Effects of Bacillus subtilis probiotics on growth performance, diarrhea, and fecal ß-hemolytic coliforms of weaned pigs experimentally infected with an enterotoxigenic *Escherichia coli*

Yijie He[1], Kwangwook Kim[1], Cynthia Jinno[1], Minho Song[2], Xunde Li[1], and Yanhong Liu[1]

[1]University of California, Davis, CA,
[2]Chungnam National University

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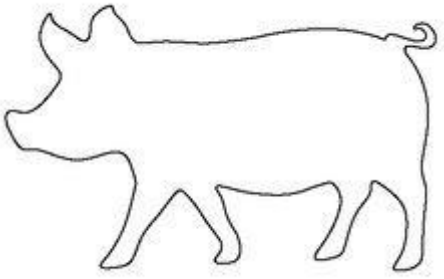
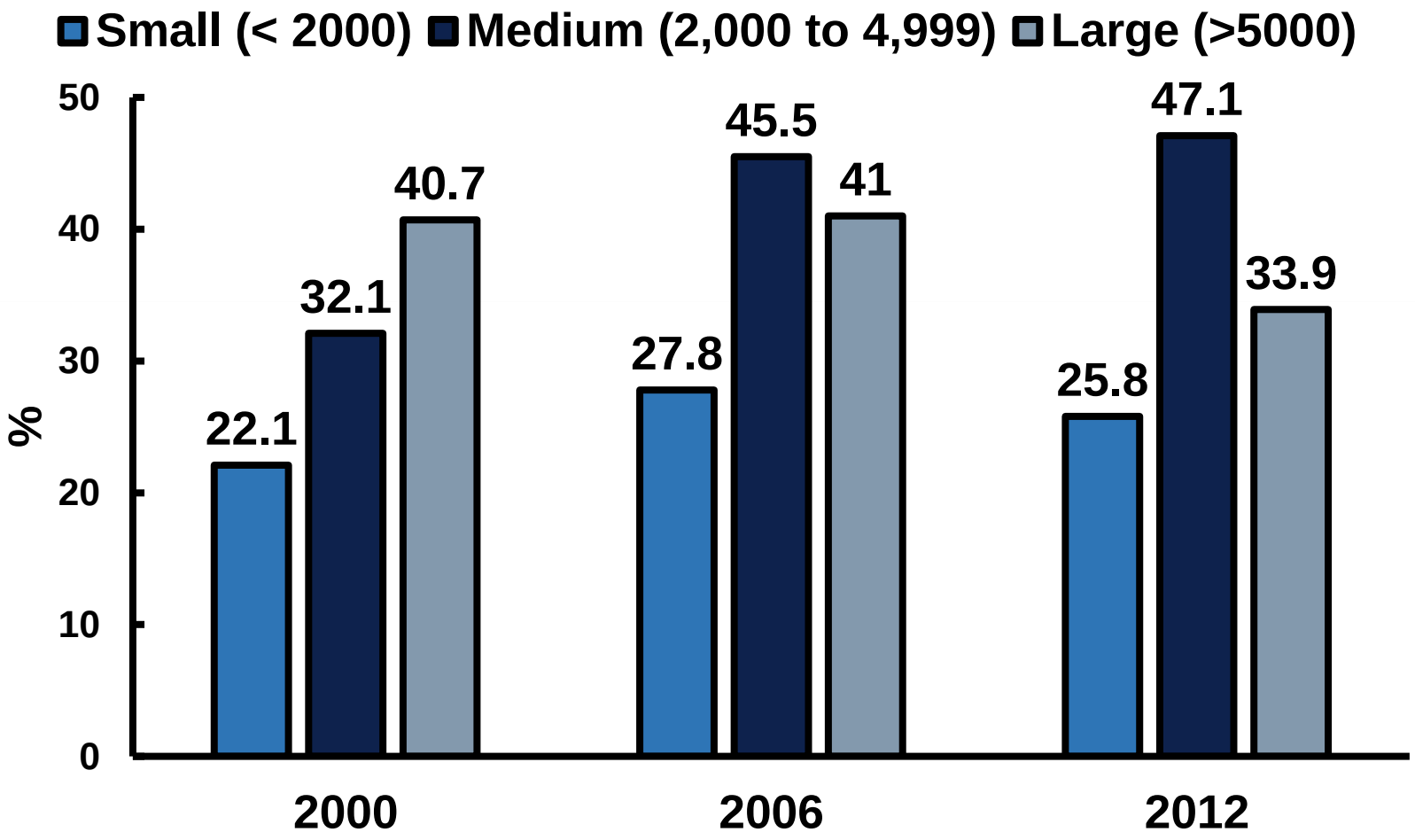
Introduction

- 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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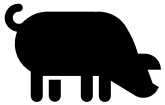
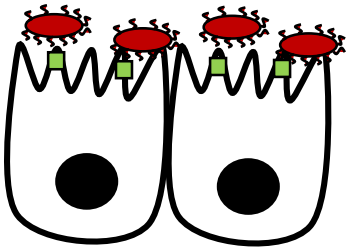
Pathogenesis of *E.coli*



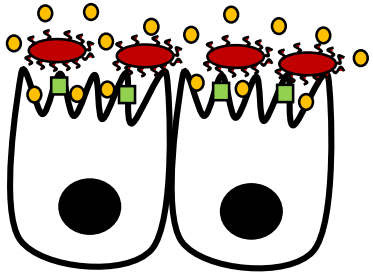
Ingestion of *E.coli*

Diarrhea
Death

Production/Economic loss



Attachment of the
E. coli to microvilli



Production of enterotoxins

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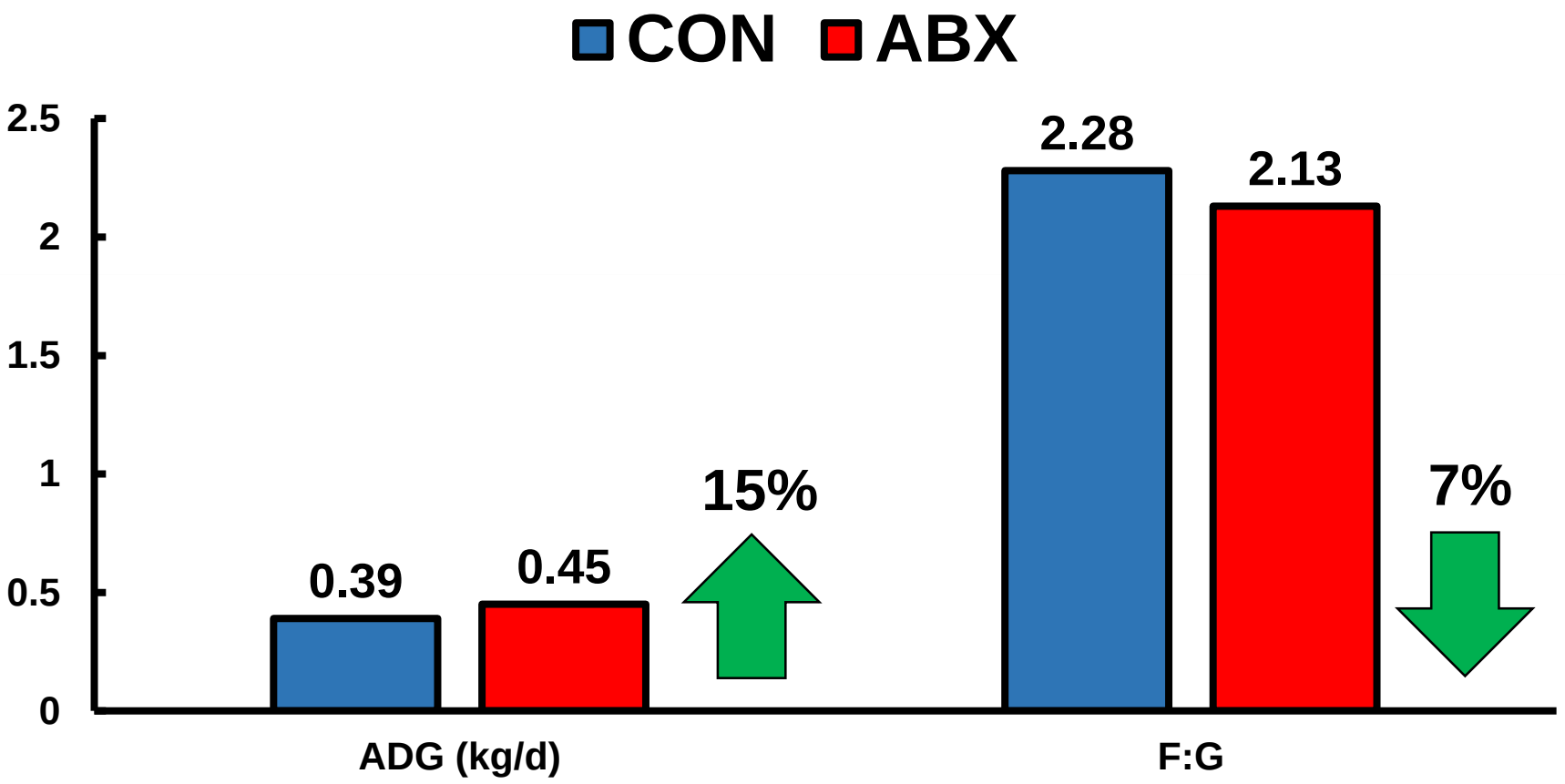
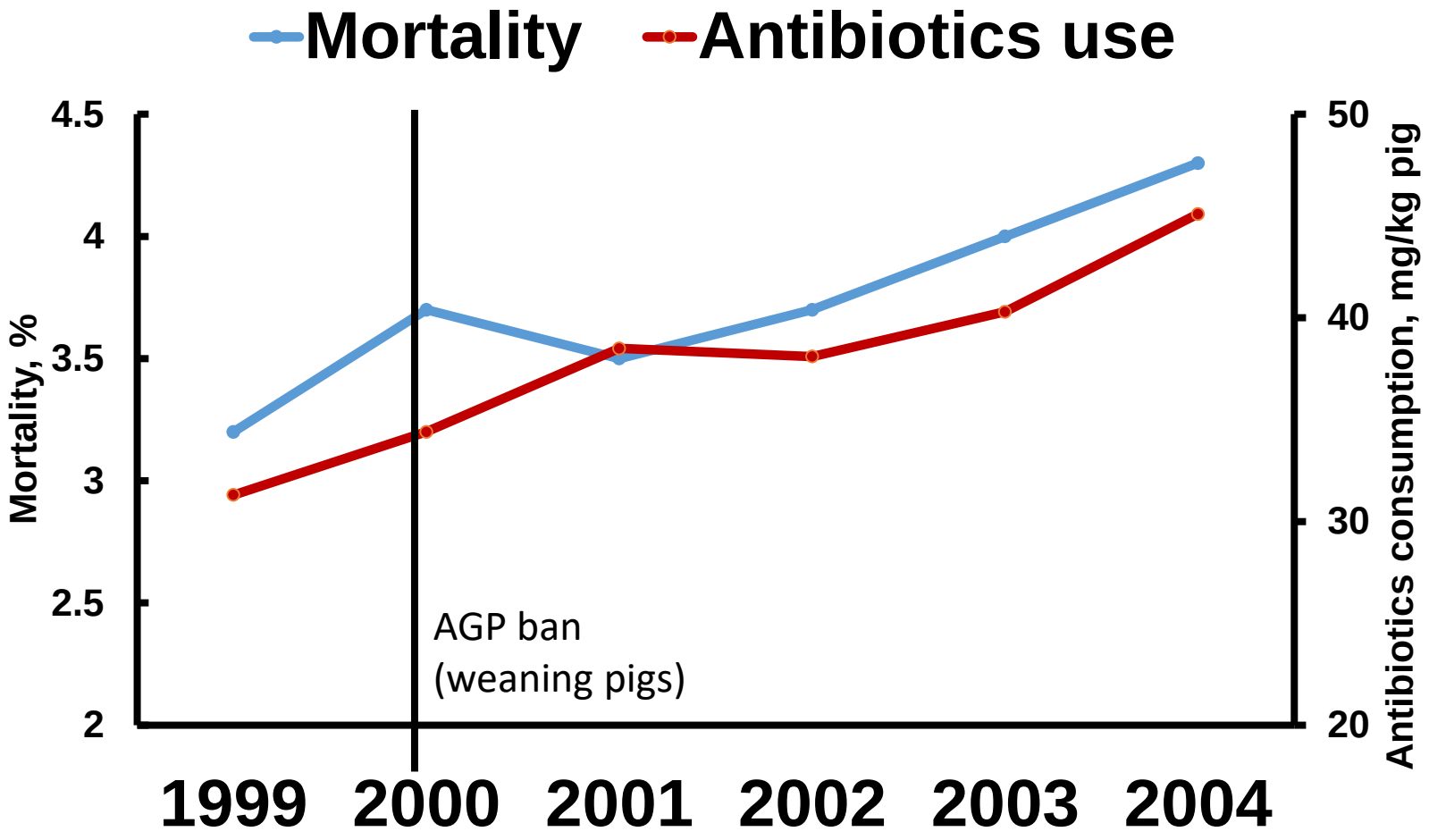
Antibiotics growth promoter



(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

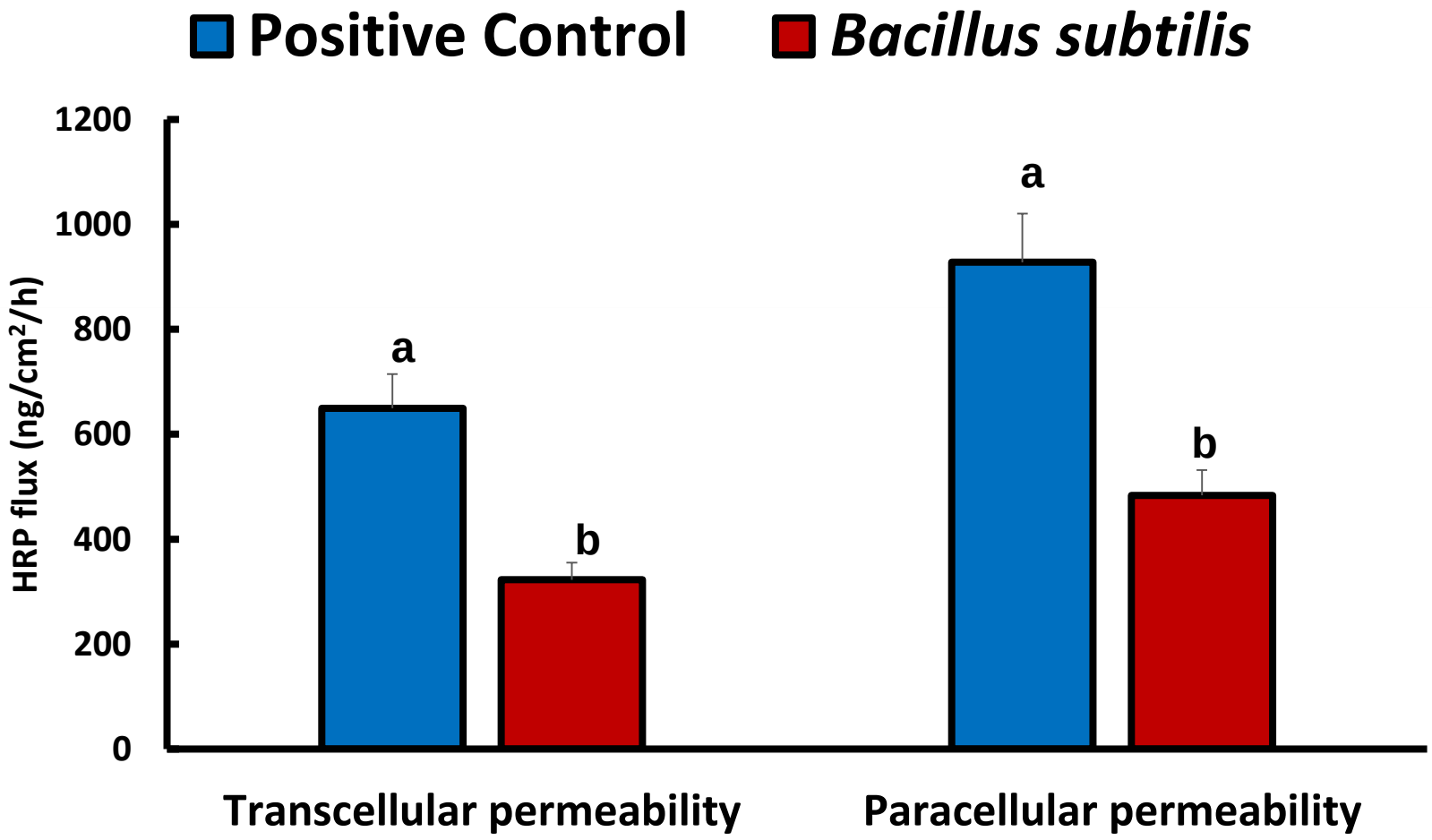
(Kenny et al., 2011)

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*)

Bacillus subtilis reduce gut permeability



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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

- 48 pigs: 21-d of age, BW = 6.17 ± 0.36 kg
- Individual pens
- 4 dietary treatments
  - Negative Control (**NC**)
  - Positive Control (**PC**)
  - CON + Carbadox (50 mg/kg*) (**AGP**)
  - CON + *Bacillus subtilis* (500 mg/kg*) (**PRO**)
- 12 replicates/treatment

*500 mg/kg = 1×10^9 cfu/kg diet

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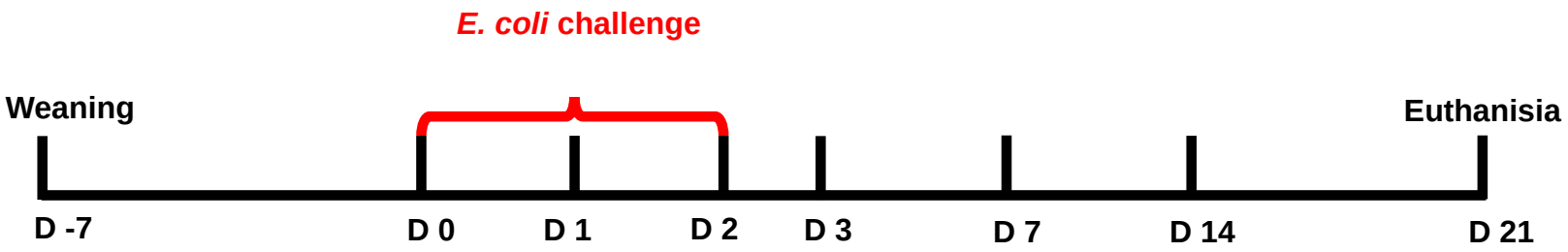
Materials and Methods



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

Materials and Methods

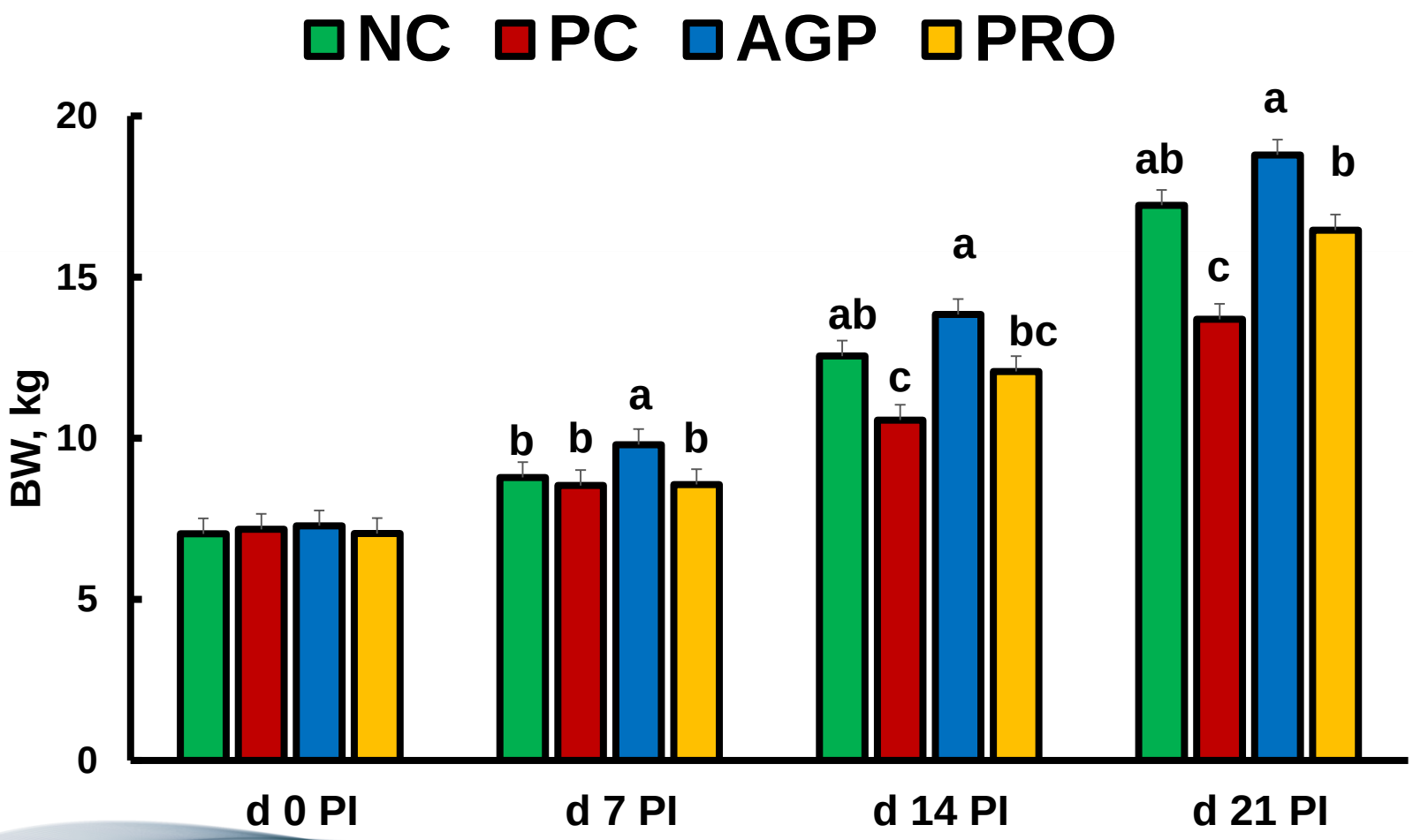
- Growth performance
  - Body weight
  - Average daily gain (ADG)
  - Average daily feed intake (ADFI)
  - Feed to gain ratio (FG)
- Daily diarrhea scores
- jejunum and ileum
  - Jejunal tight junction protein mRNA expression
  - Ileal pro-inflammatory cytokine mRNA expression

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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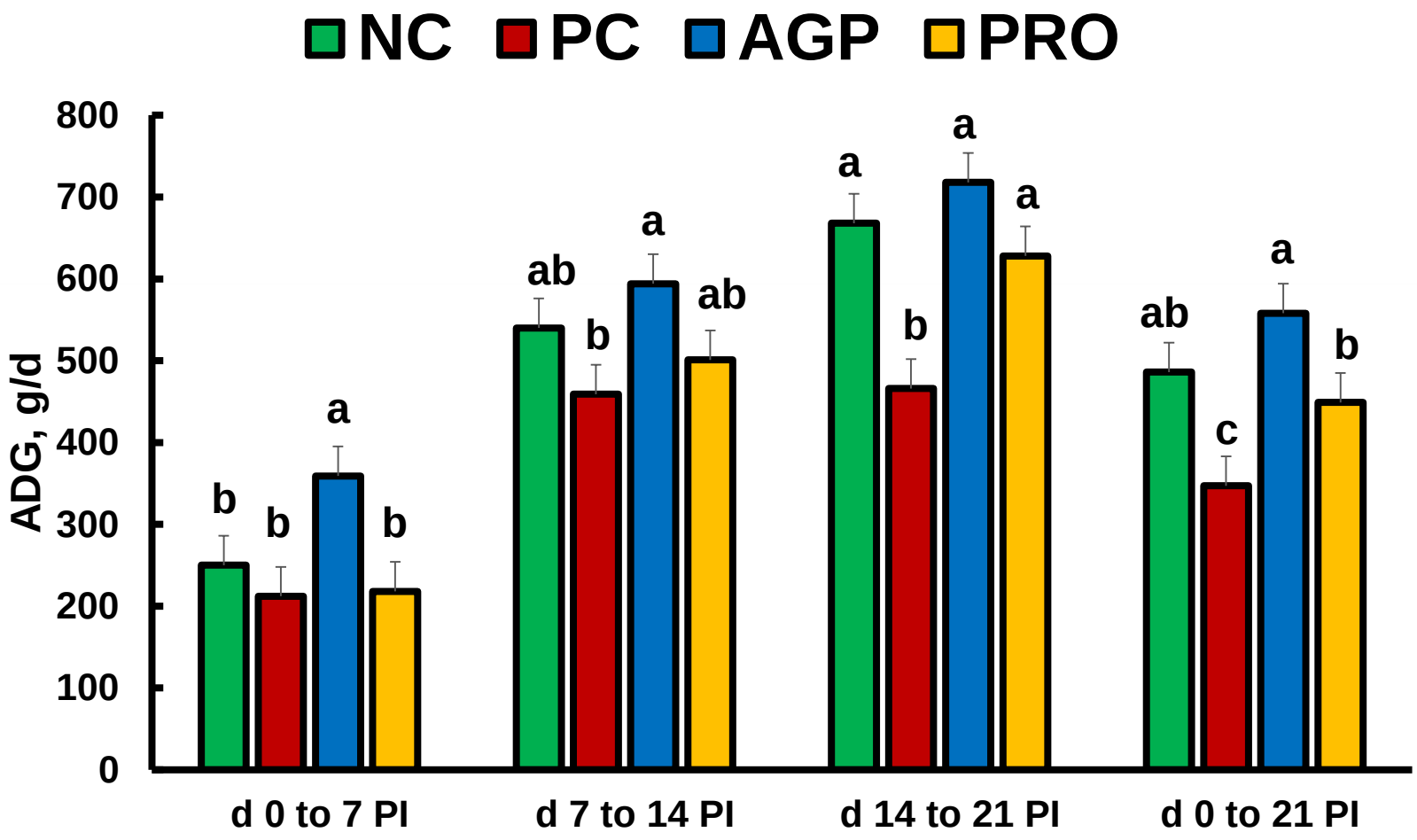
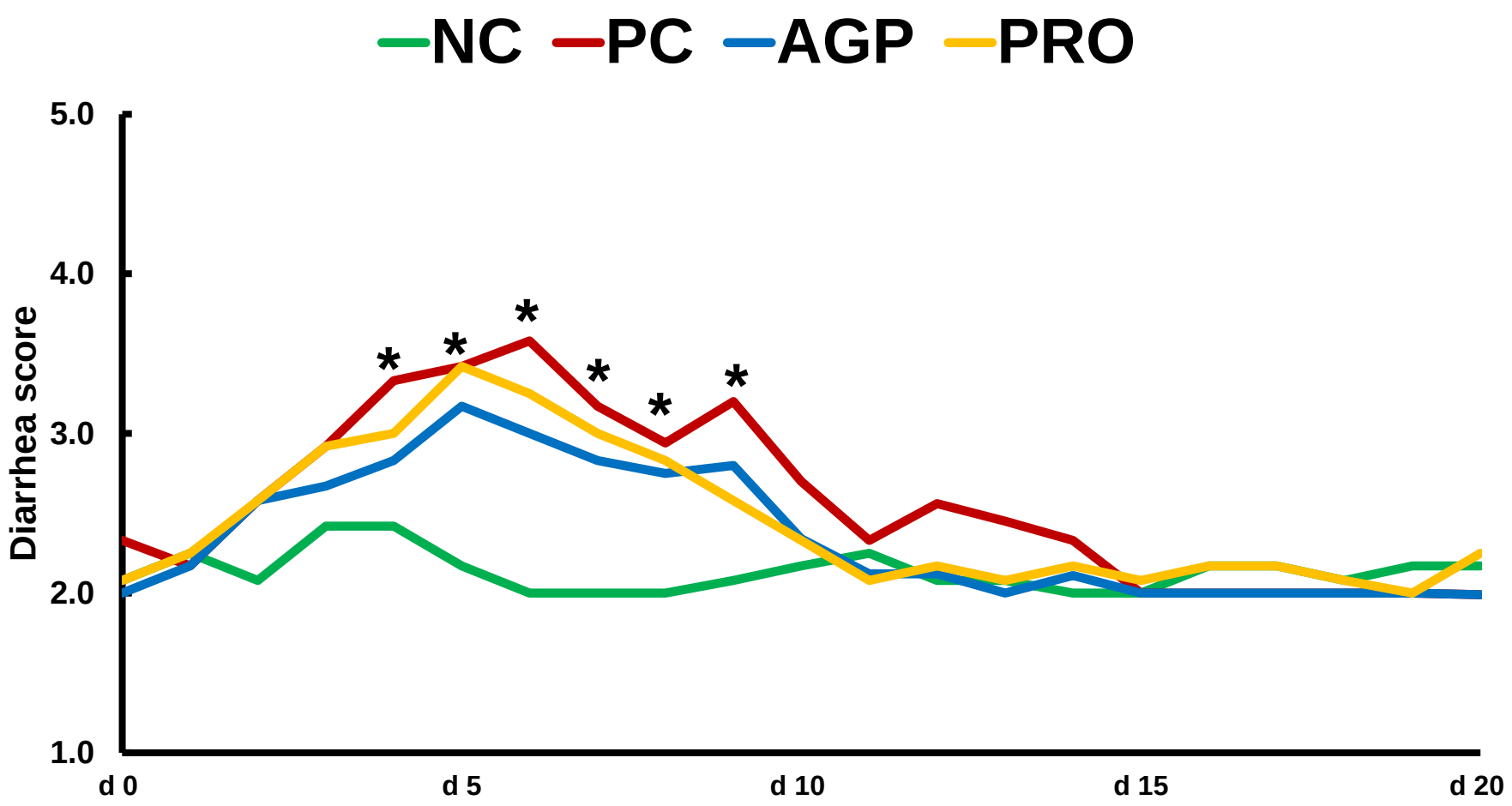
Average daily gain (ADG)



Daily diarrhea score



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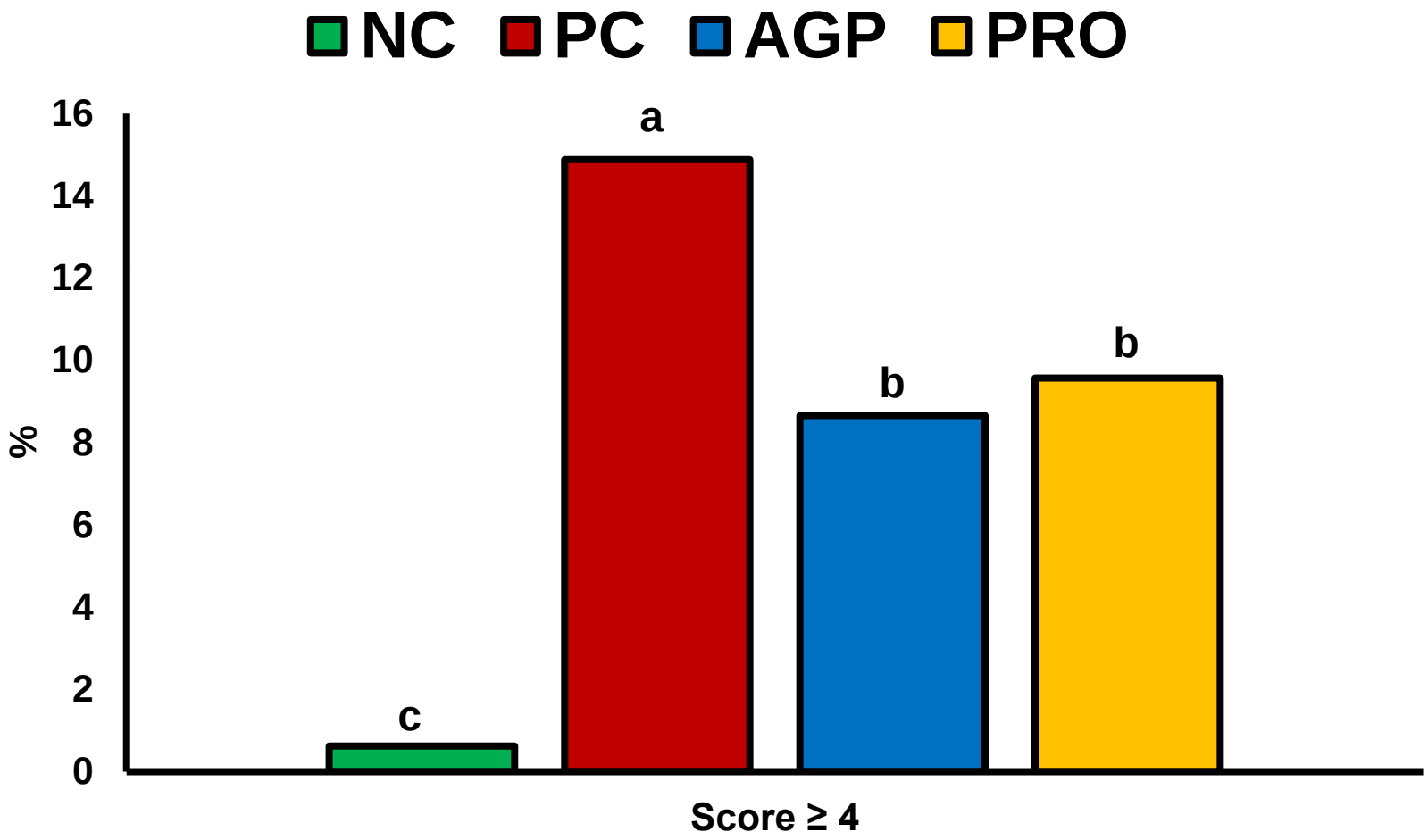
Frequency of diarrhea (d0 to d20)



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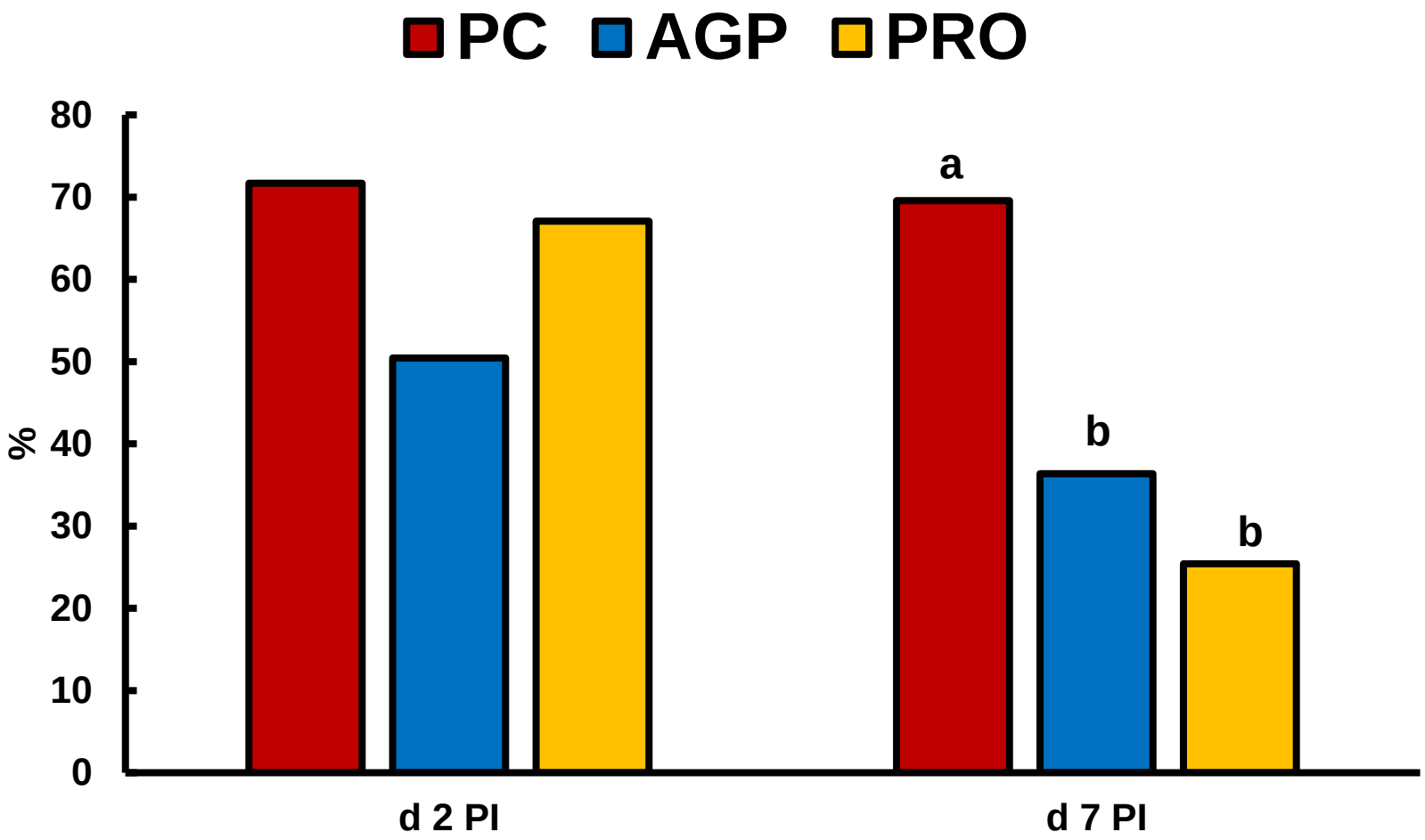
β - hemolytic coliforms



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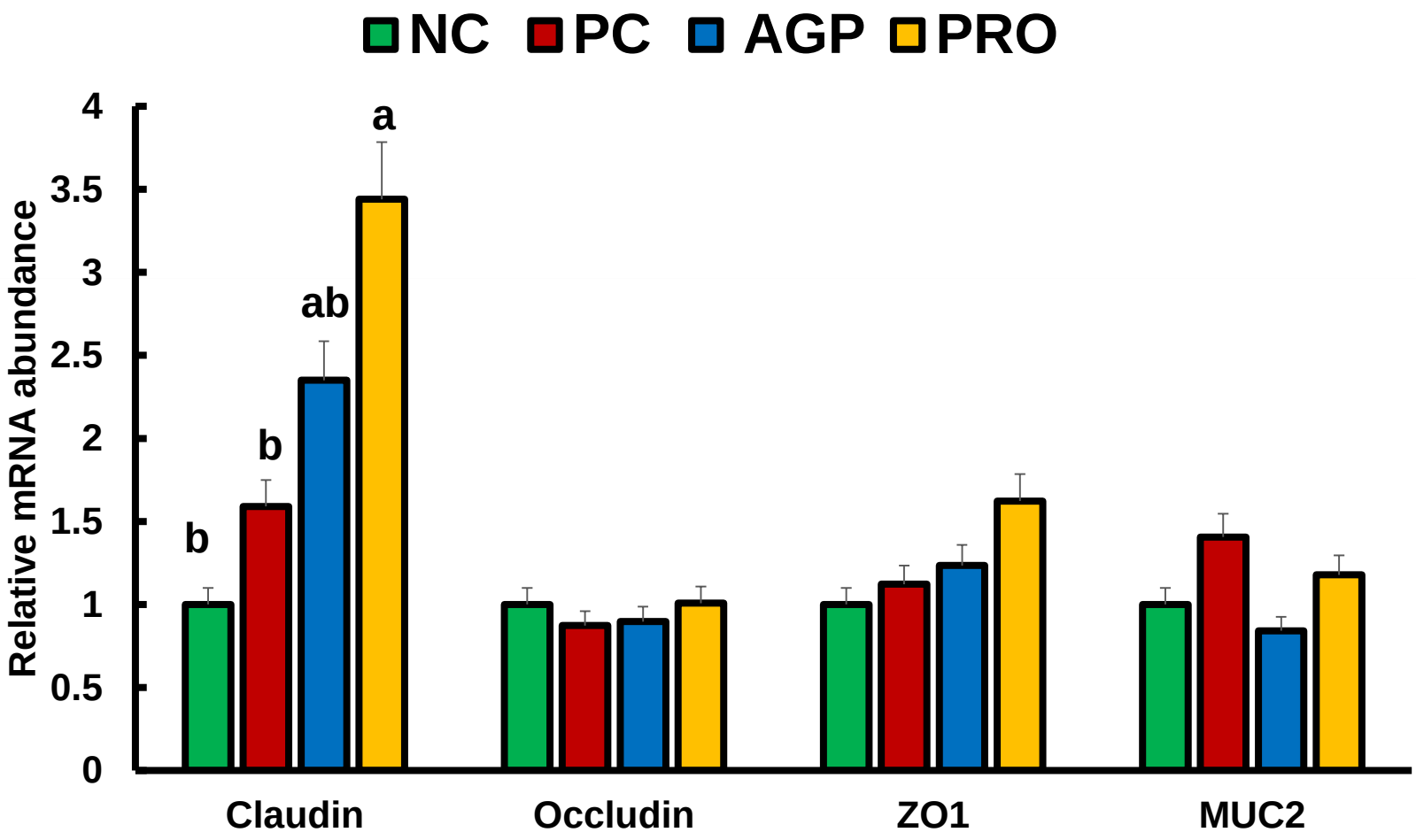
Tight junction protein in jejunum



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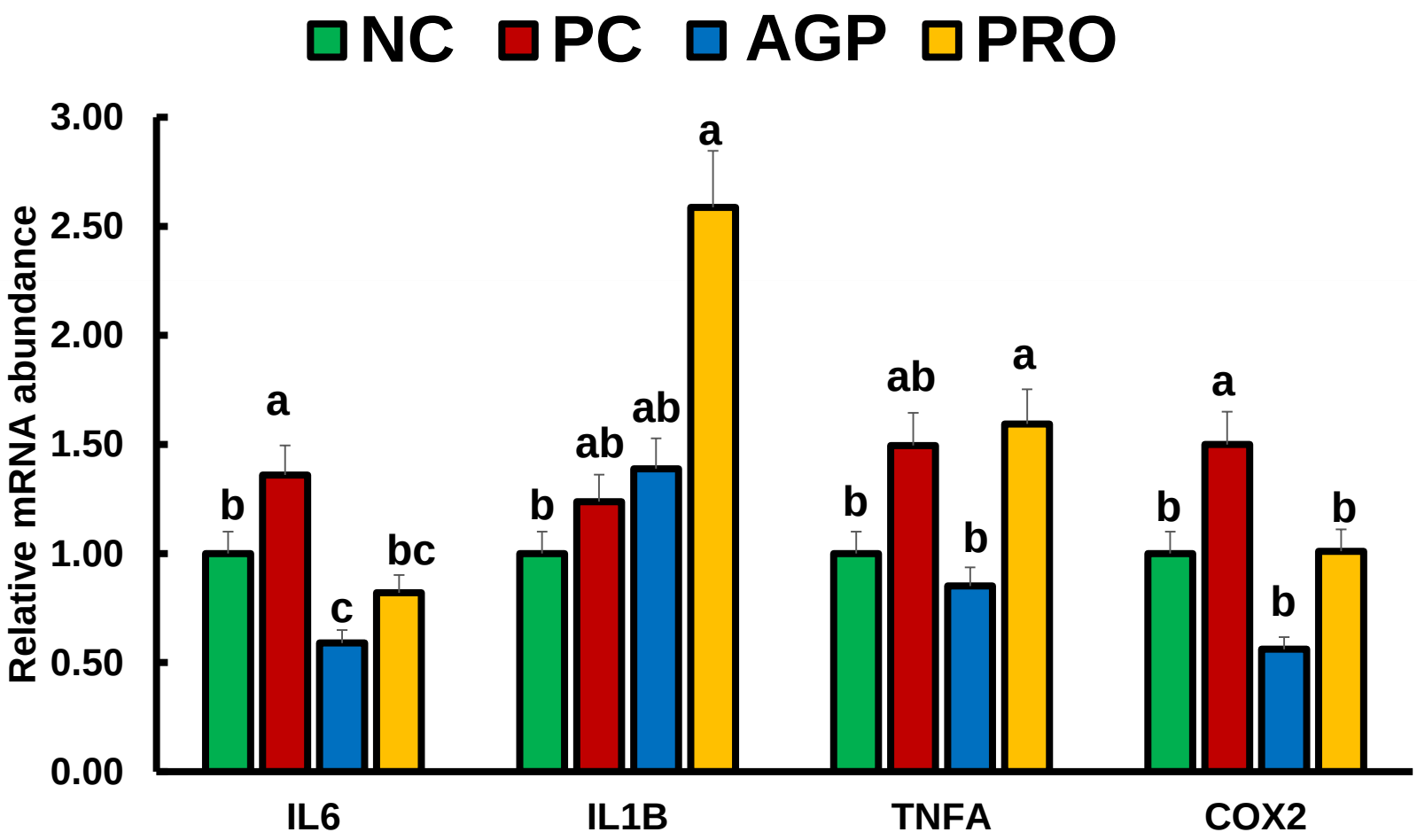
Proinflammatory cytokines in ileum



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Summary

	AGP	PRO
BW	↑	↑
ADG	↑	↑
Feed efficiency (overall)	↑	↑
Diarrhea score	↓	↓
Frequency	↓	↓
β - hemolytic coliforms	↓	↓
Claudin	NS	↑
IL6	↓	↓
COX2	↓	↓
IL1B	NS	NS

Conclusions

- *Bacillus subtilis* and carbodox supplementation to *E. coli* challenged weaned pigs reduced:
  - Diarrhea score and frequency

and improved*:*

- Growth performance
- Intestinal health

Acknowledgement

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Thank you!