Effects of oligosaccharide-based polymer on growth performance, diarrhea, and fecal β-hemolytic coliforms in weanling pigs experimentally infected with a pathogenic *E. coli*

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Outline

Challenges in pig industry

In-feed antibiotics and potential alternatives

Research objective & methods

Results & conclusions
Weaning stress

- Environmental changes
- Abrupt transition of diet
- Transportation stress
- Increased exposure to pathogens
Post weaning diarrhea in pigs

• One of the most serious threats for the swine industry

• Usually associated with proliferation of enterotoxigenic *E. coli* (ETEC)
  ✓ F4 (K88)
  ✓ F18
Post-weaning *E. coli* diarrhea

- Ingestion of *E. coli*
- Attachment of *E. coli* to receptors through fimbriae
- Colonization and release of toxins
- Increase gut permeability (water and electrolytes into intestine)

**Diarrhea**

- Performance
- Mortality
- Productivity

Intestinal epithelial cells

$=E. coli$

$=Toxin$
Post-weaning *E. coli* diarrhea morbidity

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>24%</td>
</tr>
<tr>
<td>2006</td>
<td>31.8%</td>
</tr>
<tr>
<td>2012</td>
<td>32.4%</td>
</tr>
</tbody>
</table>

In-feed antibiotics

- Antimicrobial substances active against bacteria
  - Growth promotion
  - Disease prevention
  - Disease treatment
Efficacy of antibiotics as growth promoters for weaned pigs (7-25 kg)

Daily gain

Control | Antibiotics
---|---
| | 16.4%

Gain:Feed

Control | Antibiotics
---|---
| | 6.9%

Zimmerman, 1986
Antibiotic resistance as a major public health concern

• Banned antibiotics as growth promoter in the E.U and U.S since 2006, and 2017, respectively

• Alternatives to antibiotic are highly demanded

http://inspection.gc.ca
Blood group A antigen oligosaccharides

- High correlation between blood group A antigen and F18 ETEC adherence on the small intestine of young pigs (Coddens et al., 2009; Patent US8703722B2)

- Blood group A antigen might disturb the toxin activity by interfering with ETEC binding to the receptors in the small intestine of pigs (Barra et al., 1992)
The combination of blood group A antigen oligosaccharides and carrier may enhance disease resistance of pigs against F18 *E. coli* infection by inhibiting bacterial attachment.
To investigate dietary supplementation of oligosaccharide-based polymer on growth performance, diarrhea, and fecal β-hemolytic coliforms of weaned pigs experimentally infected with a pathogenic F18 *E. coli*. 
Experimental design & treatments

- Experimental design: RCBD (Blocks: BW x Sex)
- 48 weaning pigs (7.23 ± 1.11 kg BW, 21 d old)
- Treatment: 4 treatments (12 pigs/treatment)

<table>
<thead>
<tr>
<th>Nursery basal diet as control (CON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON + 10 mg/kg of oligosaccharide-based polymer* (LOW)</td>
</tr>
<tr>
<td>CON + 20 mg/kg of oligosaccharide-based polymer* (HIGH)</td>
</tr>
<tr>
<td>CON + 50 mg/kg of antibiotics (Carbadox; AGP)</td>
</tr>
</tbody>
</table>

*Glycoconjugate composed of blood group A antigen oligosaccharides grafted on carrier and was designed and synthesized by Elicityl (France) in cooperation with Dr. Eric Cox (Ghent Univ., Belgium) and provided by Pancosma (Geneva, Switzerland)

E. coli challenged
Pathogenic F18 *E. coli* challenge (LT, STb, Stx2e); oral inoculation, $10^{10}$ cfu/dose with 3 doses

- Growth performance
  - Body weight
  - Average daily gain
  - Average daily feed intake
  - Gain:Feed

- Diarrhea severity
  - Daily diarrhea score
  - Frequency of diarrhea

- All data were analyzed by ANOVA using the PROC MIXED of SAS
Body weight

<table>
<thead>
<tr>
<th>Day</th>
<th>CON</th>
<th>LOW</th>
<th>HIGH</th>
<th>AGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>d -7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d 5 PI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d 11 PI</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

kg
Average daily feed intake

No differences in average daily gain among the treatments throughout the experiment.
Frequency of diarrhea

- Number of pen days with fecal score ≥ 4;

- Comparison of CON, LOW, HIGH, and AGP groups.

- Significance levels indicated by:
  - a
  - b

UC Davis
β-hemolytic coliforms in feces

CON | LOW | HIGH | AGP

%  

a a a  

b a a  

b a ab ab  

b
Conclusions

<table>
<thead>
<tr>
<th></th>
<th>Oligosaccharide-based polymer</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed efficiency</td>
<td>Enhanced</td>
<td>Enhanced</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>Reduced</td>
<td>Reduced</td>
</tr>
<tr>
<td>β-hemolytic coliforms</td>
<td>Relatively high percentage</td>
<td>Relatively low percentage</td>
</tr>
</tbody>
</table>

Oligosaccharide-based polymer and antibiotics may have used different mechanisms to reduce diarrhea in weaned pigs infected with a pathogenic *E. coli*.
Thank you for your attention!