Dietary supplementation of botanicals enhanced growth performance and disease resistance of weaned pigs experimentally infected with a pathogenic *E. coli*

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Outline

1. Post-weaning stress & diarrhea
2. Botanicals/Phytogenic feed additives & their effects
3. Objectives & Experimental design
4. Results & Conclusions
Weaning stress
Diet, Environment, Transportation, Pathogenic exposure

E. coli infection
Pathogenic, F4 or F18

Diarrhea
Decreased growth performance & health, increased mortality & economic losses
Post-weaning *E. coli* diarrhea

Sites with known or suspected *E. coli* diarrhea cases in one or more nursery pigs

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
</tr>
<tr>
<td>2012</td>
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</tbody>
</table>

NAHMS, Section III: Management and Productivity Changes-D. Weaned Pig Morbidity
Post-weaning diarrhea

• Mortality rates of nursery pigs ranged from 2.4 to 3.6%, of which diarrhea-caused death consist of 9.4 to 14.7% (NAHMS, 2012)

• In-feed antibiotics used for growth promoting purpose was banned in U.S. (FDA, 2016)

Botanicals/Phytogenic feed additives

• Plant-derived substances and compounds
• Essential oils - aromatic oily liquids obtained from plant materials
• In vitro biological effects
  • Antibacterial
  • Antioxidative
  • Antiviral
  • Antimycotic
  • Antiparasitic

Burt, 2004; Windisch et al., 2008
Anti-inflammatory effects

In vitro

LPS-stimulated porcine alveolar macrophages

Liu et al., 2012
Effects of botanicals on pig health and growth performance

- Increase feed intake
- Improve gut function
- Nutrient absorption
- Reinforce immune system

Source: aasv.org; Zeng et al., 2015
Thymol and cinnamaldehyde mixture enhanced weaned pig body weight

Overall (d 0 to 35 of study period)

Average daily gain

- Negative control
- Positive control (150 mg/kg chlortetracycline, 80 mg/kg colistin sulfate, 50 mg/kg kitasamycin)
- Essential oils (18 mg/kg thymol & cinnamaldehyde)

Li et al., 2012
Objectives

To investigate the effects of dietary supplementation of dietary botanical supplementation composed of cloves, cinnamon, and garlic varieties on growth performance and frequency of diarrhea of weaned piglets experimentally infected with a pathogenic F18 E. coli.
Experimental design

- **Randomized Complete Block Design**: blocks = body weight, sex, litter
- **60 weaning pigs**: crossbred, ~21 d old, initial BW = 7.17 ± 0.97 kg
- **5 treatments**: 12 pigs/treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Control</td>
<td></td>
</tr>
<tr>
<td>Positive Control</td>
<td></td>
</tr>
<tr>
<td>Botanicals blend 1 (BB1) - 100 ppm</td>
<td></td>
</tr>
<tr>
<td>Botanicals blend 2 (BB2) - 50 ppm</td>
<td></td>
</tr>
<tr>
<td>Botanicals blend 2 (BB2) – 100 ppm</td>
<td></td>
</tr>
</tbody>
</table>

*E. coli* challenge
Experimental timeline

- All pigs were orally inoculated with 3 doses of pathogenic F18 *E. coli* ($10^{10}$ cfu per dose, 3 consecutive days)

Data collection:
- Growth performance – BW, average daily gain
- Diarrhea – Daily score, Frequency of diarrhea
- Feces – β-hemolytic coliforms
Detection of β-hemolytic coliforms

Columbia blood agar
Detect β-hemolytic coliforms

MacConkey agar
Confirm lactose-fermenting bacteria
Data calculation and statistical analysis

• **Frequency of diarrhea**: the percentage of pig days with diarrhea score ≥ 3

• All data were analyzed by ANOVA using the PROC MIXED of SAS
  - Frequency of diarrhea was analyzed by Chi-square

• **Statistical model**: diet as fixed effect and blocks as random effect

• Pig was experimental unit
Body weight

- Negative control
- Positive control
- BB1-100PPM
- BB2-50PPM
- BB2-100PPM

Graph showing body weight over time (d 0, d 5 PI, d 14 PI, d 21 PI) with different treatments.
Average daily gain

d 0 to 21 PI

- Negative control
- Positive control
- BB1-100PPM
- BB2-50PPM
- BB2-100PPM
Daily diarrhea score

Diarrhea score:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal, solid feces</td>
</tr>
<tr>
<td>2</td>
<td>Moist, solid feces</td>
</tr>
<tr>
<td>3</td>
<td>Mild diarrhea</td>
</tr>
<tr>
<td>4</td>
<td>Severe diarrhea</td>
</tr>
<tr>
<td>5</td>
<td>Watery diarrhea</td>
</tr>
</tbody>
</table>

Graph showing daily diarrhea score from d-7 to d21 PI with different treatments indicated by lines and markers.
Frequency of diarrhea

Overall (d 0 to 21 PI)

- Negative control
- Positive control
- BB1-100PPM
- BB2-50PPM
- BB2-100PPM

Comparison letters: a, b, c
Conclusions

Supplementation of high dose (100 ppm) botanical blend 1 or 2

- Enhanced growth performance
- Decreased diarrhea frequency

of weaned pigs experimentally infected with F18 *E. coli*.

**Future research:**

- The impacts of botanical blends on gut microbiome
- The effects of botanical blends on systemic and intestinal inflammatory biomarkers
Acknowledgements
Thank you for your attention!