Effects of *Bacillus spp.* probiotics on systemic immunity and intestinal health of weaned pigs experimentally infected with an enterotoxigenic *Escherichia coli*

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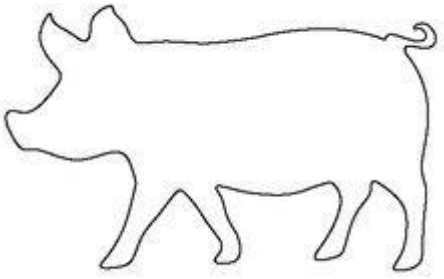
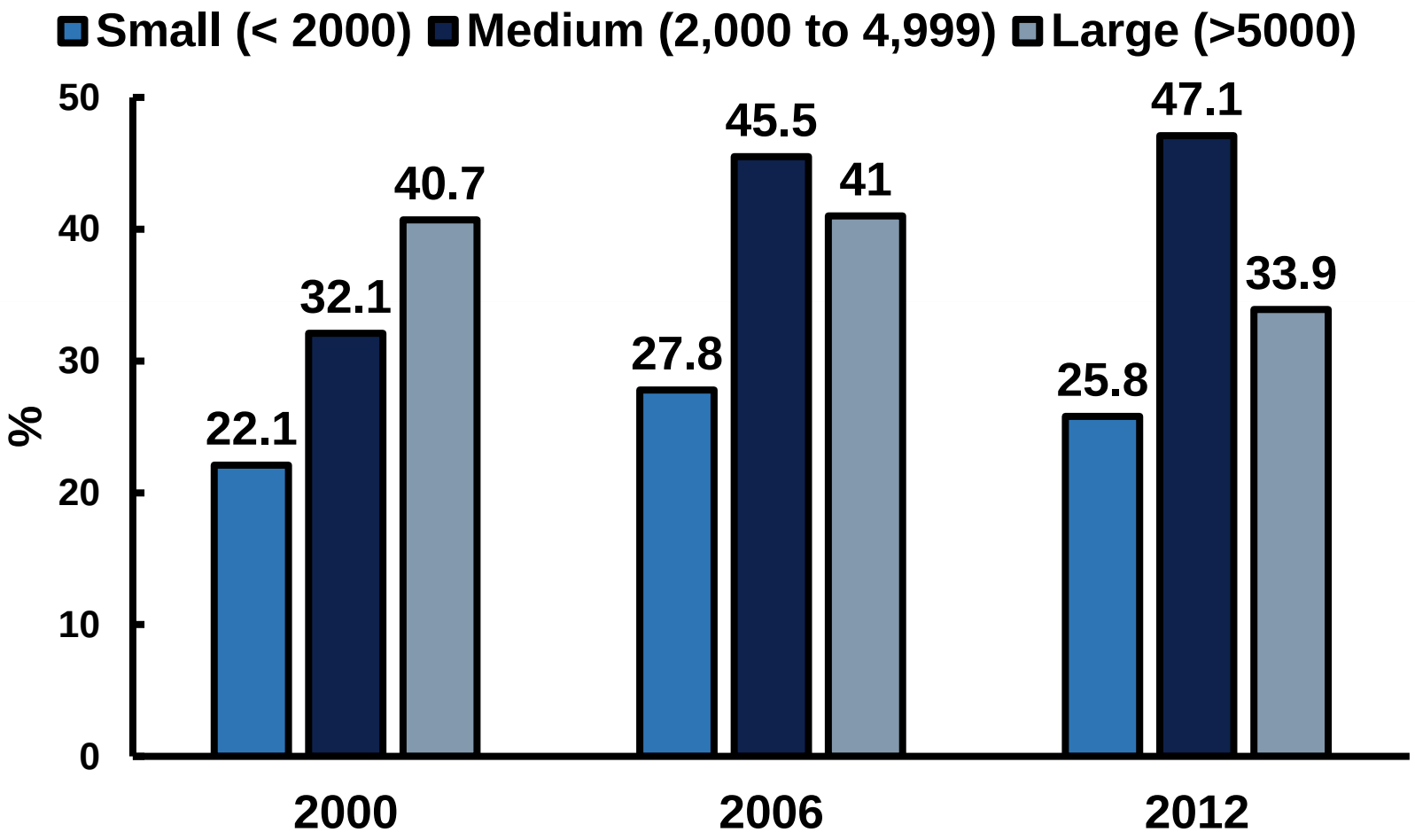
Introduction

- Weaning stress
  - Separation from the sow and littermates
  - Different physical environment
  - Sow milk to solid food
- Intestinal structure and function
- Decreased growth performance



(Pluske et al.,1997)

Post-weaning diarrhea by *E. coli* in US



(USDA NAHMS studies, 2000; 2006; 2012)

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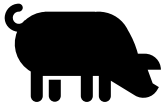
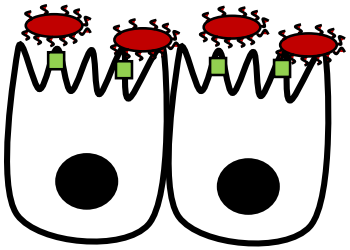
Pathogenesis of *E.coli*



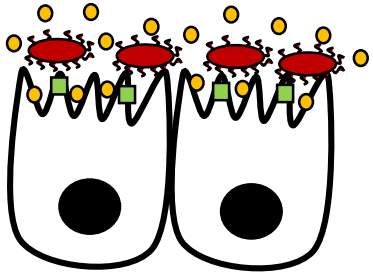
Ingestion of *E.coli*

Diarrhea
Death

Production/Economic loss



Attachment of the
E. coli to microvilli



Production of enterotoxins

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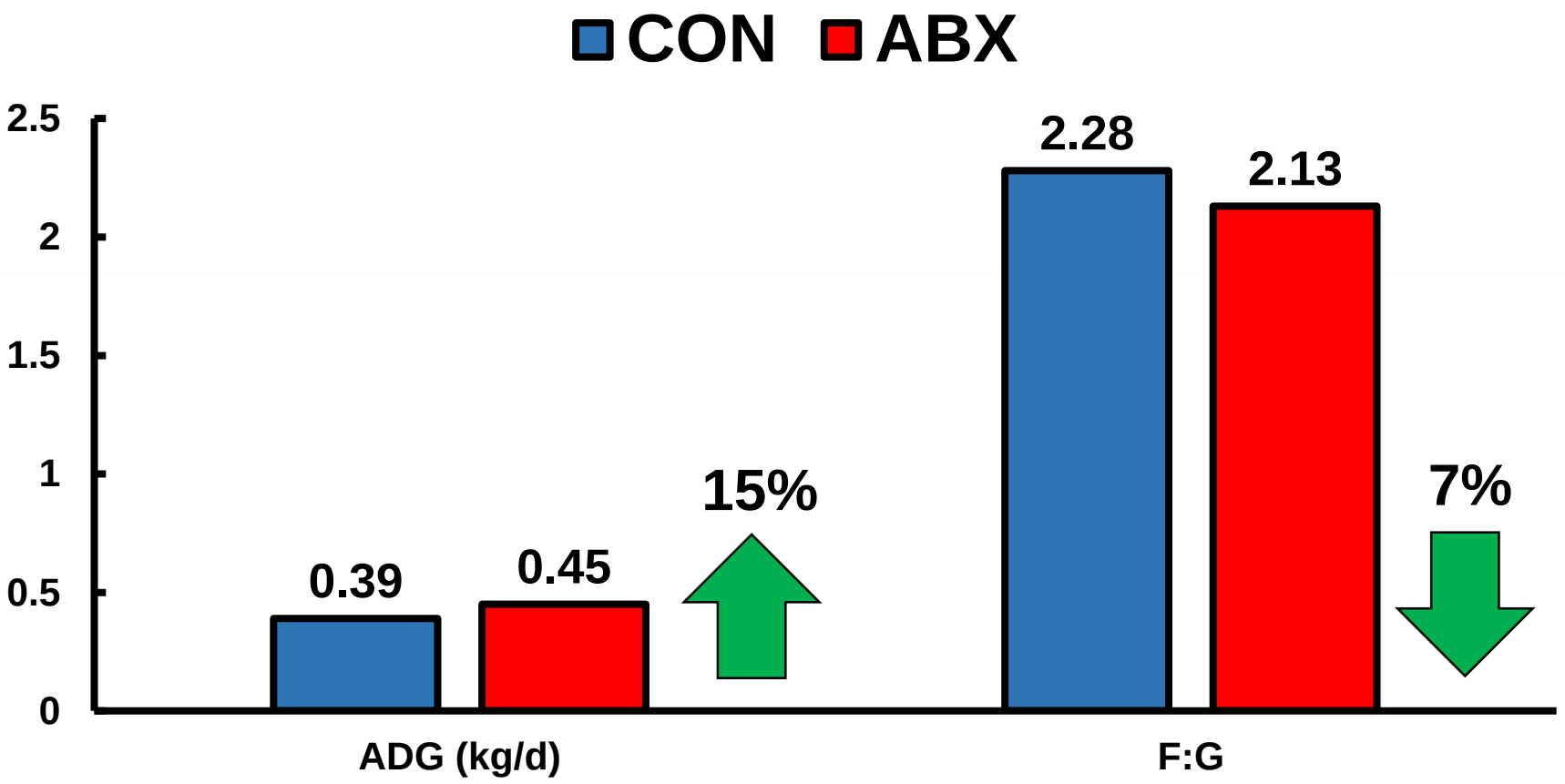
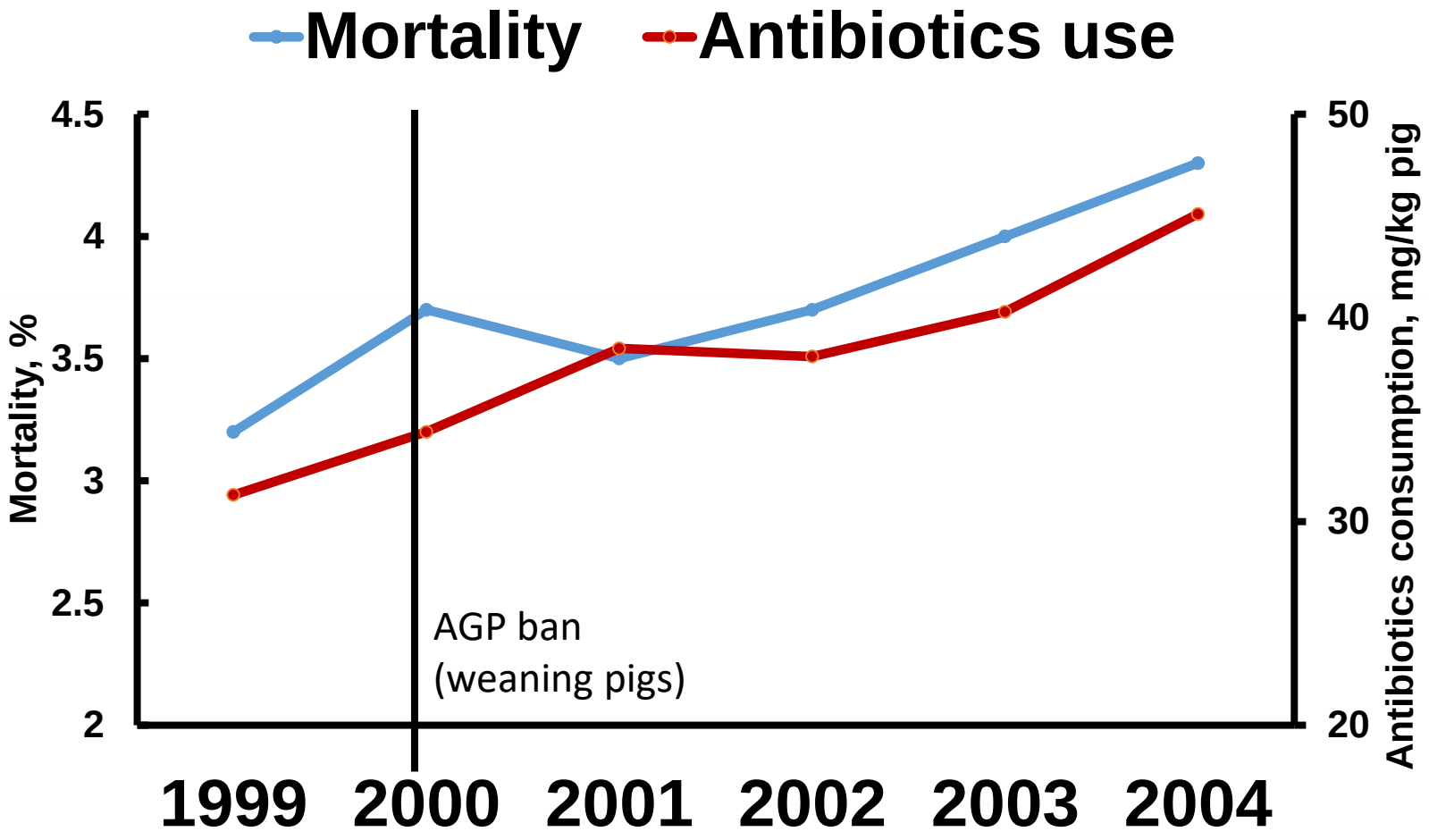
Antibiotics growth promoter



(Cromwell, 2002)

AGP ban in Denmark



(Aarestrup et al., 2009)

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Antibiotics alternatives - probiotics

- Live microorganisms confer a health benefit
- Modes of action
  - Competition for adhesion sites
  - Direct antagonism
    - Lactic acids – lowering pH
  - Modulation of immune system
    - Anti/pro-inflammatory cytokines
    - Immune cells population

(Kenny et al., 2011)

Bacillus subtilis

- Spore-forming *Bacillus spp.*
  - Resistance to harsh environment
  - Long term storage
- Favorable results
  - Reduced incidence of diarrhea
  - Improved intestinal epithelial barrier integrity

(*Bhandari et al., 2008; Yang et al., 2016*)

Objectives

- To investigate the effects of supplementation of *Bacillus spp.* to weaned pigs experimentally infected with an enterotoxigenic F-18 *E. coli*
  - Growth performance
  - Systemic immunity
  - Intestinal health

Materials and Methods

- 36 pigs: 21-d of age, BW = 7.61 ± 0.40 kg
- Individual pens
- 3 dietary treatments
  - Control (**CON**)
  - CON + *Bacillus subtilis* strain 1 (500 mg/kg*) (**PRO1**)
  - CON + *Bacillus subtilis* strain 2 (500 mg/kg*) (**PRO2**)
- 12 replicates/treatment

*500 mg/kg = 1×10^9 cfu/kg diet

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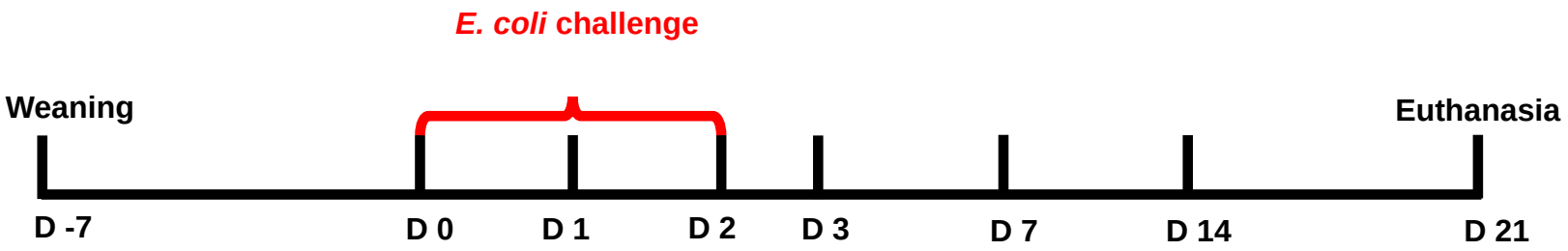
Materials and Methods



- Genotyping: F18 receptor
- Oral inoculation of F18 *E. coli*
  - LT, STb, SLT-2
  - 10^{10} cfu/dose with 3 doses
- Blood samples
  - Serum haptoglobin

Materials and Methods

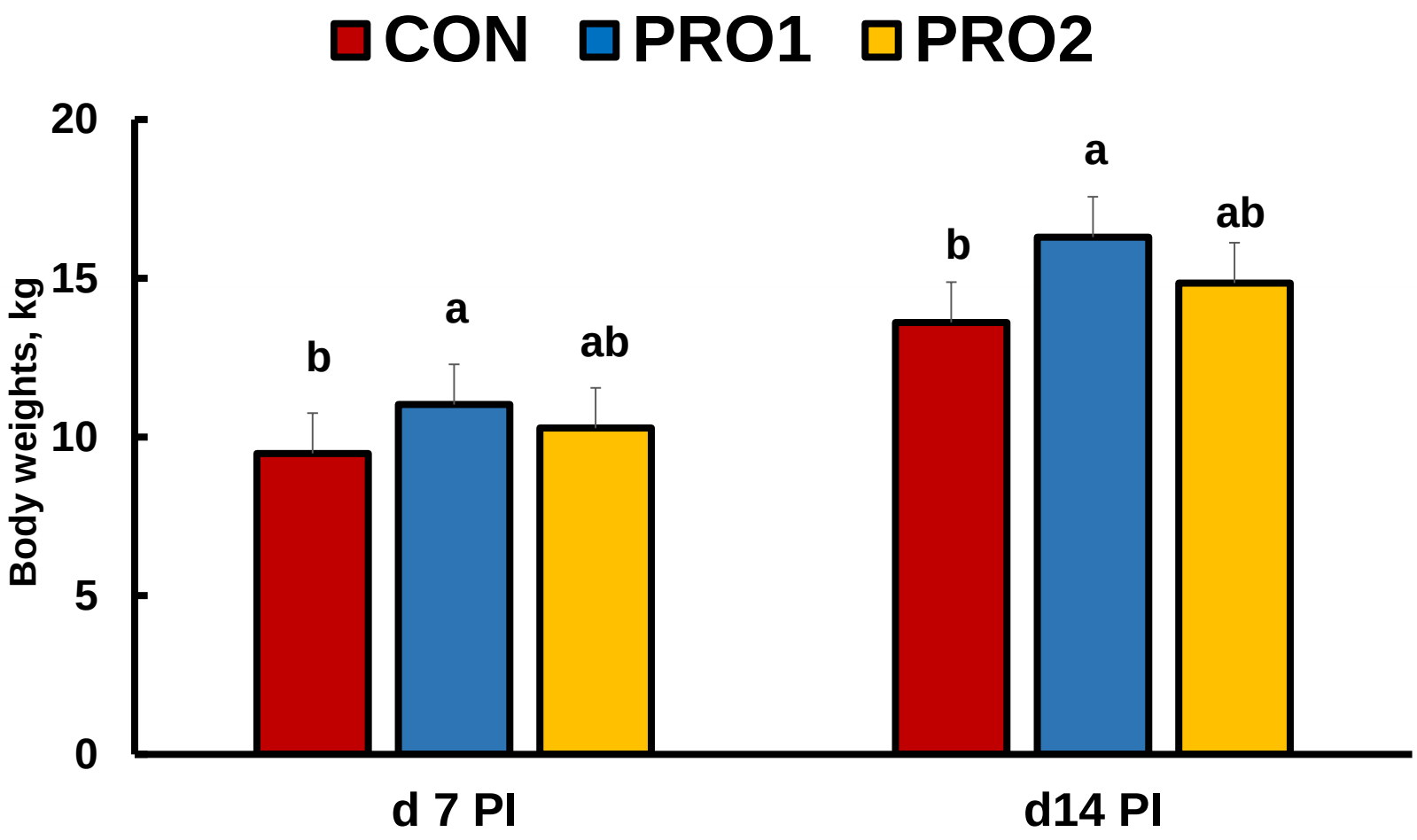
- Growth performance
  - Body weight
  - Average daily gain (ADG)
  - Average daily feed intake (ADFI)
  - Feed to gain ratio (FG)
- Daily diarrhea scores
- Duodenum, jejunum, and ileum
  - Gut morphology (Villi height and Crypt depth)
  - Mesenteric lymph nodes

Statistical analysis

- Mixed Procedure of SAS
- Randomized complete block (BW x Sex)
- Fixed effect: diet
- Random effect: block
- Significance at $P \leq 0.05$ and tendency at $P \leq 0.10$

Results

Body weights



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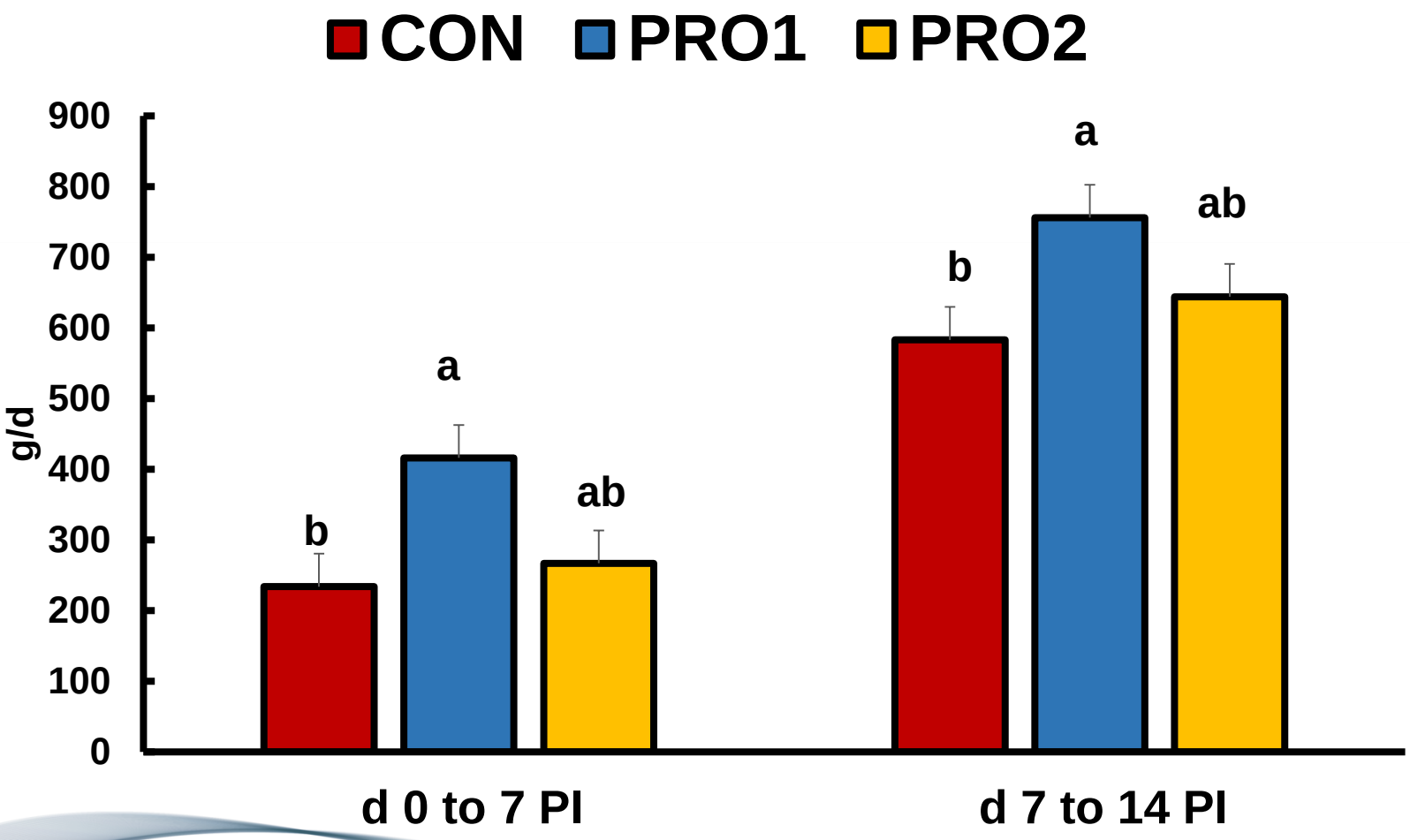
Average daily gain (ADG)



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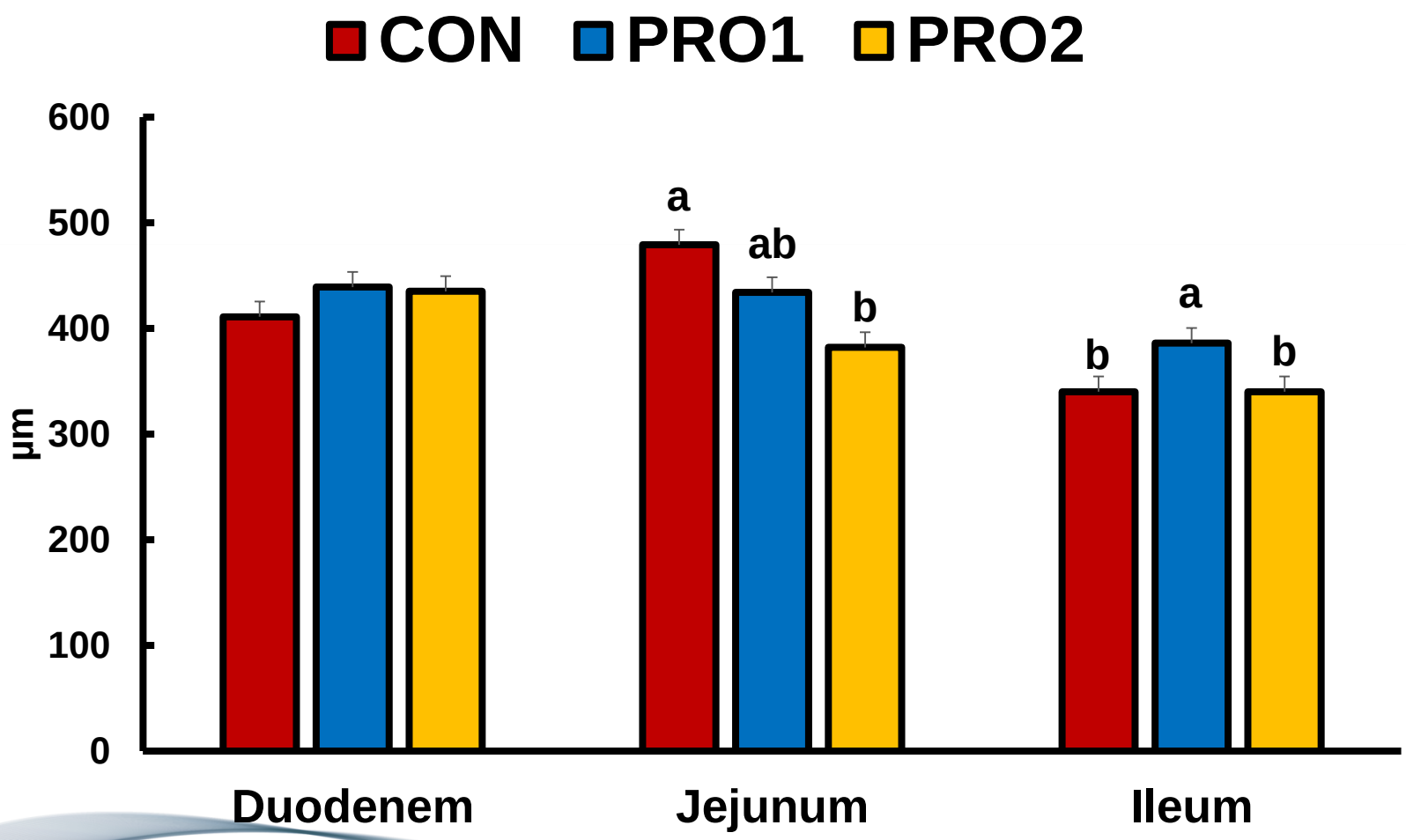
Villi height



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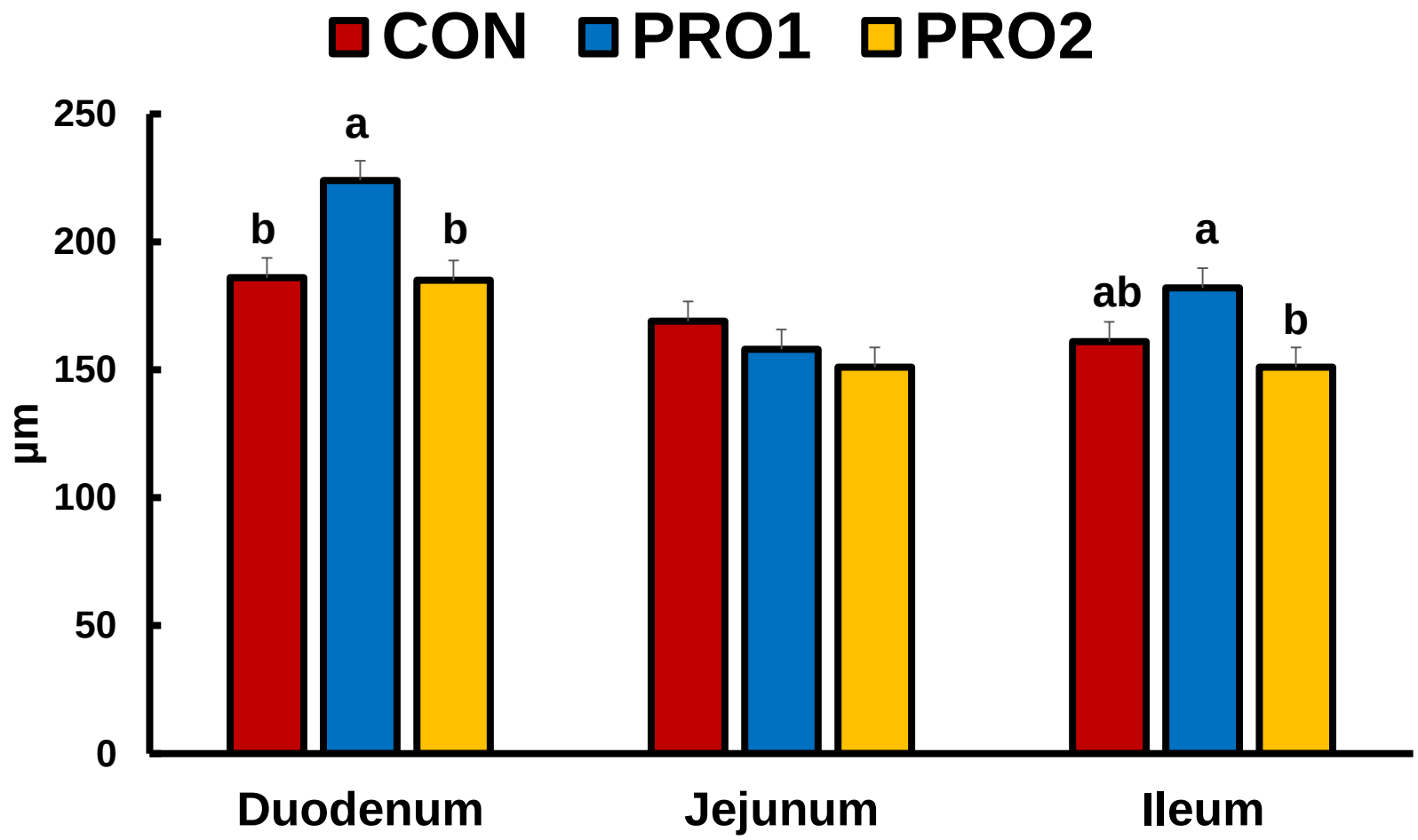
Crypt depth



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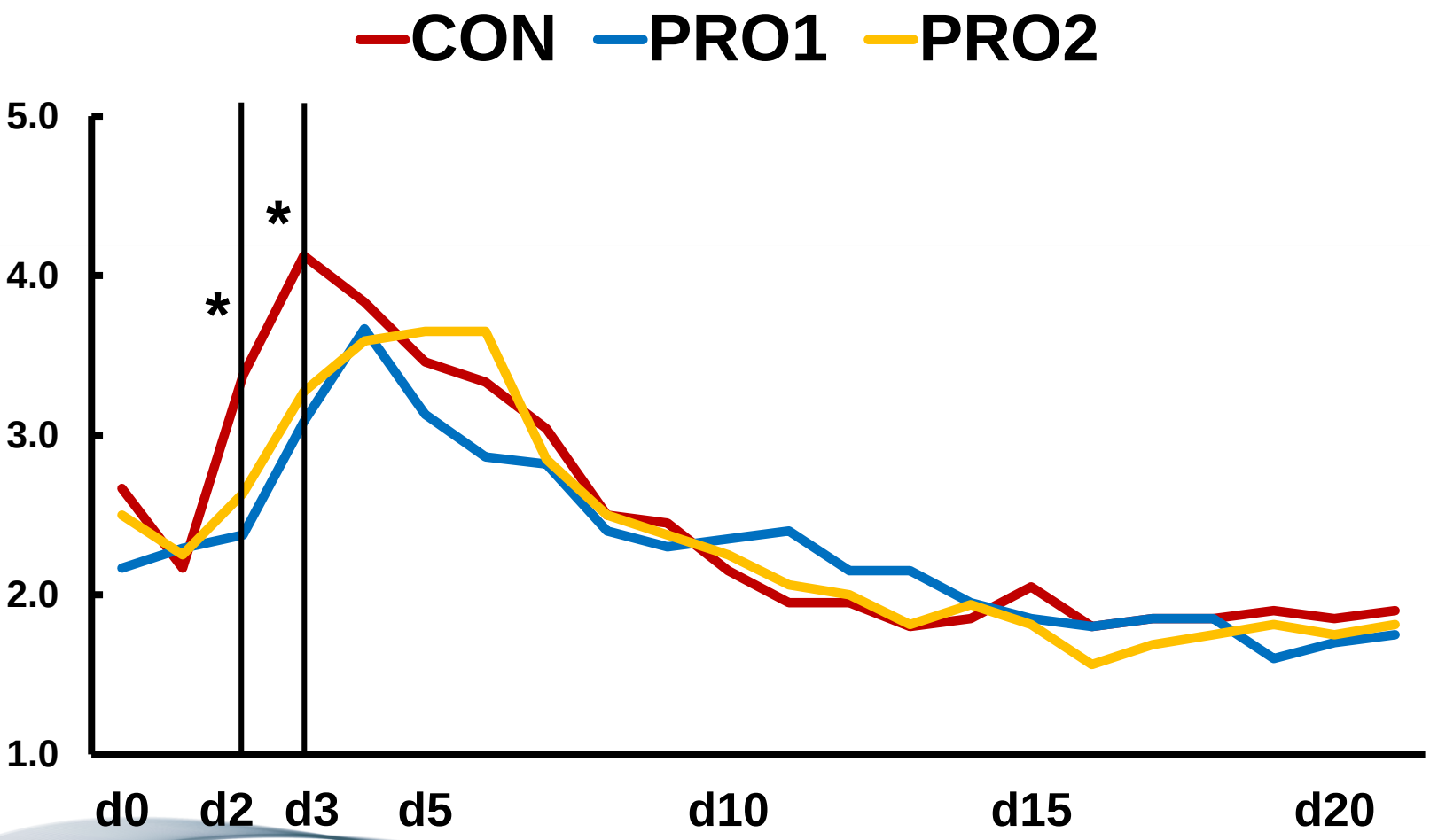
Daily diarrhea score



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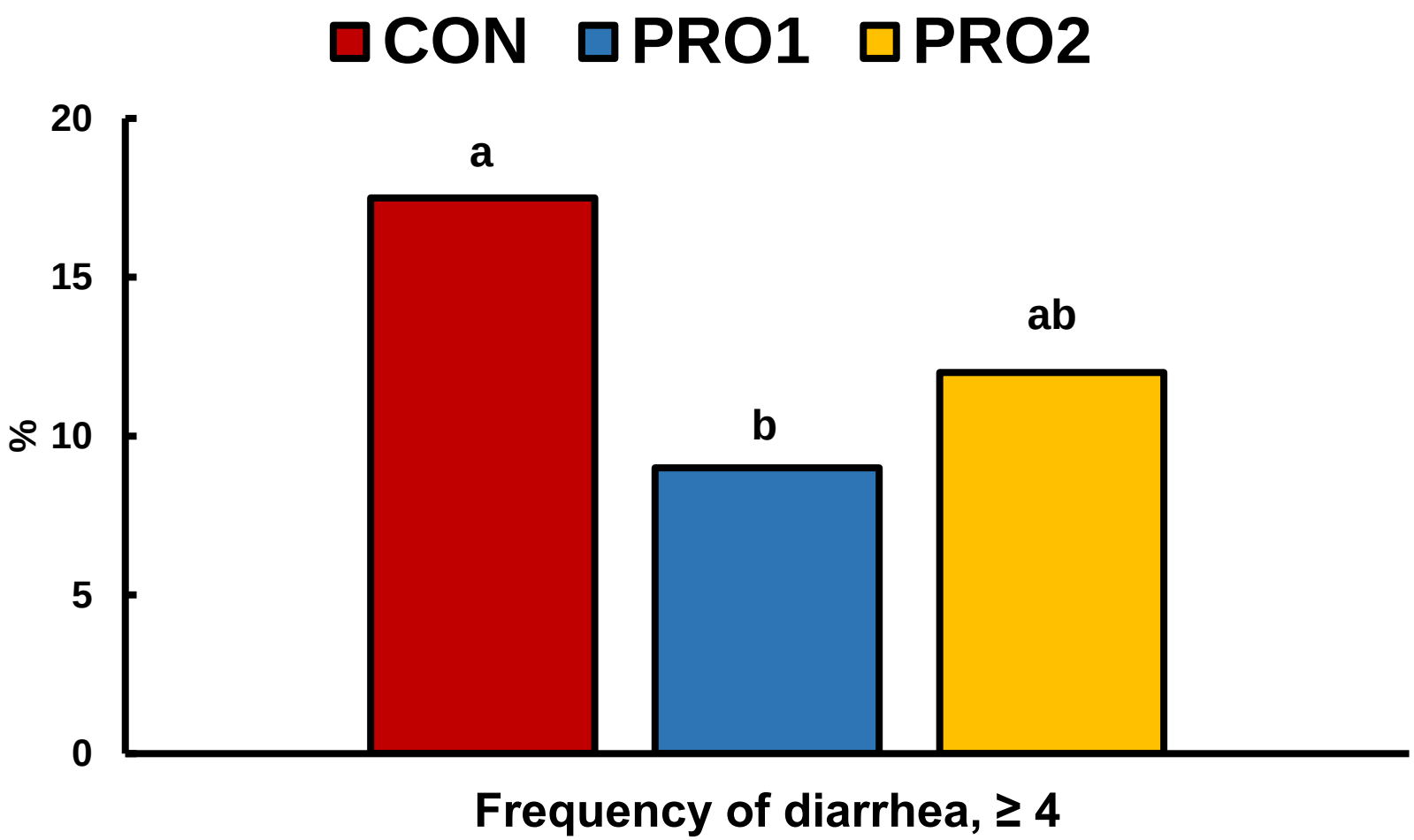
Frequency of diarrhea (d0 to d20)



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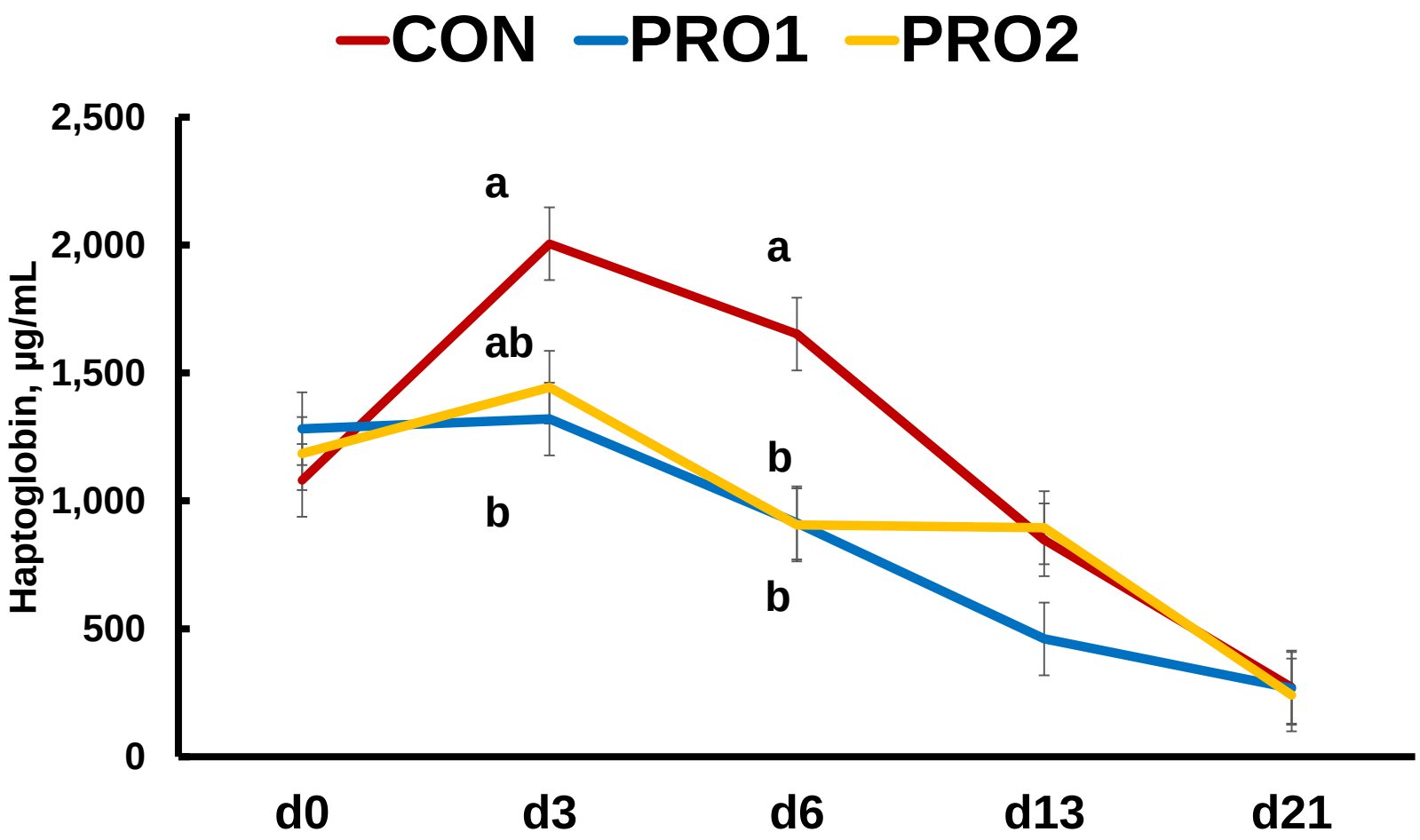
Serum haptoglobin



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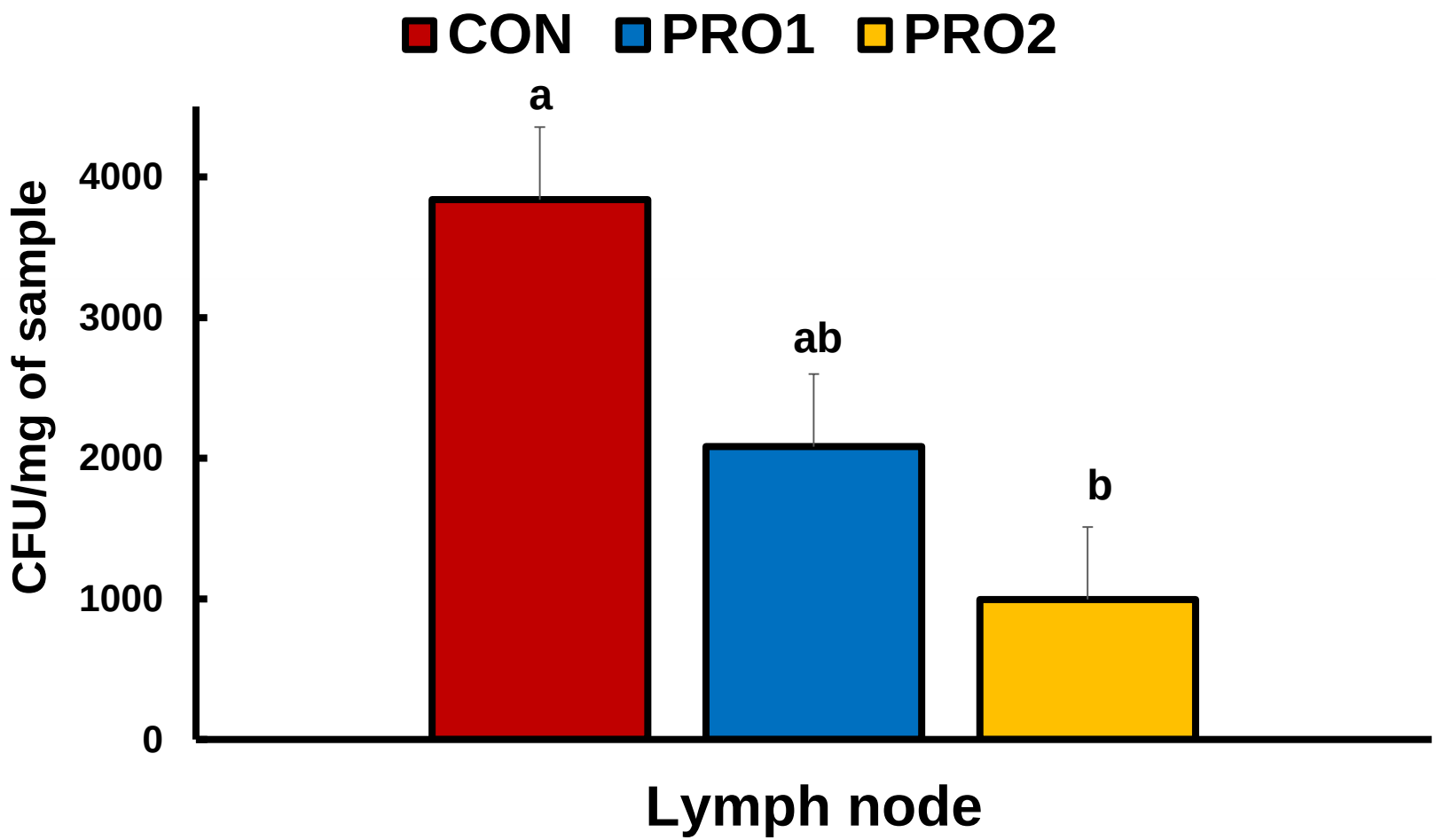
Total coliforms



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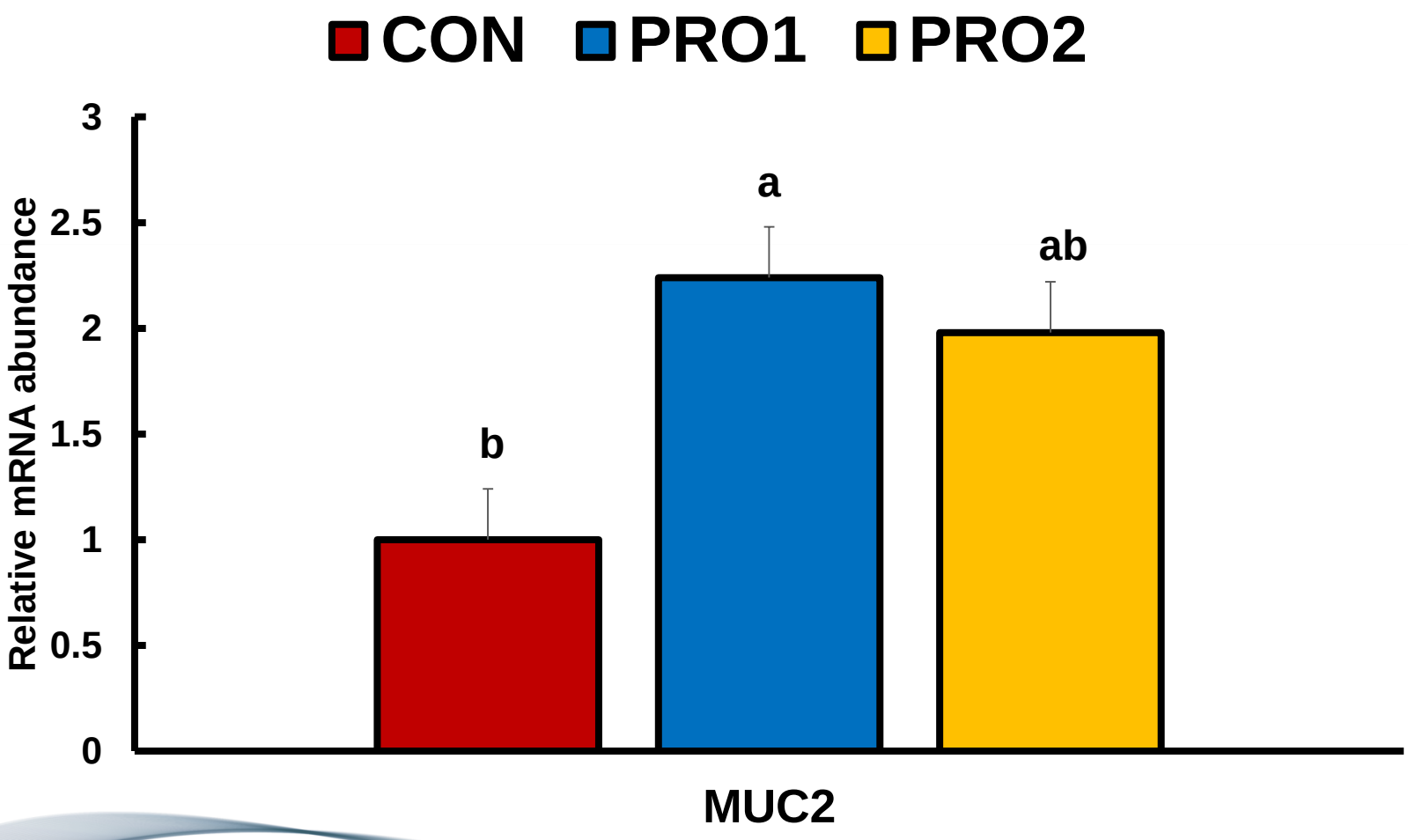
Jejunal MUC2



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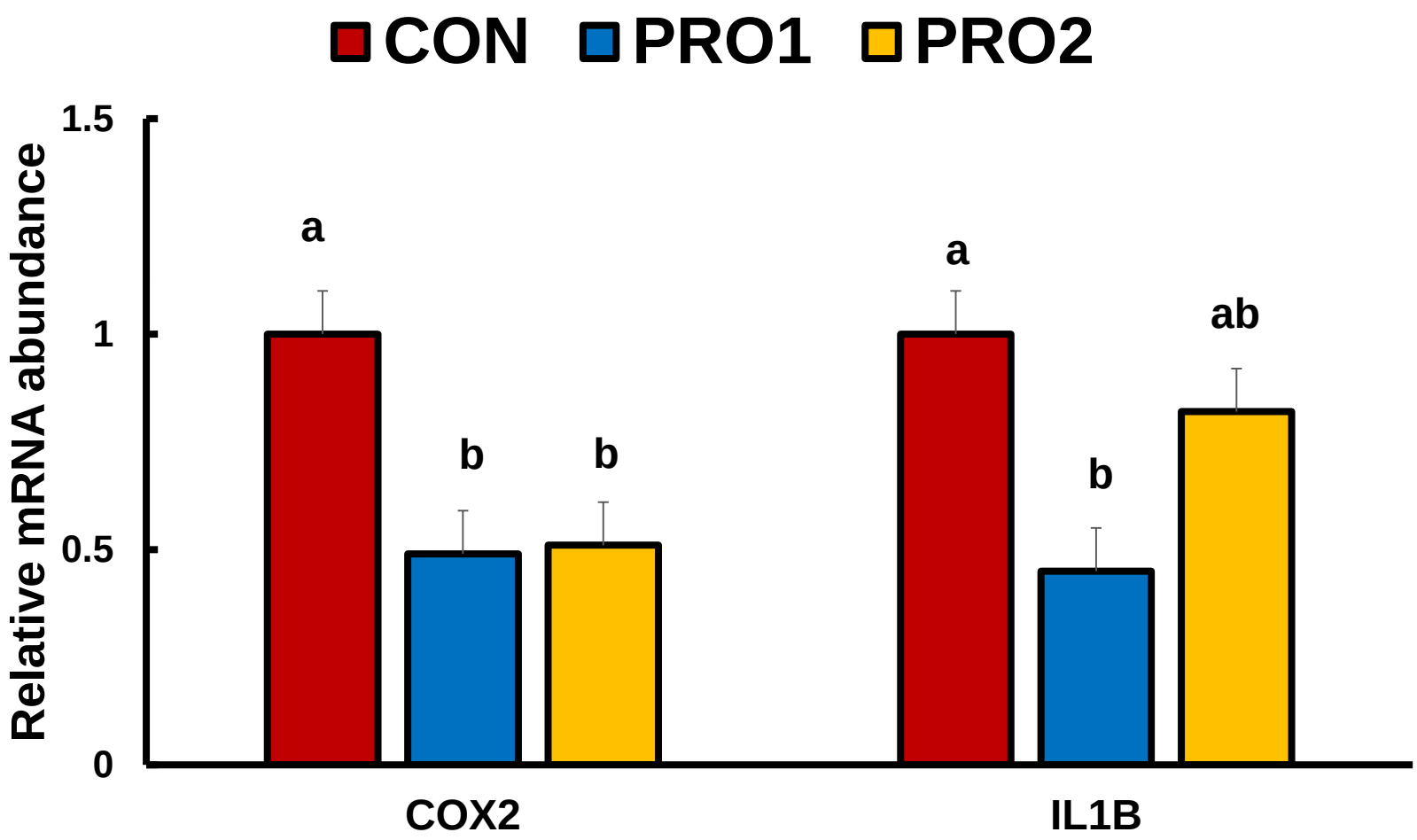
Ileal COX2 and IL1B



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Summary

	PRO1	PRO2
BW	↑	NS
ADG	↑	NS
Ileal villi height	↑	NS
Duodenal crypt depth	↑	NS
Diarrhea score	↓	↓
Frequency	↓	NS
Haptoglobin	↓	NS
MUC2	↑	NS
COX2	↓	↓
IL1B	↓	NS

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Conclusions

- *Bacillus subtilis* supplementation to *E. coli* challenged weaned pigs had improved*:*
  - Growth performance
  - Intestinal health

  And had reduced:
  - Systemic inflammation

Acknowledgement

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Thank you!