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Effect of Dietary Protein Level and Feed Restriction on Growth  
and Carcass Characteristics of Growing-Finishing Swine

Tim S. Stahly and Richard C. Wahlstrom

Research has shown that pigs fed low dietary protein levels are older at slaughter due to depressed growth rate, require more feed per unit of gain and have decreased carcass leanness and increased intramuscular fat. However, increased age at slaughter due to a restricted energy intake does not adversely affect feed efficiency and has the opposite effect on carcass quality in that carcasses have less fat and more lean. The objectives of this study were to determine the effects of dietary protein level and feed restriction on performance and carcass characteristics.

Experimental Procedure

Sixty crossbred pigs averaging approximately 45 lb. were divided into fifteen lots of four pigs each. Five replicated lots received each of the three dietary treatments. Each lot contained two barrows and two gilts with littermates distributed equally between treatments. Pigs were housed in concrete floored pens bedded with straw and had access to outside concrete feeding areas. Water was provided ad libitum. Pigs were removed for slaughter and subsequent carcass data at weekly intervals at live weights of at least 210 pounds.

The three treatments were as follows:

1. 16-14% protein diets ad libitum
2. 12-10% protein diets ad libitum
3. 16-14% protein diets fed at a restricted level to produce gains equal to pigs in treatment 2.

Compositions of the diets are shown in table 1. Changes in dietary protein were made when pigs weighed approximately 110 pounds.

Results

Growth Performance

A summary of the growth performance data is presented in table 2. Pigs fed 16-14% protein diets ad libitum gained significantly ( $P < .05$ ) faster during all growth periods and more efficiently during the finishing and combined growing-finishing periods than pigs fed the 12-10% protein diets. Feed consumption did not differ significantly between these two groups. Restricted fed pigs required significantly ( $P < .05$ ) less feed per unit of gain during all growth periods than pigs fed the low protein (12-10%) diets. Approximately 16.5% less of the high protein feed was required daily to produce gains equal to those obtained by pigs fed low protein diets ad libitum. No differences in feed/gain ratios existed between pigs fed high protein diets ad libitum or at a restricted level.

### Carcass Characteristics

The carcass data are summarized in tables 3 and 4. Dietary protein did not significantly affect dressing percent, carcass length or backfat thickness of pigs fed ad libitum. However, pigs fed high protein diets, either ad libitum or restricted, had significantly larger loin eye areas and improved percentages of ham, loin, shoulder and lean cuts than carcasses from pigs fed the low protein diets.

The 1.17 inch carcass backfat of pigs fed the 16-14% protein diets at a restricted level was significantly less than the 1.31 and 1.38 inch backfat of pigs full-fed the high and low protein diets, respectively. Restricting feed intake also resulted in significantly higher percentages of ham, ham and loin and lean cuts and a lower percentage of belly than carcasses from pigs fed this 16-14% protein diet ad libitum.

Chemical analyses of the loin muscle showed a statistically significant difference in protein, moisture and fat content. Muscle tissue from pigs fed the low protein diets had less moisture and protein and more fat than muscle from pigs fed the higher protein diets either ad libitum or restricted. Percentages of fat were 9.20, 4.66 and 3.62 for pigs fed the low protein, high protein ad libitum and high protein restricted diets, respectively. Increased marbling and juiciness scores were associated with increased intramuscular fat. Flavor, tenderness and shear test values were not significantly affected by dietary protein level or feed intake, although chops from pigs fed the low protein diets tended to be favored. The restriction in feed intake did not significantly affect the chemical composition, consumer acceptability or cooking characteristics of the loin muscle.

### Summary

Pigs weighing approximately 45 lb. initially gained significantly faster at all growth stages and were significantly more efficient in feed conversion from 110 to 210 lb. and for the entire growth period when fed ad libitum diets of 16-14% protein compared to pigs fed 12-10% protein diets. Pigs fed the 16-14% protein diets at a restricted level to allow gains equal to pigs fed 12-10% protein diets ad libitum consumed 16.5% less feed and were significantly more efficient than the low protein fed pigs.

Pigs fed the low protein diets had loin eye muscles with less protein and moisture, more fat and higher marbling and juiciness scores than the loin muscle from pigs fed the high protein diets. Loin eye size and percentages of ham, loin, ham and loin, shoulder and lean cuts were all reduced in carcasses from pigs fed low protein diets. Restricted feeding resulted in less carcass backfat, increased percentages of ham, ham and loin and lean cuts and less percent belly than in carcasses from pigs fed either high or low protein diets ad libitum.

Table 1. Composition of Diets (Percent)

Ingredient	% Protein			
	16	12	14	10
Ground yellow corn	76.41	87.71	81.94	93.44
Soybean meal (44%)	20.83	9.38	15.20	3.63
Dicalcium phosphate	1.71	1.81	2.03	2.13
Ground limestone	0.53	0.55	0.26	0.27
Trace mineralized salt <sup>a</sup>	0.50	0.50	0.50	0.50
Premix <sup>b</sup>	0.08	0.08	0.08	0.08
Calculated analyses, %				
Calcium	0.65	0.65	0.60	0.60
Phosphorus	0.50	0.50	0.55	0.55

<sup>a</sup>Contained sodium chloride, 97%; zinc, 0.8%; cobalt, 0.002%; manganese, 0.4%; copper, 0.048%; iron, 0.33%; iodine, 0.011%.

<sup>b</sup>Provided per lb. of diet: 590 I.U. of vitamin A, 91 I.U. of vitamin D, 5 I.U. of vitamin E, 1.0 mg. of riboflavin, 4.5 mg. of niacin, 5.0 mg. of pantothenic acid, 5.0 mcg. of vitamin B<sub>12</sub> and 10 mg. of aureomycin.

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

Protein level, % Feeding method	16-14	12-10	16-14
	Ad libitum	Ad libitum	Restricted
No. of pigs <sup>a</sup>	20	20	20
Avg. initial wt., lb.	44.9	45.0	44.8
Avg. final wt., lb.	213.2	205.4	209.8
Avg. daily gain, lb.			
45-110 lb.	1.55 <sup>b</sup>	1.41 <sup>c</sup>	1.39 <sup>c</sup>
110-210 lb.	1.84 <sup>b</sup>	1.42 <sup>c</sup>	1.54 <sup>c</sup>
45-210 lb.	1.70 <sup>b</sup>	1.42 <sup>c</sup>	1.46 <sup>c</sup>
Avg. daily feed, lb.			
45-110 lb.	4.01 <sup>b</sup>	4.12 <sup>c</sup>	3.28 <sup>c</sup>
110-210 lb.	5.78 <sup>b</sup>	5.31 <sup>b,c</sup>	4.74 <sup>c</sup>
45-210 lb.	5.00 <sup>b</sup>	4.85 <sup>b</sup>	4.10 <sup>c</sup>
Feed/gain			
45-110 lb.	2.62 <sup>b,c</sup>	2.95 <sup>b</sup>	2.37 <sup>c</sup>
110-210 lb.	3.20 <sup>b</sup>	4.35 <sup>c</sup>	3.32 <sup>b</sup>
45-210 lb.	2.98 <sup>b</sup>	3.77 <sup>c</sup>	2.92 <sup>b</sup>

<sup>a</sup>Five replicated lots of four pigs each.

<sup>b,c</sup>Means on the same line without a common superscript are significantly different (P <.05).

Table 3. Effects of Dietary Protein and Feed Restriction on Quantitative Carcass Traits

Protein level, % Feeding method	16-14 Ad libitum	12-10 Ad libitum	16-14 Restricted
No. of pigs	19 <sup>a</sup>	17 <sup>b</sup>	20
Backfat thickness, in.	1.31 <sup>d</sup>	1.38 <sup>d</sup>	1.17 <sup>e</sup>
Carcass length, in.	29.7	30.0	30.4
Longissimus muscle area, sq. in.	4.35 <sup>d</sup>	3.51 <sup>e</sup>	4.48 <sup>d</sup>
Dressing percent	71.83	71.16	70.94
Ham, % <sup>c</sup>	21.18 <sup>d</sup>	20.09 <sup>e</sup>	22.37 <sup>f</sup>
Loin, %	17.52 <sup>d</sup>	16.09 <sup>e</sup>	18.20 <sup>d</sup>
Ham and loin, %	38.71 <sup>d</sup>	36.18 <sup>e</sup>	40.59 <sup>f</sup>
Shoulder, % <sup>c</sup>	17.59 <sup>d</sup>	16.98 <sup>e</sup>	18.22 <sup>d</sup>
Lean cuts, % <sup>c</sup>	56.30 <sup>d</sup>	53.16 <sup>e</sup>	58.81 <sup>f</sup>
Belly, %	12.07 <sup>d</sup>	11.99 <sup>d</sup>	11.25 <sup>e</sup>

<sup>a</sup>One pig died of stress in moving to slaughter.

<sup>b</sup>Three pigs were removed before reaching slaughter weight.

<sup>c</sup>Bone in - packing house trim.

<sup>d,e,f</sup>Means on the same line without a common superscript were significantly different (P < .05).

Table 4. Effects of Protein Level and Feed Restriction on Qualitative Carcass Traits

Protein level, % Feeding method	16-14 Ad libitum	12-10 Ad libitum	16-14 Restricted
No. of pigs	19	17	20
Longissimus muscle, fresh			
Moisture, %	72.25 <sup>g</sup>	70.47 <sup>h</sup>	72.95 <sup>g</sup>
Protein, %	21.90 <sup>g</sup>	19.38 <sup>h</sup>	21.60 <sup>g</sup>
Ether extract, %	4.66 <sup>g</sup>	9.20 <sup>h</sup>	3.62 <sup>g</sup>
Marbling score <sup>a</sup>	2.55 <sup>g</sup>	3.60 <sup>h</sup>	2.35 <sup>g</sup>
Color and firmness score <sup>b</sup>	2.90	2.90	2.85
Longissimus muscle, cooked			
Shear value, kg. <sup>c</sup>	7.06	6.57	7.02
Tenderness score <sup>d</sup>	3.67	3.13	3.95
Flavor score <sup>e</sup>	3.49	3.34	3.47
Juiciness score <sup>f</sup>	4.16 <sup>g</sup>	3.09 <sup>h</sup>	4.55 <sup>g</sup>
Cooking loss, %	22.21	22.10	23.53
Drip loss, %	8.79	8.99	8.88
Volatile gas loss, %	13.42	13.11	14.65

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

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

<sup>c</sup>Kilograms of force to shear a core 2.54 cm. in diameter.

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

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

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

<sup>g,h</sup>Means on the same line without a common superscript were significantly different (P < .01).