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Effects of Weaning Age and Antibiotic Use on Pig Performance in a Commercial System

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Effects of Weaning Age and Antibiotic Use on Pig Performance in a Commercial System

Abstract

A total of 2,184 barrows and gilts (DNA 600 × PIC L42) were used in a study from weaning to market to evaluate the effect of increasing weaning age and antibiotic use on pig performance in a commercial production system. A 3 × 2 factorial arrangement was used. The treatments included weaning age (18.5, 21.5, or 24.5 days of age) and the use of antibiotic (AB) or antibiotic free (ABF). There were 14 replicate pens per treatment and 26 pigs per pen (13 barrows and 13 gilts). Pigs were weaned from a 4,000-sow farm and placed in pens by weaning age with pens randomly assigned to AB or ABF. Pigs assigned to AB had access to a diet containing 400 ppm of chlortetracycline (CTC) from d 8 to 21 post-weaning, and after a porcine respiratory and reproductive syndrome (PRRS) outbreak at week 7 post-weaning, they were medicated via drinking water for five consecutive days with CTC (10 mg/lb of body weight (BW) per day). For the first 42 days post-weaning, increasing weaning age reduced the number of pigs treated with injectable antibiotic (quadratic, $P = 0.004$), but AB use did not influence this variable ($P = 0.626$). Each additional day of weaning age resulted in greater BW at weaning and at 197 days of age with slopes of 0.484 lb and 1.485 lb, respectively (linear, $P < 0.001$). From weaning to 197 days of age, increasing weaning age increased average daily gain (0.02 lb/day of weaning age; linear, $P < 0.001$) and the same effect was found for AB (0.03 lb/d; $P = 0.009$). Weaning age and AB also affected average daily feed intake (0.03 lb/day of increase in weaning age; linear, $P < 0.001$ and 0.08 lb/d; $P = 0.031$, respectively). An interaction (linear, $P = 0.005$) was found for feed efficiency. When AB were fed, pigs weaned at 21.5 and 24.5 d were less efficient. However, AB improved feed efficiency of pigs weaned at 18.5 d. Pigs with access to AB in feed and water had lower total losses (2.7% less mortality + removal; $P < 0.001$). Increasing weaning age also marginally decreased total losses (-0.21% per day increase in weaning age; linear, $P = 0.097$). The weight sold (at 197 d of age) per pig weaned was increased by increasing weaning age (an additional 1.55 lb for each day increase in weaning age; linear, $P = 0.050$) and by using AB in feed and water (an addition of 10.1 lb/pig; $P = 0.019$). In summary, increasing weaning age linearly improved pig performance and relatively short-term use of antibiotics reduced mortality and removals. In addition, both factors contributed to maximizing the weight sold per pig weaned.

Keywords

weaning age, antibiotic, growth, swine

Authors

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Effects of Weaning Age and Antibiotic Use on Pig Performance in a Commercial System

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Summary

A total of 2,184 barrows and gilts (DNA 600 × PIC L42) were used in a study from weaning to market to evaluate the effect of increasing weaning age and antibiotic use on pig performance in a commercial production system. A 3 × 2 factorial arrangement was used. The treatments included weaning age (18.5, 21.5, or 24.5 days of age) and the use of antibiotic (AB) or antibiotic free (ABF). There were 14 replicate pens per treatment and 26 pigs per pen (13 barrows and 13 gilts). Pigs were weaned from a 4,000-sow farm and placed in pens by weaning age with pens randomly assigned to AB or ABF. Pigs assigned to AB had access to a diet containing 400 ppm of chlortetracycline (CTC) from d 8 to 21 post-weaning, and after a porcine respiratory and reproductive syndrome (PRRS) outbreak at week 7 post-weaning, they were medicated via drinking water for five consecutive days with CTC (10 mg/lb of body weight (BW) per day). For the first 42 days post-weaning, increasing weaning age reduced the number of pigs treated with injectable antibiotic (quadratic, $P = 0.004$), but AB use did not influence this variable ($P = 0.626$). Each additional day of weaning age resulted in greater BW at weaning and at 197 days of age with slopes of 0.484 lb and 1.485 lb, respectively (linear, $P < 0.001$). From weaning to 197 days of age, increasing weaning age increased average daily gain (0.02 lb/day of weaning age; linear, $P < 0.001$) and the same effect was found for AB (0.03 lb/d; $P = 0.009$). Weaning age and AB also affected average daily feed intake (0.03 lb/day of increase in weaning age; linear, $P < 0.001$ and 0.08 lb/d; $P = 0.031$, respectively). An interaction (linear, $P = 0.005$) was found for feed efficiency. When AB were fed, pigs weaned at 21.5 and 24.5 d were less efficient. However, AB improved feed efficiency of pigs weaned at 18.5 d. Pigs with access to AB in feed and water had lower total losses (2.7% less mortality + removal; $P < 0.001$). Increasing weaning age also marginally decreased total losses (-0.21% per day increase in weaning age; linear, $P = 0.097$). The weight sold (at 197 d of age) per pig weaned was increased by increasing weaning age (an additional 1.55 lb for each day increase in weaning age; linear, $P = 0.050$) and by using AB in feed and water (an addition of 10.1 lb/pig; $P = 0.019$). In summary, increasing weaning age linearly improved pig performance and relatively

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short-term use of antibiotics reduced mortality and removals. In addition, both factors contributed to maximizing the weight sold per pig weaned.

Introduction

Because swine production has followed a trend of reducing the use of antibiotics, other management strategies that influence growth and mortality, such as older weaning ages, are needed to maintain economic competitiveness of pork production. More than a decade ago, a study conducted by Main et al.[3] assessed the impact of weaning age on performance in a commercial system. The range of weaning ages used in that work was from 12 to 21.5 d, which was very applicable to the swine production of that time. Most of the findings of that study exhibited linear improvements such as growth rate, mortality, and weight sold per pig weaned, reinforcing the necessity to evaluate an older range of weaning ages. Likewise, as pressure to lower antibiotic use increases, a renewed look at weaning age appears warranted for production systems. Recently, a dose-response study[4] evaluated weaning ages from 19 to 28 d. The authors suggested increasing weaning age up to 28 d as an effective management strategy to improve nursery and finishing performance. However, the growth rate on a lifetime basis was not affected by weaning age. To our knowledge, there is no previous literature that has evaluated weaning age in a dose-response study in a factorial design combined with or without the use of antibiotics in the wean-to-finish period. Therefore, the objective of this study was to determine the effects of weaning age and antibiotic use on pig performance in a commercial production system.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment.

A total of 2,184 barrows and gilts (DNA 600 × PIC L42) were used in a study from weaning to market at 197 days of age. The study started in a 4,000-sow farm and, at weaning, pigs were transferred to a commercial research, wean-to-finish site in southern Minnesota. The facility had heaters distributed along the barn, was naturally ventilated, and was double-curtain-sided. Pens had completely slatted flooring and deep pits. Each pen was equipped with a 3-hole stainless steel feeder and a 2-hole cup waterer to allow *ad libitum* access to feed and water. The facility was equipped with a computerized feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of measuring and recording daily feed additions to individual pens.

At birth, pigs from four weaning batches were ear-tagged with different tag colors to identify the exact age at weaning time of each pig. Litters were weaned at 18, 19, 21, 22, 24, or 25 d of age. After weaning, pigs were transferred to a wean-to-finish facility, sorted by weaning age (18.5, 21.5, and 24.5 d), weighed in pens, and then, pens were randomly assigned to AB or ABF treatment. Thus, treatments consisted of a 3 × 2 factorial with weaning batch as a blocking factor. There were 28 replicates per age and

[3] Main, R. G., S. S. Dritz, M. D. Tokach, R. D. Goodband, J. L. Nelssen. 2004. Increasing weaning age improves pig performance in a multisite production system. J Anim Sci. 82: 1499-1507.
[4] Faccin, J. E. G., F. Laskoski, R. R. Ulguim, A. P. G. Mellagi, F. P. Bortolozzo. 2019. Increasing weaning age: a tool to improve pig performance in a multisite production system. J Anim Sci, 97: Supplement 2, 95–96. https://doi.org/10.1093/jas/skz122.172

36 per AB program. A total of 84 pens with 26 pigs per pen (50% barrows and 50% gilts) were used. Pigs assigned to AB had access to a diet containing 400 ppm of chlortetracycline (CTC) from d 8 to 21 post-weaning, and after a PRRS outbreak at week 7 post-weaning, they were medicated via drinking water for five consecutive days with CTC (10 mg/lb of body weight per day).

Pigs were fed common corn-dried distillers grains with solubles-soybean meal-based diets throughout the trial and were fed in meal form. Pens of pigs were weighed and feed disappearance was recorded in a weekly base until 42 d post-weaning and every 14 d thereafter to determine ADG, ADFI, and F/G. Three weeks before marketing, six pigs per pen were topped. Pens were weighed right before topping and at the final market day. At these two moments, pigs were weighed on a common day of life to allow comparison of the three different weaning ages at the same final age (176 and 197 days of age, respectively).

Injectable antibiotics were given as needed regardless of dietary treatment with all injectable antibiotic treatments individually recorded. Pigs identified to be in a nonambulatory condition, not responding to medical treatment or due to acute death, were removed from the trial. The sum of removals and mortalities was recorded as total losses.

The weight sold per pig weaned was calculated by multiplying the off-test pen weight by the percentage of pigs that reached the final market day per pen. All calculations were performed at a similar final age.

Statistical Analysis

Data were analyzed using generalized linear mixed models where weaning age and AB in the diet and water were the fixed effects, with the random effects of the batch of weaning. Statistical models were fitted using the GLIMMIX procedure of SAS (v. 9.4, SAS Institute, Inc. Cary, NC). Pre-planned linear and quadratic contrast statements were used to evaluate increasing the weaning age as well as linear and quadratic interactions with AB.

Body weight, average daily gain, average daily feed intake, feed efficiency, and the weight sold per pig weaned were evaluated assuming a normal distribution of the response variable. Losses and treated pigs were fitted using a binomial distribution. Statistical models were implemented using the GLIMMIX procedure of SAS. Pens were designated as experimental unit in all analyses. All results were considered significant at $P \leq 0.05$, and marginally significant at $0.05 \leq P \leq 0.10$.

Results and Discussion

Pigs weaned at older ages had greater feed intake (Table 1) in the first week and during the whole nursery period (linear, $P < 0.001$), as previously seen in other studies.[3,4,5] This suggests better post-weaning adaptation, which may have contributed to a lower number of pigs treated. As a response of greater feed intake, increasing weaning age

[5] Smith, A. L, K. J. Stalder, T.V. Serenius, T. J., Baas, J.W. Mabry. 2008. Effect of weaning age on nursery pig and sow reproductive performance. J Swine Health Prod. 16: 131-137.

resulted in higher (linear, $P < 0.001$) average daily gain during the nursery period. During phase 2, when the AB was present in the feed, pigs from AB treatment were less efficient ($P = 0.001$) with no difference ($P = 0.874$) in average daily feed intake, leading to lower ($P = 0.007$) average daily gain than ABF pigs. In the overall nursery period, even though AB pigs had greater feed intake ($P = 0.004$), no differences were detected for average daily gain ($P = 0.283$) and body weight at d 42 ($P = 0.419$). Thus, feed efficiency was poorer ($P = 0.003$) when AB were fed. For the first 42 days post-weaning, increasing weaning age reduced the number of pigs treated with an injectable antibiotic (quadratic, $P = 0.004$). Providing antibiotics in the feed did not influence this variable ($P = 0.626$).

From weaning to 197 days of age, increasing weaning age increased average daily gain (0.02 lb/day of weaning age; linear, $P < 0.001$) and the same effect was found for AB (0.03 lb/d; $P = 0.009$). Weaning age and AB also affected the average daily feed intake (0.03 lb/day of increase in weaning age; linear, $P < 0.001$ and 0.08 lb/d; $P = 0.031$, respectively). An interaction (linear, $P = 0.005$) was found for feed efficiency. When AB were fed, pigs weaned at 21.5 and 24.5 d were less efficient. However, AB improved feed efficiency of pigs weaned at 18.5 d.

At weaning and 197 days of age, increasing weaning age resulted in greater body weight with slopes of 0.484 lb and 1.485 lb, respectively for each day increase in weaning age (linear, $P < 0.001$). However, Faccin et al.[4] after adjusting for differences in weaning age, found that weaning age did not influence body weight at a common days of age (at 164 d). It is important to note that in that study the removal rate was highly impacted by weaning age, which could have increased the average body weight of the pens with pigs weaned younger.

Increasing weaning age resulted in no differences in losses during the nursery period ($P = 0.161$) and marginally decreased overall losses (-0.21% per day increase in weaning age; linear, $P = 0.097$). In addition, the use of antibiotic in the feed did not influence ($P = 0.170$) the percentage of losses in the first 42 d post-weaning. However, from weaning to 197 d of age, pigs with access to AB in feed and water had lower total losses (2.7% less mortality + removal; $P < 0.001$). We hypothesize that the magnitude of difference increased due to the antibiotic intervention after the PRRS outbreak.

Expressing weight sold on a per-pig-weaned basis allowed wean-to-finish performance and percentage of losses to be quantified in a manner that directly relates to the value of the weaned pig.[3] The weight sold (at 197 d of age) per pig weaned was increased by increasing weaning age (addition of 1.55 lb for each day increase in weaning age; linear, $P = 0.050$) and by using AB in feed and water (addition of 10.1 lb/pig; $P = 0.019$). Main et al.[3] found a similar effect with increased weaning age from 12 to 21 days. In both studies, the magnitude of difference in growth performance is increased by a reduction in removals and/or losses.

One of the first hypotheses of the current study was that weaning age and AB use could result in some interaction, such as a greater benefit of AB in pigs weaned at younger ages. However, this was not confirmed and both factors contributed without interacting on maximizing performance and the weight sold per pig weaned.

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Table 1. Nursery performance of pigs weaned with different weaning ages and fed with (AB) or without (ABF) antibiotic in diet[1]

	Weaning age, d							Probability, P <				
	18.5		21.5		24.5							
	Diet											
Item[2]	ABF	AB	ABF	AB	ABF	AB	SEM	AB	Linear age	Quadratic age	Linear age × AB	Quadratic age × AB
BW, lb												
Weaning	10.5	10.6	12.0	12.0	13.6	13.6	0.19	0.972	<0.001	0.650	0.886	0.888
d 7	11.7	11.7	13.6	13.6	15.5	16.0	0.77	0.361	<0.001	0.573	0.168	0.497
d 21	19.0	18.3	22.2	22.2	25.7	25.5	0.50	0.267	<0.001	0.481	0.396	0.416
d 42	37.8	38.0	43.6	44.0	49.9	50.4	1.29	0.419	<0.001	0.976	0.793	0.942
Phase 1 (d 0 to 7)												
ADG, lb	0.15	0.14	0.23	0.22	0.28	0.34	0.09	0.104	<0.001	0.860	0.009	0.119
ADFI, lb	0.23	0.24	0.29	0.29	0.32	0.38	0.05	0.170	<0.001	0.778	0.094	0.204
F/G	2.02	0.98	1.72	2.55	1.27	1.26	0.60	0.882	0.444	0.211	0.383	0.187
Phase 2 (d 8 to 21)												
ADG, lb	0.51	0.47	0.61	0.61	0.72	0.68	0.04	0.007	<0.001	0.106	0.923	0.086
ADFI, lb	0.67	0.63	0.76	0.79	0.90	0.90	0.02	0.874	<0.001	0.920	0.216	0.085
F/G	1.32	1.38	1.25	1.31	1.25	1.35	0.09	0.001	0.018	0.037	0.486	0.583
Phase 3 (d 22 to 42)												
ADG, lb	0.89	0.95	1.03	1.04	1.16	1.19	0.03	0.024	<0.001	0.469	0.675	0.347
ADFI, lb	1.31	1.39	1.50	1.58	1.74	1.81	0.05	0.001	<0.001	0.373	0.730	0.798
F/G	1.46	1.47	1.46	1.52	1.50	1.51	0.03	0.070	0.007	0.967	0.958	0.066
Overall (d 0 to 42)												
ADG, lb	0.64	0.65	0.75	0.76	0.86	0.88	0.03	0.283	<0.001	0.968	0.912	0.656
ADFI, lb	0.91	0.94	1.05	1.09	1.22	1.26	0.04	0.004	<0.001	0.473	0.748	0.644
F/G	1.42	1.44	1.39	1.44	1.41	1.43	0.02	0.003	0.204	0.194	0.974	0.166
Losses, %[3]	1.9	2.5	1.1	1.6	1.1	1.1	1.00	0.170	0.161	0.916	0.509	0.420
Treated, %[4]	24.1	24.7	23.1	21.2	10.0	9.1	3.70	0.626	<0.001	0.004	0.662	0.770

[1]A total of 2,184 pigs used in 3 × 2 factorial trial with 3 weaning ages and 2 diet programs (AB = 400 ppm of CTC in phase 2; ABF = no antibiotics in feed). Pigs were allotted in a wean-to-finish facility with 26 pigs per pen (50% barrows and 50% gilts) and 28 replications per age and 36 per feed program in 84 pens. Four weaning batches (weaned in 4 subsequent weeks) were used.

[2]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed efficiency. SEM = standard error of mean.

[3]Sum of mortality and removed pigs.

[4]Percentage of pigs treated with injectable antibiotics.

Table 2. Wean-to-finish performance of pigs weaned with different weaning ages and fed with (AB) or without (ABF) antibiotic in diet[1]

	Weaning age, d							Probability, $P <$				
	18.5		21.5		24.5							
	Diet											
Item[2]	ABF	AB	ABF	AB	ABF	AB	SEM	AB	Linear age	Quadratic age	Linear age × AB	Quadratic age × AB
BW, lb												
Weaning	10.5	10.6	12.0	12.0	13.6	13.6	0.19	0.972	<0.001	0.650	0.886	0.888
177 d of age (top)	251.9	251.7	253.5	255.5	252.9	259.1	3.30	0.098	0.008	0.505	0.109	0.765
197 d of age (sale)	287.3	288.1	291.8	293.4	292.9	298.0	3.45	0.182	<0.001	0.537	0.357	0.737
Birth to 197 d of age												
ADG, lb	1.45	1.45	1.47	1.48	1.47	1.50	0.02	0.170	0.001	0.547	0.333	0.819
Wean to 197 d of age												
ADG, lb	1.53	1.55	1.58	1.61	1.62	1.66	0.016	0.009	<0.001	0.467	0.510	0.945
ADFI, lb	3.67	3.66	3.72	3.82	3.76	3.90	0.045	0.031	<0.001	0.320	0.079	0.580
F/G	2.40	2.36	2.35	2.37	2.33	2.36	0.015	0.903	<0.001	0.324	0.005	0.209
Treated, %[3]	34.4	35.4	33.1	27.0	18.0	16.1	4.42	0.238	<0.001	<0.001	0.514	0.272
Losses, %[4]	8.8	7.6	8.8	5.4	7.9	5.9	1.18	<0.001	0.097	0.725	0.508	0.080
Weight sold/pig												
weaned, lb	260.8	265.9	263.7	277.4	268.4	279.9	6.29	0.019	0.050	0.481	0.535	0.540

[1]A total of 2,184 pigs used in 3 × 2 factorial trial with 3 weaning ages and 2 diet programs (AB = 400 ppm of CTC in phase 2 and after a porcine respiratory and reproductive syndrome (PRRS) outbreak at week 7 post-weaning via drinking water for five consecutive days with CTC (10 mg/lb of body weight per day); ABF = no antibiotics in feed). Pigs were allotted in a wean-to-finish facility with 26 pigs per pen (50% barrows and 50% gilts) and 28 replications per age and 36 per feed program in 84 pens. Four weaning batches (weaned in 4 subsequent weeks) were used.

[2]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed efficiency. SEM = standard error of mean.

[3]Percentage of pigs treated with injectable antibiotics.

[4]Sum of mortality and removed pigs.