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Effects of an additional iron dextran injection administered to piglets on hemoglobin, performance, and carcass responses

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Introduction

It is common practice to provide newborn piglets with supplemental iron to prevent iron deficiency, usually through an intramuscular (IM) injection of an iron complex, because piglets are born with very low iron stores and receive little through the sow milk.[1] Moreover, it has been suggested that the iron requirement of piglets during lactation is mainly dependent on the growth rate of the piglet during the lactation period.[1-3] Modern swine production has undergone improvements in genetics that have resulted in increased litter sizes and growth rates of nursing piglets. Given these advancements, recent work has shown that the industry standard iron injection (100-200 mg Fe) administered to piglets shortly after birth is not sufficient to maintain the iron status of the pig throughout the lactation period.[4,5] Unsurprisingly, faster-growing pigs in a litter are most susceptible to becoming iron deficient at weaning creating potential postweaning problems.[6]

Recently, Chevalier et al[7] reported that pigs administered 200 mg iron at birth had peak hemoglobin (Hb) concentration on d 17 that subsequently declined to weaning at d 22. Furthermore, pigs that only received 100 mg iron at birth had peak Hb at d 11 with a decline in Hb thereafter. These results agree with previous literature which suggests a possibility of pigs having sub-optimal hemoglobin concentrations (generally < 11 g/dL)[8] at weaning. Interestingly, it has been demonstrated that pigs with optimal hemoglobin concentrations at weaning have greater growth performance in the subsequent postweaning periods.[9,10] Furthermore, Olsen[11] demonstrated that an additional iron injection given to piglets 4 to 6 days after the initial iron injection resulted in a much larger percentage (89 % vs. 20 %) of pigs having optimal Hb concentration (≥ 11 g/dL) at weaning and a 454 g increase in body weight (BW) 42 d postweaning. Thus, there is a continued need to reevaluate iron supplementation practices as there may be a potential benefit to administration of an additional iron injection before weaning. The current experiment evaluated a second iron injection and also assessed growth performance and carcass responses past the nursery period through the finishing period.

Methods

Animals and experimental design

A total of 144 crossbred pigs (Yorkshire x Landrace x Large White; 72 barrows and 72 gilts; initial BW = 2.86 ± 0.01 kg) were assigned to either a control (CON) or added-injection treatment (+Fe) at d 6-8 of age. At enrollment (d 6-8), pairs were created by pairing two same-sex siblings with a BW difference < 0.23 kg. Within a pair, one pig was assigned to the CON and the other to +Fe group. All pigs received an initial 200 mg intramuscular (IM) iron injection (Uniferon, Pharmacosmos, Inc.) < 24 h following birth. Pigs assigned to the +Fe group received an additional 200 mg Fe IM injection at d 6-8. All pigs were weaned at d 22-25 to a nursery facility and housed 6 pigs/pen. Once weaned, both CON and +Fe pigs received a common corn-soybean meal diet formulated to meet or exceed the requirement estimates relative to body weight until slaughter. The common diet fed for the duration of the experiment was formulated to supply an added 100 mg/kg iron as ferrous sulfate. Pigs were moved from the nursery to a finisher facility about 5 wk after weaning. All pigs had ad libitum access to feed and water throughout the entire experiment.

Response measures

Body weight (BW) and feed disappearance were recorded every 2 wk to determine average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G/F). Hemoglobin (Hb) was measured at birth, enrollment, weaning, and the end of the nursery and slaughter periods by using a HemoCue Hb 201+ analyzer (HemoCue America, Brea, California). Pigs (1 pig/pen) were slaughtered at ~ 18 weeks of age under USDA inspection. The hot (HCW) and cold carcass weight (CCW), carcass length, backfat depth at four locations
(1st rib, last rib, 10th rib, and last lumbar), longissimus dorsi muscle area (LMA) were measured. Primal cut weights were also determined.

Statistical analysis

Data analyses were performed in SAS 9.4 (SAS Inst. Inc., Cary, NC, USA) by least-squares analysis of variance using the generalized linear model as a randomized complete block design. The individual pig served as the experimental unit for BW, ADG, carcass measures, and Hb data whereas the pen served as the experimental unit for ADFI and gain/feed ratio data. The statistical model included sex, treatment, sex × treatment, and allotment pair for BW, ADG, Hb, and carcass characteristics. For ADFI and gain/feed ratio, the statistical model only included effects for sex, treatment, and sex × treatment. Statistically significant differences were established at $P \leq 0.05$; tendencies were established at $P \leq 0.10$.

Results

There were expected sex effects for ADG and some carcass measures but no sex × treatment interactions for any response measures. The +Fe pigs had a greater Hb at weaning (13.1 vs. 10.7 g/dL, $P < 0.0001$) and end of the nursery (12.1 vs. 11.7 g/dL, $P = 0.01$) compared to CON pigs (Table 1). During the finisher period, +Fe pigs had a greater ADG ($P = 0.05$) compared to CON pigs (Table 2).

Table 1: Effects of an additional iron injection administered at d 6-8 on hemoglobin (Hb, g/dL) concentration[1]

	Treatment			
Time point	**CON**	**+Fe**	**SEM**	***P*-value**
Birth (d 0)	9.9	9.9	0.214	0.93
Enrollment (d 6-8)	9.1	8.9	0.122	0.13
Weaning (d 22-24)	10.7	13.1	0.152	< 0.0001
End of nursery[2]	11.7	12.1	0.129	0.01
End of study	11.9	12.0	0.136	0.66

[1] Data represent 144 pigs or 72 pigs/treatment. All pigs received an initial iron injection (200 mg Fe) at birth; the +Fe group received an additional iron injection (200 mg Fe) at enrollment.

[2] Nursery period was about 5 weeks postweaning.

Table 2: Effects of an additional iron injection administered at d 6-8 on pig bodyweight and growth performance[1,2]

	Treatment			
Items	**CON**	**+Fe**	**SEM**	***P*-value**
Bodyweight, kg				
Birth (d 0)	1.53	1.55	0.01	0.53
Enrollment (d 6-8)	2.87	2.85	0.01	0.44
Weaning (d 22-25)	7.44	7.40	0.06	0.67
Wk 2	10.51	10.85	0.11	0.03
Wk 4	19.08	19.96	0.22	0.01
Wk 5	27.63	28.15	0.27	0.17
Wk 7	40.10	40.77	0.35	0.18
Wk 9	53.69	54.72	0.49	0.13
Wk 11	67.28	68.49	0.60	0.15
Wk 13	81.03	82.70	0.76	0.11
Wk 15	91.77	93.63	0.83	0.11
Wk 17	103.89	106.88	0.97	0.03
End of study	112.79	115.77	1.03	0.04
Average daily gain, kg				
Preweaning	0.29	0.29	0.004	0.73
Nursery	0.55	0.56	0.01	0.10
Finisher	0.91	0.94	0.01	0.05
Wean to end of study	0.81	0.83	0.01	0.04
Average daily feed intake, kg[3]	1.88	1.90	0.04	0.74
Gain/feed ratio[3]	0.43	0.44	0.004	0.33

[1] Data represent 144 pigs or 72 pigs/treatment. All pigs received an initial iron injection (200 mg Fe) at birth; the +Fe group received an additional iron injection (200 mg Fe) at enrollment.

[2] Preweaning period included enrollment to weaning; nursery period included weaning to about Wk 5; finisher period included Wk 5 to slaughter.

[3] Average daily feed intake and gain/feed ratio are for the entire wean to end of study period.

Table 3: Effects of an additional iron injection administered at d 6-8 on carcass traits[1]

	Treatment			
Items	**CON**	**+Fe**	**SEM**	***P*-value**
Slaughter weight, kg	113.13	114.72	1.75	0.53
Hot carcass weight, kg	82.75	84.85	1.49	0.33
Cold carcass weight, kg	80.93	82.99	1.48	0.34
Carcass length, cm	81.73	82.37	0.66	0.50
Backfat depth, cm				
First rib	3.37	3.43	0.22	0.84
Last rib	2.16	2.60	0.23	0.19
10th rib	1.82	1.85	0.15	0.88
Last lumbar	1.57	1.50	0.14	0.76
Loin muscle area, cm^2	44.06	45.32	1.69	0.60
Absolute primal cut, kg				
Boston butt	3.72	3.71	0.08	0.96
Picnic shoulder	3.90	3.98	0.13	0.65
Loin	9.95	10.67	0.23	0.04
Belly	6.34	6.30	0.16	0.87
Spare rib	1.55	1.63	0.04	0.14
Ham	9.04	9.28	0.18	0.35

[1] Treatment means are reported as least squares means from 12 pigs per treatment; data is based on the left side of the carcass. All pigs received an initial iron injection (200 mg Fe) at birth; the +Fe group received an additional iron injection (200 mg Fe) at enrollment.

Overall, pigs receiving the added iron injection had an ~ 4% increase in ADG ($P = 0.04$) from weaning to the end of study. The cumulative improvement in ADG from weaning to end of study resulted in +Fe pigs having a heavier BW at the end of the study (115.77 vs. 112.79 kg; $P = 0.04$). Carcass response measures (Table 3) of the selected slaughter pigs demonstrated that +Fe pigs had ~ 2.5% numerically heavier HCW and CCW ($P = 0.34$) and significantly heavier trimmed loin (10.67 vs. 9.95 kg; $P = 0.04$) compared to the CON pigs.

Discussion

The mean hemoglobin value for CON pigs at weaning was 10.7 g/dL that is below the oft-recognized target of 11 g/dL and demonstrated that greater than 50% of the pigs would be considered anemic. The added iron injection resulted in an increase in mean hemoglobin to 13.1 ($P < 0.0001$). The elevated hemoglobin was maintained through the end of the nursery period ($P < 0.01$). During this period of elevated hemoglobin status, the BW was improved at Wk 2 and Wk 4 in the nursery ($P < 0.03$) and, while not significant at the end of the nursery at Wk 5, was an advantage of about 500 grams. The BW difference between the two treatment groups continued to grow with each biweekly weighing, becoming significant ($P < 0.04$) again by the end of the study at which time the difference between treatments was about 3.0 kg. The current nursery growth performance response agrees with previous work[2] which reported that pigs administered a second iron injection one week prior to a weaning at 28 days had an increase in daily BW gain (380 g vs. 362 g) through the following three weeks in the nursery as well as a report[12] that observed an increase in nursery ADG of 28 grams (526 vs. 498 g/d; $P = 0.033$) when a second injection was given 4 days before weaning at d 18-24. The continuation of the pigs used herein through the finishing stage allowed a broader assessment of the impact of that improved nursery growth. The selection of one pig/pen for slaughter and carcass measures resulted in a smaller treatment difference (that would be an artifact of the selection process) being only about 50% of the BW difference of the total group of pigs for which growth performance was measured. In general, the +Fe pigs had numerically greater carcass weight and primal cuts that were reflective of the slaughter weight improvement. However, there was a significant increase in loin weight ($P < 0.04$) that was probably the result of the slight increase in BW coupled with the numerical increase in carcass length. In conclusion, administering an additional iron injection resulted in greater Hb at weaning and the end of the nursery as well as improved growth performance from weaning to slaughter weight and improved carcass measures commensurate with that increased body weight.

References

1. Venn, J., R. McCance, and E. Widdowson. 1947. Iron metabolism in piglet anaemia. *J. Comp. Pathol. Ther.* 57: 314-325. **doi :https://doi.org/10.1016/S0368-1742(47)80037-2**

2. Kamphues, J. K. Männer, and C. Netzer. 1992. Effects of a 2nd iron injection in suckling pigs on iron retention and performance before and after weaning. *Proc. 12th IPVS Congress*. 601.

3. Van Gorp, S., H. Segers, and C. Von der Recke. 2012. Preventing iron deficiency by avoiding an iron gap in modern pig production. *Proc. Am. Assoc. Swine.Vet.* 43: 407-408.

4. Bhattarai, S., J. P. Nielsen. 2015. Early indicators of iron deficiency in large piglets at weaning. *J. Swine Health Prod.* 23: 10–17.

5. Perri, A. M., R. M. Friendship, J. C. Harding, and T. L. O'Sullivan. 2016. An investigation of iron deficiency and anemia in piglets and the effect of iron status at weaning on post-weaning performance. *J. Swine Health Prod.* 24:10-20.

6. Jolliff, J., and D. Mahan. 2011. Effect of injected and dietary iron in young pigs on blood hematology and postnatal pig growth performance. *J. Anim. Sci.* 89:4068-4080.

7. Chevalier, T. B., H. J. Monegue, M. D. Lindemann. 2021. Effects of iron injection dosage to newborn piglets on hematological measures, growth performance pre and postweaning, and postweaning tissue mineral content. *J. Swine Health Prod.* 29: 189-199.

8. Thorn, C. E., 2010. Hematology of the pig, In: Weiss, D. J., and J. K. Wardrop, 6th ed. Shalm's Veterinary Hematology, Wiley-Blackwell., Ames, IA, p. 843-851.

9. Bhattarai, S., and J. P. Nielsen. 2015b. Association between hematological status at weaning and weight gain post-weaning in piglets. *Livestock Sci.* 182:64-68. **doi: https://doi.org/10.1016/j.livsci.2015.10.017**

10. Fredericks, L., C. Olsen, A. Maschhoff, and C. Shull. 2018. Evaluation of the impact of iron dosage on post-weaning weight gain, and mortality. *Proc. Am. Assoc. Swine. Vet.* 49: 315.

11. Olsen, C. 2019. The economics of iron deficiency anemia on US swine production: An annual impact of 46-335 million US dollars. *Proc. Am. Assoc. Swine. Vet.* 50: 351-352.

12. Chevalier, T. B., and M. D. Lindemann. 2019. Effects of an additional iron injection administered to piglets before weaning. *J. Anim. Sci.* 97 (Suppl. 3):227. **doi.org/10.1093/jas/skz258.462**