Optimizing iron status of weaned pigs through supplementation

SOW'S milk is a rich source of nutrients that allows piglets to grow at an exceptional rate, leading to a weaned pig at 21 days of age that is as much as five times its birth weight.

However, iron is a limiting nutrient in sow's milk for the suckling pig without sufficient exposure to external sources such as soil, feces, feed or an iron supplement. Therefore, a common iron supplementation protocol is to administer a 200 mg iron injection from iron dextran one to four days after farrowing.

Depending upon birthweight of individual pigs, this dosage would range from 220 mg/kg of bodyweight for a 2 lb. pig to 118 mg/kg of bodyweight for a 3.75 lb. pig.

Even though the need for iron supplementation in neonatal pigs has been studied for several decades, reports still occur of pigs with poor iron status during the postweaning period, and the debate continues over the best practices to prevent iron deficiency anemia during this stage of the pig's life.

Interestingly, research on the topic has demonstrated that the largest pigs at weaning are generally at the highest risk for anemia (Jolliff and Mahan, 2011). This can be explained by the rapid growth and expanding blood volume of these bigger pigs, creating an iron dilution effect, along with the reality that they received a lower dose relative to their bodyweight at birth.

In a survey of 20 swine farms in Canada, Perri et al. (2016) reported that 6% of pigs at weaning and 18% of pigs sampled three weeks postweaning had hemoglobin levels below 9 g/dL, which is often considered the arbitrary threshold for anemia determination. Within individual farms, the incidence of anemia three weeks postweaning was as high as 32% in this survey.

The authors concluded that the typical industry dose of 200 mg of iron at birth is insufficient for optimizing the iron status of all pigs in a commercial environment and pointed out that the use of pharmacological zinc and copper levels in nursery diets likely contributed to the iron deficiency. While the authors discussed the lack of clarity around defining a hemoglobin level as the threshold for anemia, their assumed value of 9 g/dL did correspond to pigs that were 1.8 lb. lighter three weeks postweaning versus pigs with what they considered normal hemoglobin levels.

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Bottom Line

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Little benefit has been reported for increasing the iron injection dosage above 200 mg at processing (Joliff and Mahan, 2011; Murphy et al., 1997).

To the contrary, Starzynski et al. (2013) demonstrated that large doses of injected iron elevated levels of the peptide hormone Hepcidin-25 (Figure), which down-regulates intestinal absorption and re-utilization of iron. Furthermore, high doses of injectable iron created oxidative stress and injection-site swelling and can cause death in iron-sensitive pigs.

Starzynski et al. suggested that an approach to optimize iron physiology in the neonatal pig would likely combine a low-dose parenteral bolus of iron on days 2-4 of life, such as a 50 mg injection of iron dextran, with a means of oral iron supplementation starting at days 7-10.

It has been reported that the mechanisms for intestinal iron absorption that include the two intestinal iron transporters DMT1 and ferroportin are strongly expressed at their known site of activity in enterocytes beginning as early as day 4 of life (Starzynski et al., 2013).

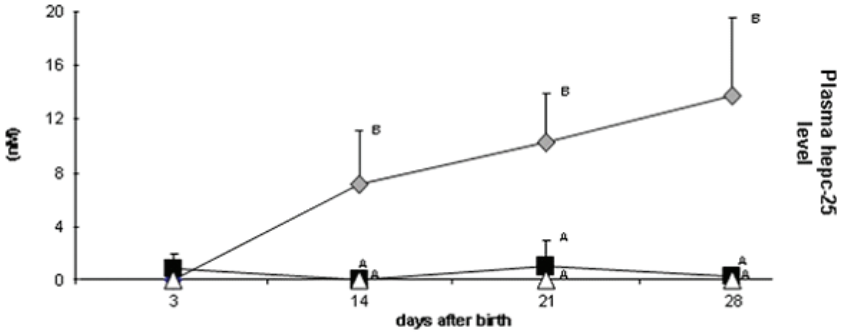
The ability to absorb iron at an early age in the absence of a high-dose iron injection seems to be supported by Kegley et al. (2002), whose research demonstrated effective absorption of ferrous sulfate and iron-methionine when pigs were given a single oral bolus of 200 mg of iron three days post-farrowing. Iron-methionine was calculated to have bioavailability of 180% of ferrous sulfate in this situation. However, neither source given as a single bolus was sufficient to maintain iron levels to weaning, which

Effects of dietary iron concentration postweaning on growth, diarrhea occurrence and hematological indices

	-Dietary iron supplement, mg/kg-				Std. error	-----P value-----	
	0	50	100	250	of means	Linear	Quadratic
Days 0-28							
ADG, g	214	211	216	197	2.70	0.04	0.13
Avg. daily feed intake, g	373	353	373	357	6.58	0.68	0.98
Gain:feed, g/kg	578	598	578	553	8.78	0.24	0.22
Diarrhea, %*	8.30	13.90	27.80	41.70	3.58	<0.001	0.18
Day 28 hemoglobin, g/dL	9.10	10.20	10.20	11.10	0.28	0.02	0.84
Day 28 hematocrit, %	30.50	33.90	33.70	35.00	0.84	0.09	0.52

*Diarrhea defined as liquid feces and reported as percentage of pigs within a pen.
Adapted from Lee et al. (2008).

Plasma Hepcidin-25 levels in response to iron injection protocols



Piglets were supplemented with:
◇ 150 and 40 mg Fe/kg b.w. on days 3 and 21, respectively
■ 37.5 mg Fe/kg b.w. on days 3 and 14
△ 37.5 mg Fe/kg b.w. on day 3

Source: Adapted from Starzynski et al., 2008.

suggests a need for further oral supplementation later in the lactation period.

It is important to understand that iron protocols in the suckling period directly affect not only the pig's iron status at weaning but also its ability to absorb dietary iron postweaning. The combined impact of iron management from birth through the nursery period dictates iron status and performance.

Data from Virginia Tech presented at the 2018 Midwest Animal Science Meetings suggested that pigs injected with 100 mg of iron at birth and fed starter diets with pharmacological levels of copper responded with higher average daily gain (ADG) in the nursery when given a second 100 mg injection of iron at weaning versus pigs that did not receive the second 100 mg iron injection (Estienne et al., 2018).

It's unclear if this effect would be the same if pigs had received 200 mg of iron at birth but highlights the complexity of overall iron management through the weaning period and the potential interactions with other trace minerals.

Iron is generally supplemented in starter diets in the form of ferrous sulfate. Research evaluating other sources of iron have not demonstrated superior availability postweaning (Lewis et al., 1996; Williams et al., 2018). The dietary concentration of iron to which weanling pigs will respond is highly dependent upon their iron status.

Research evaluating dietary iron levels with pigs that were not supplemented with iron in the suckling period overestimated the dietary needs from a practical perspective. Lee et al. (2008) demonstrated that feeding excessive dietary iron shifts the intestinal microflora unfavorably and increases the incidence of diarrhea as pathogenic *Escherichia coli* may utilize the iron for proliferation (Table).

Suggested dietary iron levels in starter diets are in the range of 100-180 parts per million (National Swine Nutrition Guide, 2010).

The Bottom Line

The typical iron management protocol for young pigs that consists of a single 200 mg iron injection post-farrowing with 100-150 ppm of dietary iron from highly available sources in the nursery may be sufficient, in most instances, to maintain the iron status of weaned pigs. The consideration of a second injection at weaning should likely be constrained to a low dose if used to limit oxidative stress and prevent down-regulation of dietary iron absorption postweaning.

Recent data on using a lower injection dose near birth to minimize hepcidin levels, coupled with providing a highly bioavailable oral iron source mid-lactation or a second injection, seem to show promise for optimizing iron status while minimizing any negative effects of iron supplementation. However, these types of iron management protocols require validation under commercial conditions and may be more laborious to implement.

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