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Hsin-Yi Chen
University of Nebraska - Lincoln

Austin Lewis
University of Nebraska - Lincoln, alewis2@unl.edu

Phillip S. Miller
University of Nebraska - Lincoln, pmiller1@unl.edu

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The Effects of Dietary Protein Concentration on Performance and Visceral Organ Mass in Finishing Barrows and Gilts

Hsin-Yi Chen
Austin J. Lewis
Phillip S. Miller[1]

Summary and Implications

The response of finishing barrows and gilts to five dietary protein concentrations was evaluated. Barrows and gilts have different requirements for protein and differ in their sensitivities to excessive intakes of protein. Gilts appeared to be affected by dietary protein concentrations to a greater extent than did barrows. Significant differences in weight gain did not occur but, the lowest average daily gain was for pigs fed the two highest protein levels. Increased dietary protein concentration resulted in increased liver, kidney, and pancreas weights. These data indirectly suggest that maintenance energy requirements of barrows and gilts may be increased as dietary protein concentration is increased, even though there was no significant reduction in growth rate or feed efficiency. Consumption of protein above the requirement (corn-soybean meal diets) results in protein (amino acids) wastage because the animal is unable to convert dietary amino acids to body protein.

Introduction

In the 1994 Nebraska Swine Report, we described an experiment where we found that feeding high-protein diets to growing-finishing gilts reduced growth performance and carcass protein accretion but increased carcass leanness. Because the response of pigs to dietary protein concentration varies with the genetic and physiological characteristics of the pig, we hypothesized that barrows and gilts might respond differently to protein intake. Therefore, the present experiment was conducted to evaluate the effect of dietary protein concentration on growth performance in barrows and gilts and to identify potential physiological mechanisms responsible for the reduced performance of barrows and gilts that consume excessive protein.

Procedures

Sixty crossbred pigs (30 barrows and 30 gilts) with an initial body weight of 112 lb were allotted to a randomized complete block experiment with a 2 x 5 factorial arrangement of treatments. There were two sexes (barrow and gilt) and five protein levels (13, 16, 19, 22, and 25% crude protein [CP]). Diets (Table 1) were corn-soybean meal-based and were fortified with vitamins and minerals to meet or exceed the National Research Council requirements for 110- to 240-lb pigs. The range of CP levels was obtained by changing the ratio of corn to soybean meal.

Pigs were housed individually in an environmentally regulated facility and had *ad libitum* access to feed and water throughout the experiment. Pigs were weighed and feed intakes were measured weekly to determine aver-

(Continued on next page)

Table 1. Composition of diets[a]

Item	Dietary protein concentration, %				
	13	16	19	22	25
Ingredient, %					
Corn	85.15	77.40	69.75	61.85	54.10
Soybean meal, 46.5% CP	12.35	20.25	28.00	36.00	43.90
Dicalcium phosphate	1.00	.80	.65	.50	.35
Limestone	.40	.45	.50	.55	.55
Salt	.30	.30	.30	.30	.30
Trace mineral premix	.10	.10	.10	.10	.10
Vitamin premix	.70	.70	.70	.70	.70
Nutrient composition[b]					
Crude protein, %	11.98	15.23	17.63	20.95	24.14
Lysine, %	.56	.79	1.00	1.12	1.32
Calcium, %	.53	.57	.54	.56	.52
Phosphorus, %	.48	.49	.47	.48	.49
Metabolizable energy, kcal/lb[c]	1,501	1,496	1,491	1,485	1,480

[a]As-fed basis.
[b]Analyzed composition.
[c]Calculated.

Table 2. Effect of protein level and sex on growth performance

Sex	Barrow					Gilt				
Item[a] CP, %	13	16	19	22	25	13	16	19	22	25
No. of pigs	6	6	6	6	6	6	6	6	6	6
Day 0 to 35										
ADG, lb[b]	2.12	2.09	2.33	2.10	2.14	2.03	2.13	1.92	1.93	1.85
ADFI, lb[d]	7.45	7.21	7.28	7.07	7.00	7.35	7.40	6.76	6.80	6.44
Feed/gain[b]	3.55	3.46	3.12	3.37	3.28	3.64	3.49	3.55	3.55	3.49
Day 35 to slaughter										
ADG, lb	1.82	1.88	1.90	1.72	1.77	1.88	1.96	1.79	1.69	1.76
ADFI, lb[c]	7.00	7.50	7.18	7.07	7.04	6.68	7.13	6.62	5.98	6.15
Feed/gain[b]	3.83	3.96	3.79	4.12	4.04	3.61	3.64	3.71	3.57	3.49
Day 0 to slaughter										
ADG, lb	1.96	1.98	2.10	1.90	1.94	1.95	2.04	1.85	1.80	1.80
ADFI, lb[ce]	7.21	7.36	7.22	7.07	7.02	6.99	7.26	6.69	6.36	6.29
Feed/gain	3.69	3.72	3.44	3.73	3.64	3.62	3.56	3.63	3.55	3.49

[a]ADG = average daily gain and ADFI = average daily feed intake.
[b]Main effect of sex (P<.01).
[c]Main effect of sex (P<.05).
[d]Linear effect of protein (P<.01).
[e]Linear effect of protein (P<.05).

age daily gain (ADG), average feed intake (ADFI), and the ratio of feed: gain (ADFI/ADG).

Pigs remained on the experiment until the average body weight reached approximately 250 lb. Three blocks of pigs were randomly selected and slaughtered after a 24-hour fast. Organs were separated and weighed immediately after slaughter. Weights of the following organs and tissues were obtained: 1) liver with gall bladder removed; 2) heart with blood clots removed; 3) kidneys; 4) leaf fat; 5) pancreas with associated fat tissue removed; 6) stomach, which was weighed full and after contents were removed; and 7) intestinal tract, which was weighed full and after contents were removed. Intestine was separated into small and large intestines and mesentery.

Results and Discussion

Growth Performance. Average daily gain, average daily feed intake, and feed/gain data are presented in Table 2. The experimental period was divided into two periods to examine the response pattern associated with diet and sex. Barrows grew faster and utilized feed more efficiently (P<.01) than gilts in the first period (day 0 to 35). In the second period (day 35 to 75), barrows ate more feed (P<.05) but utilized feed less efficiently (P<.01) than gilts. Overall, ADG and ADFI/ADG were not influenced by either sex or dietary protein concentration. However, increasing protein level decreased ADFI (P<.05) and the reduction was greater in gilts than in barrows (P<.05). The results of growth performance from this experiment were different from our observations in the 1994 Nebraska Swine Report, where high protein levels reduced ADG. Although differences in weight gain in the present study were not statistically significant, the lowest ADG was for pigs fed the two highest protein levels. The differences between the two experiments may be due to the genetic background and weight range of pigs and the inclusion of barrows in the present experiment.

Organ weights. Data for organ weights are summarized in Table 3. Barrows had lighter kidney and stomach weights (P<.01) than gilts. Increased protein level resulted in increased liver, kidney (linear, P<.01), and pancreas weights (linear, P<.05), whereas weight of mesentery tissue (primarily fat) was decreased as protein level increased (linear, P<.05). The liver and kidney are the major sites of amino acid degradation and nitrogen clearance. Increased weight of liver and kidney found in this experiment may be related to the higher amounts of nitrogenous compounds processed by these organs. The weight of pancreas was also increased with increasing dietary protein. The result

Table 3. Effect of protein level and sex on organ weight[a]

	Sex	Barrow					Gilt				
Item	CP, %	13	16	19	22	25	13	16	19	22	25
Liver, g[c]		1340	1385	1441	1704	1655	1395	1500	1649	1588	1816
Heart, g		419	351	444	400	387	371	354	400	373	399
Kidney, g[bc]		336	288	328	381	382	315	372	417	402	442
Spleen, g		193	157	192	156	165	188	152	172	173	167
Pancreas, g[d]		114	134	138	134	126	111	132	140	139	166
Stomach, g[b]		554	545	535	539	529	573	672	567	563	579
Small intestine, g		1421	1300	1361	1453	1540	1237	1425	1363	1562	1437
Large intestine, g		1036	1156	987	1063	1142	975	1165	1068	1026	1045
Leaf fat, g		2629	2023	1821	2328	2106	2557	1693	2295	2094	2011
Mesentery tissue, g[c]		1893	1859	1522	1882	1432	1785	1835	1893	1549	1583

[a]Final empty-body weight was used as a covariate in the statistical analysis. Empty-body weight = (live weight minus gastrointestinal contents).
[b]Main effect of sex (P<.01).
[c]Linear effect of protein (P<.01).
[d]Linear effect of protein (P<.05).

reflected that greater amounts of pancreatic enzymes were required to digest the larger quantity of protein consumed by pigs fed the high protein diets. These data indirectly suggest that maintenance energy requirements of barrows and gilts may be increased as dietary protein concentration is increased, even though there was no significant reduction in growth rate or feed efficiency.

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[1]Hsin-Yi Chen is a graduate student, Austin J. Lewis is a Professor, and Phillip S. Miller is an Assistant Professor in the Department of Animal Science.