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Effect of Dietary Protein Level on Growth and Carcass Characteristics  
of Growing-Finishing Swine Fed to Heavy Weights

Keith E. Gilster and Richard C. Wahlstrom

In a previous experiment reported in A.S. Series 71-38, it was found that for growing pigs optimum gain, feed efficiency and carcass quality (meatiness) occurred at different dietary protein levels. It also appeared that the dietary protein level fed during the period of 170 to 250 lb. affected carcass development more than did dietary protein during the early growing phase. Therefore, this experiment was conducted to further study the effect of high and low dietary protein levels for pigs during three growth periods, 50 to 100 lb., 100 to 170 lb., and 170 to 250 lb.

Experimental Procedure

Seventy-two crossbred barrows and 48 crossbred gilts averaging approximately 44 lb. were divided into three replicates. Within each replicate, 2 gilts and 3 barrows were randomly assigned on the basis of weight and sire to one of the following eight treatments.

Treatment	Percent Protein (calculated)		
	Initial wt. 100 lb.	100-170 lb.	170-250 lb.
A	12	10	10
B	12	10	18
C	12	18	10
D	12	18	18
E	18	10	10
F	18	10	18
G	18	18	10
H	18	18	18

The composition of the diets fed is shown in table 1. Housing and management of the pigs and data collected were similar to that described in the previous experiment reported in A.S. Series 71-38.

Results and Discussion

Growth Performance

The growth performance data are summarized in table 2. Pigs fed the high protein diet gained significantly ( $P < .01$ ) faster than those pigs fed low protein diets during all growth periods. From a weight of 44 to 100 lb. pigs fed the 18% protein diet gained an average of 1.60 lb. per day while pigs that received

the 12% protein diet gained 1.30 lb. per day. From 100 to 170 lb. pigs fed the 10% protein diet gained only 1.26 lb. daily compared to 1.68 lb. daily gain if fed 18% protein diets. The 10% protein diet also appeared to be somewhat inadequate for the finishing period of 170 to 250 lb. Some compensatory gain was noted when the high protein diet was fed following a period on the low or deficient protein diet. For the complete experiment daily gains ranged from 1.31 lb. for pigs fed the 12-10-10% protein sequence to 1.71 lb. for pigs fed the 18-18-18% protein sequence.

There were significant ( $P < .01$ ) differences in feed per gain between treatments at all weight periods as well as for the entire experiment. Pigs fed the 18% protein diet required about 30% less feed per lb. gain than those fed the 12% protein diet up to an average weight of 100 lb. (2.64 vs. 3.44 lb. feed per lb. gain). More variation existed in feed per gain during the latter two growth periods. Feed requirement appeared to be affected by the performance and diet fed during the previous period. For the entire trial feed per gain varied from 3.65 lb. for pigs fed the 12-18-10% protein sequence to 4.65 lb. for those pigs fed 12-10-10% protein diets. It is interesting to note that the diets fed to these two groups varied only during the second period (100 to 170 lb.).

#### Carcass Characteristics

The carcass data are summarized in tables 3 and 4. Highly significant differences existed among treatments for loin eye area. Those pigs fed the 12-10-10 and 18-10-10% protein sequence diets exhibited the smallest loin eye areas. The largest loin eye areas were produced by pigs fed the 18-10-18, 18-18-10 and 18-18-18% protein sequence diets. A significant difference existed among treatments for percent of lean cuts. Pigs fed the 12-10-10 and 18-10-10% protein sequences exhibited the least percent lean cuts, while carcasses from pigs fed the 18-10-18 and 18-18-18% protein sequence diets produced the largest percent of lean cuts. As in the previous trial, meatier carcasses were produced when pigs were fed higher protein diets. Significant sex differences also existed in loin eye area, backfat, length and ham and loin percent.

Significant differences existed among treatments in regard to percent fat and marbling score in the loin muscle. Pigs fed the low protein sequence diets had the highest percent fat (5.24) and marbling score (2.83). The lowest percent fat in the loin muscle was found in the muscle of pigs fed the 18-18-18% protein sequence diet (1.79%). Shear values were highest in pigs on the 18-18-10 and 18-18-18% protein diets. Likewise, the taste panel evaluated the pork chops from these pigs to be somewhat less tender than those from the other groups. However, the differences between treatments were not significant in either shear or taste panel evaluation.

Chops from pigs fed the low protein sequence diets were more juicy which may relate to their higher fat content. The driest chops were found to be those that had the least amount of fat in the muscle.

#### Summary

Pigs weighing approximately 44 lb. initially gained faster and more efficiently when fed an 18% protein diet as compared to those pigs fed a 12% protein diet up to 100 lb. Results indicate that feeding of a 12-10-10 or 18-10-10% protein sequence resulted in lower overall gains and feed efficiency. Those pigs fed the 18-10-18 and

18-18-18% protein sequences had the largest loin eye areas, highest percent ham and loin and percent lean cuts. Those pigs fed the 12-10-10 and 18-10-10% protein sequences had the smallest loin eye areas, most backfat, lowest lean cut percentage, highest percent of fat in the muscle and highest marbling score.

Table 1. Composition of Diets (Percent)

Ingredient	Percent protein (calculated)		
	18	12	10
Ground yellow corn	70.25	87.10	92.60
Soybean meal (44%)	26.72	9.67	4.02
Dicalcium phosphate	2.00	2.30	2.50
Ground limestone	0.40	0.30	0.25
Trace mineral salt	0.50	0.50	0.50
Vitamin-antibiotic premix <sup>a</sup>	0.13	0.13	0.13
Calculated analysis, %			
Calcium	0.71	0.71	0.72
Phosphorus	0.71	0.70	0.72
Chemical analysis, %			
Protein	20.10	14.60	10.66
Moisture	9.06	7.37	9.42
Fat	2.18	2.17	1.78

<sup>a</sup> Provided per lb. of diet: 1,500 I.U. of vitamin A, 180 I.U. of vitamin D, 11 I.U. of vitamin E, 2.93 mg. of riboflavin, 5.51 mg. of pantothenic acid, 13.48 mg. of niacin, 14.98 mg. of choline, 5.30 mcg. of vitamin B<sub>12</sub> and 16.74 mg. of tyran.

Table 2. Effect of Protein Level on Growth Performance of Growing-Finishing Swine

Treatment Protein, % <sup>a</sup>	A 12-10-10	B 12-10-18	C 12-18-10	D 12-18-18	E 18-10-10	F 18-10-18	G 18-18-10	H 18-18-18
No. of pigs <sup>b</sup>	14 <sup>c</sup>	14 <sup>c</sup>	15	15 <sup>d</sup>	15	15	15	15 <sup>d</sup>
Avg. init. wt., lb.	44.3	43.6	43.5	43.7	43.8	43.7	43.9	43.6
Avg. final wt., lb.	250.5	252.9	252.5	250.0	250.7	252.0	251.3	251.6
Avg. daily gain, lb.								
Init. wt. to 100 lb.**	1.31	1.32	1.25	1.32	1.66	1.52	1.57	1.65
100 to 170 lb.**	1.16	1.21	1.81	1.68	1.33	1.33	1.54	1.68
170 lb. to final wt.**	1.48	2.23	2.04	1.91	1.64	1.84	1.76	1.80
Init. wt. to final wt.**	1.31	1.53	1.66	1.64	1.53	1.55	1.62	1.71
Avg. feed per lb. gain, lb.								
Init. wt. to 100 lb.**	3.46	3.36	3.49	3.44	2.57	2.67	2.67	2.64
100 to 170 lb.**	5.37	5.22	3.40	3.83	4.87	4.84	4.30	4.11
170 lb. to final wt.**	4.95	3.41	4.01	4.30	4.93	3.98	4.44	4.51
Init. wt. to final wt.**	4.65	4.13	3.65	3.88	4.22	3.91	3.90	3.83
Avg. daily feed, lb.								
Init. wt. to 100 lb.	4.61	4.52	4.40	4.56	4.31	4.08	4.19	4.35
100 to 170 lb.	6.34	6.66	6.25	6.50	6.53	6.62	6.71	6.85
170 lb. to final wt.	6.92	7.24	7.70	7.99	7.88	7.11	7.70	7.72
Init. wt. to final wt.	6.06	6.39	6.03	6.34	6.42	6.07	6.32	6.41

<sup>a</sup> Diets changed when a lot averaged approximately 100 and 170 lb.

<sup>b</sup> Three lots of 5 pigs each per treatment.

<sup>c</sup> One pig removed during the period of initial weight to 100 lb. Data are not included.

<sup>d</sup> One pig removed during the period of 170 to 250 lb. Data are not included for that period.

\*\* Significant difference  $P < .01$ ).

Table 3. Effect of Protein Level on Carcass Traits of Growing-Finishing Swine

Treatment	A	B	C	D	E	F	G	H
Protein, %	12-10-10	12-10-18	12-18-10	12-18-18	18-10-10	18-10-18	18-18-10	18-18-18
No. of pigs <sup>a</sup>	14	14	15	14	15	15	15	14
Avg. loin eye area <sup>**</sup> , <sup>++</sup>	4.43	4.97	4.79	4.88	4.59	5.30	5.20	5.31
Avg. backfat, in. <sup>+</sup>	1.45	1.41	1.43	1.38	1.44	1.36	1.39	1.38
Avg. length, in. <sup>++</sup>	31.23	31.10	31.09	30.95	31.25	31.03	31.13	30.93
Avg. ham and loin, % <sup>b</sup> , <sup>+</sup>	31.75	32.48	33.25	31.88	31.35	33.62	32.15	34.07
Avg. lean cuts, % <sup>c*</sup>	44.42	45.03	45.90	44.87	43.99	46.81	44.94	46.74
Avg. dressing percent	69.39	68.92	69.27	68.98	69.86	69.43	71.00	69.47

<sup>a</sup> Three lots of five pigs each per treatment.

<sup>b</sup> Closely trimmed, boneless ham and bone-in loin.

<sup>c</sup> Closely trimmed, boneless ham, boneless shoulder and bone-in loin.

<sup>+</sup> Significant sex difference  $P < .05$ .

<sup>++</sup> Significant sex difference  $P < .01$ .

<sup>\*</sup> Significant difference  $P < .05$ .

<sup>\*\*</sup> Significant difference  $P < .01$ .

Table 4. Results of the Effect of Protein Level on the Chemical, Physical, Taste Panel and Cooking Characteristics of the Pork Loin of Growing-Finishing Swine

Treatment Protein, %	A 12-10-10	B 12-10-18	C 12-18-10	D 12-18-18	E 18-10-10	F 18-10-18	G 18-18-10	H 18-18-18
No. of pigs	14	14	15	14	15	15	15	14
Loin muscle <sup>a</sup>								
Avg. moisture, %	70.99	71.08	71.33	71.18	71.23	70.92	71.71	71.74
Avg. protein, %	21.35	22.54	22.07	22.67	21.96	22.82	22.48	22.03
Avg. fat, % <sup>*,†</sup>	5.24	3.31	3.08	3.05	4.42	3.06	2.56	1.79
Avg. marbling <sup>b</sup>	2.83	2.61	1.92	2.31	2.61	2.17	2.25	2.19
Avg. color and firmness <sup>c</sup>	2.28	2.14	1.81	1.94	2.39	2.28	2.39	2.19
Avg. shear, lb. <sup>d</sup>	13.34	13.89	12.39	14.42	14.31	14.97	17.11	15.50
Avg. cooking loss, %	21.04	20.80	21.47	23.11	21.77	22.54	21.54	22.77
Avg. tenderness <sup>e</sup>	3.44	3.37	2.92	3.22	3.65	3.64	4.29	4.03
Avg. flavor <sup>f</sup>	3.37	3.39	3.56	3.59	3.58	3.60	3.62	3.85
Avg. juiciness <sup>g</sup>	3.75	4.26	4.66	4.30	4.24	4.74	4.38	4.87

<sup>a</sup> Fresh basis.

<sup>b</sup> Based on a 1 to 5 scale, 1 = trace to 5 = abundant.

<sup>c</sup> Based on a 1 to 5 scale, 1 = pale, soft and watery to 5 = dark and firm.

<sup>d</sup> Pounds of force to shear one inch core.

<sup>e</sup> Based on a 1 to 8 scale, 1 = extremely tender to 8 = extremely tough.

<sup>f</sup> Based on a 1 to 8 scale, 1 = extremely desirable to 8 = extremely undesirable.

<sup>g</sup> Based on a 1 to 8 scale, 1 = extremely juicy to 8 = extremely dry.

<sup>†</sup> Significant sex difference  $P < .05$ .

\* Significant difference  $P < .05$ .

\*\* Significant difference  $P < .01$ .