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The most common slaughter weight of market barrows and gilts is 200 to 230 lb. The price paid for market swine slaughtered at a weight heavier than 230 lb. is often discounted. In addition, feed efficiency appears to decrease as pigs are fed to heavier weights. Therefore, both the producer and the buyer often discriminate against marketing swine at heavier weights. However, marketing at heavier weights would allow the production of more pounds of pork per sow unit and also enable the packer to process more pork from a given number of hogs, thus lowering the total processing cost.

It has been observed that certain strains of well muscled pigs can grow efficiently to a weight beyond 230 lb. without depositing excess fat in the carcass. However, the nutritional requirements of the market pig for weights above 220 lb. have not been well established. To produce a pig that is trim, muscular and efficient at a heavy weight requires a pig that has the proper genetic background and one that is fed a diet that will express his genetic capabilities.

The purpose of the two successive experiments reported herein was to determine the protein requirement of swine from a weight of approximately 44 to 245 lb.

Experimental Procedure

Ninety-six crossbred barrows averaging approximately 50 lb. were divided into four replicates. Within each replicate, four pigs were randomly assigned on the basis of weight and sire to one of the following six dietary treatments:

	Percent protein (calculated)		
Treatment	Initial wt. 100 lb.	100-170 lb.	170-245 lb.
A	20	20	20
B	20	16	12
C	12	12	12
D	12	16	20
E	16	12	12
F	16	12	16

The composition of the diets fed is shown in table 1. Feed and water were provided ad libitum. Pigs were housed in portable wood frame houses with concrete floors and a connecting 6 x 12 ft. concrete outside pen where waterers and feeders were located. This experiment was conducted during the spring and summer, 1970. Diets, when changed in level of protein, were altered when a lot averaged approximately 100 and 170 lb. As pigs approached 245 lb., they were weighed weekly. If

a pig weighed at least 245 lb., he was removed from the experiment and allowed access to water but not feed for 24 hours. After the 24-hour shrink period, the pigs were slaughtered. Carcass data were collected after the carcasses had cooled a minimum of 24 hours.

Dressing percent was calculated using the unshrunk live weight and the chilled carcass weight. Ham and loin percent was based on the chilled carcass weight and the weight of the closely trimmed, boneless ham and bone-in loin. Percent lean cuts was based on the chilled carcass weight and the closely trimmed boneless ham, boneless shoulder and the bone-in loin. Prior to shear test and taste panel evaluation, loin muscle samples were cooked to an internal temperature of 165° F. Loin eye samples were removed from the 10th rib for chemical analyses, from the 11th rib for shear test and from the 12th and 13th ribs for taste panel evaluation.

Results and Discussion

Growth Performance

The growth performance data are summarized in table 2. Up to a weight of 100 lb., pigs fed a 20% protein diet had an average daily gain of 1.70 lb. as compared to 1.67 lb. for pigs fed 16% protein diets and 1.39 lb. for those fed 12% protein diets. The gains of pigs fed the 20 and 16% protein diets were significantly ($P < .01$) faster than the gains of pigs fed the 12% diet during this initial feeding period. A significant difference in average daily gain was also noted for the period from 100 to 170 lb. Pigs fed the 16% protein diet gained most rapidly, 1.89 lb. and 2.02 lb. for treatments B and D, respectively. The faster gain of pigs on treatment D may have been due, at least in part, to compensatory growth. This group gained only 1.37 lb. per day up to 100 lb. when they were fed the 12% protein diet, while treatment B gained 1.67 lb. daily during the same period when they received the high protein (20%) diet. There were no significant differences in rate of gain between treatments during the 170 to 245 lb. weight period. For the entire experiment, 50 to 245 lb., pigs fed the 20-16-12% protein sequence gained the most rapidly, 1.87 lb. per day. Pigs fed the 12-12-12% and 12-16-20% protein sequences gained the most slowly, 1.72 lb. and 1.78 lb. per day, respectively. This appeared to be due to the slower growth of these pigs during the initial growth period. The differences among treatments for average daily gain during the total period were significant ($P < .05$). Gain and feed data were also obtained when the respective lots of pigs averaged 210 lb. so that a comparison could be made of pigs fed to 210 or 250 lb. market weight. Similar treatment results were observed in average gains from initial weight to 210 or 250 lb.

There was a highly significant difference in feed per gain during the initial growth period (up to 100 lb.) with pigs requiring significantly less feed as the protein content of the diet increased. Feed per gain averaged 3.24, 2.85 and 2.49 lb. for pigs fed the 12, 16 and 20% protein diets, respectively. There were no significant differences in feed per gain due to dietary protein level during any of the other feeding periods. Likewise, for the entire experiment the differences in feed per gain were not significantly different, ranging from a low of 3.33 lb. for pigs fed the 20-16-12% protein sequence to 3.61 lb. for the pigs fed the 12-16-20% protein sequence. It is also interesting to note the increase in feed required by all treatment groups when pigs were fed to 245 lb. compared to the feed requirement at a weight of 210 lb.

There was no difference in feed consumption by pigs due to level of protein in the diet.

Carcass Characteristics

The carcass data are summarized in tables 3 and 4. Significant differences in carcass traits were found only in percent ham and loin and percent lean cuts. There appeared to be a trend toward slightly meatier carcasses when pigs were fed higher protein diets. Carcasses from pigs fed the 12-12-12% protein sequence had the smallest loin eye area, percent ham and loin and percent lean cuts. Also, the three treatment groups that were fed the 12% protein diet from 170 lb. to slaughter had less average percent ham and loin and lean cuts than did carcasses from pigs fed 16 or 20% protein during this period.

Chemical analyses of the loin muscle showed a statistically significant difference in fat content. Loin muscles from pigs fed the high protein diet for the entire trial had the least fat (2.84%) and those from pigs fed the low protein diet for the entire trial had the highest percent fat (4.97%). Percent protein in the loin muscle also followed this trend with a relatively high percent of protein in the muscles of pigs fed the high protein diet and the lowest percent in muscles of pigs fed the low protein diet. Other treatment groups were intermediate in both fat and protein content.

Marbling score appeared to be related to fat content as the higher marbling levels were present in the groups fed the lower protein diets that had higher levels of fat in the loin muscle. Likewise, shear force was slightly less when the muscle contained more fat.

There were no significant differences in any of the taste panel data. This would indicate that dietary protein levels of the magnitude used in this experiment do not affect the acceptability of pork by the consumer.

Summary

Pigs weighing approximately 50 lb. initially gained significantly faster and more efficiently up to 100 lb. when fed either a 20% or 16% protein diet as compared to a 12% protein diet. Pigs fed the 20-16-12% protein sequence gained the fastest and most efficiently up to a weight of both 210 lb. and a final weight of 250 lb. Pigs fed the 12-16-20% protein sequence had the lowest backfat, longest carcasses, highest percent ham and loin and percent lean cuts. Pigs fed the low protein sequence possessed loins with the most intramuscular fat, lowest percent protein and moisture, and highest percentage of cooking loss.

Table 1. Composition of Diets (Percent)

Ingredient	Percent protein (calculated)		
	20	16	12
Ground yellow corn	63.90	75.00	86.10
Soybean meal (44%)	33.10	21.87	10.62
Dicalcium phosphate	1.92	2.10	2.30
Ground limestone	0.45	0.40	0.35
Trace mineral salt	0.50	0.50	0.50
Vitamin-antibiotic premix[a]	0.13	0.13	0.13
Calculated analysis, %			
Calcium	0.73	0.73	0.73
Phosphorus	0.71	0.71	0.71
Chemical analysis, %			
Protein	20.73	16.27	12.37
Moisture	10.99	11.27	10.97
Fat	1.69	2.01	2.07

[a] 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_{12}, and 16.74 mg. of tylan.

Table 2. Results of the Effect of Protein Level on the Performance Traits of Growing-Finishing Swine

Treatment Protein, %[a]	A 20-20-20	B 20-16-12	C 12-12-12	D 12-16-20	E 16-12-12	F 16-12-16
No. of pigs[b]	16	16	16	16[c]	16	16[c]
Avg. init. wt., lb.	50.2	50.3	50.3	49.9	50.6	50.2
Avg. final wt., lb.	251.8	249.5	247.9	247.8	250.1	249.4
Avg. daily gain, lb.						
Init. wt. to 100 lb.**	1.72	1.67	1.40	1.37	1.69	1.65
100 to 170 lb.*	1.84	1.89	1.80	2.02	1.81	1.83
170 lb. to final wt.	1.87	1.98	1.91	1.90	1.85	1.84
Init. wt. to 210 lb.*	1.83	1.85	1.67	1.72	1.78	1.80
Init. wt. to final wt.*	1.82	1.87	1.72	1.78	1.80	1.81
Avg. feed per lb. gain, lb.						
Init. wt. to 100 lb.**	2.49	2.48	3.30	3.18	2.86	2.83
100 to 170 lb.	3.51	3.38	3.35	3.11	3.52	3.31
170 lb. to final wt.	4.09	3.83	3.97	4.03	3.74	3.91
Init. wt. to 210 lb.	3.25	3.14	3.42	3.28	3.26	3.25
Init. wt. to final wt.	3.49	3.33	3.58	3.61	3.44	3.54
Avg. daily feed, lb.						
Init. wt. to 100 lb.	4.27	4.13	4.62	4.32	4.86	4.65
100 to 170 lb.	6.51	6.45	6.03	6.33	6.43	6.17
170 lb. to final wt.	7.52	7.49	7.46	7.56	6.79	7.10
Init. wt. to 210 lb.	6.00	5.87	5.79	5.71	5.84	5.90
Init. wt. to final wt.	6.31	6.19	6.02	6.41	6.13	6.39

[a] Diets changed at average lot weights of 100 and 170 lb.
[b] Four lots of four pigs each per treatment.
[c] One pig removed during the period of 170 lb. to final weight. Data are not included for that period.
* Significant ($P < .05$).
** Significant ($P < .01$).

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

Treatment	A	B	C	D	E	F
Protein, %	20-20-20	20-16-12	12-12-12	12-16-20	16-12-12	16-12-16
No. of pigs[a]	16	16	16	15	16	15
Avg. loin eye area, sq. in.	4.87	4.74	4.50	4.84	4.87	4.75
Avg. backfat, in.	1.44	1.44	1.49	1.39	1.50	1.48
Avg. length, in.	31.16	31.30	31.25	31.35	31.11	31.08
Avg. ham and loin, %*	31.73	31.21	30.76	32.39	31.17	31.44
Avg. lean cuts, %**	44.73	43.86	43.58	45.43	43.69	44.25
Avg. dressing percent	69.16	69.64	69.73	69.18	70.64	72.02
Avg. live probe, in.[d]	1.18	1.18	1.24	1.13	1.23	1.23

[a] Four lots of four pigs each per treatment.
[b] Closely trimmed, boneless ham and bone-in loin.
[c] Closely trimmed, boneless ham, boneless shoulder and bone-in loin.
[d] Backfat probe at 210 lb.
* Significant ($P < .05$).
** Significant ($P < .01$).

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 20-20-20	B 20-16-12	C 12-12-12	D 12-16-20	E 16-12-12	F 16-12-16
No. of pigs	16	16	16	15	16	15
Loin muscle[a]						
Avg. moisture, %	72.19	71.76	71.27	71.70	71.31	71.69
Avg. protein, %	22.14	22.17	21.22	21.93	22.13	22.03
Avg. fat, %*	2.84	3.61	4.97	3.32	3.97	3.20
Avg. marbling[b]	2.63	2.75	3.06	2.73	3.31	2.58
Avg. color and firmness[c]	2.56	2.56	2.69	2.81	2.56	2.35
Avg. shear, lb.[d]	15.20	15.15	14.90	15.26	14.21	15.35
Avg. cooking loss, %	12.48	12.61	14.35	13.35	11.69	14.20
Avg. tenderness[e]	3.79	3.66	4.21	4.03	3.62	4.00
Avg. flavor[f]	3.76	3.71	3.75	3.81	3.78	3.94
Avg. juiciness[g]	3.88	3.98	4.20	4.04	3.38	4.16

[a] Fresh basis.
[b] Based on a 1 to 5 scale, 1 = trace to 5 = abundant.
[c] Based on a 1 to 5 scale, 1 = pale, soft and watery to 5 = dark and firm.
[d] Pounds of force to shear a one inch core.
[e] Based on a 1 to 8 scale, 1 = extremely tender to 8 = extremely tough.
[f] Based on a 1 to 8 scale, 1 = extremely desirable to 8 = extremely undesirable.
[g] Based on a 1 to 8 scale, 1 = extremely juicy to 8 = extremely dry.
* Significant ($P < .05$).