Dietary supplementation of blends of organic acids and monoglycerides alleviated diarrhea and systemic inflammation of weaned pigs experimentally infected with enterotoxigenic *Escherichia coli* F18

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Outline

- Post-weaning diarrhea in pigs
- Organic acids and monoglycerides
- Experimental design
- Results and conclusions
Post-weaning diarrhea (PWD)

- Gastrointestinal disease
- Enterotoxigenic *Escherichia coli* (ETEC)
  - F18 fimbrial adhesin
- Intestinal health
  - Dehydration
    - Water and electrolytes
  - Reduced feed intake and weight gain
  - Sudden death
Restriction of antibiotic use in feed

- Prevent and treat PWD
  - Antimicrobial effects
  - Nutrients availability

- Public health risk and concern
  - Antimicrobial resistance
  - Environmental transmission
    ✓ Prohibition of antibiotic growth promoters (Jan 2017, FDA)

Organic acids (I)

- Organic compound (carboxyl group)
  - Acidic properties

- Lowering gastric pH
  - Reduced survival of pathogens
  - Inactive pepsinogen to active pepsin
    - Nutrients digestibility
    - Growth performance

HCl production in %

Pig age in weeks

Pig progress, 2021
Organic acids (II)

- **Antimicrobial activity**
  - Indirect (lowered pH)
    - Acid-intolerant bacteria (*E. coli* and *Salmonella*)
  - Direct
    - Penetrating bacterial cell wall
    - Disrupting physiological homeostasis
  - **Reduction in pathogen load**
    - Subclinical infection
    - Diarrhea

Monoglycerides

- **Glycerol** linked to **fatty acids** (esterification)
  - Strong covalent bond
    - **Stable** (non-volatile/-corrosive, and heat stable)
    - **Neutral taste and odor**
    - **pH-independent**
  - Amphiphilic nature
    - **Antimicrobial activity**
  - Synergistic effects
    - **Organic acids**
Objective

- Effects of dietary supplementation of **organic acids blend, monoglycerides blend, or combination of both** on weaned pigs experimentally infected with ETEC F18
  - Diarrhea
  - Bacterial translocation
  - Systemic inflammation
  - Growth performance
Animals & experimental design

- **Animals**
  - 40 weaned pigs (initial BW = 7.81 ± 0.84 kg; 21 d old)
  - Individual housing (10 replications/treatment)

- **4 dietary treatments**
  - Corn-soybean meal-based nursery diet (CON)
  - CON + 0.3% organic acids (OAs)
  - CON + 0.3% monoglycerides (MGs)
  - CON + 0.2% organic acids and 0.2% monoglycerides (OAs+MGs)

- **2-phase feeding** (2 weeks/phase; overall 4 weeks)
Timeline and data collection

- Daily fecal score (1 to 5; firm feces to watery diarrhea)
- β-hemolytic coliforms in feces
- Complete blood counting (d 0, 5, and 14 PI)
- Bacterial translocation (mesenteric lymph nodes and spleen; d 21 PI)
- Growth performance

ETEC challenge
- All pigs were orally inoculated with ETEC F18 ($10^{10}$ CFU/dose)
β-hemolytic coliforms
(feces)

Columbia blood agar
(β-hemolytic coliforms)

MacConkey agar
(Confirm lactose-fermenting bacteria)
Bacterial translocation
(mesenteric lymph nodes & spleen)

Plate homogenized samples

Brain heart infusion (BHI) agar
(Total coliform colonies)
Statistical analysis

- PROC MIXED of SAS
  - Randomized complete block design
    - Block: group, BW, and sex
  - Experimental unit: pig
  - Fixed effect: dietary treatment

- Chi-square test
  - Frequency of diarrhea
Daily fecal score

*Fecal score = 1, firm feces; 2, moist feces; 3, mild diarrhea; 4, severe diarrhea; 5, watery diarrhea
Frequency of diarrhea (overall)

Frequency = number of pig days with fecal score ≥ 3

- Control
- OAs
- MGs
- OAs+MGs

Legend:
- a
- b
β-hemolytic coliform positive rate (%, in feces)
β-hemolytic coliforms to total coliforms (% in feces)
Bacterial translocation

Mesenteric lymph nodes

Spleen

*CFU = colony forming unit
Blood profile (I)

White blood cell

Neutrophil

$10^3/\mu L$

- Control
- OAs
- MGs
- OAs+MGs

$d 0 PI$, $d 5 PI$, $d 14 PI$
Blood profile (II)

**Lymphocyte**

**Neutrophil:Lymphocyte**
**Growth performance (overall)**

*ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio*
Conclusions

- Supplementation of organic acids blend, monoglycerides blend, or the combination
  - Reduce the frequency of diarrhea
  - Decrease the percentage of β-hemolytic coliforms in feces and bacterial translocation into immune organs
  - Modify the systemic inflammation of weaned pigs infected with ETEC F18
Future research

- The effects of organic acids blend, monoglycerides blend, or the combination of both on
  - Gut integrity
    - Gene expression analysis
  - Systemic inflammatory responses
    - Serum TNF-α and acute phase proteins
  - Metabolomic profile
  - Growth performance at large scale
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https://animalnutr-ansci.faculty.ucdavis.edu/
Greatly appreciate your attention!