Born2Live: Maximizing piglet survival via altered nutrition for hyper-prolific sows

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Agenda

• Farrowing process and stillborn piglets
• Colostrum: Yield-, intake-, how and when is it produced?
• Maximizing milk yield and feed efficiency
What makes prolific sows special?

Genetic selection: Litter size ↑

⇒ Challenges productivity / physiology

1. Farrowing length
2. Colostrum yield
3. Milk yield

Can we improve these traits by improving nutrition of prolific sows?
Trends in stillbirth rate (%) in Denmark

- Stillbirth rate has declined since 2009 (due to new selection index)
- Piglet mortality is still challenging the Danish pig industry

DPRC (1999-2016)
Does sow nutrition play a role for the farrowing process?

Farrowing time < -------> number of stillborn piglets

<table>
<thead>
<tr>
<th>Farrowing time, min</th>
<th>Number of stillborn piglets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=56</td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>n=53</td>
</tr>
<tr>
<td>≥ 3</td>
<td>n=17</td>
</tr>
</tbody>
</table>
Energy uptake from the GI-tract

Starch (~50%)

Uptake from stomach and small intestine
Energy uptake from starch (feed @ 0 h)

Peaks 30 minutes after feeding.
~5-fold higher than before.
PLASMA GLUCOSE AND FARROWING LENGTH

- LOW FIBER DIET
- HIGH FIBER DIET

**Feyera et al. (2018)**

**Time from feeding to farrowing (hours)**
ENERGY STATUS AND FARROWING LENGTH

Time from feeding to farrowing (hours)

Feyera et al. (2018)
Impact of increased fibre supply d 101 of gestation until farrowing on piglet mortality

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Fiber-suppl.</th>
<th>P-val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups (weeks)</td>
<td>32</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Number of sows</td>
<td>298</td>
<td>322</td>
<td></td>
</tr>
<tr>
<td>Total born per litter</td>
<td>18.4</td>
<td>18.1</td>
<td>0.38</td>
</tr>
<tr>
<td>Dead born per litter, %</td>
<td>8.7</td>
<td>6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mortality, birth - weaning, %</td>
<td>14.6</td>
<td>13.7</td>
<td>0.21</td>
</tr>
<tr>
<td>Total mortality, %</td>
<td>22.3</td>
<td>19.9</td>
<td>0.004</td>
</tr>
<tr>
<td>Medication, % of sows</td>
<td>6.4</td>
<td>5.3</td>
<td>0.66</td>
</tr>
</tbody>
</table>

(Feyera et al., 2017)
Energy uptake from the GI-tract

Fibre (8%)

Uptake from caecum and colon
Energy uptake from fibre (feeding @ 0 hours)

- **High fibre diet**
- **Standard diet**

...is constant for 24 hours!

(Serena et al., 2009)
Constipation and farrowing length

(Oliviero et al., 2010)
Farrowing length and protein in sow feed

Protein content in sow feed (%)

Farrowing length (hours)

Dietary fiber

(Tydlitat et al., 2008)
Fibre is a GREAT substrate to ensure high energy status during farrowing (and to avoid constipation)
ENERGY STATUS DURING FARROWING

Time from feeding to farrowing (hours)

Feyera et al. (2018)
ENERGY STATUS DURING FARROWING AND STILLBIRTH RATE (%)
ENERGY STATUS AND BIRTH ASSISTANCE (% BIRTHS ASSISTED)

Birth assistance, %

Time from feeding to farrowing, hours

- ≤ 3 h
- 3 to 6 h
- > 6 h
FARROWING IS LIKE RUNNING A MARATON

ALL PIGLETS NEED TO BE BORN...

.......before plasma glucose become critically low (2 mmol/L)
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- Colostrum: Yield-, intake-, how and when is it produced?
- Maximizing milk yield and feed efficiency
IMPORTANCE OF COLOSTRUM

"Piglets born alive should be kept alive"
Impact of colostrum intake on piglet survival

Quesnel et al., (2012)
Colostrum and survival

What is most important during the first few critical days?

1. High colostrum intake (each piglet)
2. High colostrum yield (increases probability of sufficient intake for all littermates)
3. Colostrum quality (Composition, contents of immunoglobulins and growth factors)
Impact of Litter size on production and intake of colostrum

Colostrum yield, kg/sow

Colostrum intake, g/piglet

Krogh (2017)
Colostrum (g/piglet)

(Data: 60 farrowings from 3 exp)

Low feed intake pre partum

Large litter size (>26)

Low mean birth weight (average < 900 g)
Should fiber in the diets be higher – and when? (Theil et al., 2014)

<table>
<thead>
<tr>
<th>Diet Description</th>
<th>Mating/Parturition</th>
<th>Weight Gain (g/piglet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33% sugar beet pulp</td>
<td>Mating- &gt; d 108</td>
<td>135</td>
</tr>
<tr>
<td>21% pectin residue</td>
<td>Mating- &gt; d 108</td>
<td>131</td>
</tr>
<tr>
<td>46% potato pulp</td>
<td>Mating- &gt; d 108</td>
<td>71</td>
</tr>
<tr>
<td>Standard gest diet (17%)</td>
<td>Mating- &gt; d 108</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Krogh et al., 2015)</td>
</tr>
<tr>
<td>12% sugar beet pulp</td>
<td>d 105 -&gt; parturition</td>
<td>101</td>
</tr>
<tr>
<td>17% alfalfa</td>
<td>d 105 -&gt; parturition</td>
<td>90</td>
</tr>
<tr>
<td>Standard lact diet (15%)</td>
<td>d 105 -&gt; parturition</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Loisel et al., 2013)</td>
</tr>
<tr>
<td>SBP, Sunflow, soy (23%DF)</td>
<td>d 106 -&gt; parturition</td>
<td>76</td>
</tr>
<tr>
<td>Low fiber (13% DF)</td>
<td>d 106 -&gt; parturition</td>
<td>85</td>
</tr>
</tbody>
</table>
When does colostrum production occur?

#DEG = Number of Differentially Expressed Genes

Mammary biopsies collected -14, -10, -6, -2, and +1 DIM

(Palombo et al., 2018)
Experiment with 10 multicatheterised sows

- Aim: to understand ontogeny of colostrogenesis
Blood sampling protocol during the colostrum period

During farrowing, hours after birth of first piglet:

- Whole blood
  - blood gasses

- Plasma
  - Energy metabolites
  - pAH
  - IgG and IGF-I
Net mammary carbon balance during the colostrum period (0-24h) (Carbons for protein in colostrum not included!)

Input and output of mammary carbon was similar 0-24 h

=> Fat and lactose in colostrum is mainly produced after onset of farrowing!

Lack of glucogenic precursors

=> Oxidation of ketogenic substrates

Feyera et al. (2019)
Impact of reproductive stage

Krogh et al. (2017)
Colostrum production – new thoughts...

Why did sows fed high fibre from mating until d 108 produce more colostrum? (Theil et al., 2014)

Why did sows fed high fibre during the last week prior to parturition NOT produce more colostrum? (Krogh et al., 2015)

1. Are mammary glands getting adapted over time to oxidize ketogenic substrates?

2. Is a greater part of fat secreted in colostrum produced prior to parturition when sows are fed high fiber?
Fibres in the diet may increase colostrum production. Mechanism still needs to be clarified.
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<table>
<thead>
<tr>
<th>Sow back fat (mm) at d 109 of gestation</th>
<th>Litter weight gain (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-16</td>
<td>2.10</td>
</tr>
<tr>
<td>17-18</td>
<td>2.20</td>
</tr>
<tr>
<td>19-20</td>
<td>2.30</td>
</tr>
<tr>
<td>21-22</td>
<td>2.40</td>
</tr>
<tr>
<td>23-24</td>
<td>2.50</td>
</tr>
<tr>
<td>25-26</td>
<td>2.60</td>
</tr>
</tbody>
</table>

**Recommended farrowing level in DK when sows**

-10% to -13% (Kim et al., 2015)

**Impact of sow back fat on litter weight gain**
Is mobilization during lactation good or bad?

Maximizing milk production from feed will increase feed efficiency. However, mobilization of energy from mobilized energy for milk production will have an efficiency of 89% (11% lost as heat). Restoring mobilized energy will have an efficiency of 73% (27% lost as heat). Mobilization + restoring = 65% (35% lost as heat).
UTILIZATION OF DIETARY ENERGY

(Pedersen et al., 2019)
Impact of dietary protein (Lysine) on milk yield

Hojgaard et al., 2019

1. parity

≥2. parity

Breakpoint: 12.5%

(Hojgaard et al., 2019)
First limiting AA ALSO determines how much EXCESS dietary AA is being oxidised

First limiting AA in the feed determines how much colostrum or milk protein can be produced

Oxidation of AA (protein) is costly in two ways

⇒ More energy is lost in urine
⇒ More energy is lost as heat

The study by Tydlitat (2008) and Pedersen (2019) may suggest that too much dietary protein contributed to energy depletion during farrowing
Utilization of Dietary Energy in High Yielding Lactating Sows

Recommended level of CP for lactating sows in DK (2019)

Undersupply of CP (or AA) => lower productivity

Oversupply of CP (or AA) => lower feed efficiency
Xylanase – a way to improve feed efficiency

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Xylanase</th>
<th>P-Val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow feed intake (kg/d)</td>
<td>6.6</td>
<td>6.9</td>
<td>**</td>
</tr>
<tr>
<td>Energy digestibility (%)</td>
<td>82.9</td>
<td>83.9</td>
<td>**</td>
</tr>
<tr>
<td>Weight loss (kg/week)</td>
<td>3.4</td>
<td>1.3</td>
<td>*</td>
</tr>
<tr>
<td>Milk Yield (kg/d)</td>
<td>13.3</td>
<td>13.0</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Zhou et al. (2018)
Conclusions

- Sows lack energy during farrowing - more energy and 3 daily meals are needed
- Fiber in feed: constipation ↓ Energy status ↑ stillbirth rate ↓
- Colostrum HIGHLY important for piglet survival
- Lactose and fat in colostrum is mainly produced (>80%) after onset of parturition
- Fiber in feed before parturition may increase colostral fat
- Sugar beet pulp and pectin fibres enhance colostrum yield
- Feed efficiency / lactation performance may be increased by
  1. Controlling back fat (management/long term feeding)
  2. Maximizing milk produced directly from feed
  3. Avoiding under- and oversupply of dietary CP (and AA’s)
  4. Adding xylanase to the feed
Thank you for your attention 😊