Strategies to Replace Antibiotics for Animal Productivity

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Why Remove Antibiotics

• Increase in the incidence of antibiotic resistant bacteria threatens our health
  – Use of antibiotics in livestock feed
  – Use of antibiotics in consumer products
  – Use of antibiotics in human medicine

• Consumer demand
  – A segment of consumers are demanding food from animals that are not fed antibiotics.
Role of Antibiotics in Animal Production

• Antibiotics
  – Treat an existing infection
  – Prevent a potential infection
Stressors:

- Weaning
- Dietary Transition
- Co-mingling
- Pathogen Exposure
- Social

The immune response begins at local tissue sites with recruitment of inflammatory cells.

Neutrophils and Macrophages

These stimulated cells produce pro-inflammatory cytokines, affecting multiple tissue cells including the brain, the HPA axis, the liver, adipose tissue, muscle and bone.

IL-1
IL-6
TNF-α

Hypothalamic-Pituitary-Adrenal Axis

- ↓Feed Intake
- ↑ACTH
- Adrenals
- ↑Glucocorticoids
- ↑BMR
- ↑Fever

Stimulation of the Acute Phase Protein Response

- ↑AA uptake
- ↑haptoglobin
- ↑C-reactive protein
- ↑glucose
- ↑serum amyloid A
- ↑α - acid glycoprotein

Adipose Tissue

- ↑lipolysis
- ↑adipocytokines
- ↓LPL

Skeletal Muscle

- AA release
- Protein Synthesis
- ↑AA uptake

Bone

- ↑WBC
- ↑Bone resorption
Role of Antibiotics in Animal Production

- **Antibiotics**
  - Treat an existing infection
  - Prevent a potential infection

- **Energy that would be diverted to the immune system is available for productive functions.**
  - Increased growth rate
  - Improved feed efficiency
Alternatives to Antibiotics

• Change husbandry practices to prevent exposure to pathogens.

• Strategic use of vaccinations to improve the animals resistance to infection.

• Non antibiotic feed additives
  – Enzymes
  – Pro- and Pre-biotics
  – Micronutrients, ie, Zn, Cu
  – Functional ingredients:
    • oligo saccharides
    • MCFA / VFA
    • Functional Proteins
Considerations

• Ease of implementation
• Consistency of response
• Cost
Functional Protein: Spray Dried Animal Plasma (SDAP)

- SDAP is produced by separating the cellular fraction from whole blood and subsequent spray drying, retaining functionality of the proteins present in plasma.

- In 2008, the ASAS identified Spray-Dried Plasma as one of the 10 most important discoveries in Swine Nutrition in the past 100 years.
### Percentage improvement in performance of pigs fed plasma protein compared to other protein sources (D 0-14 after weaning)

<table>
<thead>
<tr>
<th>Reference</th>
<th>n(^1)</th>
<th>ADG</th>
<th>ADFI</th>
<th>FCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffey and Cromwell, 2001 (Plasma vs other proteins)</td>
<td>79</td>
<td>+25.0</td>
<td>+21.0</td>
<td>+4.0</td>
</tr>
<tr>
<td>Van Dijk, 2001 (Plasma vs Milk protein sources)</td>
<td>38</td>
<td>+23.9</td>
<td>+24.5</td>
<td>+0.1</td>
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<tr>
<td>Van Dijk, 2001 (Plasma vs Soy protein sources)</td>
<td>14</td>
<td>+38.1</td>
<td>+28.8</td>
<td>+7.9</td>
</tr>
</tbody>
</table>

\(^1\) Number of experiments

Decreased Scour Score
Three Experiment Summary in Pigs

Gatnau and Zimmerman, 1993. Unpublished Data
### FPs During Disease Challenge

- **Studies in multiple species**
- **Studies with both enteric and respiratory challenges**
- **Adding FP improves:**
  - Fecal score (less diarrhea)
  - Average daily gain
  - Survival
  - Feed efficiency

<table>
<thead>
<tr>
<th>Species</th>
<th>Pathogen</th>
<th>Results</th>
<th>Author</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↓ fecal score</td>
<td>Borg et al.</td>
<td>1999</td>
</tr>
<tr>
<td>Pigs</td>
<td>Salmonella</td>
<td>↓ fecal score</td>
<td>Borg et al.</td>
<td>1999</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↑ ADG, ↓ mortality</td>
<td>Bosi et al.</td>
<td>2001</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↑ ADG, ↓ IgA</td>
<td>Bosi et al.</td>
<td>2004</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↑ ADG, ↑ Lactobacilli</td>
<td>Torrallardona et al.</td>
<td>2003</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↑ ADG</td>
<td>Campbell et al.</td>
<td>2001</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↓ shedding</td>
<td>Deprez et al.</td>
<td>1996</td>
</tr>
<tr>
<td>Pigs</td>
<td>Rotavirus</td>
<td>↓ diarrhea</td>
<td>Crl et al.</td>
<td>2007</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↓ fecal score</td>
<td>Nollet et al.</td>
<td>1999</td>
</tr>
<tr>
<td>Pigs</td>
<td>LPS</td>
<td>↓ cytokine mRNA expression</td>
<td>Touchette et al.</td>
<td>2002</td>
</tr>
<tr>
<td>Pigs</td>
<td>E. coli</td>
<td>↑ ADG, ↓ fecal score</td>
<td>Van Dijk et al.</td>
<td>2002</td>
</tr>
<tr>
<td>Pigs</td>
<td>Gastric ulcers</td>
<td>↓ clinical symptoms, ↑ ADG</td>
<td>Crenshaw et al.</td>
<td>2003</td>
</tr>
<tr>
<td>Pigs</td>
<td>PRRS</td>
<td>↑ feed efficiency</td>
<td>Escobar et al.</td>
<td>2006</td>
</tr>
<tr>
<td>Pigs</td>
<td>PCVAD</td>
<td>↑ survival</td>
<td>Messier et al.</td>
<td>2007</td>
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<tr>
<td>Pigs</td>
<td>PCVAD</td>
<td>↑ ADG, ↓ clinical symptoms</td>
<td>Morés et al.</td>
<td>2007</td>
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<tr>
<td>Calves</td>
<td>Coronavirus</td>
<td>↑ recovery</td>
<td>Arthington et al.</td>
<td>2002</td>
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<tr>
<td>Calves</td>
<td>Crypto. parvum</td>
<td>↓ scours, ↓ shedding</td>
<td>Hunt et al.</td>
<td>2002</td>
</tr>
<tr>
<td>Calves</td>
<td>E. coli</td>
<td>↑ survival, ↑ ADG, ↓ scours</td>
<td>Nollet et al.</td>
<td>1999</td>
</tr>
<tr>
<td>Calves</td>
<td>E. coli</td>
<td>↑ survival, ↑ ADG, ↓ scours</td>
<td>Quigley &amp; Drew</td>
<td>2000</td>
</tr>
<tr>
<td>Shrimp</td>
<td>WSSV</td>
<td>↑ survival, ↑ ADG</td>
<td>Russell &amp; Campbell</td>
<td>2000</td>
</tr>
<tr>
<td>Trout</td>
<td>Yersinia ruckeri</td>
<td>↑ survival, ↑ ADG</td>
<td>Aljaro et al.</td>
<td>1998</td>
</tr>
<tr>
<td>Poultts</td>
<td>Pasteurella multocida</td>
<td>↑ survival, ↑ ADG</td>
<td>Campbell et al.</td>
<td>2004</td>
</tr>
<tr>
<td>Broilers</td>
<td>Necrotic Enteritis</td>
<td>↑ survival, ↑ feed efficiency, ↑ ADG</td>
<td>Campbell et al.</td>
<td>2006</td>
</tr>
</tbody>
</table>
**SDAP is an Alternative to Antibiotics**

**Effect of feed medication on the performance response of piglets to SDP in the two weeks after weaning**

<table>
<thead>
<tr>
<th>Medication</th>
<th>0-14 days Post-Weaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>YES</td>
<td>110</td>
</tr>
<tr>
<td>NO</td>
<td>33</td>
</tr>
</tbody>
</table>

Pigs perform well in the absence of antibiotics when they are fed plasma.

- Higher average daily gain
- Higher average daily feed intake
- Improved feed efficiency

N: Number of trials.
*p*<0.05. Statistical significance of improvement over control without plasma

Plasma vs ATB during *Salmonella* Challenge

1. Positive Control – no supplement
2. Antibiotics - 0.05% Salinomycin and 0.033% Zinc bacitracin
3. Low SDPP -10 g/kg diet
4. High SDPP - 20 g/kg diet
5. Negative Control - no supplement, not challenged.

**Challenge**

- On 8, 10 and 12d, birds were inoculated with 2 mL of bacterial suspension (5.9 x 10⁸ CFU/ml)
- Unchallenged birds received 2 ml of LB broth

Beski et al., 2015. J. Animal Physiology and animal nutrition.
Functional proteins allow energy and nutrients for growth and other productive functions.
• In livestock production antibiotics are effective in the treatment and prevention of infections.  
  – Improves production efficiency

• Options and Considerations  
  – Effectiveness  
  – Ease of adaption  
  – Cost