

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



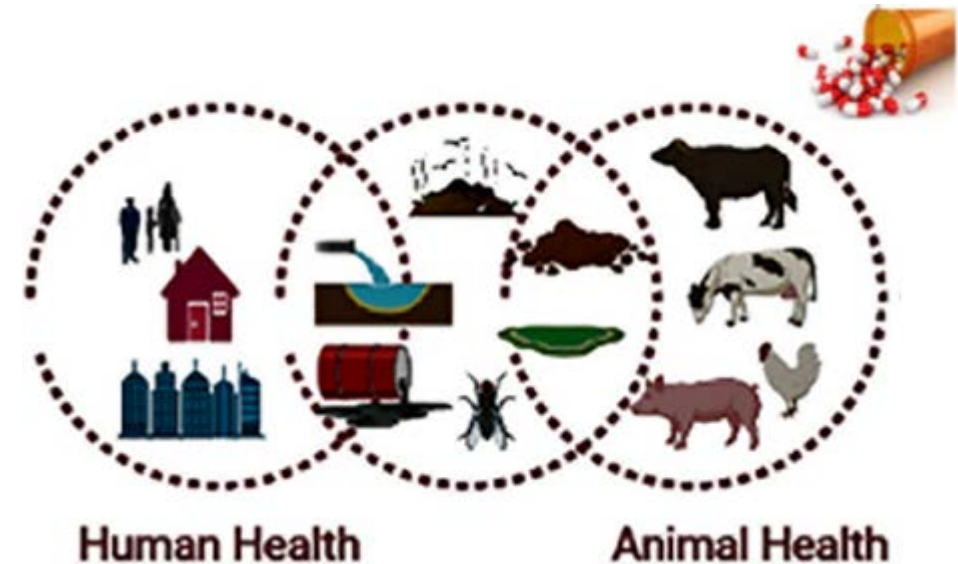
Restriction of antibiotic use in feed

❖ 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

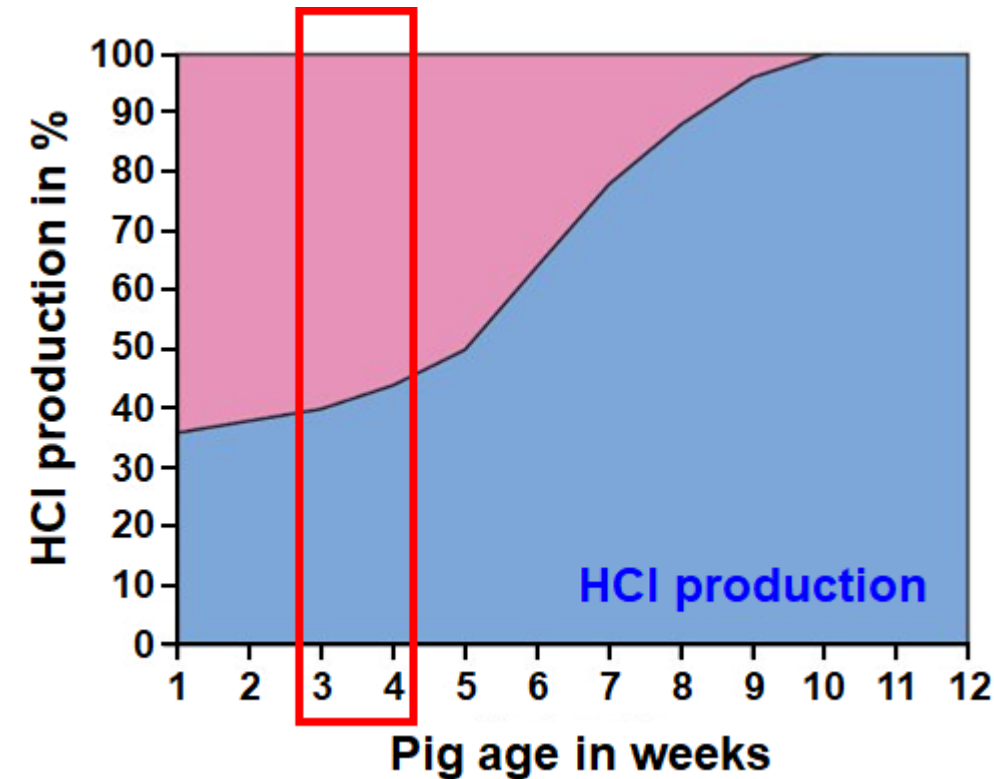
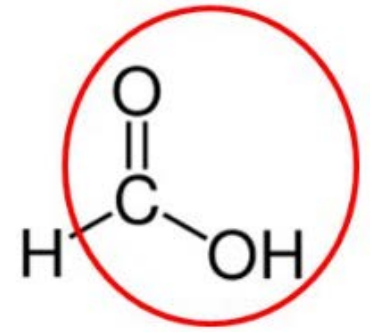
❖ **Lowering gastric pH**

➤ Reduced survival of pathogens

➤ Inactive pepsinogen to active pepsin

✓ ↑ Nutrients digestibility

✓ ↑ Growth performance

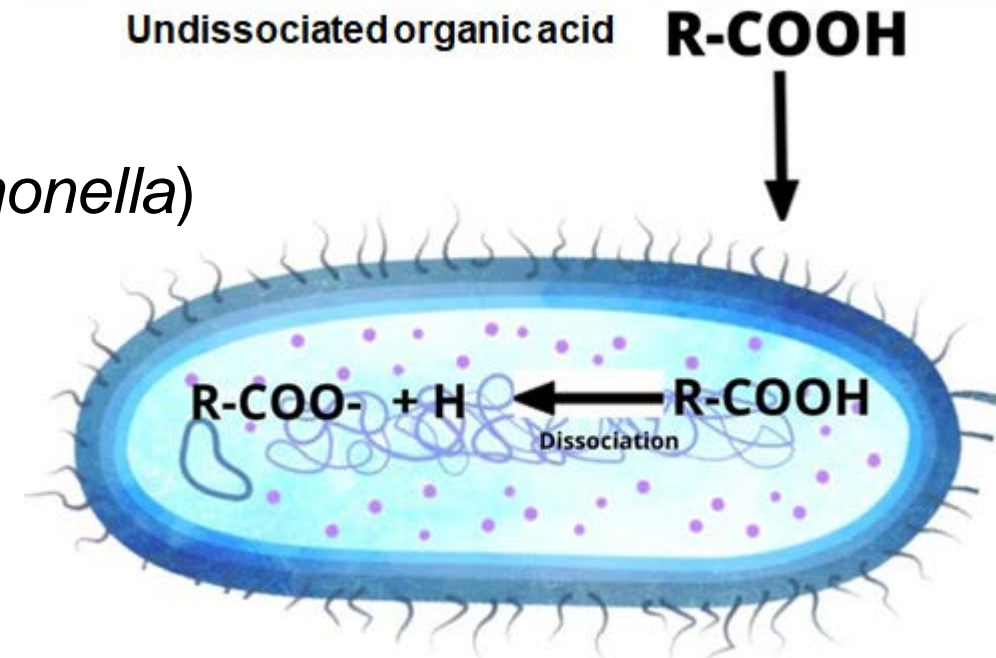


Pig progress, 2021

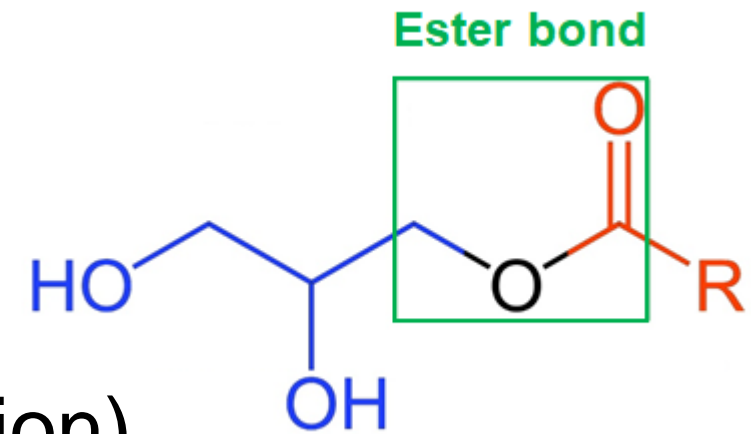
Organic acids (II)

❖ 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

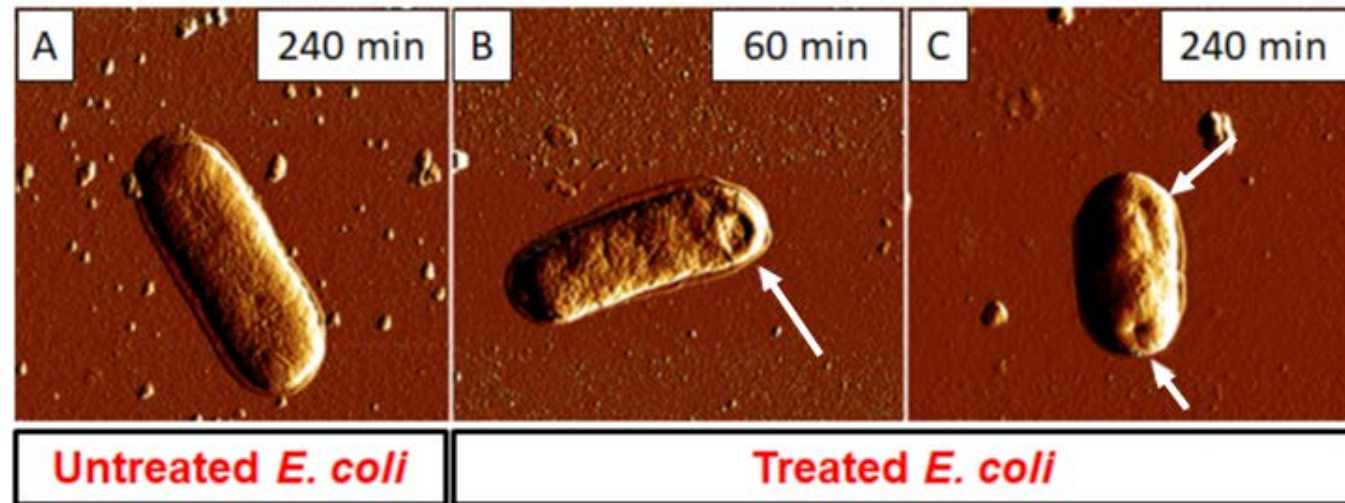


Monoglycerides



❖ **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



Batovska et al., 2009. Polish J. Microbiol. 58
Hyltdgaard et al., 2012. Appl. Environ. Microbiol. 78

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

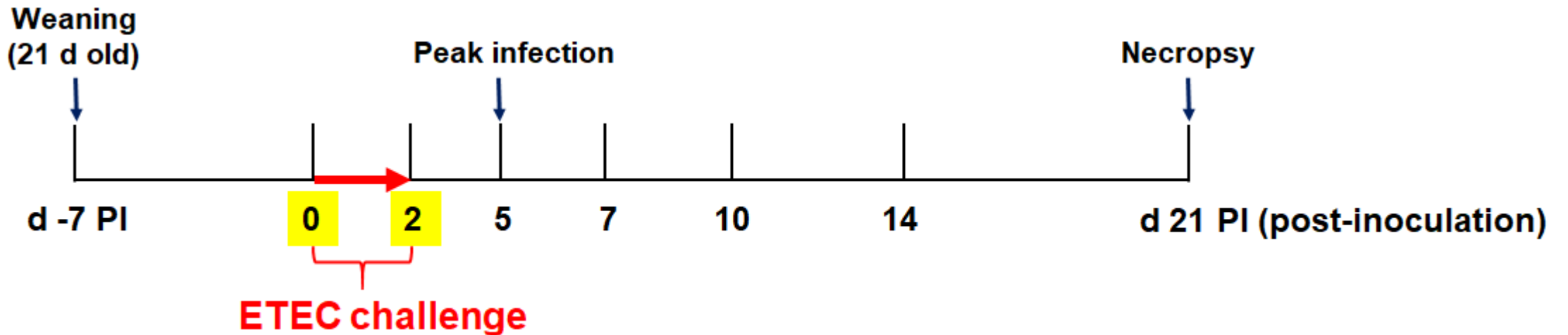
- 40 weaned pigs (initial BW = 7.81 ± 0.84 kg; 21 d old)
- Individual housing (10 replications/treatment)

❖ 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)

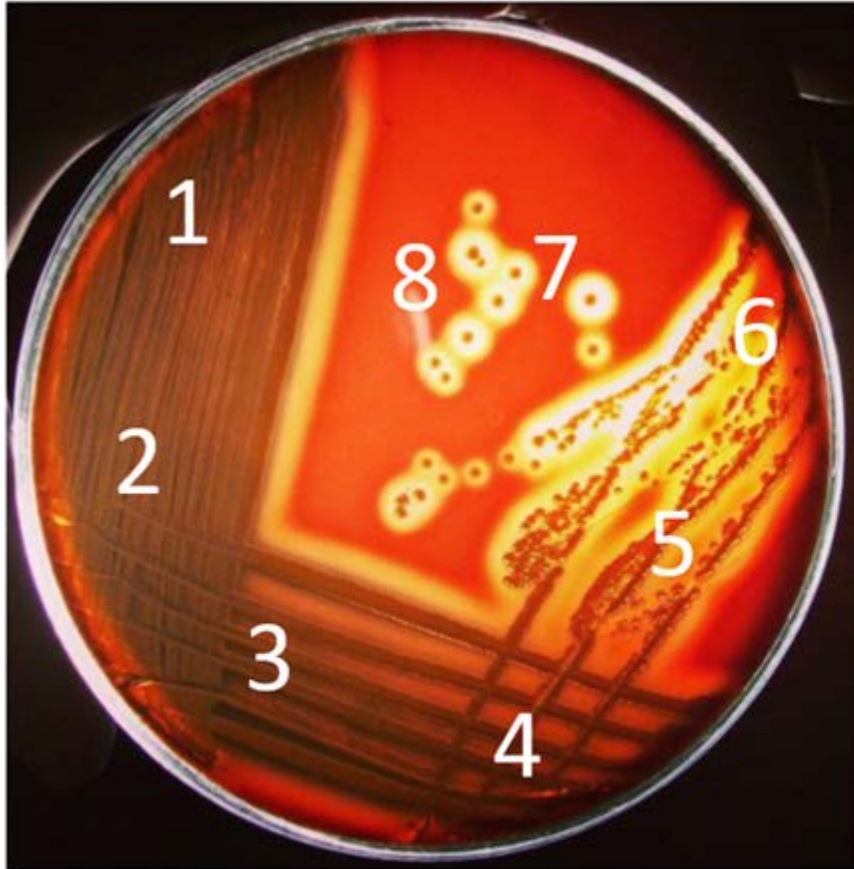
Timeline and data collection



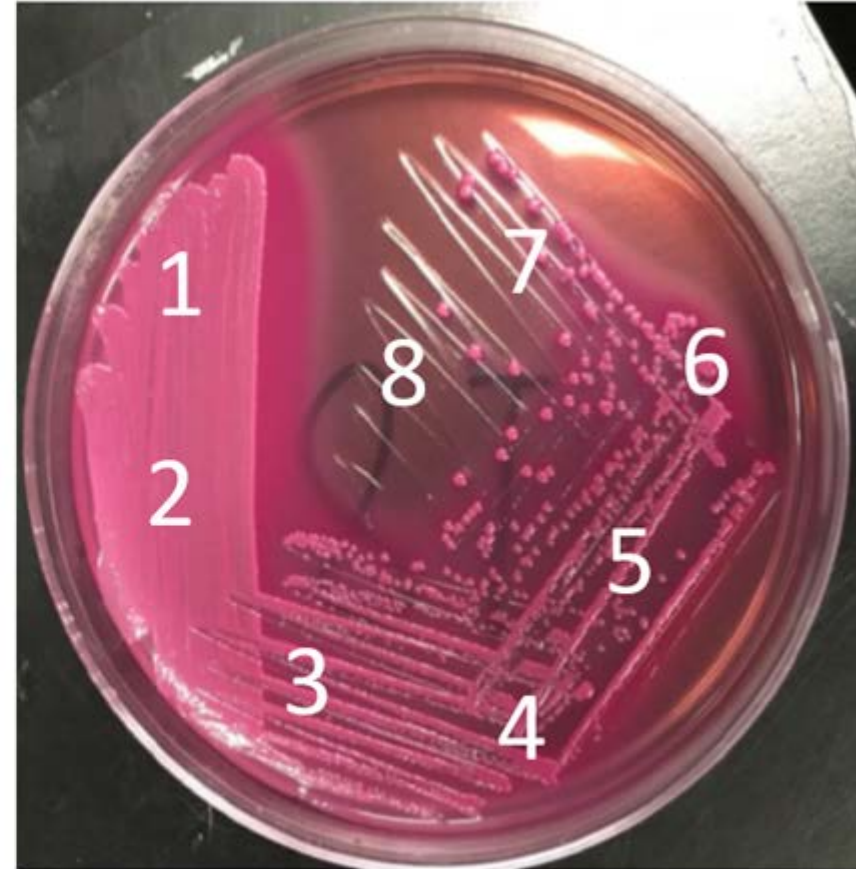
➤ All pigs were orally inoculated with ETEC F18 (10^{10} CFU/dose)

- ❖ 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

β -hemolytic coliforms (feces)

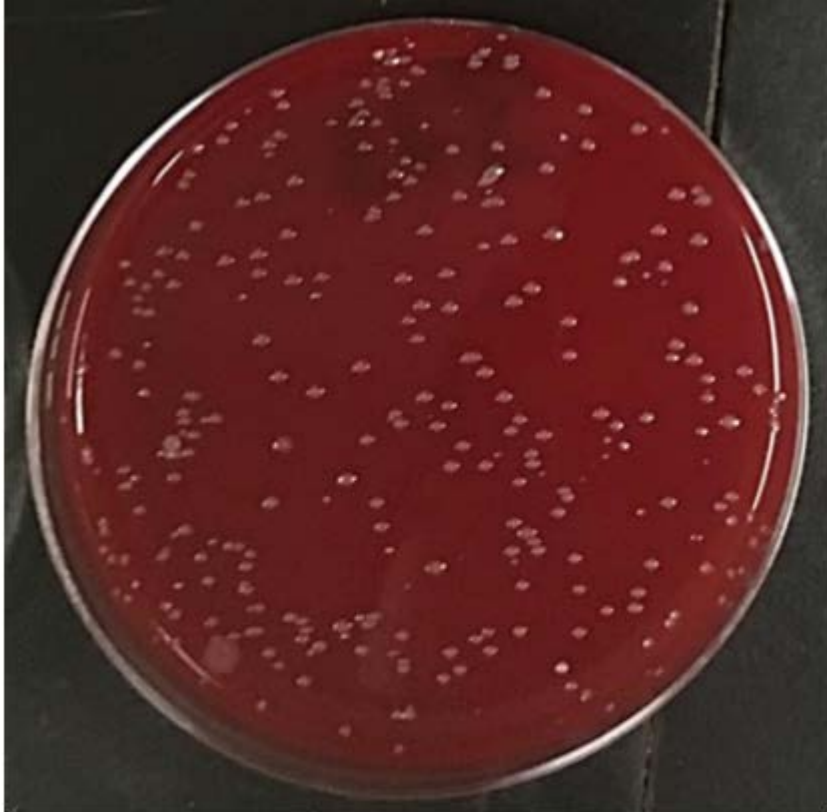


Columbia blood agar
(β -hemolytic coliforms)



MacConkey agar
(Confirm lactose-fermenting bacteria)

Bacterial translocation (mesenteric lymph nodes & spleen)



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

← **Plate homogenized samples**

Statistical analysis

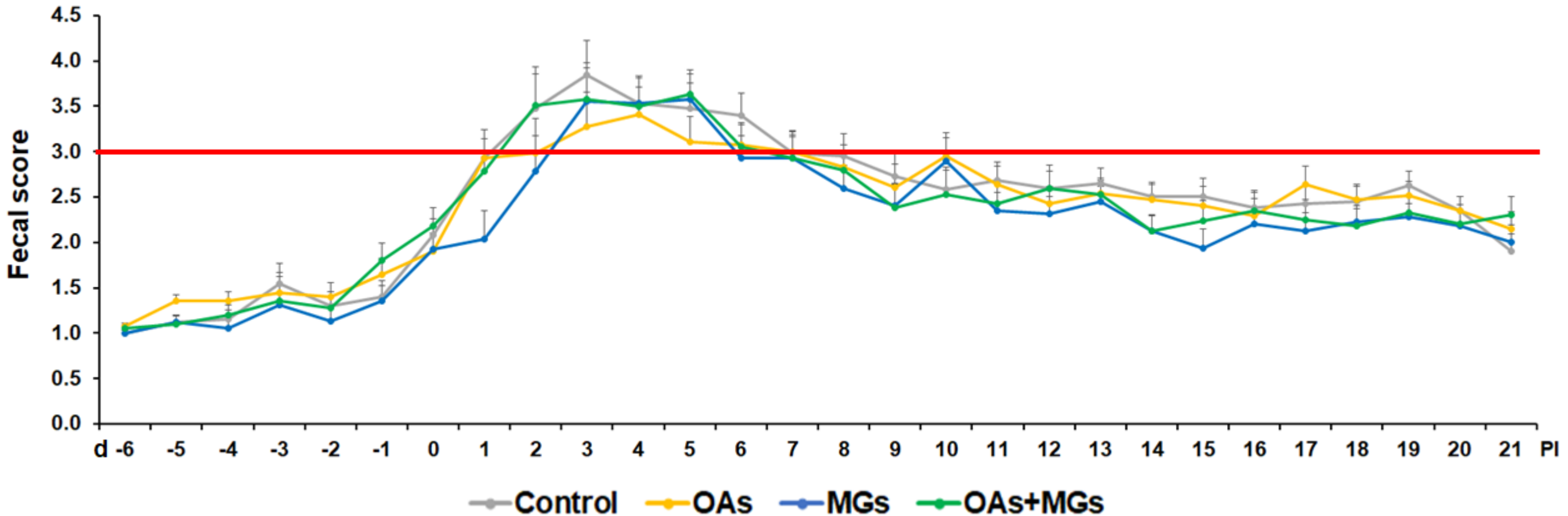
❖ PROC MIXED of SAS

- Randomized complete block design
 - ✓ Block: group, BW, and sex
- Experimental unit: pig
- Fixed effect: dietary treatment

❖ Chi-square test

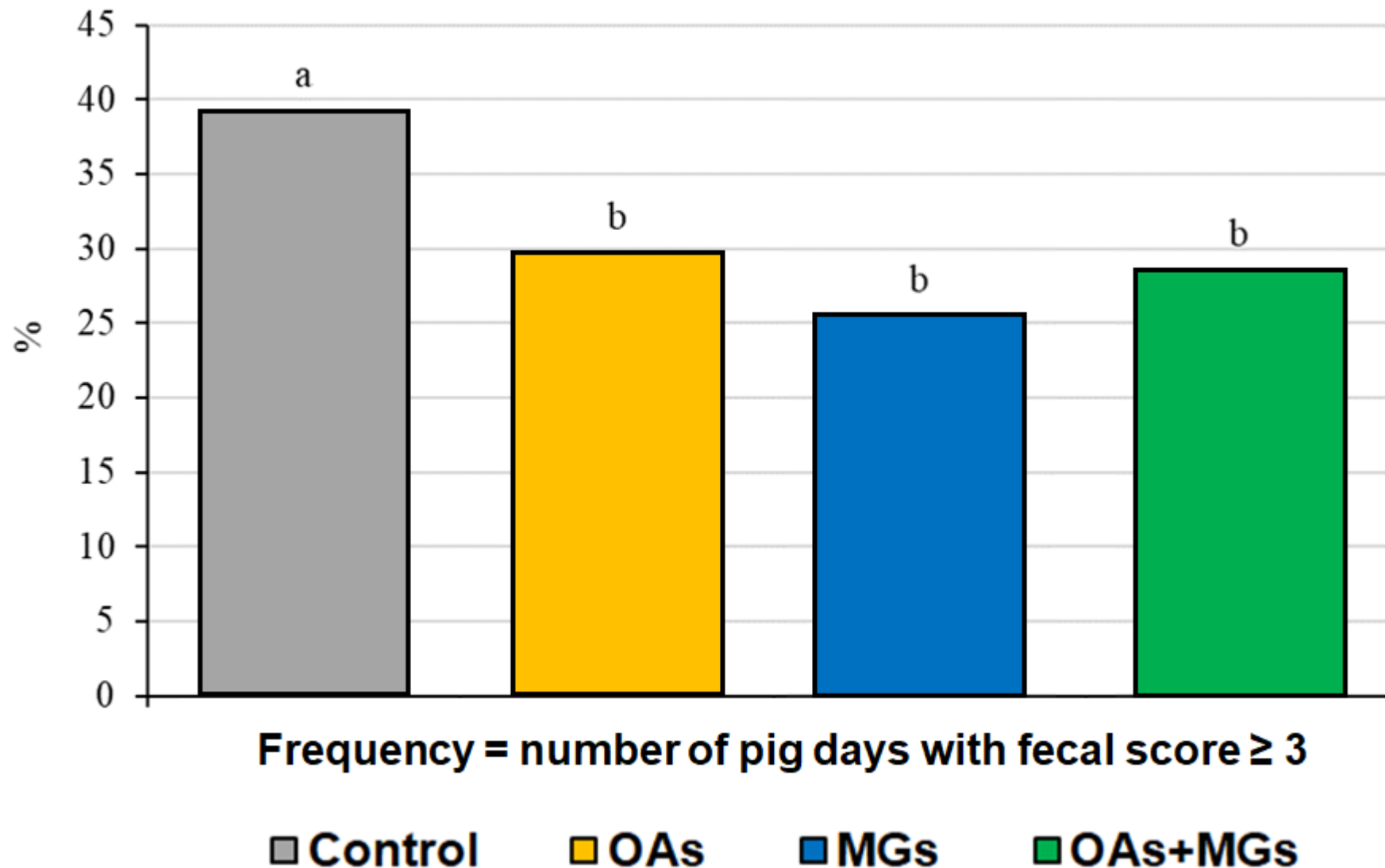
- Frequency of diarrhea

Daily fecal score

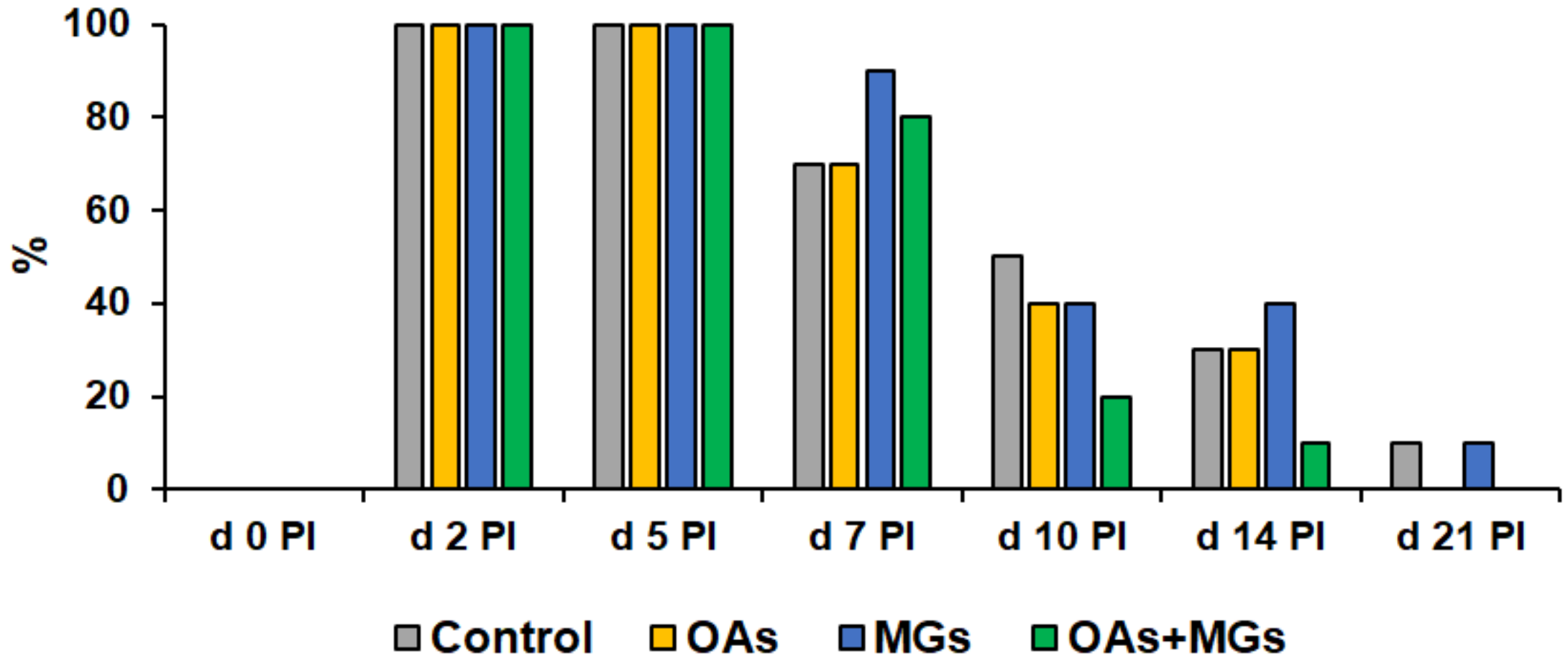


*Fecal score = 1, firm feces; 2, moist feces; 3, mild diarrhea; 4, severe diarrhea; 5, watery diarrhea

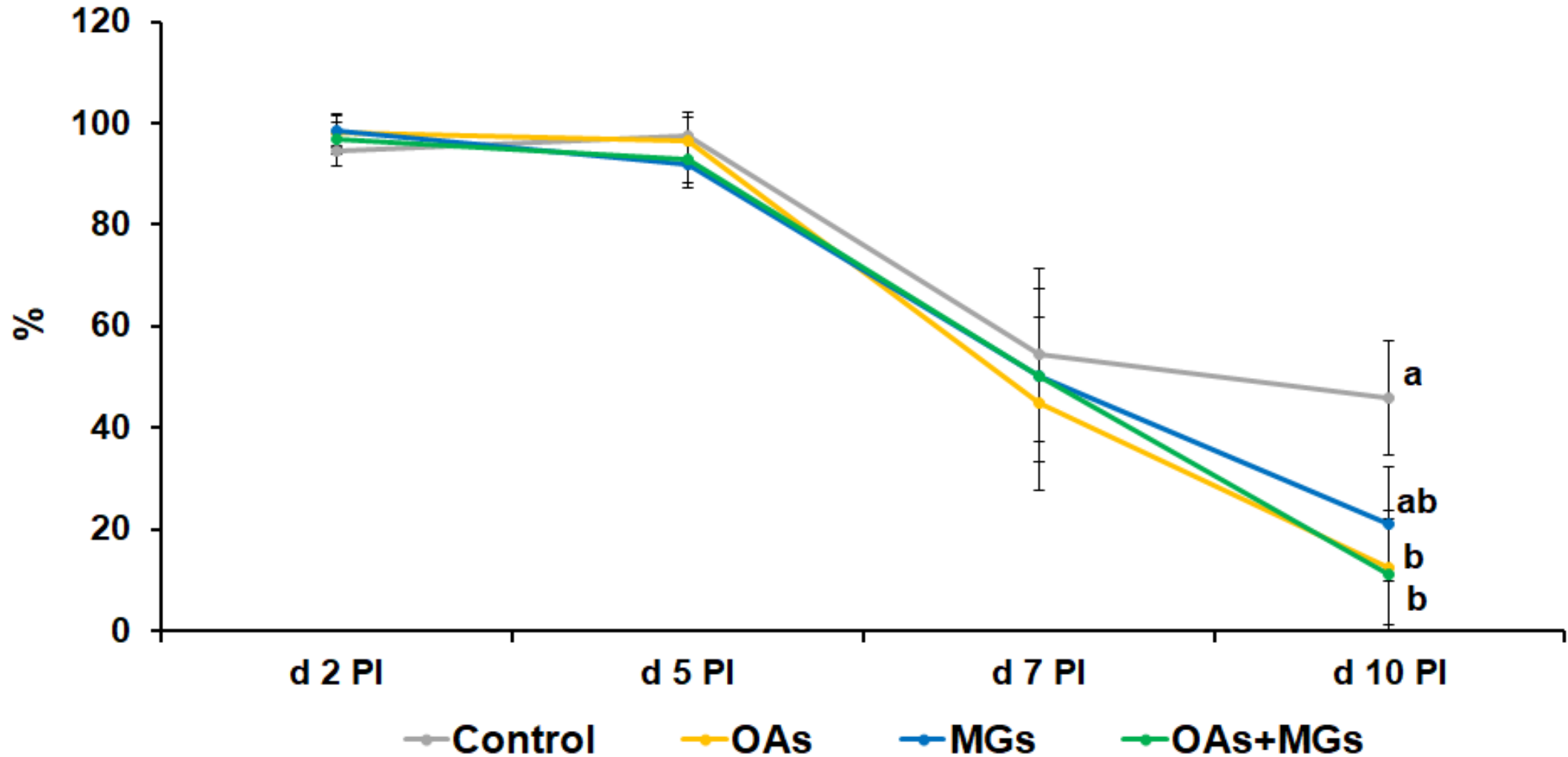
Frequency of diarrhea (overall)



β -hemolytic coliform positive rate (% in feces)

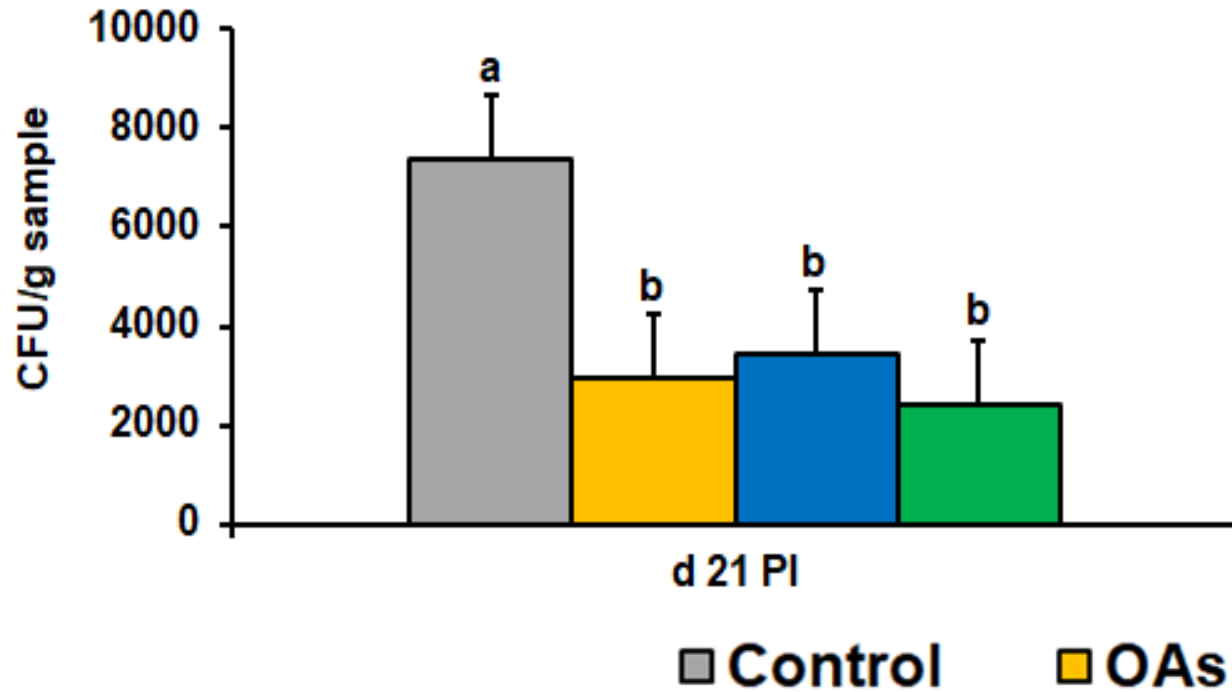


β -hemolytic coliforms to total coliforms (% in feces)

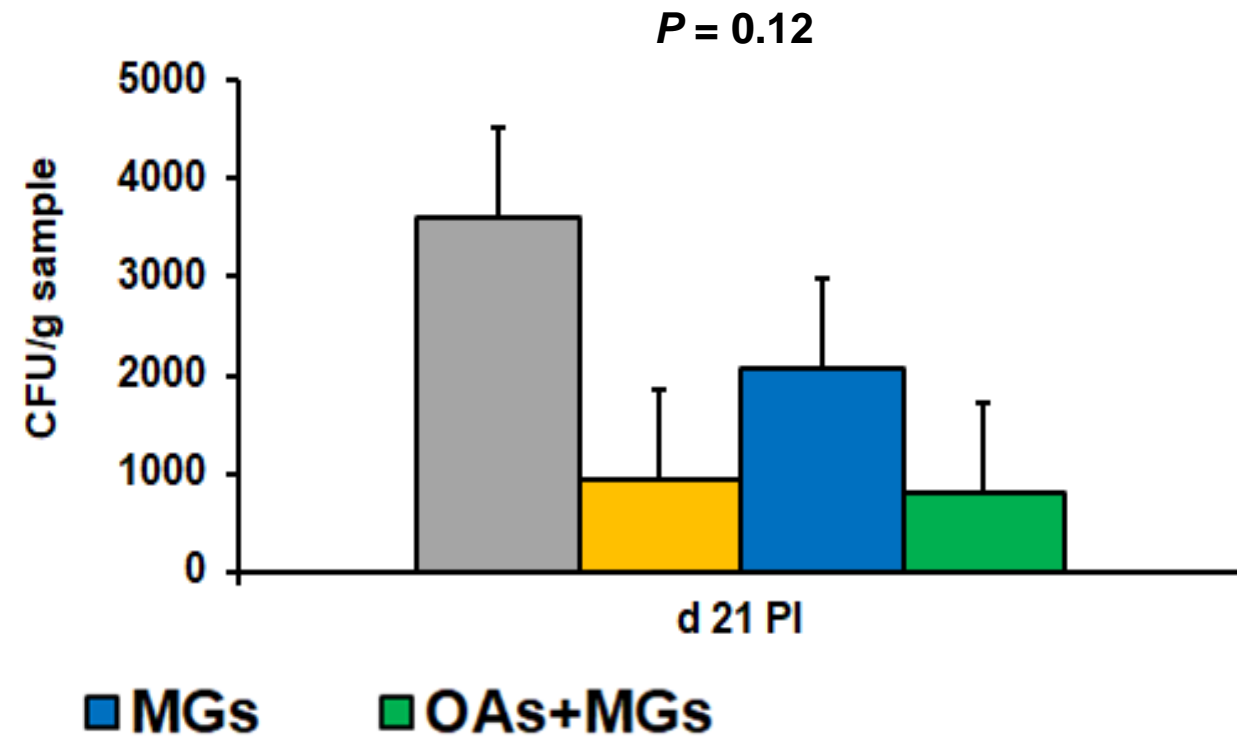


Bacterial translocation

Mesenteric lymph nodes



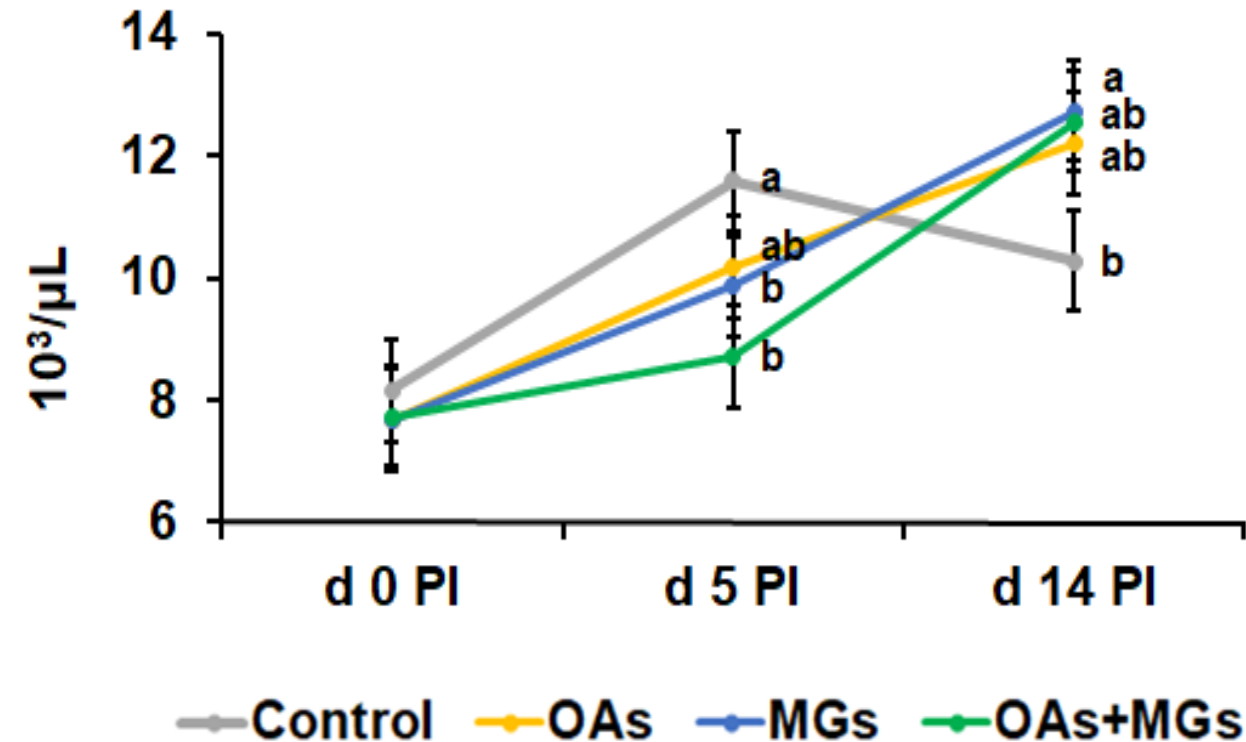
Spleen



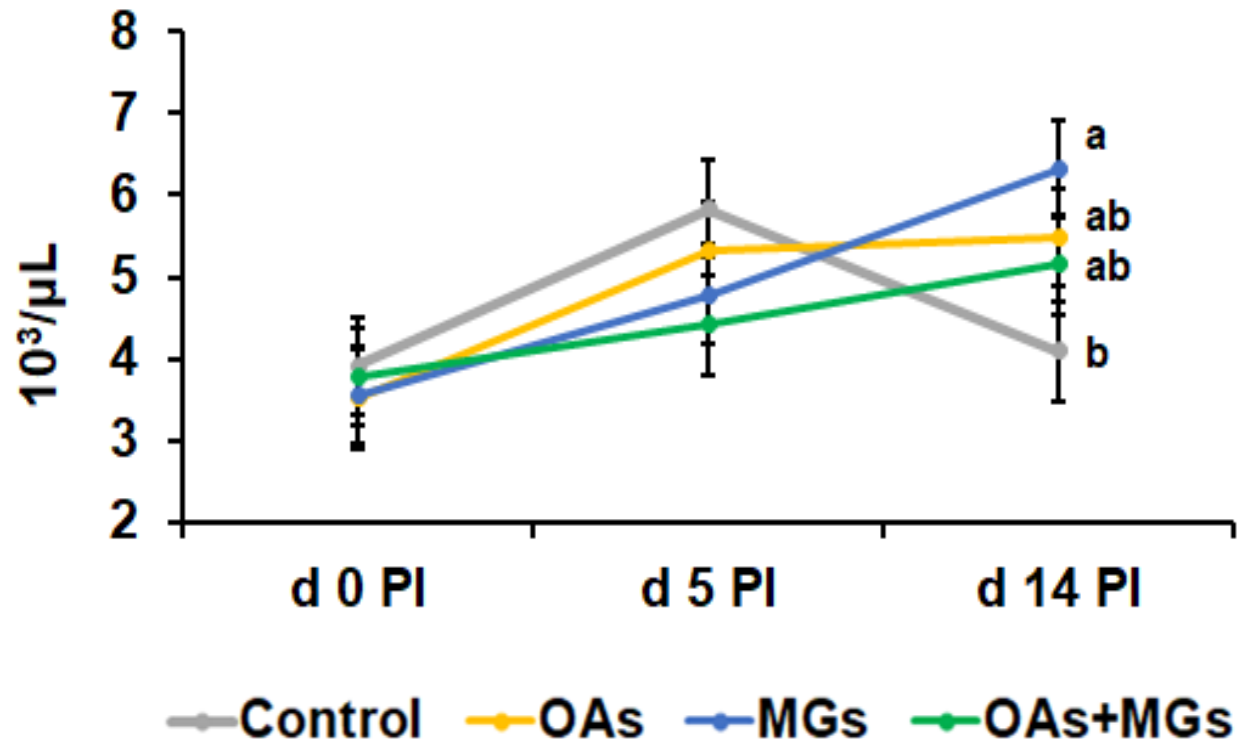
*CFU = colony forming unit

Blood profile (I)

White blood cell

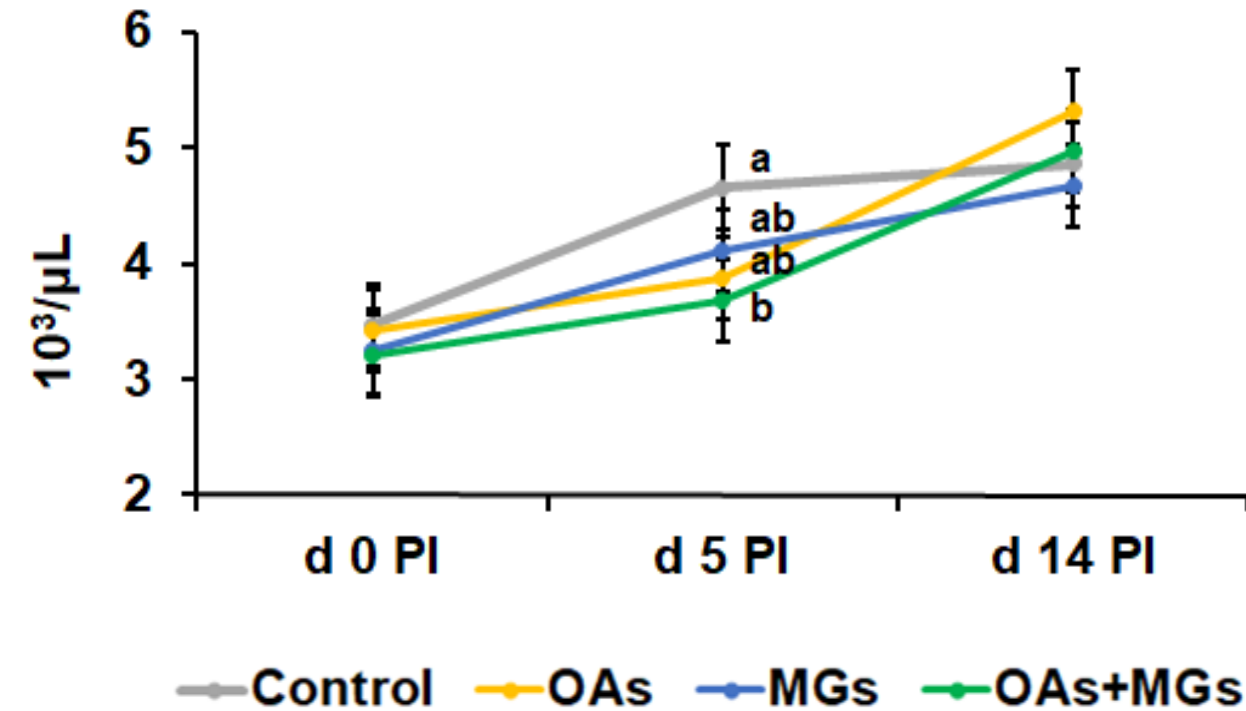


Neutrophil

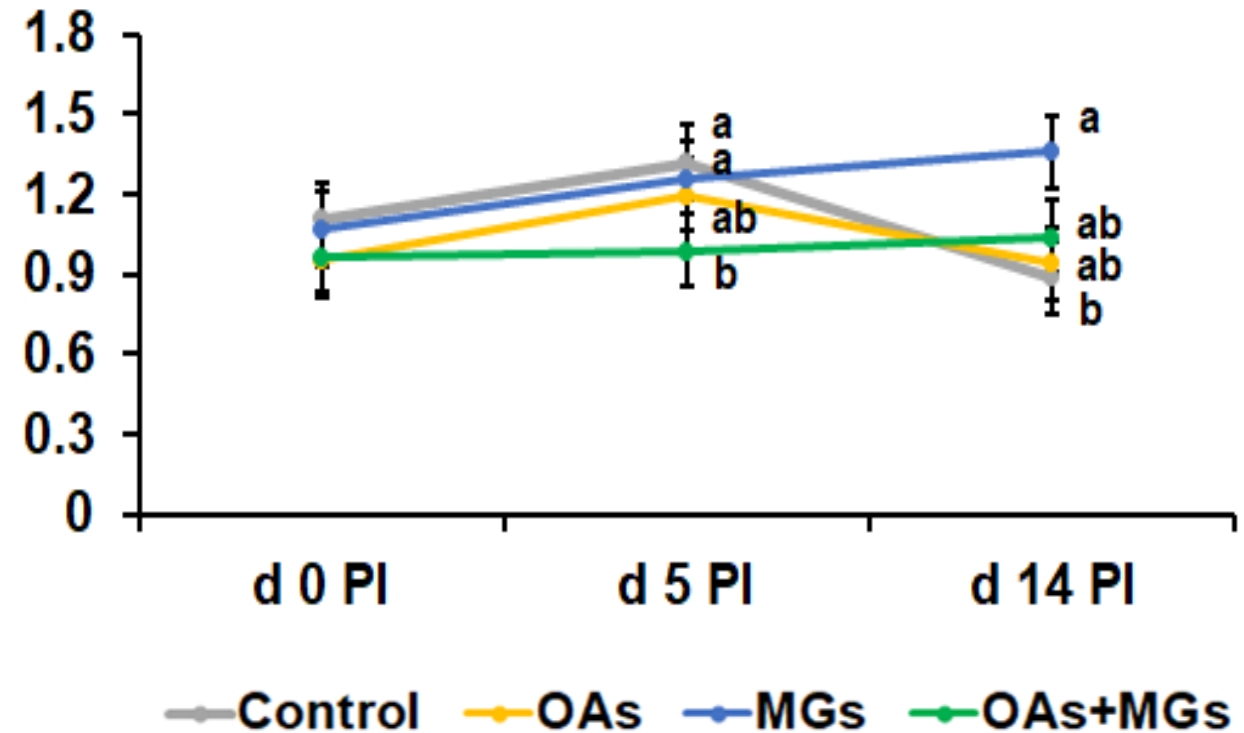


Blood profile (II)

Lymphocyte

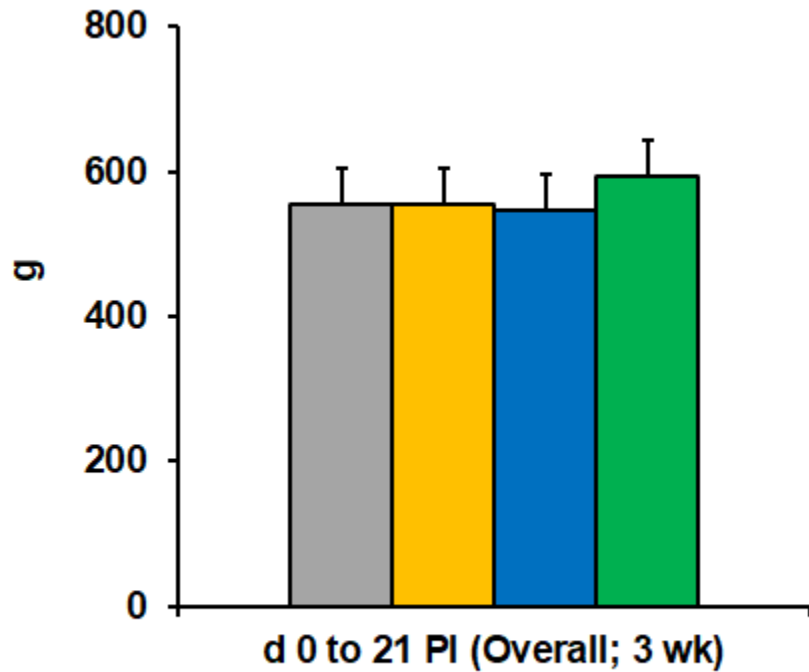


Neutrophil:Lymphocyte

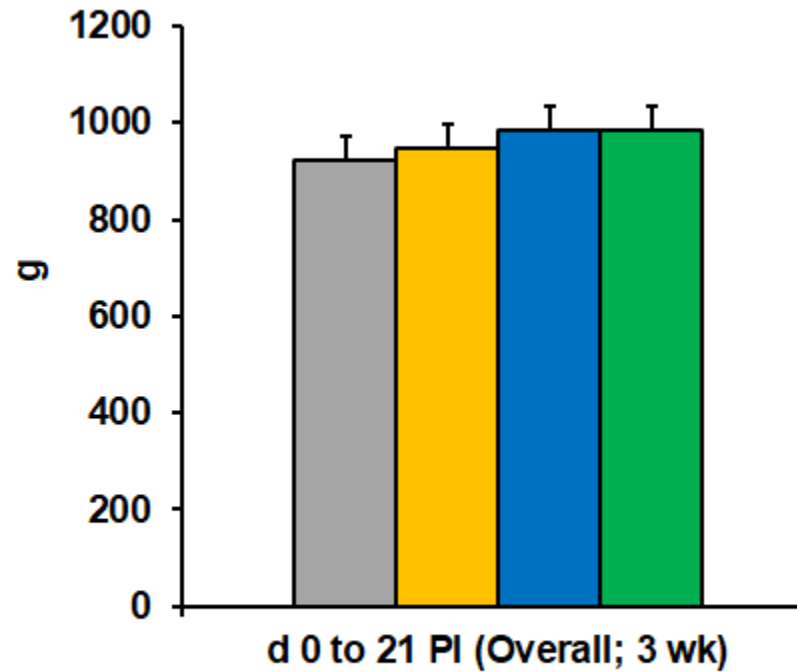


Growth performance (overall)

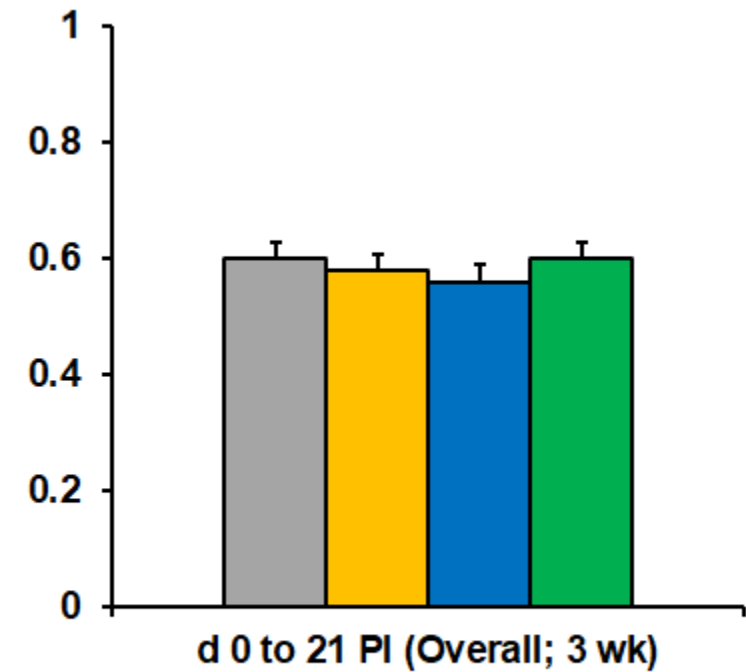
ADG



ADFI



G:F



■ Control ■ OAs ■ MGs ■ OAs+MGs

*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

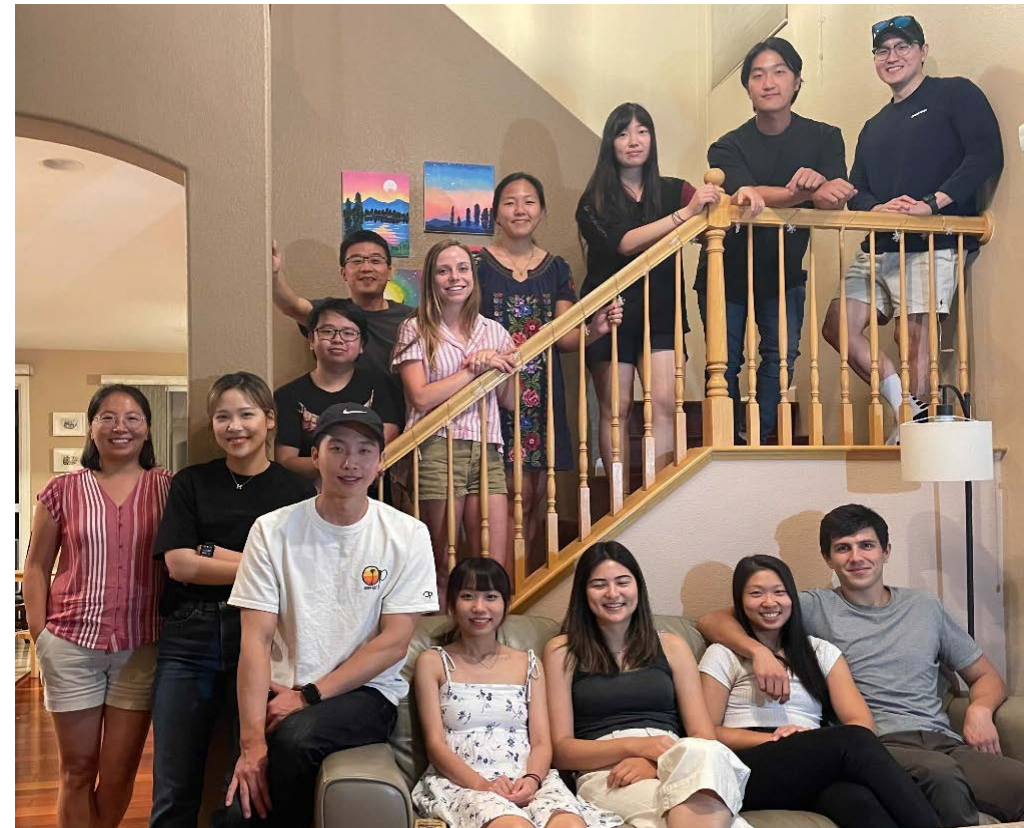
- ❖ The effects of **organic acids blend, monoglycerides blend, or the combination of both** on
 - **Gut integrity**
 - ✓ Gene expression analysis
 - **Systemic inflammatory responses**
 - ✓ Serum TNF- α and acute phase proteins
 - **Metabolomic profile**
 - **Growth performance at large scale**

Acknowledgements

- ❖ Comparative Animal Nutrition & Physiology Laboratory
- ❖ Eastman Animal Nutrition



<https://animalnutr-ansci.faculty.ucdavis.edu/>



Greatly appreciate your attention!

