Iron for piglets
- How do we avoid anaemia? And overdose?!

Tim H. Hansen, R&D
Biofiber-Damino

What is FerkoFer®?
- A practical, oral iron supplement in the form of a dry powder
- Provides sufficient supply of iron
- Contains microencapsulated absorbable iron
- Patented product (EP 0641236 and EP 1083800)
Administration of FerkoFer

FerkoFer is given 3 times during the period from 2-4 days after farrowing until the piglets are 8-12 days old. Each time, 1 measuring cup (approx. 40 g) is given per litter of 12 piglets. Thus, after the 3 administrations, each piglet in the litter has received approx. 10 g of FerkoFer. In this way, it is achieved that iron is available to the piglet throughout period.

Application in practice

Farrowings usually take place at the end of the week. Monday after the farrowing, the administration of FerkoFer begins. It continues as shown in the illustration. A total of 10 g of FerkoFer is administered per piglet, equivalent to 120 g per litter (12 piglets).
Distribution of FerkoFer

FerkoFer is distributed in a clean dry place on the floor, between the sow and the resting place of the piglets, but out of reach of the sow and not too close to the slats.

The theoretical requirement

The total iron requirement ("consumption") of the piglet during the 3 first weeks after birth is app. 230 mg.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total iron requirement</td>
<td>app. 230 mg</td>
</tr>
<tr>
<td>Iron reserve at birth</td>
<td>app. 50 mg</td>
</tr>
<tr>
<td>Supply from the sow's milk</td>
<td>app. 25 mg</td>
</tr>
<tr>
<td>Required iron supplement</td>
<td>app. 155 mg</td>
</tr>
</tbody>
</table>
The hemoglobin concentration in 13-27 days old piglets, which have been given oral iron powder from Biofiber-Damino (brown curve) or injection iron (blue curve). Both curves are based on measurements of more than 7000 piglets.
### Trial in Belgium 2010

<table>
<thead>
<tr>
<th></th>
<th>FerkoFer</th>
<th>Injection</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 25 Hb.konc, (g/l)</td>
<td>75,9</td>
<td>78,1</td>
<td>0,25</td>
</tr>
<tr>
<td>Day 25 Hb.konc, (n=240)</td>
<td>109,6</td>
<td>101,1</td>
<td>&lt;0,01*</td>
</tr>
<tr>
<td>Time spent/litter (sec.)</td>
<td>27,3</td>
<td>56,9</td>
<td>&lt;0,01*</td>
</tr>
<tr>
<td>Mortality day 3-25, (%)</td>
<td>11.4</td>
<td>12.2</td>
<td>0,78</td>
</tr>
<tr>
<td>Daily weight gain (g/day)</td>
<td>253,9</td>
<td>248,8</td>
<td>0,17</td>
</tr>
</tbody>
</table>


### Another French trial...

<table>
<thead>
<tr>
<th></th>
<th>FerkoFer (n=58)</th>
<th>Injection (n=51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin, (g/l), day 19</td>
<td>112,9</td>
<td>113,0</td>
</tr>
<tr>
<td>Daily w. gain, day 1-19 (g)</td>
<td>241</td>
<td>221</td>
</tr>
</tbody>
</table>
Haemoglobin concentration vs. weaning weight

- Oral iron powder (n=58)
- Injection (n=51)

Hepcidin: Key regulator of iron absorption in the gut

The liver excretes hepcidin (D) when body iron levels are sufficient. Ferroportin (B) – the iron transporter in the intestinal cell – is inhibited by hepcidin.

FerkoFer compared to 1x and 2x injection

A German study on different iron supplementation methods (n=64-69 in each group). 1x inj. significant lower on day 21 and 28.
Reference ranges

Hemoglobin:

90–130 g/l in adult pigs

Hb concentration in free range piglets

No iron supplementation
Haemoglobin in pigs

\[ \alpha \beta \ \beta \alpha \]

\[ \alpha \beta \ \beta \alpha \]

Fetal hemoglobin
Adult hemoglobin

+ 2,3-Bisphosphoglycerate (DPG)

Changes in haematology

![Graph showing changes in haematology over age in days]

*Fig. 2. Postnatal changes of pig red cell DPG and ATP concentrations. Symbols as in Fig. 1. Adult values (±1 SD) are mean values from 8 determinations.*
Swedish trial (Holmgren, 1996). The trial was carried out in 3 herds, where it was examined how many piglets were affected by polyarthritis, after they had received an iron injection (iron dextran) on the 1st or the 5th day of life, respectively, or no iron injection. (n=1737)
Trials from Schweden on piglet iron and polyarthritis. More piglets suffered from polyarthritis when iron dextran was injected compared to voluntary oral iron.

Results are confirming Holmgren, 1996.

Lipinski et al. (2010), Benefits and Risks of Iron Supplementation in Anemic Neonatal Pigs The American Journal of Pathology, Vol. 177, No. 3.
Iron toxicity in the liver

Histological examination of the liver. Big iron dextran deposits – even after one day!


Level of oxidative stress in liver of control and iron supplemented piglets

The Best Iron Administration?

Conclusions

- Absorption of FerkoFer (dietary iron) is regulated in the gut
- Injected iron cannot be regulated
Conclusions

What is an appropriate amount of iron and haemoglobin varies individually – it depends on:

- Health status
- Size
- Age

Bovine colostrum for gut protection

Tim Hesselballe Hansen, R&D, Biofiber-Damino A/S
Colostrum collection and production

Basic principles:

- Big batches – homogeneity
- Only 1st and 2nd milking
- Handle with care – low temperatures
- WHOLE colostrum – only water is removed
Composition of bovine colostrum?

Bioactivity in colostrum:

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Immune development</th>
<th>Anti-inflammatory</th>
<th>Tolerance/turning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunglobulin, SIGA, SIGG, SGAM</td>
<td>Macrophages</td>
<td>Cytokines (IL-10, TGF-β)</td>
<td>Cytokines (IL-10, TGF-β)</td>
</tr>
<tr>
<td>Lactoferrin, lactotransferrin II and HI</td>
<td>Neutrophils</td>
<td>IL-1 receptor antagonists</td>
<td>Anti-idiotypic antibodies</td>
</tr>
<tr>
<td>Lysozyme</td>
<td>Lymphocytes</td>
<td>TNF-α and IL-1 receptors</td>
<td>Anti-oxidants</td>
</tr>
<tr>
<td>Lactoperoxidase</td>
<td>Cytokines</td>
<td>αCD4</td>
<td>Adhesion molecules</td>
</tr>
<tr>
<td>Nucleotides, hydrolyzing antibodies</td>
<td>Growth factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>α-galactosides and p-galactosides</td>
<td>Hormones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apolipoproteins</td>
<td>Milk proteins</td>
<td>Long-chain PUFA</td>
<td></td>
</tr>
<tr>
<td>Cytokines</td>
<td>Long-chain PUFA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth factors</td>
<td>Adhesion molecules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free secretory components</td>
<td>SHBG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligosaccharides and peptides</td>
<td>CRP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatty acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myeloid leukemia and cytokines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vEGF</td>
<td>Complement and complement receptors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EGF/EGFR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGF-β receptor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biliary factor</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Not species specific!
Research projects:
FØSU 2008-2013, NEOMUNE 2013-2018

How to feed a (weak) newborn

A: Feeding interventions:
- When to start oral feeding?
- How much to feed & how?
- Which milk diet to feed?
- Nutrient composition?
- Bioactive nutrients?

B: Gut-related endpoints:
- Structure, digestion, absorption
- Neurons, motility, gut peptides
- Pathology, diarrhea, intolerance

C: Immune-related endpoints:
- Infections, sepsis, vaccination
- Tissue inflammatory mediators
- Gut microbiota colonization

D: Brain-related endpoints:
- Growth, structure, neurotrophic
- Signaling, receptors, inflammation
- Memory, learning, psychomotor
Biofiber-Damino’s role in Neomune

Bovine colostrum for:

Piglet model studies at universities (China, Denmark, Belgium etc.)

Clinical trials, Intensive care units and children’s hospitals (Denmark, Netherlands, China, Australia)

NEC – Necrotizing enterocolitis. Fast progression from non-specific signs to extensive inflam. and necrosis in GIT

ALL – Acute Lymhoblastic Leukemia. GIT toxicity during chemotherapy.
ALL – Acute lymphoblastic leukemia

- Most common form of childhood cancer
- Aggressive treatment - chemotherapy
- GIT toxicity in 40-100 % of patients
- Piglet studies

Effect of bovine colostrum on inflammation during chemotherapy – intestinal mucositis

Peter Erik Lotko Pontoppidan, Institut for Human Ernæring, University of Copenhagen
Effect of BC on piglets during chemotherapy

Fed 165ml/kg/d, d0-11, BUCY d1-6, n=37, Pontoppidan et al., 2015

Colostrum and preterm piglets

- Piglets (92-95 % gestational age) as a model for premature babies
- Immature gut
- Feed intolerance
- High risk of NEC
- Long term effects
Colostrum and preterm piglets

Birth – the biggest transition!

**Experimental design**

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 3</th>
<th>Day 4-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesarean -&gt; TPN</td>
<td>2x formula + colostrum</td>
<td>sacrificed</td>
</tr>
<tr>
<td>formula</td>
<td>2x formula + colostrum powder</td>
<td></td>
</tr>
<tr>
<td>Colostrum</td>
<td>2x formula + past. colostrum powder</td>
<td></td>
</tr>
</tbody>
</table>

N=45, 105-107 days of gestation.
Støy et al. 2012.
Colostrum and preterm piglets

<table>
<thead>
<tr>
<th>Formula (n = 14)</th>
<th>NEC incidence (%)</th>
<th>Mean NEC score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F colostrum (n = 13)</td>
<td>69</td>
<td>2.3</td>
</tr>
<tr>
<td>Colostrum (n = 7)</td>
<td>50</td>
<td>1.6</td>
</tr>
<tr>
<td>2F + pulver colostrum (n = 8)</td>
<td>38</td>
<td>1.6</td>
</tr>
<tr>
<td>2F + past. pulver colostrum (n = 9)</td>
<td>33</td>
<td>1.5</td>
</tr>
</tbody>
</table>

How can research in bovine colostrum be used in pig production?
IUGR-piglets are very common

A litter of 16 piglets
Biofiber-Damino

SparkoDan

- Bovine colostrum
- Bioactivity
- Water based
- Colostrum supplement, not substitute!
- Gut protection

Dosing SparkoDan:
2 pump slugs = ca. 4 ml
pr. gris pr. dosing