormones may be important factors influencing carcass and production traits. However, work with stilbestrol and testosterone in the form of pellet implants showed little effect on traits studied (Dinusson, Klosterman and Buchanan, 1951; Woehling *et al.*, 1951; Pearson *et al.*, 1952; Sleith *et al.*, 1953). However, later work by Beeson *et al.* (1955), Jordan, Waite and Scholz (1965) and Baker *et al.* (1967) indicated that oral administration diethylstilbestrol or methyltestosterone alone or in combination, increased carcass leanness.

The purpose of this study was to determine the effect of a combination of diethylstilbestrol and methyltestosterone with varying levels of dietary protein on gain, feed conversion and carcass characteristics of barrows from a line that had not been selected for carcass leanness or production traits.

Materials and Methods

This study consisted of two experiments and utilized 372 barrows from the gene pool herd located at the Swine Research Center, Lincoln, Nebraska. The genetic background of these pigs consisted of 14 breeds which had been introduced into the herd over several years. Random mating had been practiced in this herd with no known selection for the production or carcass traits measured in this study. Pigs were raised in drylots with portable sheds and feed and water were supplied *ad libitum*.

Tylosin was included in all diets at a concentration of 11 mg per kilogram. Diethylstilbestrol (DES) and methyltestosterone (MT) were added to diets at levels of 2.2 mg per kilogram. Simplified corn soybean meal diets

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were used in both trials. Analysis of random samples of the mixed feed yielded protein levels very similar to the calculated levels.

Pigs were individually weighed at 14-day intervals and were removed from the experiment on a weight constant basis. All carcass data were collected after the carcasses had been in the cooler for approximately 24 hr. at the Geo. A. Hormel (Packing) Plant, Fremont, Nebraska. Conventional procedures were used to measure carcass traits. Least square analysis was used to evaluate major effects and interactions. All means presented in the tables are least square means.

Experiment 1. One hundred and forty-four barrows were randomly assorted within three weight replications with average initial weights over treatments of 44, 35 and 26 kilograms. The experiment consisted of four dietary protein level combinations of 18 to 16, 16 to 14, 14 to 12 and 12 to 10% protein with and without the DES+MT combination. The pigs within the specific treatments were placed on the lower level of protein when the average weight of the pigs within the pen was 57 kilograms. The DES+MT hormone combination was added to the specific diets at the beginning of the experiment and removed 72 hr. before slaughter. Pigs were individually taken off test at $91 \text{ kg} \pm 2.5$ kilograms.

Experiment 2. The second experiment consisted of 128 barrows from the gene pool herd. All pigs were started on a simplified 16% protein corn-soybean meal diet and were changed to an 18, 16, 14 or 12% protein diet with or without DES+MT when the average pig weight within pens was 57 kilograms. Each treatment consisted of two weight replications of eight pigs. In this experiment the DES+MT hormone combination change was made at 57 kg as opposed to its addition at the beginning of the trial in experiment 1. Also, in experiment 2 the pigs were taken off experiment individually at 104 ± 2.5 kg as compared to 91 ± 2.5 kg in experiment 1.

Results

Experiment 1. The combination of DES+MT significantly ($P < .01$) reduced growth rate regardless of dietary protein levels when compared to controls (table 1). The suppression of growth rate was particularly marked on the low dietary protein level (12 to 10%) with average daily gain means of 0.74 kg for barrows receiving the hormones and 0.90 kg for the controls. The differences in average

TABLE 1. PERFORMANCE OF BARROWS FED DIETHYLSTILBESTROL AND METHYLTESTOSTERONE IN DIETS CONTAINING FOUR LEVELS OF DIETARY PROTEIN (EXPERIMENT 1)^{a, b}

Level of protein	Hormones		Avg of protein level
	Without	With	
	Avg daily gain, kg ^{c, d}		
18-16% C.P.	0.90	0.86	0.88
16-14% C.P.	0.94	0.84	0.89
14-12% C.P.	0.94	0.86	0.90
12-10% C.P.	0.90	0.74	0.82
Avg of hormone	0.92	0.82	....
	Feed/gain ratio ^e		
18-16% C.P.	3.50	3.33	3.41
16-14% C.P.	3.33	3.35	3.34
14-12% C.P.	3.29	3.45	3.37
12-10% C.P.	3.58	3.70	3.64
Avg of hormone	3.42	3.46	....

^a Avg initial wt was 35 kg; avg final wt was 91 kilograms.

^b The values are an average of 18 animals per treatment.

^c Hormone effect significant ($P < .01$).

^d Protein level x hormone interaction significant ($P < .10$).

^e Level of protein significant ($P < .05$).

daily gain among dietary protein levels were not significant. However, the interaction of protein levels with DES+MT was significant ($P < .10$). On a within treatment basis there was a significant ($P < .05$) reduction in daily gain in all light weight replications, particularly those receiving the hormones.

DES+MT combination had no significant affect on feed efficiency with means of 3.42 and 3.46 for barrows receiving the control and hormone treated diets, respectively. The protein levels significantly affected efficiency ($P < .05$). Most of the difference in feed conversion occurred between the means of low level of dietary protein (12 to 10%) and the means of the three other levels.

The carcasses from the barrows fed DES+MT were leaner as evidenced by a significant increase in ham and loin percent and a significant reduction in backfat (table 2, $P < .025$ and $P < .05$, respectively). Carcass length was not significantly affected by the DES+MT combination. With the unselected line of barrows used in this study small non-significant differences were found among dietary protein levels on carcass traits and no interactions of significance were apparent. However, on the low dietary protein level regardless of the presence of hormones or not there was an increase in backfat thickness (table 2).

Experiment 2. The DES+MT combination significantly ($P < .005$) reduced growth rate

TABLE 2. CARCASS CHARACTERISTICS OF BARROWS FED DIETHYLSTILBESTROL AND METHYLTESTOSTERONE IN DIETS CONTAINING FOUR LEVELS OF DIETARY PROTEIN (EXPERIMENT 1)^{a, b}

Level of protein	Hormones		Avg of protein level
	Without	With	
Avg backfat thickness, cm ^c			
18-16% C.P.	4.40	3.96	4.19
16-14% C.P.	4.26	4.10	4.18
14-12% C.P.	4.34	4.01	4.17
12-10% C.P.	4.40	4.38	4.39
Avg of hormone	4.35	4.11	....
% ham and loin (carcass) ^a			
18-16% C.P.	35.90	37.51	36.70
16-14% C.P.	36.52	37.12	36.82
14-12% C.P.	36.55	37.49	37.02
12-10% C.P.	36.23	36.28	36.26
Avg of hormone	36.30	37.10	.....
Avg carcass length, cm			
18-16% C.P.	76.7	78.3	77.5
16-14% C.P.	78.6	76.7	77.7
14-12% C.P.	77.2	78.1	77.6
12-10% C.P.	77.3	78.3	77.7
Avg of hormone	77.4	77.9	....

^a Avg initial wt was 35 kg; avg final wt was 91 kilograms.

^b The values are an average of 18 animals per treatment.

^c Hormone effect was significant ($P < .05$).

^d Hormone effect was significant ($P < .025$).

the same as occurred in experiment 1 (table 3). The interaction of dietary protein level with the hormone combination was significant ($P < .05$). This compares favorably with the first experiment where a small protein-hormone interaction was evident. A depression in gain occurred on all protein levels in the diets where DES+MT had been added except for 16% protein. The greatest depression occurred at 12% protein. Dietary protein level had no significant effect on average daily gain in this experiment.

The feed-gain ratio was affected significantly ($P < .05$) in experiment 2, opposed to no specific difference in experiment 1. Two variables were changed in the second experiment, (1) the hormones were added to the diets at a heavier pig weight (57 kg) and (2) the slaughter weight was 13 kg heavier. The dietary protein level did not significantly affect feed efficiency in experiment 2. Interactions between DES+MT and dietary protein levels were not statistically significant.

Carcass data of barrows in experiment 2 are presented in table 4. As in experiment 1 the DES+MT treatment increased ham and loin percent ($P < .005$) and decreased backfat thickness ($P < .005$). Carcass length was not affected by DES+MT. The dietary levels of

protein used in this study did not significantly influence any of the carcass traits studies. No androgenic (riding) side effects or mammary enlargement were noted in any of the pigs in experiment 1 or 2 which had received the hormone combination.

Discussion

The data presented in these two experiments clearly indicate that the combination of DES+MT increases carcass leanness as measured by percent ham and loin of the cold carcass weight and decreases backfat thickness. The increase in carcass leanness occurred with the barrows, which by most present standards, would be called a fat-type animal. The efficacy of improved carcass leanness is in agreement with most research with methyltestosterone fed singly or in a combination of DES+MT (Beeson *et al.*, 1955; Perry *et al.*, 1956; Jordan *et al.*, 1965; Baker *et al.*, 1967a; Thrasher *et al.*, 1967; Bider *et al.*, 1969; Heidenreich, Gulotta and Ambrosins, 1970). Recent research with these hormones indicates the increased lean content of the carcass is the result of increased nitrogen retention (Baker *et al.*, 1967b; Melliore, Waitt and Jordan, 1970).

The beneficial effect of DES+MT on carcass leanness was present regardless of the dietary protein level. No significant effects on carcass leanness due to protein level were obtained in this study. Only in experiment 1, on the low level of dietary protein (12 to

TABLE 3. PERFORMANCE OF BARROWS FED A COMBINATION OF DIETHYLSTILBESTROL AND METHYLTESTOSTERONE IN DIETS CONTAINING FOUR LEVELS OF DIETARY PROTEIN (EXPERIMENT 2)^{a, b}

Level of protein	Hormones		Avg of protein level
	Without	With	
	Avg daily gain, kg ^{c, d}		
18% C.P.	0.84	0.79	0.81
16% C.P.	0.78	0.79	0.79
14% C.P.	0.86	0.81	0.84
12% C.P.	0.85	0.76	0.80
Avg of hormone	0.83	0.79	....
	Feed/gain ratio ^e		
18% C.P.	3.41	3.40	3.40
16 C.P.	3.41	3.16	3.28
14% C.P.	3.26	3.24	3.25
12% C.P.	3.35	3.26	3.30
Avg of hormone	3.36	3.26	....

^a Avg initial wt was 57 kg; avg final wt was 104 kilograms.

^b The values are an average of 16 animals per treatment.

^c Hormone effect significant ($P < .005$).

^d Protein level x hormone interaction significant ($P < .05$).

^e Hormone effect significant ($P < .05$).

TABLE 4. CARCASS CHARACTERISTICS OF BARROWS FED DIETHYLSTILBESTROL AND METHYLTESTOSTERONE IN DIETS CONTAINING FOUR LEVELS OF DIETARY PROTEIN (EXPERIMENT 2)^{a, b}

Level of protein	Hormones		Avg of protein level
	Without	With	
Avg backfat thickness, cm °			
18% C.P.	4.22	3.68	3.95
16% C.P.	4.05	3.66	3.85
14% C.P.	4.22	3.68	3.95
12% C.P.	4.17	3.73	3.94
Avg of hormone	4.17	3.68	....
% ham and loin (carcass) °			
18% C.P.	35.65	36.66	36.15
16% C.P.	35.28	37.13	36.20
14% C.P.	35.40	36.54	35.97
12% C.P.	35.33	36.59	35.96
Avg of hormone	35.42	36.73	.....
Avg carcass length, cm			
18% C.P.	79.0	78.6	78.8
16% C.P.	78.7	77.3	78.0
14% C.P.	78.1	78.9	78.5
12% C.P.	78.2	77.8	78.0
Avg of hormone	78.5	78.2	....

^a Avg initial wt was 57 kg; avg final wt was 104 kilograms.^b The values are an average of 16 animals per treatment.^c Hormone effect significant ($P < .005$).

10%) was there an indication of increased backfat thickness and decreased leanness with lower protein levels (table 2). With the barrows used in this study it appears that carcass leanness was maximized at a dietary protein level of 12% and that higher levels did not alter carcass leanness markedly. This is somewhat in disagreement with the work of Baker *et al.* (1967a) which suggest a 14% dietary protein level with DES+MT is necessary to maximize carcass leanness. The variation between the two studies may be due to the differences in the genetic potential and needs of the animals used to produce lean tissue. Other studies without DES+MT have suggested an increase in carcass leanness with increased dietary protein levels (Clawson, 1967; Hale and Southwell, 1967; Lee, McKee and Horvath, 1967). However, Meade, Dukelow and Grant (1966) with pigs of similar type as used in this study reported no significant effects on carcass leanness from dietary protein levels above 12% protein or with the addition of lysine alone or in combination with methionine to 12% protein diets. This experiment and other studies point out the need to identify the genetic background of the animals used since this could affect response to dietary protein levels.

In both experiments the DES+MT combination significantly reduced gains as compared to controls regardless of dietary protein levels. In experiment 2, the DES+MT was not added in the diets until the average pen weight of the pigs was 57 kg as opposed to an average pen weight of 35 kg in experiment 1. The addition of the DES+MT at heavier weights reduced the gain depression (experiment 1-0.10 kg *vs.* 2-0.04 kg). The addition of the hormones to the diets at heavier weights did not appear to alter their effect on increased carcass leanness. However, pigs in experiment 2 were slaughtered at heavier weights (91 kg *vs.* 104 kg). Although dietary protein levels used in the study did not significantly affect daily gain, significant interactions between DES+MT and dietary protein were present. Greater depressions of gain in both experiments occurred with DES+MT on the lower protein levels (experiment 1-12 to 10%, experiment 2-12%). These data suggest a minimum of 12 to 14% dietary protein for maximum gain with DES+MT. Most research with DES+MT combination shows some depression of gain with barrows (Jordan *et al.*, 1965; Baker *et al.*, 1967a; Bider *et al.*, 1969; Thrasher *et al.*, 1967). However, the work of Baker *et al.* (1967a) also suggests the depression in gain can be reduced by adequate dietary protein. The addition of DES+MT at heavier weights of 55 to 60 kg in this study reduced gain depression but maintained improved carcass leanness when barrows were marketed at 104 kilograms.

It is well established that restricted feeding will alter carcass composition. Pigs fed the DES+MT combination grew slower and consumed less feed. Thus the effect of restricted feed intake on carcass composition can not be ignored. However, the mechanism by which the hormone combination exerted its influence on carcass composition either by affecting diet acceptability or metabolically is unknown. Regardless, the pigs fed the hormone combination did in fact have significantly leaner carcasses.

Results of DES+MT on feed efficiency varied between experiments with no significant effects in experiment 1 and a small but significant improvement in feed conversion in experiment 2. Also dietary protein levels significantly improved feed conversion in experiment 1, but not in the second experiment. The difference in protein response can probably be explained by the deletion of the lower level of dietary protein (12 to 10%) in experiment

2. It appears that the low protein level (12 to 10%) accounted for most of the protein effect in experiment 1. Thrasher *et al.* (1967), Jordan *et al.* (1965), and Baker *et al.* (1967a) indicated improvements in feed conversion with DES+MT.

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