INFLUENCE OF DIET COMPLEXITY AND WEANING AGE ON CARCASS CHARACTERISTICS AND GROWTH PERFORMANCE FROM WEANING TO MARKET[1]

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Summary

A total of 180 barrows (initially 7.4 or 11.9 lb and 9 or 19 d of age) was used in a growth assay to determine the influence of two weaning ages and three diet complexity sequences on growth performance and carcass characteristics. The growth performance of pigs used in this trial was excellent, as shown by the range of average age at 240 lb from 144 to 149.7 d. Growth performance was similar regardless of weaning age. Thus, when health status and environment are similar, pigs weaned at 19 d of age can attain a weight of 240 lb at the same age as pigs weaned at 9 d of age. The three complexity sequences varied widely in diet composition and the length of time the complex diets were fed. The high complexity sequence was formulated to achieve maximal gain regardless of cost, the medium complexity sequence was formulated to closely match current Kansas State University recommendations, and the low complexity diets were very simple diets with minimal amounts of alternative ingredients fed for short periods of time. Pigs performed the best on the high or medium sequence in Phase I postweaning. However, growth performance of pigs fed the simple sequence was similar to that of pigs in the medium or high sequences for the 15 to 40 lb phase. Thus, the data tend to indicate that diet complexity is critical in the first week postweaning, but the complexity can be decreased rapidly for feeding high health-status pigs without reducing performance. This experiment illustrates the tremendous growth potential of the high health-status pigs and that similar growth and performance can be achieved from pigs weaned at 9 and 19 d of age.

(Key Words: Starter Pig, Diet Complexity, Growth.)

Introduction

Segregated early weaning has become a standard management practice on many farms as a means of disease control. Several experiments have demonstrated the benefits of early weaning for disease elimination. The benefits of increasing the health status have included much higher growth rates and improved expression of the pigs potential to produce lean meat. Therefore, our objective was to compare the growth of 9- and 19-d-old weaned pigs raised in the same environment under the same management when obtained from a herd with a high health status. It is also known that immune stimulation elicits compounds that have a negative effect on pigs' feed intake. One of the primary objectives when formulating nursery diets is selecting ingredients that will stimulate feed intake to maximize performance. The selected ingredients thus make the diet more complex. Therefore, when the negative effects of infectious disease have been eliminated, complex diets may not be needed to stimulate feed intake and maximize nursery growth performance. Therefore, our two objectives were 1) to compare the growth performances of pigs weaned at 9 d and at 19

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d of age and 2) to examine the influence of diet complexity on the growth performance of high health-status pigs.

Procedures

A total of 180 barrows (initially 7.4 lb or 11.9 lb and 9 or 19 d of age) were used. Pigs were fed three different diet complexities for each of the two weaning ages. Thus, the six treatments were a high, medium, or low complexity phase-feeding sequence for the 9-d-old weaned pigs and a high, medium, or low sequence fed to the 19-d weaned pigs. Diet composition and phase-feeding scheme are listed in Tables 1 and 2. Diet complexity was altered by varying the level of dried whey, lactose, soy products, spray-dried porcine plasma, spray-dried blood meal, and select menhaden fishmeal in the diets. Pigs were phase fed according to weight, with complexity decreasing as weight increased for each phase-feeding sequence. The high complexity diet sequences were designed to maximize gain regardless of price. These diets consisted of high levels of high quality alternative protein sources and milk products. The complex diets also were fed to heavier weight pigs than normally recommend. Diets fed in the high complexity sequence were similar to many diets formulated in the commercial feed industry. The medium complexity diet sequences also consisted of many of the same high quality alternative protein sources and milk products used in the high complexity diet sequences. However, they were not fed for such long periods or at such high levels. These diets were formulated to balance between maximal growth performance and optimal economics. The medium complexity sequences were formulated to closely match the current Kansas State University recommendations. The low complexity diet sequences were extremely simple diets that were composed of extremely low levels of spray-dried porcine plasma, select menhaden fish meal, and dried whey. These ingredients were also only included in the diets for short time periods. All diets within a weight range were formulated to the same dietary lysine level. Pigs were fed diets formulated to contain 1.7% lysine from weaning to 11 lb, 1.5% lysine from 11 to 15 lb, 1.4% lysine from 15 to 25 lb, 1.3% lysine from 25 to 40 lb, 1.2% lysine from 40 to 140 lb, and .9% lysine from 140 to 240 lb. All pigs were fed the same diets from 40 to 240 lb.

Pigs were housed in the same environmentally controlled nursery for the first 55 d postweaning. Pigs were allotted by weight and placed in pens containing five pigs per pen initially. Each pen was 4 ft × 4 ft with slotted metal flooring. A self-feeder and nipple waterer were located in each pen to allow ad libitum consumption of feed and water. A control group composed of only pigs weaned at 9 d of age was housed in an identical nursery. The purpose of the control group was to compare the growth performance of the 9-d-old groups between barns. The comparison was made to make sure that the 19-d-old pigs did not contaminate the 9-d-old pigs with infectious disease that might have hindered growth performance. At 55 d postweaning, pigs were moved to an open-fronted building (4 ft × 15 ft pens with solid flooring). Each pen contained a single-hole feeder and a nipple waterer to accommodate ad libitum access to feed and water. When the mean wt of pigs in a pen averaged 25, 40, and 240 lb, the pig weighing closest to the pen mean was slaughtered for carcass chemical composition. Carcass measurements were recorded 24 h postmortem for the 240-lb pigs.

Data were analyzed as a randomized complete block design. General linear model procedures were used with initial weight as a blocking factor. Main effect and interaction contrasts then were examined to determine effects of weaning age and diet complexity.

Results and Discussion

The growth performance of pigs used in this growth assay was excellent, as shown by the range of average ages at 240 lb (144 to 149.7 d; Table 3). Pigs fed the medium complexity diet were the youngest at 240 lb. Note that the pigs weaned at 9 d attained a weight of 15 lb at a younger age than the pigs weaned at 19 d of age, although the 9-d-old pigs had a lower ADG from weaning to

15 lb. The younger age can be explained by the fact that the pigs were younger at weaning and were in an accelerated phase of growth compared to the 19-d-old pigs. However, at 25 lb, no difference in age occurred between the two groups weaned at different ages, and the similar growth was maintained for the remainder of the experiment. This can be explained by the 19-d-old pigs having superior ADG and feed efficiency from 15 to 25 lb than the 9-d-old pigs. Thus, when health status and environment are similar, conventionally weaned pigs at 19 d of age can attain a weight of 240 lb at the same age as pigs weaned at 9 d of age.

The effect of diet complexity was most pronounced in the early postweaning period. The 9-d-old pigs fed the high diet complexity during the period from weaning to 11 lb had the best ADG, which was driven by increased ADFI from weaning to 11 lb. The ADG was then similar between diet complexities for the 9-d-old weaned pigs during the 11 to 15 lb period. A similar response was observed for the 19-d-old pigs from weaning to 15 lb, with the high and medium complexities giving better ADG than the low complexity treatment. The 19-d-old pigs then had similar ADG in the 15 to 25 lb period across diet complexities. Therefore, complexity did not affect ADG in the 15 to 40 lb period. However, complexity had a significant effect on ADG ($P<.01$) in the 40 to 240 lb period, with the medium complexity treatment giving the best ADG for both the 9-d and 19-d groups. The data tend to indicate that diet complexity is critical in the first week postweaning, but that in high health-status pigs, the complexity can be decreased rapidly without reducing performance. The data also indicate that a very complex diet sequence fed in the nursery phase does not maximize performance in the subsequent growing-finishing phase.

Carcass characteristics at 240 lb are listed in Table 4. The results indicate an interaction ($P<.02$) for amount of leaf fat. The interaction is the result of pigs weaned at 9 d of age and fed the low complexity diets having the most leaf fat (Table 4). Although no significant differences occurred for average backfat, tenth rib backfat, and loin eye area, the pigs weaned at 9 d of age and fed the low complexity diets had the greatest amount of backfat and the smallest longissimus muscle area.

The high complexity sequences resulted in a higher cost per lb of gain and poorer growth performance than the medium complexity sequences (Table 5). The feed cost per lb of gain was higher from weaning to 40 lb, lower from 40 to 240 lb, and slightly higher for the overall growth period when comparing the medium complexity sequence to the low complexity sequence. If the producer can take advantage of the increased throughput, the decreased days to market would result in lowering the fixed costs per pig, and, hence, pigs fed the medium complexity sequences would have lower or similar cost per lb of gain compared to pigs fed the low complexity sequences. Thus, the balance between growth performance and economics would indicate feeding a medium complexity diet in the immediate postweaning period and rapidly decreasing the complexity for the remainder of the finishing period.

In conclusion, this experiment illustrates the tremendous growth potential of the high health-status pig. This experiment also indicates that similar growth and performance can be achieved from pigs weaned at 9 and 19 d of age, even when fed diets with a wide range of complexities. More research is needed to further define the effects of nursery diet complexity on pigs with different health status.

Table 1. Diet Composition

	Weaning to 11 lb			11 to 15 lb				15 to 25 lb			25 to 40 lb		40 to 140 lb	140 to 240 lb
Item	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Corn	31.24	31.62	31.75	40.78	40.41	40.00	32.94	48.62	51.07	50.01	53.50	61.04	60.36	77.85
Dried whey	30.00	25.00	20.00	25.00	25.00	20.00	20.00	20.00	10.00	5.00	15.00	--	--	--
Lactose	5.00	5.00	--	5.00	--	--	--	--	--	--	--	--	--	--
Soybean meal (48.5% CP)	--	14.12	31.48	--	16.19	25.92	38.23	16.76	28.56	36.87	25.41	34.19	34.85	19.51
Moist extruded soy protein concentrate	8.73	--	--	8.19	--	--	--	--	--	--	--	--	--	--
Spray-dried porcine plasma	10.00	7.50	2.00	7.50	7.50	2.50	--	3.00	--	--	--	--	--	--
Select menhaden fishmeal	6.00	6.00	6.00	3.00	--	--	--	3.00	--	--	3.00	--	--	--
Spray-dried blood meal	--	1.75	--	1.75	1.75	2.50	--	2.00	2.50	--	--	--	--	--
Soybean oil	6.00	6.00	6.00	5.00	5.00	5.00	5.00	3.00	3.00	3.00	--	--	2.00	--
Monocalcium phosphate (21% P)	1.14	1.15	.85	1.62	1.79	1.70	1.46	1.46	1.85	1.82	.88	1.46	1.21	.98
Antibiotic[a]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	--	--
Limestone	.19	.165	.23	.47	.64	.68	.67	.50	.80	.84	.55	.90	.88	.92
Vitamin premix	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.20	.15
Trace mineral	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.10
DL-methionine	.119	.124	.113	.112	.142	.123	.116	.77	.102	.078	.033	.039	--	--
Copper sulfate	.075	.075	.075	.075	.075	.075	.075	.075	.075	.075	.075	.075	--	--
L-lysine HCl	.10	.10	.10	.10	.10	.10	.10	.15	.15	.15	.15	.15	--	--
Salt	--	--	--	--	--	--	--	--	.25	.75	--	.75	.35	.35
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

[a]To provide 50 g/ton carbadox

Table 2. Diet Sequence Fed for Each Treatment[a]

	Diet sequence						
	9 d weaning			19 d weaning			
Item, lb	High	Med	Low	Hight	Med	Low	Lysine, %
Weaning to 11	A	B	C	na[b]	na	na	1.70
11 to 15	D	F	G	D	E	G	1.50
15 to 25	H	I	I	H	I	J	1.40
25 to 40	K	L	L	K	L	L	1.30
40 to 140	M	M	M	M	M	M	1.20
140 to 240	N	N	N	N	N	N	.90

[a]Pigs were fed within each treatment diet sequences varying in complexity and decreasing in complexity as pig weight increased. Each letter represents the diet listed in Table 1.
[b]Not applicable because 19 d pigs weighed more than 11 lb at the initiation of the experiment.

Table 3. Effect of Weaning Age and Diet Complexity on Growth Performance[a]

	9 d weaning			19 d weaning			P value			
Item	High	Med	Low	High	Med	Low	Age	Diet	A×D[b]	CV
Wean to 11 lb										
ADG, lb	.51	.44	.42	--	--	--	na[c]	.01	na	5.7
ADFI, lb	.48	.44	.43	--	--	--	na	.10	na	10.1
F/G	.95	.99	1.00	--	--	--	na	.18	na	5.1
11 to 15 lb										
ADG, lb	.80	.79	.75	--	--	--	na	.57	na	11.2
ADFI, lb	.95	.86	.85	--	--	--	na	.03	na	7.0
F/G	1.18	1.10	1.15	--	--	--	na	.06	na	5.1
Wean to 15 lb										
ADG, lb	.64	.59	.55	.79	.80	.68	.01	.01	.36	10.0
ADFI, lb	.70	.63	.60	.68	.70	.66	--	--	.03	6.5
F/G	1.09	1.06	1.08	.86	.87	.96	--	--	.01	3.1
15 to 25 lb										
ADG, lb	.97	.95	.96	1.01	1.05	1.03	.01	.95	.56	7.0
ADFI, lb	1.31	1.27	1.24	1.19	1.24	1.29	--	--	.04	6.2
F/G	1.35	1.34	1.30	1.17	1.18	1.26	--	--	.01	2.6
25 to 40 lb										
ADG, lb	1.34	1.29	1.22	1.33	1.28	1.33	.13	.07	.05	5.0
ADFI, lb	1.96	1.96	1.93	1.85	1.86	1.92	.01	.67	.09	3.2
F/G	1.46	1.53	1.59	1.39	1.46	1.45	.01	.01	.11	2.9
40 to 240 lb										
ADG, lb	1.93	2.01	1.95	1.96	2.03	1.92	.82	.01	.40	2.9
ADFI, lb	5.59	5.65	5.52	5.55	5.88	5.65	--	--	.01	1.5
F/G	2.90	2.81	2.83	2.83	2.90	2.94	--	--	.01	1.7
AGE, d										
11 lb	16.2	17.2	18	--	--	--	na	.01	na	3.7
15 lb	22	23.3	24.0	24.0	24.0	25.3	--	--	.03	2.4
25 lb	34.3	34.3	35.3	33.7	33.7	35.8	.50	.01	.42	3.6
40 lb	44.3	47.3	48.0	45.2	45.7	46.5	.11	.01	.07	3.1
140 lb	98.5	99.2	100.0	104.5	103.7	105.0	.01	.07	.33	1.2
240 lb	148.0	144.5	149.2	147.5	144.0	149.7	--	--	.03	0.3

[a]Pigs weaned at 9 d of age were initially 7.4 lb, and pigs weaned at 19 d of age were initially 11.9 lb. Each number is the mean of 6 pens (5 barrows per pen from weaning to 25 lb, 4 barrows per pen 25 to 40 lb, and 3 barrows per pen 40 to 240 lb).
[b]Age × Diet interaction.
[c]Not applicable because 19 d pigs weighed more than 11 lb at the initiation of the experiment.

Table 4. Effect of Weaning Age and Diet Complexity on Carcass Characteristics at 240 Lb[a]

Item	9 d weaning			19 d weaning			P Value			
	High	Med	Low	High	Med	Low	Age	Diet	AxD[b]	CV
Leaf fat, lb	3.0	2.7	4.3	2.7	3.0	2.2	--	--	.02	31.3
Backfat										
Average, in	.96	.96	1.08	.96	.99	.98	.45	.45	.45	13.8
Tenth rib, in	1.01	1.04	1.25	1.06	1.19	1.05	.95	.48	.17	20.9
Longissmus muscle area, in^2	6.04	6.19	5.41	5.97	6.12	6.09	.51	.46	.41	13.2

[a]Pigs weaned at 9 d of age were initially 7.4 lb, and pigs weaned at 19 d of age were initially 11.9 lb. Pigs were fed varying complexity dietary regimens in the nursery from weaning to 40 lb. Pigs were then fed common diets from weaning to market. Each number is the mean for 6 pigs.

[b]Age × diet interaction.

Table 5. Effect of Weaning Age and Diet Complexity on Feed Cost[a]

Item	9 d weaning			19 d weaning		
	High	Med	Low	High	Med	Low
Weaning to 40 lb						
Total, $	8.13	5.30	4.47	5.54	3.82	3.32
$ / lb gain	.249	.162	.137	.197	.136	.118
40 to 240 lb						
Total, $	35.57	34.62	34.85	35.34	36.40	36.57
$ / lb gain	.178	.173	.174	.177	.182	.183
Weaning to 240 lb						
Total, $	43.69	39.92	39.32	40.89	40.22	39.89
$ / lb gain	.188	.172	.169	.179	.176	.175

[a]Ingredient prices used were corn; $2.20/bu, soybean meal; $200/ton, dried whey; $.262/lb, spray-dried porcine plasma $2.00/lb, spray-dried blood meal; $.45/lb, select menhaden fish meal; $.406/lb. No charge was included for feed processing or delivery.