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Effect of Two Injectable Iron Sources and Three Administration Programs on Growth Performance and Hemoglobin Levels in Suckling Pigs

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Summary

A total of 756 newborn pigs (DNA 600 × 241) from two farrowing groups were used in a 17-d study to evaluate the effects of two different injectable iron sources and three different administration programs on growth performance and hemoglobin levels. A total of 63 litters were utilized, with the number of pigs per sow equalized on each day of farrowing. One day after birth, all piglets were weighed and divided into groups to create light and heavy groups within the litter. Lightest and heaviest pigs were removed such that the heaviest six pigs from the light group and the lightest six pigs from the heavy group were allotted in a randomized complete block design to one of six treatments. There was one lightweight block and one heavyweight block within the litter, resulting in 126 replications per treatment, with the piglet considered the experimental unit. The six treatments consisted of two different sources of injectable iron (iron dextran, Anem-x 100, Aspen Vet, Loveland, CO; gleptoferron, Gleptoforte 200, CEVA Animal Health, Lenexa, KS) administered on d 1 at either 100 or 200 mg per pig, or 100 mg administered on d 1 and an additional 100 mg administered on d 11 of lactation. Piglet body weight was determined for all the pigs on d 1, 5, 11 and 17 of lactation to calculate ADG. Hemoglobin values were determined for six pigs (one for each treatment) per litter on d 5, 11 and 17. The six pigs selected within the litter were from the same body weight group, and the body weight group alternated between sows such that a similar number of light and heavy pigs were bled for each treatment. Subsequently, 298 pigs from the second farrowing group were weighed, and 154 were bled to determine hemoglobin values on day 18 after weaning. During the nursing period, no significant iron source × program interactions ($P > 0.05$) were observed for BW, ADG, or hemoglobin values. Piglet BW and ADG were not impacted ($P > 0.05$) by iron source or program during lactation. However, hemoglobin values were greater on d 11 ($P = 0.024$) and 17 ($P = 0.001$) for pigs injected with iron from gleptoferron compared to those injected with iron dextran. The iron injection program also impacted hemoglobin values, with d 11 hemoglobin being greater ($P < 0.05$) for those that received 200 mg on d 1 compared to pigs receiving 100 mg. On d 17 of lactation (weaning),

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hemoglobin was lowest ($P < 0.05$) for pigs that received 100 mg on d 1 compared to those that received 200 mg on d 1 or those that received 100 mg on d 1 and an additional 100 mg injection on d 11. Injectable iron source or program had no impact on hemoglobin or ADG measured 18 d after weaning. In summary, gleptoferron resulted in higher hemoglobin levels and administration of 100 mg iron on d 1 resulted in the lowest hemoglobin levels compared to the administration of 200 mg on d 1 or 100 mg administered on both d 1 and 11. Neither source nor iron injection program impacted piglet growth performance during lactation or postweaning growth or hemoglobin levels.

Introduction

Despite piglets requiring 7 to 16 mg of iron per day, sow milk contains only 1 mg/L and piglets are usually born with insufficient iron reserves of only 50 mg.[2] For this reason, shortly after birth the intramuscular administration of a dose of iron to suckling pigs is a common and well-established practice in the swine industry. This procedure prevents iron deficiency, anemia, and low performance.[3] However, Friendship et al.[4] suggested that this practice can be insufficient to maintain the iron status in fast-growing piglets during lactation and after weaning. This observation indicates that the application of a second dose of iron during lactation could be useful to maintain the iron status in piglets. However, there is no consensus regarding the proper dosage and timing of iron injection that results in the best performance. Among the multiple injectable iron sources available for use in pigs, the most commonly used is iron dextran. Iron dextran consists of ferric hydroxide complexed with a low molecular weight dextran, providing a slower release of iron into the bloodstream.[5] Gleptoferron, a more soluble iron source, is a colloidal solution containing ferric hydroxide, dextran, and glucoheptonic acid designed for improved Fe solubility and absorption that has been introduced to the industry in recent years.[6] Little data are available that compares the different sources of injectable iron and iron injection programs on piglet performance. Thus, the objective of this study was to evaluate the effects of two different iron sources and three different administration programs on growth performance and hemoglobin levels in suckling pigs.

Materials and methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for this experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS.

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Animal and treatments

A total of 756 newborn pigs (DNA 600 × 241) from two farrowing groups were used in a 17-d study. A total of 63 litters were utilized with the number of pigs per sow equalized on each day of farrowing. One day after birth, all piglets were weighed and divided into groups to create two body weight groups (light and heavy). The heaviest six pigs from the light group and the lightest six pigs from the heavy group were allotted in a randomized complete block design to one of six treatments to create a lightweight block and a heavyweight block within the litter resulting in 126 replications per treatment with piglet considered the experimental unit. The six treatments consisted of two different sources of injectable iron (iron dextran, Anem-x 100 iron; Aspen Vet, Aspen Vet, Loveland, CO; gleptoferron, Gleptoforte 200, CEVA Animal Health, Lenexa, KS) administered on day 1 at either 100 or 200 mg per pig, or 100 mg administered on day 1 and an additional 100 mg administered on day 11 of lactation. Creep feed was not offered to suckling pigs, and sows were fed a common lactation diet *ad libitum*.

Farrowing performance

Pigs were weighed on d 5, 11 and approximately d 17 (day before weaning) to determine BW change and ADG. There was a 4-d window for farrowing, so each litter was weighed according to age, except for the last day where all piglets were weighed on the same day, the day before weaning. Subsequently, 298 pigs from the second farrowing group were weighed 18 d after weaning to determine BW change and ADG post weaning.

Blood samples

Hemoglobin level was determined from 86 randomly selected piglets at d 1 before iron injection and in six pigs (one for each treatment) per litter on d 5, 11, and 17. The six pigs selected within the litter were from the same body weight group, and body weight group alternated between sows, so there were a similar number of light and heavy pigs bled for each treatment. Additionally, hemoglobin was determined from 154 pigs from the second farrow group 18 d after weaning. Blood samples were collected from the right ear by vein puncture using a sterile needle. Samples were analyzed using the HemoCue 201+ Hb analyzer (HemoCue America).

Statistical analysis

Growth data of suckling pigs were analyzed as a randomized complete block design in a 2 × 3 factorial arrangement, using the individual pig as the experimental unit, iron source and iron program as fixed effects, and farrowing group and sow as random effects using SAS OnDemand for Academics (SAS Institute, Inc., Cary, NC). Growth data of nursery pigs were analyzed separately using the same procedures on the subset of 298 piglets that were followed into the nursery. Hemoglobin values from suckling pigs were measured as a repeated measure within pig, with the individual pig as the experimental unit, treatment and timepoint as fixed effects, and group, sow, and pig as random effects. Hemoglobin values of nursery pigs were analyzed separately using the same procedures on a smaller subset of 154 piglets that were followed into the nursery and had previously been bled for hemoglobin determination. Treatment differences were considered significant at $P \leq 0.05$.

Results and Discussion

Throughout the trial, there were no iron source × injection program interactions observed ($P > 0.05$) for any response criteria (Table 1). Neither iron source nor injection program influenced ($P > 0.05$; Table 2) suckling piglet BW or ADG. Hemoglobin values were greater on d 11 ($P = 0.024$) and 17 ($P = 0.001$) for pigs injected with iron from gleptoferron compared to those injected with iron dextran. Iron injection program also impacted hemoglobin values with d 11 hemoglobin being greater ($P = 0.001$) for those that received 200 mg on d 1 compared to pigs receiving 100 mg. On d 17 of lactation, hemoglobin was lowest for pigs that received 100 mg on d 1 compared to those that received 200 mg on d 1 or those that received 100 mg on d 1 with an additional 100 mg injection on d 11 with the latter two treatments not differing. Injectable iron source or program had no impact on hemoglobin or ADG measured 18 d after weaning. In summary, neither source nor iron injection program impacted piglet growth performance during lactation, but pigs receiving iron from gleptoferron had increased hemoglobin levels at weaning. Providing at least 200 mg of iron either at d 1 or splitting the dose by providing 100 mg at d 1 and d 11 resulted in higher weaning hemoglobin compared to only providing 100 mg on d 1. For those pigs that were followed into the nursery, iron injection source and program had no impact on postweaning growth or hemoglobin levels.

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Table 1. Interactive effects of iron sources and injection program on growth performance and hemoglobin levels in suckling pigs[1]

	Iron source							P =		
	Iron dextran, mg/pig			Gleptoferron, mg/pig						
d 1:	100	200	100	100	200	100				
d 11:	---	---	100	---	---	100	SEM	Program × source	Program	Source
BW, lb										
d 1	3.54	3.53	3.54	3.54	3.54	3.54	0.08	0.997	0.998	0.977
d 5	5.15	5.18	5.08	5.11	5.13	5.17	0.11	0.583	0.912	0.983
d 11	8.66	8.71	8.47	8.72	8.58	8.79	0.17	0.226	0.892	0.450
d 17	12.79	12.70	12.60	12.76	12.60	12.88	0.26	0.590	0.802	0.733
ADG, lb										
d 1 to 5	0.36	0.37	0.34	0.35	0.36	0.36	0.032	0.330	0.815	0.938
d 5 to 11	0.64	0.64	0.61	0.66	0.63	0.66	0.034	0.087	0.538	0.174
d 11 to 17	0.77	0.76	0.76	0.77	0.76	0.78	0.076	0.946	0.835	0.697
d 0 to 17	0.57	0.56	0.55	0.57	0.55	0.57	0.052	0.444	0.775	0.605
Hemoglobin, mg/L[2]										
d 1[3]			10.11 ± 1.78							
d 5[4]	8.6	8.8	8.6	8.5	8.8	8.6	0.151	0.953	0.178	0.930
d 11[4]	9.5	10.0	9.6	9.8	10.2	9.8	0.134	0.765	0.001	0.024
d 17[4]	9.4	11.0	11.3	10.2	11.4	11.4	0.166	0.103	< 0.001	0.001

[1] A total of 756 piglets (DNA 241 × 600) were used in a 17-d study to evaluate the impact of two iron sources and three iron injection programs on growth performance and hemoglobin levels. Piglet was the experimental unit and there were 126 replications per treatment.

[2] Blood samples were collected from the ear vein of the same piglet within each treatment and crate on the indicated days. Hemoglobin concentrations were determined using the HemoCue 201+ system (HemoCue AB, Ängelholm, Sweden).

[3] Before the first iron injection was administered, hemoglobin concentrations were analyzed in 86 randomly selected piglets. Values represent the mean ± standard deviation.

[4] Program × Source × Timepoint, $P = 0.502$; Program × Timepoint, $P < 0.001$; Source × Timepoint, $P = 0.031$; Program × Source, $P = 0.380$; Program, $P < 0.001$; Source, $P = 0.009$; Timepoint, $P < 0.001$.

Table 2. Main effect of iron sources and injection program on growth performance in suckling pigs[1]

	Iron source					Iron program (dose, mg/pig)				
					d 1:	100	200	100		
	Iron dextran	Glepto-ferron	SEM	*P* =	d 11:	---	---	100	SEM	*P* =
BW, lb										
d 1	3.5	3.5	0.07	0.977		3.5	3.5	3.5	0.07	0.998
d 5	5.1	5.1	0.09	0.983		5.1	5.2	5.1	0.10	0.912
d 11	8.6	8.7	0.13	0.450		8.7	8.6	8.6	0.14	0.892
d 17	12.7	12.7	0.21	0.733		12.8	12.6	12.7	0.22	0.802
ADG, lb										
d 1 to 5	0.36	0.36	0.031	0.938		0.36	0.36	0.35	0.031	0.815
d 5 to 11	0.63	0.65	0.032	0.174		0.65	0.63	0.64	0.032	0.538
d 11 to 17	0.76	0.77	0.075	0.697		0.77	0.76	0.77	0.075	0.835
d 0 to 17	0.56	0.56	0.051	0.605		0.57	0.56	0.56	0.051	0.775
Hemoglobin, mg/L[2]										
d 5	8.7	8.7	0.151	0.930		8.5	8.8	8.6	0.151	0.178
d 11	9.7	9.9	0.134	0.024		9.6[b]	10.1[a]	9.7[b]	0.134	0.001
d 17	10.6	11.0	0.166	0.001		9.8[b]	11.2[a]	11.4[a]	0.166	< 0.001

[ab] Means on the same row with different superscripts differ, *P* < 0.05.

[1] A total of 756 piglets (DNA 241 × 600) were used in a 17-d study to evaluate the impact of two iron sources and three iron injection programs on growth performance and hemoglobin levels. Piglet was the experimental unit and there were 63 replications per iron source treatment and 42 replications per iron injection program treatment.

[2] Blood samples were collected from the ear vein of the same piglet within each treatment and crate on the indicated days. Hemoglobin concentrations were determined using the HemoCue 201+ system (HemoCue AB, Ängelholm, Sweden).

Table 3. Effect of iron sources and administration programs on growth performance and hemoglobin levels of pigs pre-and post-weaning[1]

	Iron source									
	Iron dextran, mg/pig			Gleptoferron, mg/pig				*P* =		
d 1:	100	200	100	100	200	100		Program × source		
d 11:	---	---	100	---	---	100	SEM		Program	Source
BW, lb										
d 1	3.53	3.56	3.54	3.53	3.57	3.58	0.131	0.979	0.893	0.796
d 5	5.14	5.18	5.19	5.18	5.24	5.24	0.179	0.995	0.897	0.670
d 11	8.56	8.58	8.44	8.69	8.63	8.69	0.265	0.896	0.959	0.391
d 17	12.63	12.79	12.42	12.93	12.85	12.87	0.389	0.809	0.841	0.297
d 35	20.74	21.42	21.15	21.19	21.42	20.88	0.665	0.737	0.558	0.871
ADG, lb/d										
d 1 to 5	0.33	0.32	0.33	0.33	0.33	0.33	0.019	0.953	0.924	0.655
d 5 to 11	0.69	0.68	0.65	0.70	0.68	0.69	0.025	0.573	0.510	0.253
d 11 to 17	0.83	0.87	0.82	0.87	0.86	0.86	0.036	0.590	0.581	0.231
d 0 to 17	0.61	0.62	0.60	0.63	0.62	0.63	0.022	0.714	0.792	0.255
d 17 to 35	0.45	0.48	0.49	0.46	0.48	0.45	0.025	0.326	0.454	0.433
Hemoglobin, mg/L[2]										
d 5[3]	8.76	8.76	8.51	8.60	8.72	8.60	0.271	0.884	0.754	0.886
d 11[3]	9.30	9.87	9.73	9.54	9.96	9.95	0.231	0.918	0.054	0.298
d 17[3]	9.38	10.76	11.36	10.17	11.58	11.08	0.268	0.042	< 0.001	0.030
d 35[3]	10.20	10.13	10.37	10.33	10.68	10.32	0.288	0.517	0.884	0.344

[1] A subset of pigs from the larger experiment were followed through the early nursery stage to evaluate growth performance from weaning to d 35 of age and d 35 hemoglobin concentration. For this, a total of 298 piglets (DNA 241 × 600) were used with the main source effect represented by 142 and 156 replications for dextran and gleptoferron, respectively. For program, there were 95, 104, and 99 replications for the 100 mg, 200 mg, and 100 + 100 mg programs, respectively.

[2] Blood samples were collected from the ear vein of the same piglet within each treatment and crate on the indicated days. Hemoglobin concentrations were determined using the HemoCue 201+ system (HemoCue AB, Ängelholm, Sweden). Hemoglobin was analyzed on a subset of the population that was followed into the nursery, with 154 piglets selected due to having previously provided blood for hemoglobin analysis preweaning. For source, there were 73 and 81 replications for dextran and gleptoferron, respectively. For program, there were 49, 55, and 50 replications for the 100 mg, 200 mg, and 100 + 100 mg programs, respectively.

[3] Program × Source × Timepoint, $P = 0.399$; Program × Timepoint, $P < 0.001$; Source × Timepoint, $P = 0.447$; Program × Source, $P = 0.399$; Program, $P < 0.001$; Source, $P = 0.076$; Timepoint, $P < 0.001$.