Dietary resistant potato starch alters immunological status and microbial populations in swine to limit *Salmonella*

Crystal L. Loving, PhD  
Research Leader  
Food Safety and Enteric Pathogens Unit  
National Animal Disease Center  
USDA-ARS, Ames, IA  
crystal.loving@usda.gov
What is purpose of alterbiotic administration?

*Alterbiotic – bio-approach to modulate intestinal status

• Promote growth (nutrient uptake)?
• Modulate immune status?
• Enhance intestinal integrity?
• Modulate microbial composition or function?
• Prevent or limit infection/colonization?

• Determining the mode of action of various alterbiotics will allow for targeted applications in production.
Fermentation products can alter immune cellular responses and status

Enhanced growth of beneficial bacteria producing micronutrient end products (e.g., short chain fatty acids):

- Butyrate, etc
Does addition of 5% resistant starch (raw potato starch, RPS) to swine diet modulate:
- Intestinal microbial populations & short-chain fatty acid levels?
- Intestinal immune status?
  - T-regulatory cell populations? IgA-secreting cells?
  - Local defense proteins or cytokines?
Dietary resistant potato starch (RS) increased cecal SCFA levels

• Increased butyrate and lactate in cecal contents of pigs fed RPS (raw potato starch)
Dietary RPS modulated microbial community structure
Microbial communities altered by dietary RS

Genera in bold: harbor species with capacity for respiration
Dietary RPS altered mucosal immune status

Increased cecal expression of genes associated with epithelial integrity

Increased levels of total IgA in feces, but no increase in IgA+ cells in cecum
RPS did not alter abundance of cecal T cells

- No overall difference in #CD3+ T cells between groups
Dietary RPS altered cecal Treg cell frequency

Decreased cytotoxic T cells

Increased CD4+

Increased T regs

No differences in total CD3+ cells – differences in phenotype of T cells present
Dietary RPS as an alterbiotic

*Alterbiotic – bio-approach to modulate intestinal status

- Promote growth (nutrient uptake)?
  ✓ Modulate immune status
  ✓ Enhance intestinal integrity
  ✓ Modulate microbial composition or function

- Prevent or limit infection/colonization?

- Determining the mode of action of various alterbiotics will allow for targeted applications in production.
Dietary RPS as an alterbiotic

*Alterbiotic – bio-approach to modulate intestinal status

- **Promote growth (nutrient uptake)?**
  - ✓ Modulate immune status
  - ✓ Enhance intestinal integrity
  - ✓ Modulate microbial composition or function

- **Prevent or limit infection/colonization?**

- Determining the mode of action of various alterbiotics will allow for targeted applications in production.
Dietary RPS can alter production parameters

<table>
<thead>
<tr>
<th>Diet</th>
<th>ADG, kg</th>
<th>ADFI, kg</th>
<th>G:F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.32(^a)</td>
<td>0.37(^a)</td>
<td>0.88</td>
</tr>
<tr>
<td>CTC</td>
<td>0.43(^b)</td>
<td>0.51(^b)</td>
<td>0.85</td>
</tr>
<tr>
<td>5% inulin</td>
<td>0.37(^{ab})</td>
<td>0.44(^{ab})</td>
<td>0.87</td>
</tr>
<tr>
<td>5% Resistant Starch (RS)</td>
<td>0.40(^b)</td>
<td>0.46(^{ab})</td>
<td>0.87</td>
</tr>
<tr>
<td>0.25% Butyrate</td>
<td>0.36(^{ab})</td>
<td>0.42(^{ab})</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Delta BW, kg

Collaboration with Nicholas Gabler, Iowa State University
Dietary RPS and *Salmonella* shedding

- Nursery pigs fed 5% RPS for 4 weeks
- Oral inoculation with monophasic *Salmonella*
  - Maintained on 5% RPS diet for additional 21 days
  - Fecal shedding overtime
  - SCFA analysis
Dietary RPS reduced *Salmonella* shedding
Proposed MOA – limit low level inflammation

Reduced inflammation
O₂ consumption by epithelial cells = anaerobic environment
Increased gut integrity
Negative correlation between butyrate and *Salmonella* shedding

Increased cecal butyrate even after *Salmonella* challenge
Reduced *Salmonella* shedding with increased butyrate levels

Trachsel et al, unpublished data
Dietary RPS can serve as alterbiotic

- Potential to promote growth
- Potential to modulate microbial communities
  - Modulate immune status
  - Enhance intestinal integrity
- Potential to limit *Salmonella* shedding

- Why potential? – dependent on food web of organisms that utilize RPS as substrate.
- Determining the mode of action of various alterbiotics will allow for targeted use in production.
Thanks to:

Dr. Julian Trachsel
Dr. Heather Allen
Dr. Cassidy Briggs
Dr. Brian Kerr (ARS-NLAE)
Dr. Nicholas Gabler (ISU)
Zahra Bond
Sam Humphrey
Jenn Jones
Elli Whalen
Dr. Shyamesh Kumar
Dr. David Alt
Animal Care Staff

Dr. Julian Trachsel

Dr. Kristen Byrne
Innate Training/immunomodulation
Poster MI11 & IM2

Dr. Shawn Bearson
Dr. Brad Bearson
Poster VA3
DIVA Salmonella vaccine

My peeps