Do piglets need iron supplementation in organic farms?

Elodie Merlot, Maud Pauwels, Gwendoline Hervé, Vincent MÜller, Catherine Belloc, Armelle Prunier

Do piglets need iron supplementation in organic farms?

Elodie Merlot[1], Maud Pauwels[1,2], Gwendoline Hervé[3], Vincent Muller[3], Catherine Belloc[2], A Prunier[1]

[1]INRAE, Agrocampus Ouest, PEGASE, 35590, Saint-Gilles, France

[2]INRA, Oniris, BioEpAR,, 44307, Nantes, France

[3]Selas Epidalis, 35500, Vitré, France

Keywords: piglet, iron status, indoor, outdoor

Abstract

The neonatal pig is prone to iron deficiency, which can lead to growth retardation, cognitive and immune deficits. This study aimed at describing the iron status of piglets at weaning in French indoor and outdoor farms.

It was carried out in 11 outdoor and 10 indoor organic farms located in the West of France. In each farm, approximately 30 piglets (half males and females) from 4 to 7 litters were blood sampled. In total, 606 piglets of 42 ± 3 days of age, weighing 12.0 ± 3.0 kg live weight were bled at 1.1 ± 1.7 days from weaning (mean ± SD).

Iron injections were used in most indoor farms (400 mg: 1 farm, 200 mg: 8 farms, 100 mg: 1 farm, no supplementation: 1 farm), while in outdoor systems, primarily no supplementation was performed (200 mg: 1 farm, no supplementation: 10 farms). In comparison with the indoor where 200 mg of iron was injected, the outdoor non-supplemented piglets had a greater blood haemoglobin concentration (118 vs 105 ± 3 g/L, P < 0.001) and a higher red blood cell volume (60 vs. 54 ± 1 fl, P < 0.01), indicating a better iron status. In the only indoor farm that did not use iron supplementation, these two variables were low (81 ± 3 g/L and 48 ± 1 fl, respectively), showing an iron deficiency.

To conclude, outdoor piglets find a sufficient amount of iron in their natural environment to fulfil their needs, probably by foraging and ingesting soil. Indoors, iron supplementation is necessary, but a single intramuscular iron injection, besides its controversial acceptability in organic farming, might be suboptimal to prevent anaemia in piglets. Thus, there is a need for finding alternative oral solutions to iron injection, ensuring a sufficient, natural and progressive iron intake to newborn piglets.

Introduction

Piglets have low iron stores at birth and sow milk is naturally poor in iron, while piglet requirements are high due to rapid growth (Lipinski et al. 2010). Thus, piglets may develop iron deficiency anaemia during lactation, which in turn can lead to growth retardation, cognitive and immune deficits. In organic farming, unlike conventional farming, iron administration in injectable form is not systematic. According to current knowledge, iron supplementation seems essential for piglets raised indoors, but outdoors, soil ingestion might be sufficient to avoid deficiency. However, few data are available.

Infections and proinflammatory states can also generate iron-deficiency anaemia. This adaptive response against microbial development relies on the sequestration of iron in macrophages and intestinal cells under the action of hepcidine. Again, piglet health and inflammatory status in organic pig farming have been the subject of very few publications.

Thus, the objective of this study was to compare haematological parameters, inflammatory status, and oxidative stress in piglets raised indoors and outdoors and according to the dose of iron administered.

Material and methods

Organic farrow-to-finish farms (11 outdoors, 10 indoors) located in the west of France were selected among the voluntarily farmers. The visit occurred the day of weaning (11 farms), one to six days before (nine farms), or the day after (one farm). On each farm, 18 to 30 piglets of both sexes from 4 to 7 litters (sows of different parities) were weighed and blood sampled. In total, 606 piglets were assessed.

The Procyte Dx Idexx automated system was used to measure haemoglobin (Hb) concentration, haematocrit, red blood cell and reticulocyte counts, mean blood cell volume and mean corpuscular Hb. Blood iron content and indicators of health were also measured: haptoglobin (Hp) concentration to assess inflammatory status, dROM (hydroperoxides) and blood antioxidant capacity (BAP) for oxidative stress.

Statistical analyses (type 3 mixed ANOVAs) were performed using the lmer test package from the R software (version 3.5.3). Housing type and sex were included as fixed factors, body weight as a covariate and farm as a random factor. A square root transformation was performed for Hp and iron to normalize the data. For age at sampling, a t-test was performed. All results are expressed as adjusted means ± SE.

Results

The practice of iron supplementation varied between farms (Table 1). Indoors, piglets received no supplementation on one farm (In-No), one injection of 100 mg iron on one farm (In-100), one injection of 200 mg iron on seven farms (In-200) or two injections of 200 mg iron on one farm (In-400). Outdoors, animals did not receive iron supplementation in 10 out of 11 farms (Out-No) and received one injection of 200 mg iron in the last one (Out-200). Only the Out-No and In-200 conditions could be statistically compared because, for others, the condition and the farm effect were confounded.

Live weight of In-200 and Out-No piglets at blood sampling was similar (P > 0.1, Table 2). Age at sampling was slightly lower in In-200 and Out-No conditions, but the difference was not significant (40.9 ± 0.8 vs. 43.7 ± 1.0 days of age, P = 0.07).

Table 1: Number of farms and animals per group

Condition	Rearing	Iron supply[1]	Nb farms	Nb pigs
In-No	Indoors	0 (0)	1	30
In-100	Indoors	100 (1)	1	30
In-400	Indoors	400 (2)	1	30
Out-200	Outdoors	200 (1)	1	30
In-200	Indoors	200 (1)	7	206
Out-No	Outdoors	0 (0)	10	280

[1]the first number indicates the dose of iron in mg/pig and the number in brackets the number of injections/pig

Table 2: Bodyweight, blood antioxidant potential (BAP), hydroperoxides (dROM) and haptoglobin (Hp) plasma concentrations.

Condit-ion	Weight (kg)	BAP (µM Eq Vit. C)	dROM (mg Eq H2O2/dL)	Haptoglobin (g/L)
In-No	11.1 ± 0.6	2607± 31	771 ± 44	1.35 ± 0.26
In-100	12.5 ± 0.4	2661 ± 39	833 ± 26	1.45 ± 0.22
In-400	10.2 ± 0.6	2390 ± 34	1009 ± 45	1.13 ± 0.16
Out-200	11.2 ± 0.6	2676 ± 33	824 ± 30	0.45 ± 0.05
In-200	11.4 ± 0.9	2476 ± 68	798 ± 40	0.89 ± 0.11^{A}
Out-No	12.7 ± 0.6	2454 ± 45	812 ± 27	$0.52 \pm 0.0.6^{B}$

^{A,B}: different superscripts indicate a significant difference between In-200 and Out-No conditions.

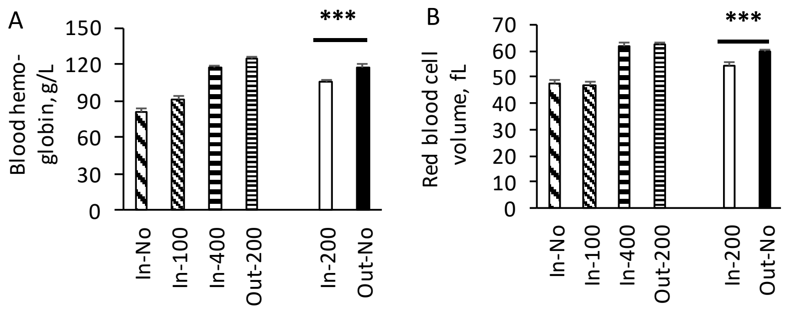

Figure 1. Plasma haemoglobin concentration (A) and red blood cell volume (B).

*** indicates significant differences between In-200 and Out-No treatments with a P-value < 0.001.

The mean Hb concentration ranged from 81 ± 18 g/L (In-No farm) to 125 ± 9 g/L (out-200 farm, Figure1). It was significantly higher in Out-No than in In-200 animals ($p<0.001$). The red blood cell volume ($P<0.001$), the haematocrit ($P<0.001$), the mean cell volume ($P<0.001$), and the mean corpuscular haemoglobin content ($P<0.001$) were also significantly higher in the Out-No compared to the In-200 animals. Hb concentration and the haematocrit were greater in females (Hb: 113.0 ± 1.6 vs. 110 1.6 g/L, $P<0.01$, haematocrit: 40.2 ± 0.2 vs 39.3 ± 0.6, $P < 0.05$).

Plasma iron was lower in In-200 pigs than in Out-No pigs (14.0 ± 2.2 vs 21.5 ± 1.8 µmol/L, $P < 0.05$) and in males than in females (16.2 ± 1.3 vs 19.0 ± 1.6 µmol/L, $P < 0.01$). The haptoglobin concentration was higher in piglets kept indoors than outdoors ($p<0.01$). The BAP and dROM concentrations were not influenced by the farming system (Table 2) or the sex of the piglets.

Discussion

Present data show that iron supplementation is not necessary to prevent anaemia in piglets raised outdoors in agreement with previous studies carried out in 3-4-weeks-old piglets (Kleinbeck and McGlone 1999; Brown et al. 1996). Our results demonstrate that this is still true in 6-week old piglets, even though they depend less on milk for feeding. Outdoor piglets can ingest iron from the soil present in their environment. This is sufficient in most outdoor farms as in the present study, but it may not be in locations where soil bioavailability in iron is very low (Brown et al. 1996; Szabo and Bilkey 2002). Indoors, a minimal dose of 200 mg iron was necessary to achieve a sufficient haemoglobin level, as previously shown (Svoboda et al., 2018). The better status obtained outdoors shows that this might not be the optimal supplementation method.

The inflammatory status was higher indoors, possibly linked to a heavier microbial load than outdoors, as previously suggested by Kleinbeck and McGlone (1996).

Conclusion and suggestions for research

This study revealed that outdoor piglets usually find a sufficient amount of iron in their natural environment. Indoors, iron supplementation is necessary, but a single intramuscular iron injection might be suboptimal to prevent anaemia. Thus, there is a need for finding oral alternatives to iron injection to ensure a sufficient, natural and progressive iron intake to newborn piglets and in line with organic principles.

This work was carried out with financial support from the INRAE in support of an Era-Net CORE Organic Cofund project (Power project: https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/power/).

References

Brown JME, Edwards SA, Smith WJ, Thompson E, Duncan J (1996). Welfare and production implications of teeth clipping and iron injection of piglets in outdoor systems in Scotland. Preventive Veterinary Medicine 27, 95-105.

Kleinbeck SN, McGlone JJ (1999). Intensive indoor versus outdoor swine production systems: genotype and supplemental iron effects on blood haemoglobin and selected immune measures in young pigs. Journal of Animal Science 77, 2384-2390.

Lipinski P, Starzyński RR, Canonne-Hergaux F, Tudek B, Oliński R, Kowalczyk P, Dziaman T, Thibaudeau O, Gralak MA, Smuda E, Woliński J, Usińska A, Zabielski R (2010). Benefits and risks of iron supplementation in anemic neonatal pigs. American Jornal of Pathology 177, 1233-43.

Svoboda M, Pist'kova K (2018). Oral iron administration in suckling piglets - a review. Acta Veterinaria Brno 87, 77-83.

Szabo P and Bilkey G (2002). Short communication - Iron deficiency in outdoor pig production. Journal of Veterinary Medicine Series A 49, 390-91.