OPPORTUNITY TO IMPROVE IRON STATUS

IN NEWLY WEANED PIGLETS FOR IMPROVED PRODUCTION EFFICIENCY

Anaemia is still present in newly weaned piglets and can lead to reduced weight gain. This article discusses factors limiting bioavailability of iron in feed, and strategies to improve iron status in piglets.

The introduction of hyper-prolific sows has led to an increased number of weaned piglets per sow, leading to greater stress placed on newly weaned piglets. Bigger litter sizes are often reflected in lower average weaning weights, and so focusing on ways of improving post-weaning growth is very important. Pig production systems are hence becoming more interested in the iron status of piglets due to performance impact and sudden death. More than 60% of the body's iron is present in the form of haemoglobin in circulating red blood cells.Insufficient supplementation or absorption of iron causes iron-deficiency anaemia, characterised by insufficient red blood cells and haemoglobin, loss of appetite, lethargy, increased respiration rate, poor growth and mortality.

It is established that there are very low levels of iron in sows' milk and confined pigs (i.e., without access to soil, which contains relatively high levels of iron) are susceptible to anaemia if they are not administered an iron injection (200 mg) early in life. It is therefore a common practice in indoor production units to inject the newly weaned pig in the first few days post-farrow to avoid iron deficiency. This is critical as piglets are usually born with approximately 50 mg of iron and, with the requirement of 8-16 mg iron daily in fast-growing piglets, this would be depleted in 3-5 days.

Interestingly, data from the US and Denmark show that even with an iron injection, modern pigs from high milk producing sows may still become borderline anaemic by weaning, and this may be associated with the fastest growing piglets. This is highlighted further by a recent Canadian study (Perri et al 2015) that looked at the iron status of more than a 1000 weaned piglets from 20 commercial farms. Small, medium and heavy piglets were selected 1-2 days before weaning from all litters. Serum and whole blood samples were collected, and body weights recorded, and then repeated for the same pigs 21 days later. Haemoglobin, haematocrit and other blood parameters were measured, and iron and zinc oxide protocols for the farm are recorded. The haemoglobin results showed that, while all piglets received a 200 mg iron injection, among the pre-weaned pigs were 6.4% anaemic (< 9 g/dl), 28.4% deficient (9 – 11 g/dl) and 65.2% normal (> 11 g/dl), showing that at least 35% of piglets weaned were iron deficient. Despite pigs given iron-supplemented feed, iron deficiency further increased to 60% post-weaning, and this was exacerbated by higher zinc oxide in the diet.

Furthermore, piglets that were anaemic at weaning were 0.83 kg lighter 21 days post-weaning. The research demonstrates that, even with iron injection, piglets are still susceptible to anaemia and poor post-weaning growth. Although seen as mitigating anaemia, iron injections may also have some negative effects associated with higher oxidative stress on the animal. Indeed, studies have indicated that the requirement for biological antioxidants increases in piglets administered an iron injection.

Even with current practices, anaemia in pigs at and post-weaning is widespread and can have a deleterious effect on post-weaning growth. Hence, any new post-weaning feed applications that can mitigate iron deficiency should be explored.

Factors reducing iron bioavailability

Minerals

Nutritionists need to know the antagonistic effect of high levels of other minerals against iron absorption. Minerals that can reduce iron bioavailability are divalent minerals, such as Ca, P, Zn, Cu and Mn, which share the small intestinal divalent metal transporter. In pig diets, other minerals are used sparingly due to toxicity or environmental legislation issues, so may have limited impact. However, using zinc to control post-weaning diarrhea in piglets is common, with levels typically up to 2500-3000 ppm, depending on the market, and this can impact iron bioavailability as highlighted in the Canadian study. In this study, zinc oxide in the post-weaning diet increased anaemia occurrences by three to four-fold compared to pigs fed less than 500 ppm zinc oxide. This highlights the importance of recognising antagonistic relationships between minerals when formulating diets for weaner pigs.

Phytate

Another dietary factor that affects iron bioavailability is phytate, a strong chelator of divalent metal ions. Traditionally, piglet diets were made up of highly digestible animal proteins such as plasma, poultry, fish and blood meals containing significant levels of high bioavailability haem iron. However, with a focus on lower cost diets, more expensive animal proteins used in starter feeds are replaced by higher use of vegetable proteins such as soybean meal, corn distillers grains, soy protein concentrates and yeast products, which are low in iron and higher in phytate content. This results in both lower levels and poor bioavailability of dietary iron. Another challenge is the increased dietary phytate associated with the increased use of vegetable protein sources resulting in an increased phytate:iron ratio in diets of commercial weaner pigs. Hurrell (2003) reported that decreasing phytate:iron ratio by decreasing phytate levels in bread exponentially increased iron absorption in humans. Using this human model, in a typical commercial piglet diet with 0.8-1.0% phytate, potentially only 20-30% of the iron consumed by the piglet post-weaning is absorbed. With marginal iron status on commercial farms, this trend towards higher vegetable proteins and phytate levels in starter feeds may contribute to higher incidence of anaemia seen on farms.

Phytase

Traditionally, 500 FTU/kg phytase has not been used in starter feeds (wean to 21d) for phosphorus release due to lower levels of dietary phytate associated with animal protein-based feeds. However, with dietary phytate recognised as an anti-nutrient, the use of high doses of phytase in starter feeds to target >80% phytate destruction has improved post-weaning performance. Supplementation of 1500 – 2500 FTU/kg phytase aims to achieve near complete breakdown of phytate (IP_6) and the lower isomers (IP_5 – IP_2). Even in small amounts, phytate and its lower isomers can reduce the bioavailability of protein and divalent metal ions. This has particular relevance to iron, with trial results at 21 days post-weaning showing that reduced phytate content in piglet ileal digesta was associated with increased haemoglobin levels (Mansbridge et al., 2016, Fig 1a). Furthermore, a weaner pig study demonstrated that increasing doses of modified *E. coli* phytase (Quantum Blue) linearly increased iron status measured as the proportion of haematocrit, indicating increased proportion of red blood cells in the blood(Laird et al., 2017, Figure 1b).

Data show that even with an iron injection, pigs from high milk producing sows may still become borderline anaemic by weaning.

This improved iron status, as measured by haemagloblin and haematocrit, was also reflected in an improved level of pig performance. Laird (Fig 2) showed that increasing haematocrit status of the piglets was reflected in an improved growth and FCR. The highest performance at 21 days post-weaning was observed in pigs fed diets containing high iron (320 ppm) and high phytase (2500 FTU/kg Quantum Blue).

There is increased focus on improving iron status of piglets, with the target of reducing aneamia and improving post-weaning performance, particularly in production systems with hyper-prolific sows. One application that may be beneficial in improving iron status of the weaned piglet is the use of higher levels of phytase to unlock the dietary iron potential bound by phytate.

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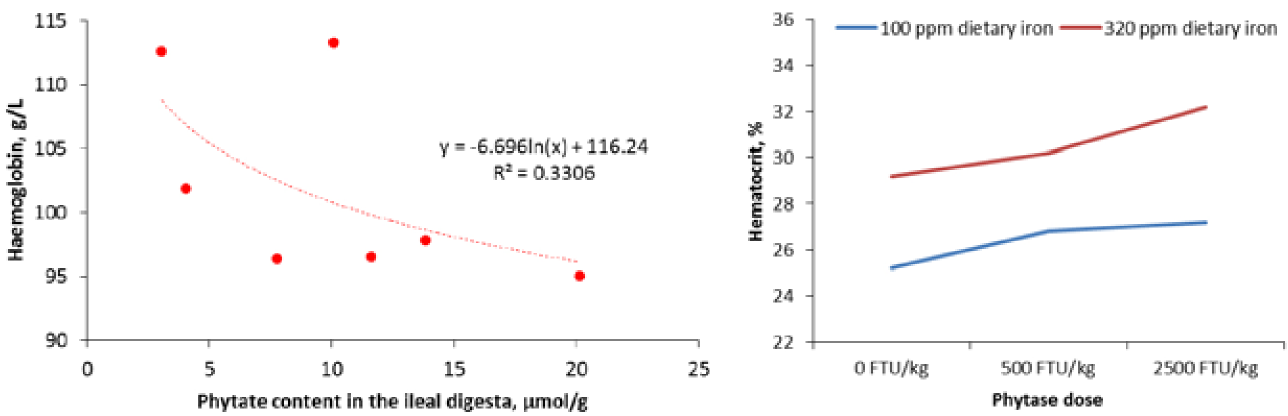

Figure 1. A) Relationship between phytate content in the ileal digesta and haemoglobin levels in pigs at 21 day post-weaning (adapted from Mansbridge et al; 2016), and B) Effect of dietary iron and phytase dose on iron status of piglets at 21 day post-weaning (measured as proportion of haematocrit) (Iron P<0.05, Phytase P<0.05, Iron x phytase interaction P<0.05. Laird et al., 2017).

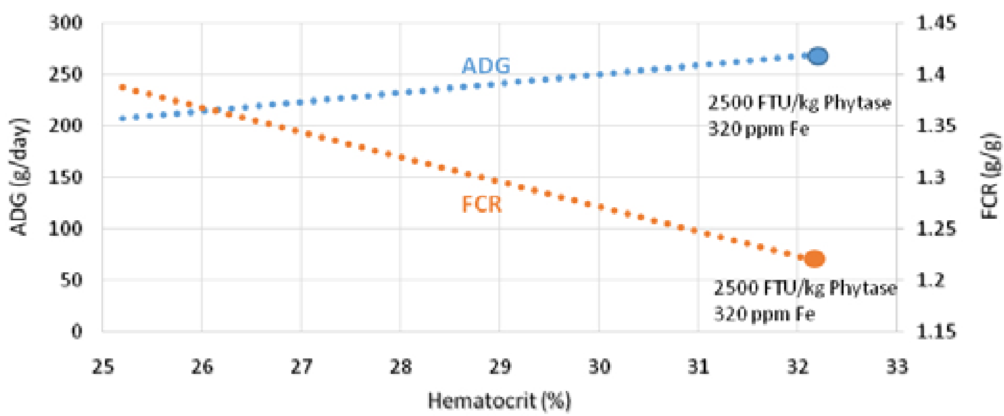

Fig 2. The effect of heamatocrit level on ADG and FCR at 21 d

Ref: Laird et al 2017