Supplementation of *Bacillus subtilis* Combined with Plant Extracts Effect on Growth Performance and Post-weaning Diarrhea in Pigs

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Abstract 230

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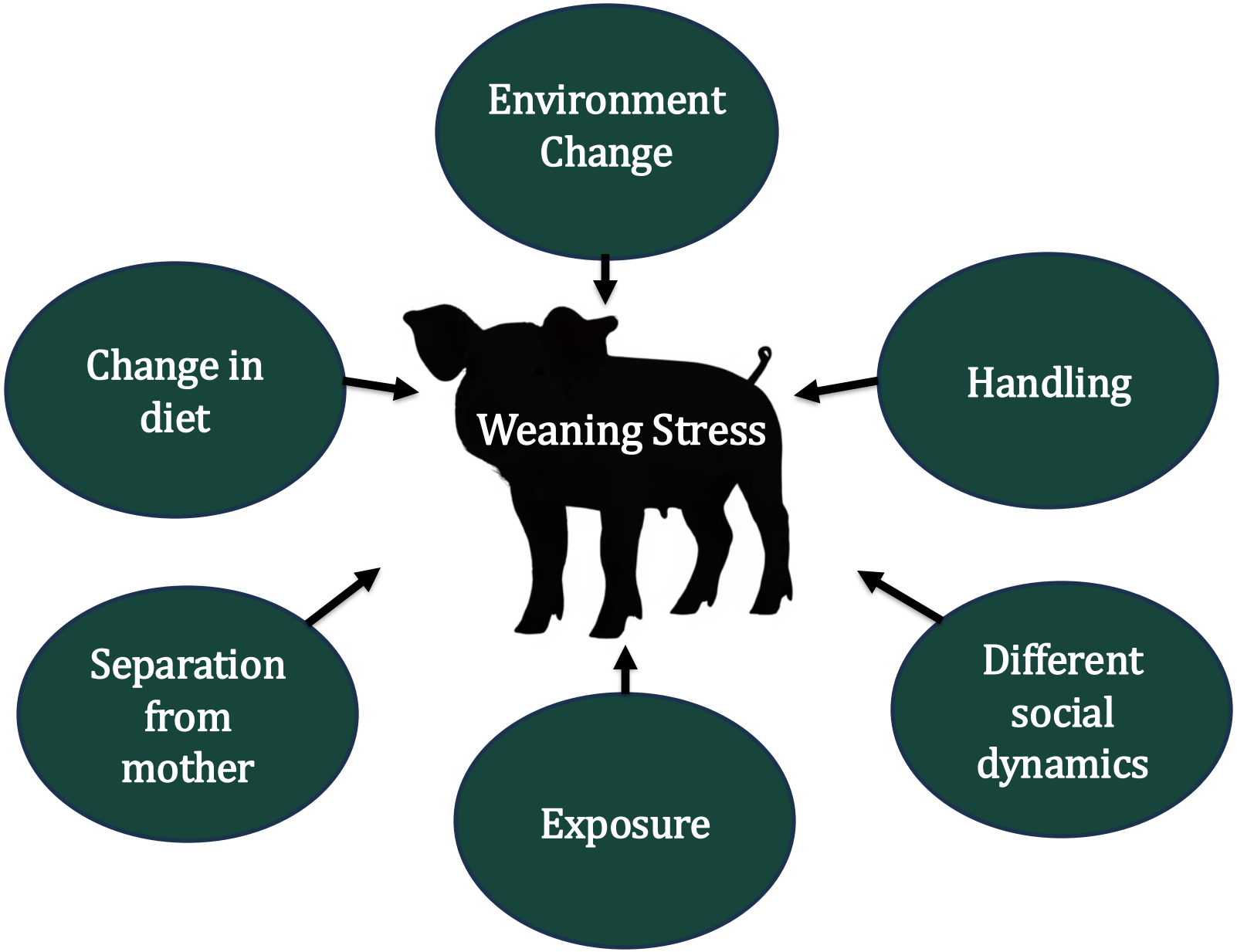
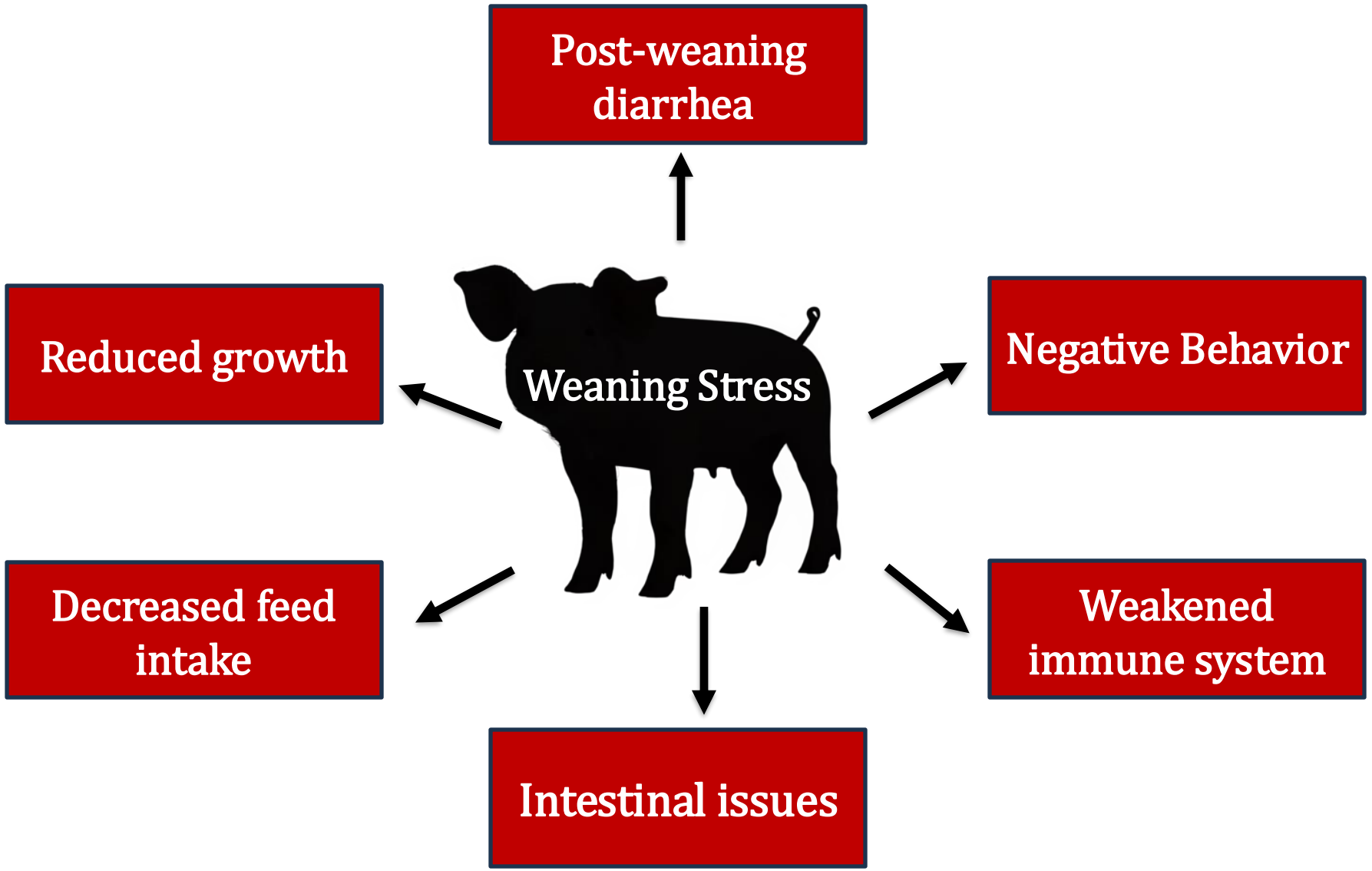
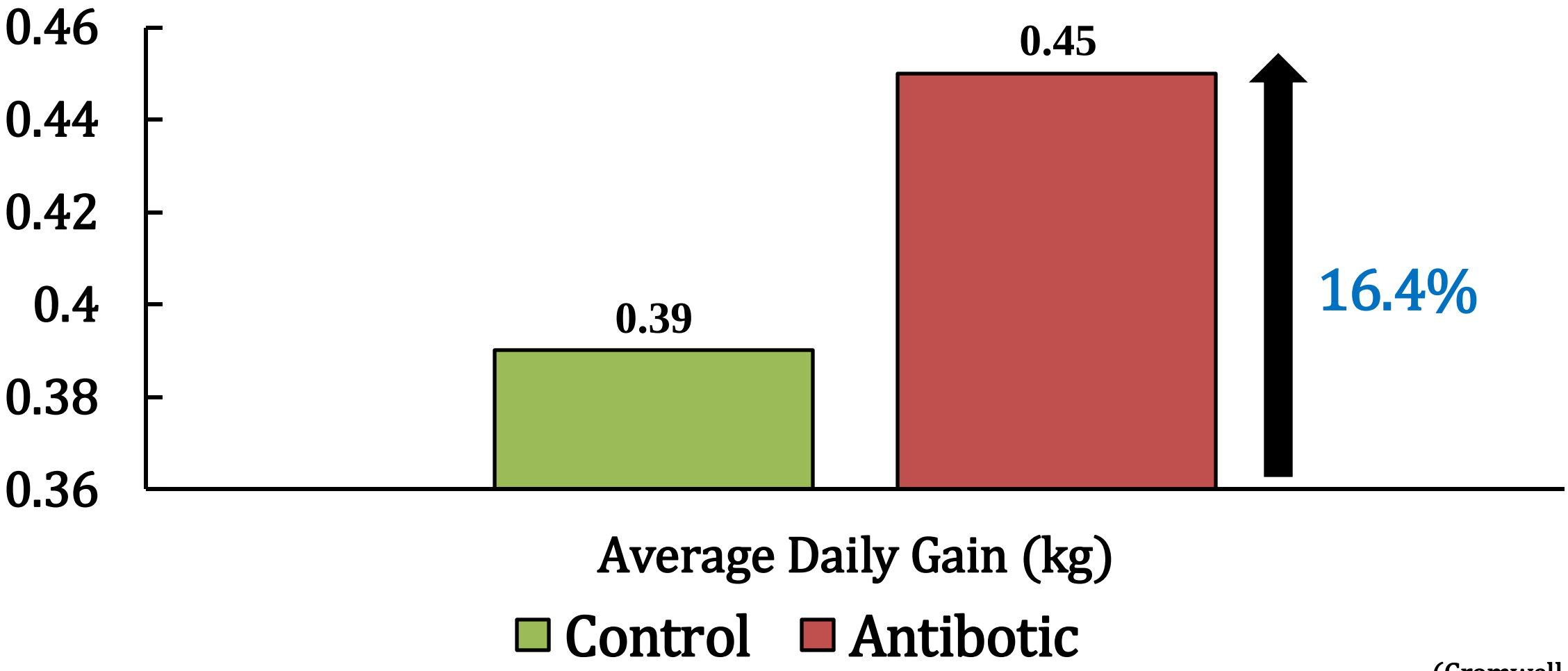
Outline

- Introduction
  - ✓ Weaning Stress
  - ✓ Antibiotics
  - ✓ Feed Additives
- Objective & Hypothesis
- Results & Conclusion
- Future Research


Environment Change
Change in diet
Handling
Weaning Stress
Separation from mother
Different social dynamics
Exposure

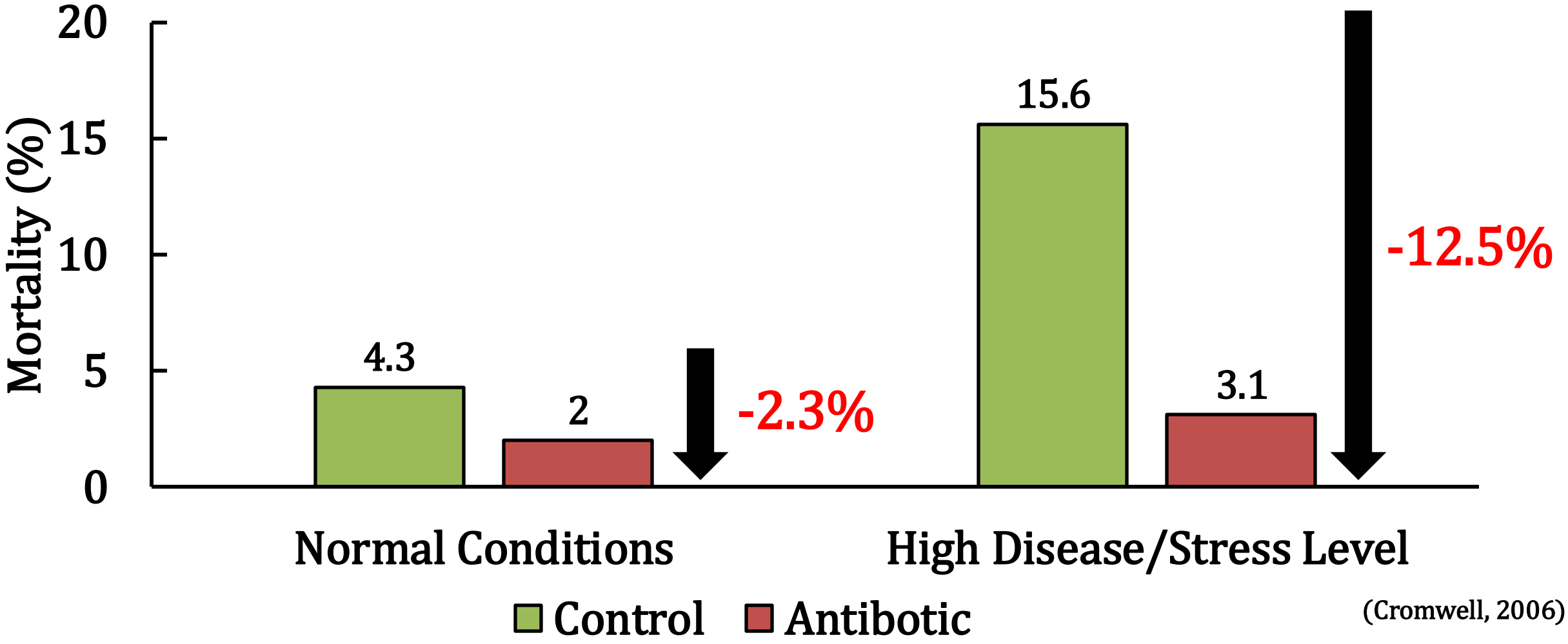

Post-weaning diarrhea
Reduced growth
Weaning Stress
Negative Behavior
Decreased feed intake
Weakened immune system
Intestinal issues

In-Feed Antibiotics in Starting Phase (7-25 kg)



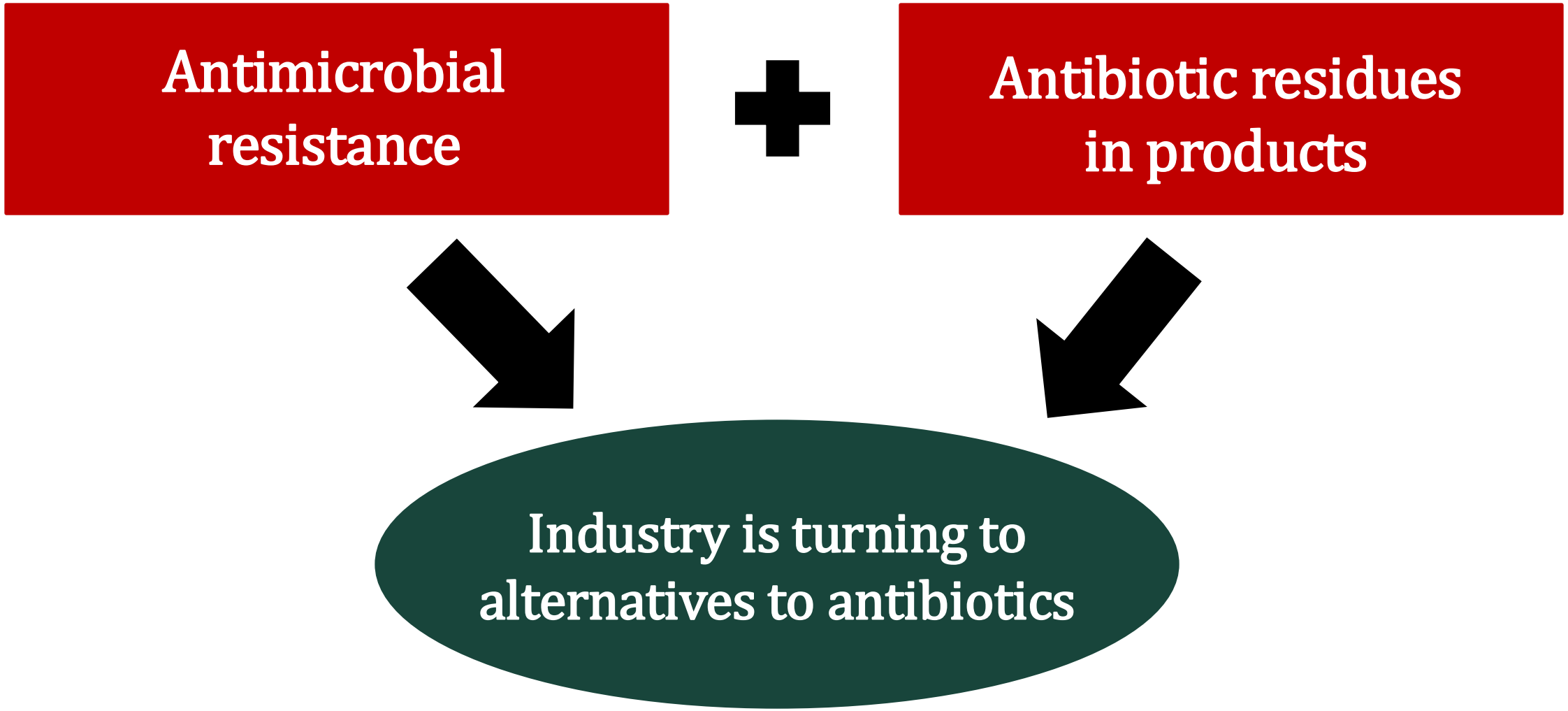
(Cromwell, 2006)

Effects of In-Feed Antibiotics on Mortality of Young Pigs

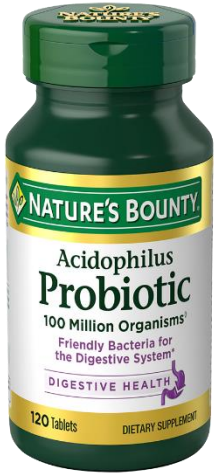


(Cromwell, 2006)

Concerns on Antibiotic Use



Potential Alternative to Antibiotics



Direct-fed microbials

- Known as probiotics
- Live beneficial bacteria
- Improve microbial balance, digestion, and immune system

(Jacela JY, DeRouchey JM, Tokach MD, et al. 2010)

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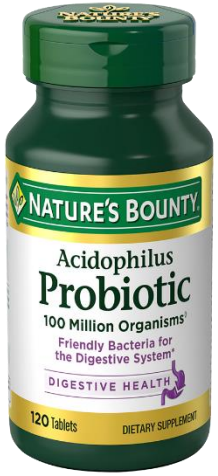

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Effectiveness

- Stable
- Ability to replicate
- Block growth of harmful bacteria

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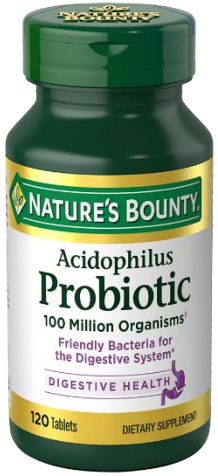

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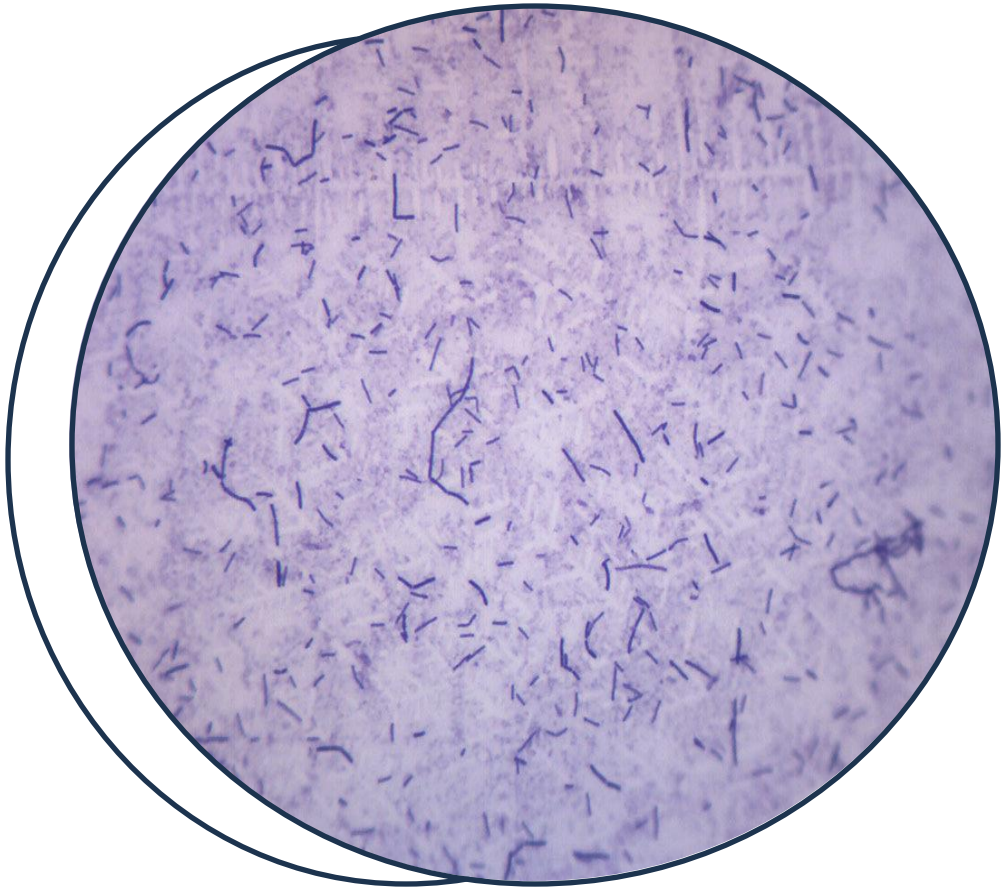
Common strains

- *Lactobacillus* species
- *Enterococci* species
- *Bacillus* species

(Jacela JY, DeRouchey JM, Tokach MD, et al. 2010)

Bacillus subtilis

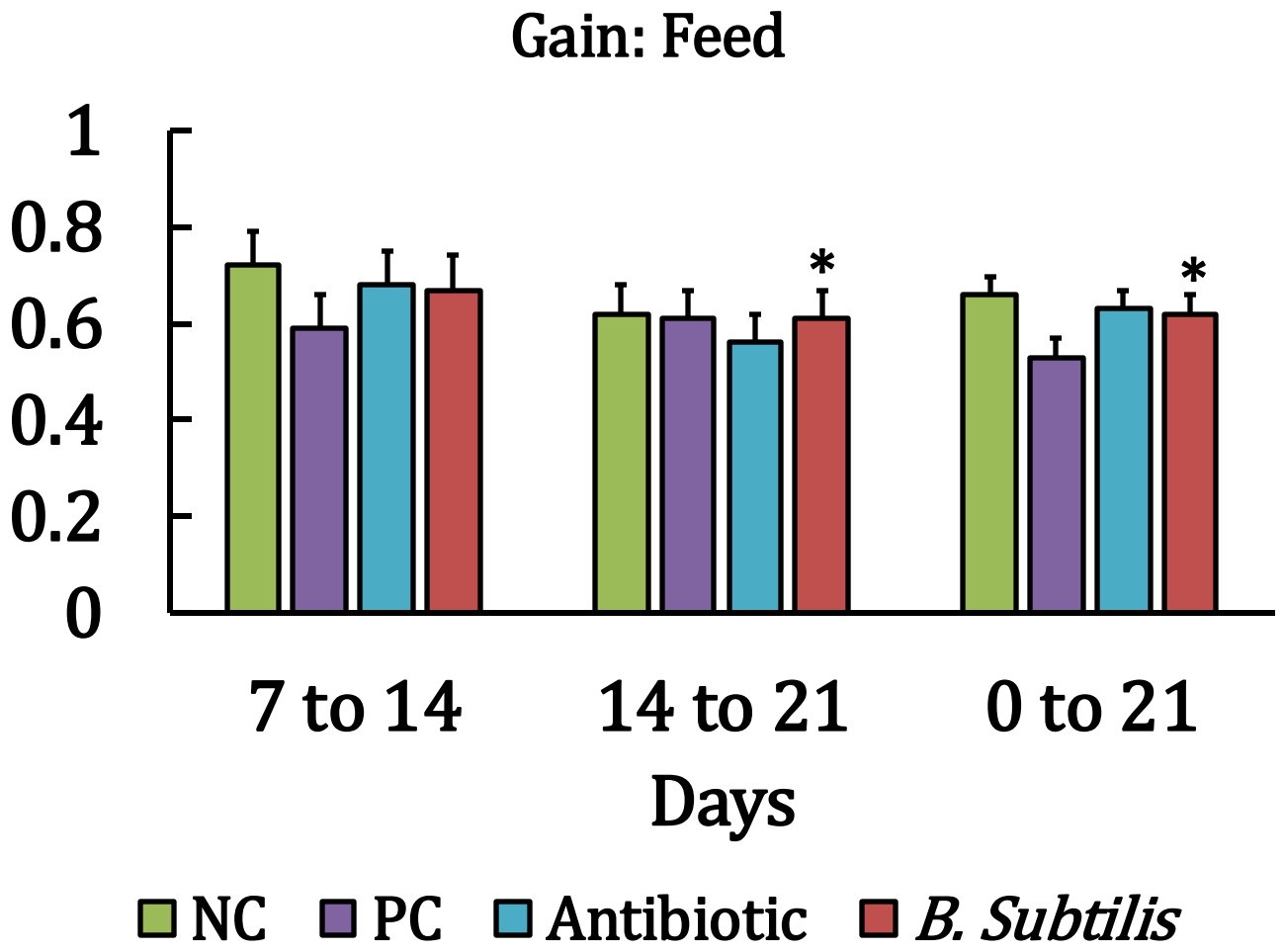


- Best studied gram-positive organism
- Fast growing
- Stable
- Modifiable
- Easy cultivation
- Improve:
  - Digestion
  - Intestinal health
  - Disease prevention

(Errington, Jeffery, and Lizah T. van der Aart. 2020)

Previous Study: *Bacillus subtilis*

- Study on the impact of *Bacillus subtilis* inclusion in ETEC infected pigs
- Improved growth performance and disease resistance
- 2.56×10^9 CFU/kg of *Bacillus subtilis*



* $0.05 < P < 0.10$: Statistical trend

(He et al. 2020)

Plant Extracts: made from plants using a solvent

Cinnamon

Anti-inflammatory, antimicrobial, antioxidant

(Rao et al., 2014)

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Thyme

Anti-inflammatory, antiviral, antibacterial

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+

Thyme
Anti-inflammatory, antiviral, antibacterial

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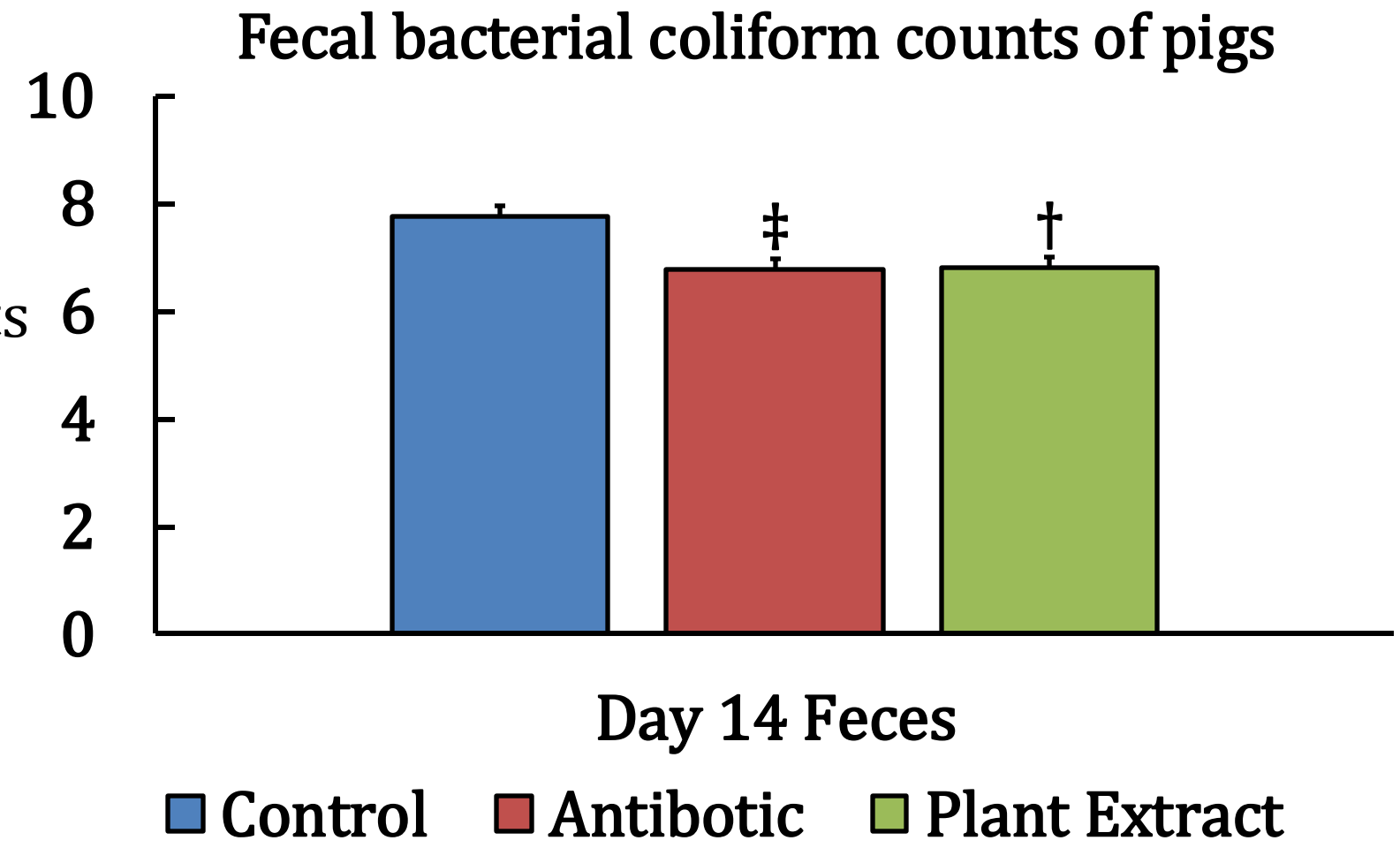
Previous Study: Plant Extract

- Study on the impact of plant extract inclusion in post weaning piglet's diets
- Plant extract: including cinnamon and thyme



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‡ $P < 0.05$: Significant difference

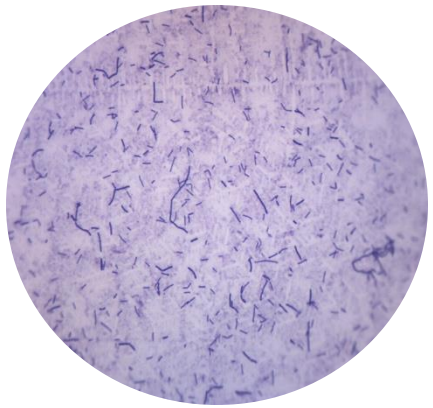
(Namkung et al., 2004)

Objective

To investigate the effects of dietary supplementation with ***Bacillus subtilis*** and **plant extracts** on growth performance and diarrhea of weanling pigs

Hypothesis

Supplementation of *Bacillus subtilis* combined with plant extracts will have a **positive impact on growth** and **decrease the incidence of diarrhea**

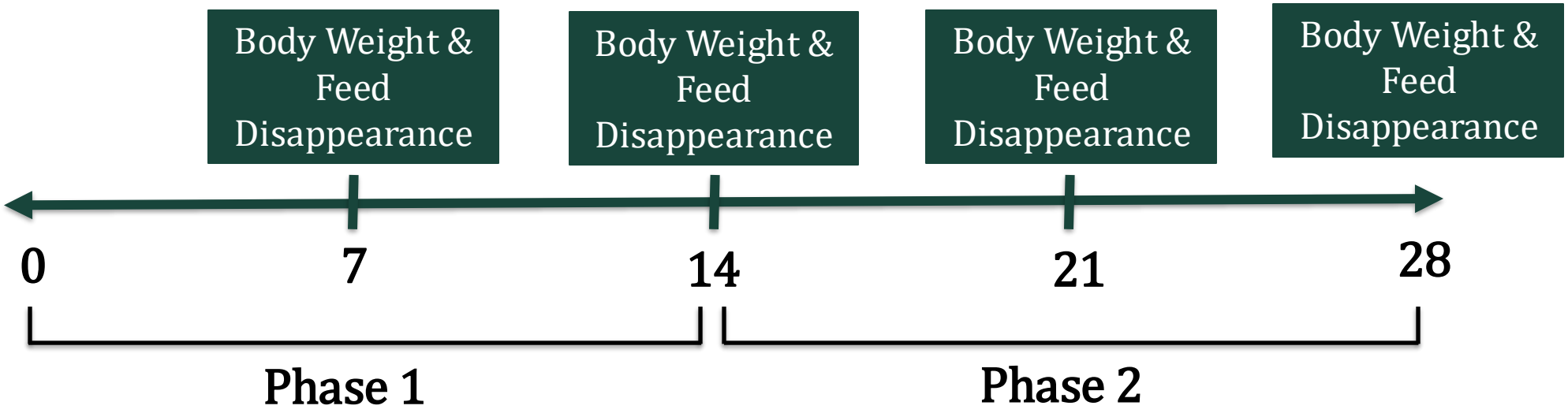


Experimental Design

- Randomized Complete Block Design (Blocks: BW x Sex)
- 240 weanling pigs
  - Average Body Weight: 6.12 ± 0.53 kg
  - Average Age: 19 ± 1 d old
- 4 treatment groups:
  - 6 pigs/pen
  - 10 replicates

1. Control (CON) basal nursery diet
2. *Bacillus subtilis* single dose (BPS) CON + 500 mg/kg of *Bacillus subtilis* and plant extract
3. *Bacillus subtilis* double dose (BPD) CON +1000 mg/kg of *Bacillus subtilis* and plant extracts
4. Antibiotic (ATB) CON + 50 mg/kg carbadox

Experimental Design

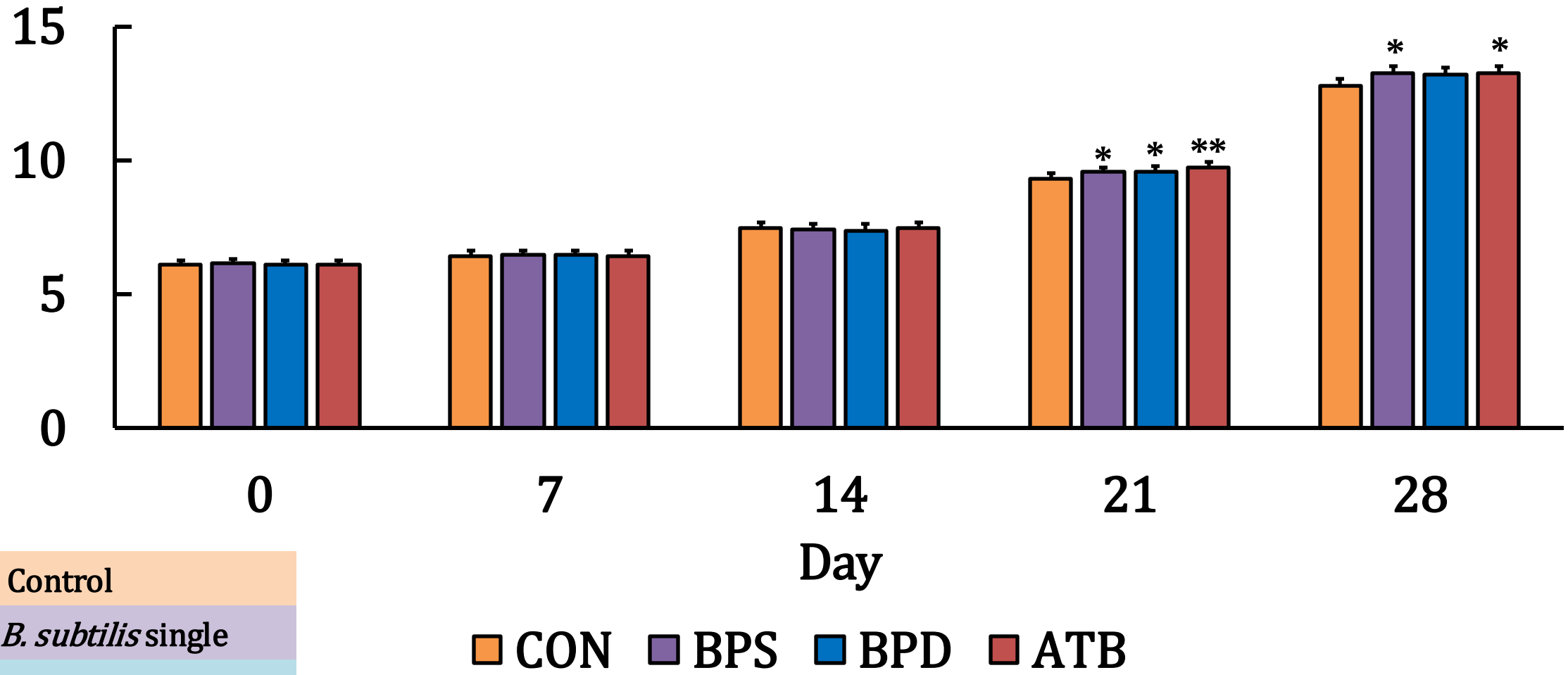


- Calculation of average daily gain, average daily feed intake, and feed efficiency
- Diarrhea scores were recorded twice daily during experiment
  - Scores ranging from 1 to 5 (1= normal to 5= watery diarrhea)
  - Frequency of diarrhea:
    - ✓ 3 ≥ incidence of diarrhea
    - ✓ 4 ≥ severe diarrhea

Statistical Analysis

- Statistical Model:
  - Response Variable: $Y_{ijk} = \mu + D_i + B_{jk} + \epsilon_{ijk}$
  - Experimental Unit: Pen
  - Fixed effect: Diet
  - Random Effect: Block
- Growth Performance:
  - Analyzed by ANOVA using the PROC MIXED of SAS
- Diarrhea Frequency:
  - Analyzed by Chi-square test
- Significance at $P \leq 0.05$ and tendency at $0.05 < P \leq 0.10$

Body Weight, kg



CON: Control

BPS: *B. subtilis* single

BPD: *B. subtilis* double

ATB: Antibiotic

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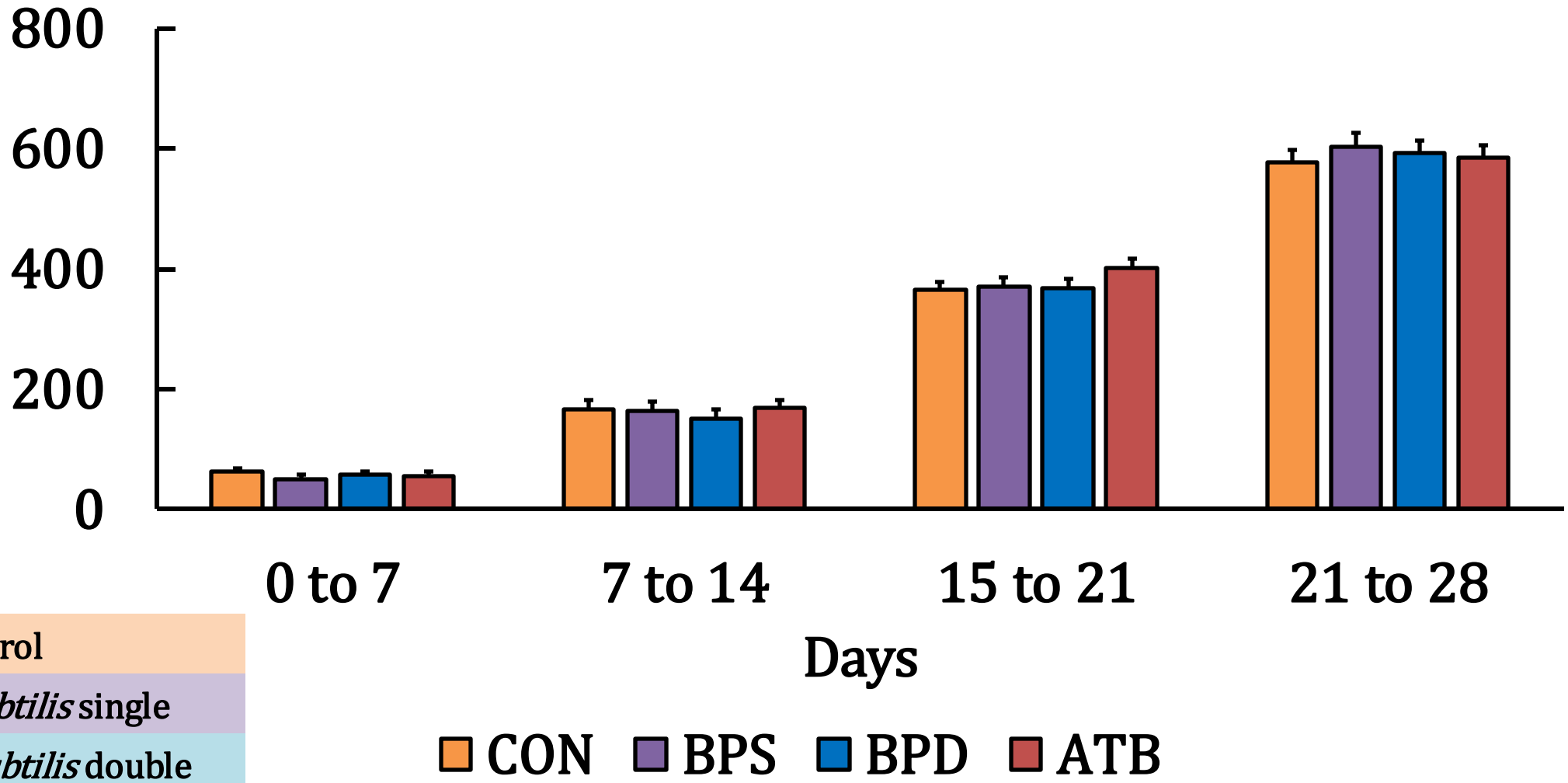
Average Daily Gain, g/d



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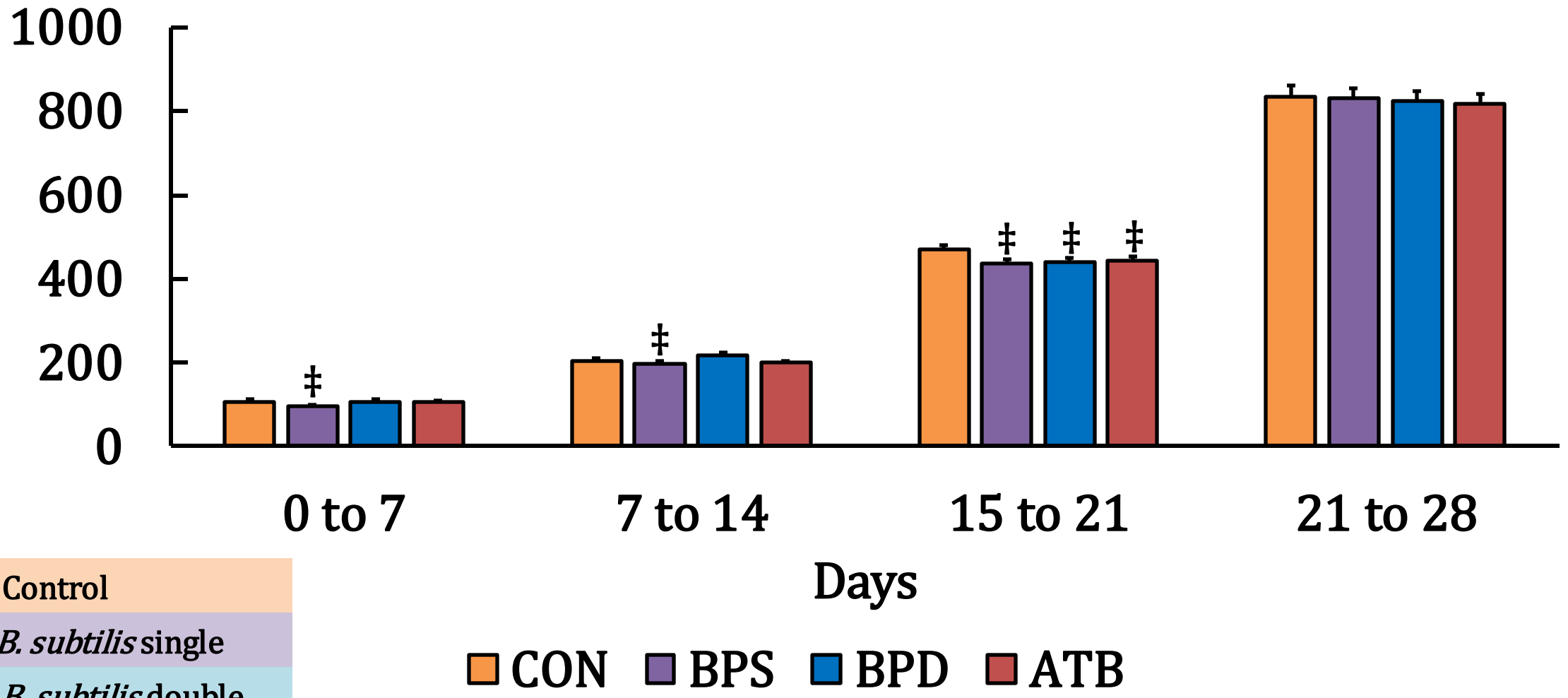

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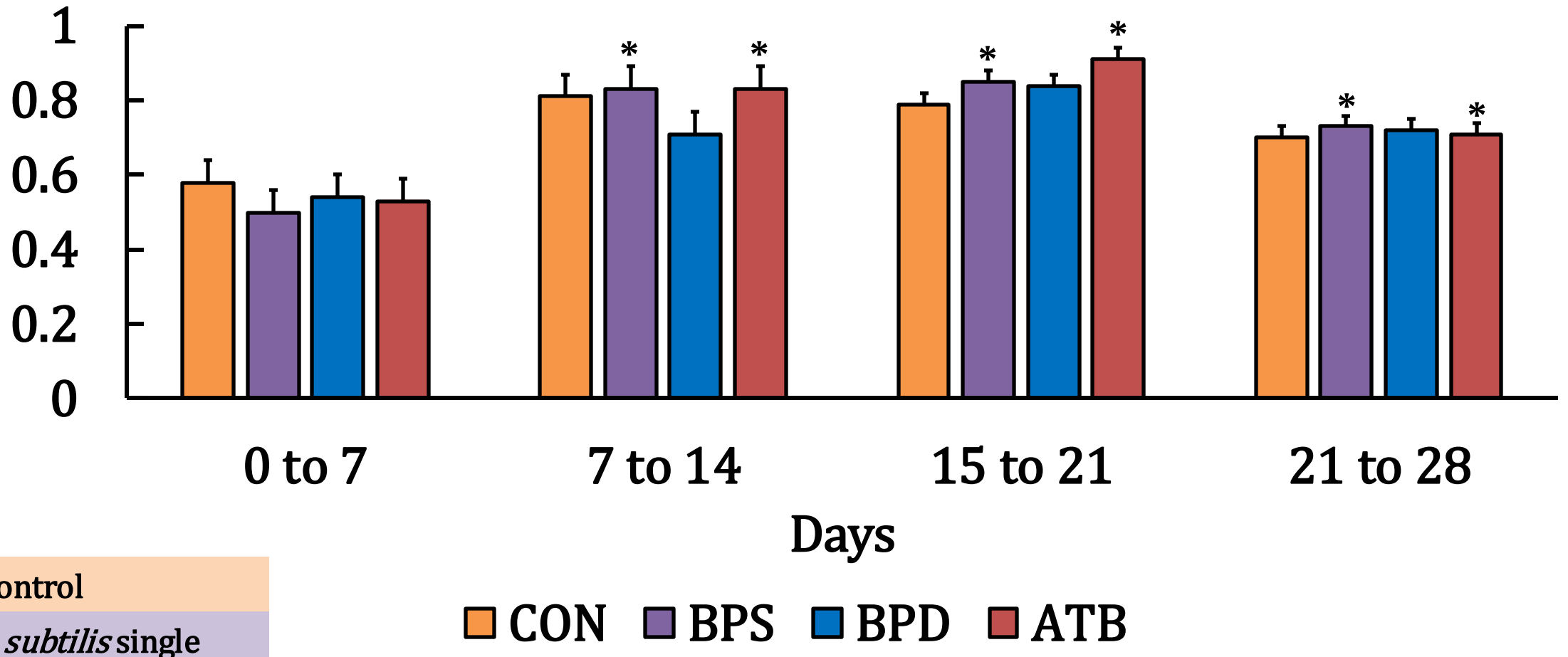
Feed efficiency (Gain to Feed Ratio)



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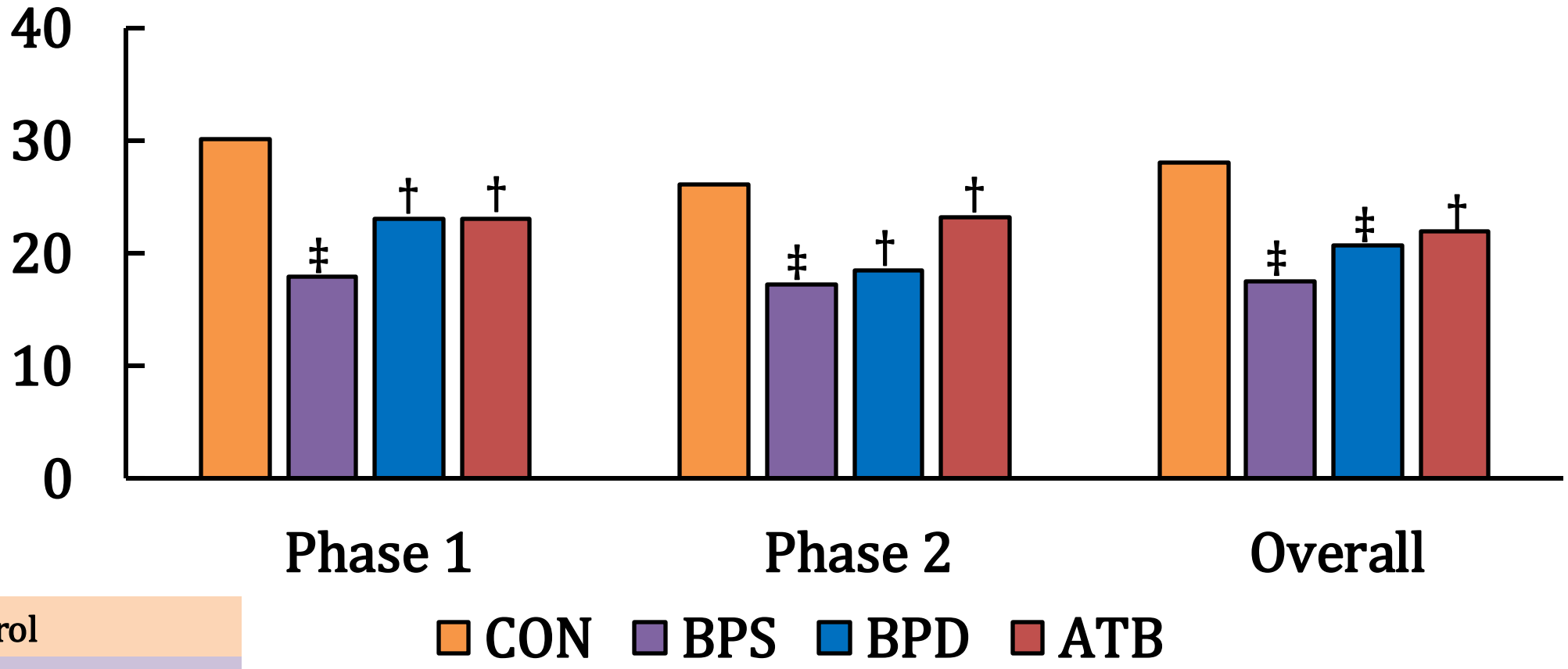
Frequency of Incidence of Diarrhea ≥ 3 ,%



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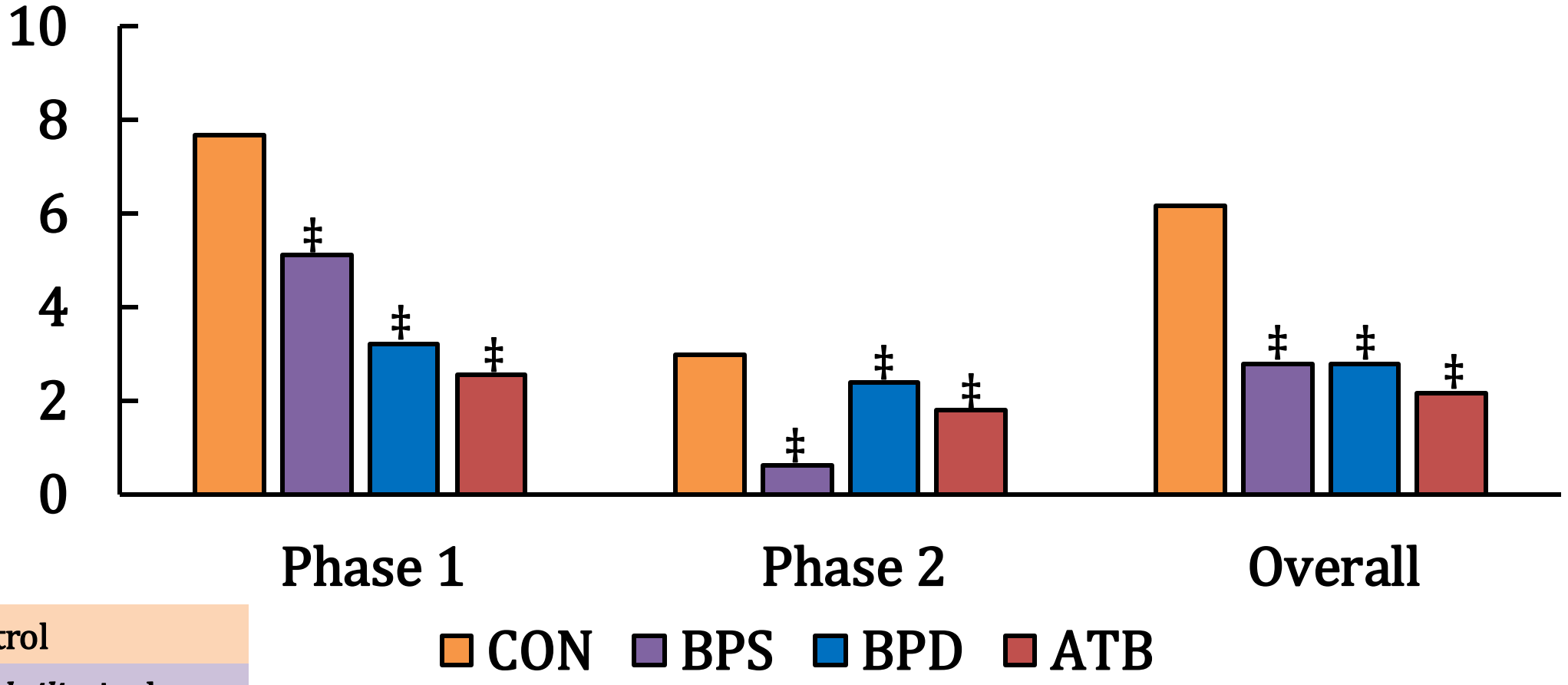
Frequency of Severe Diarrhea ≥ 4, %



CON: Control

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Conclusions

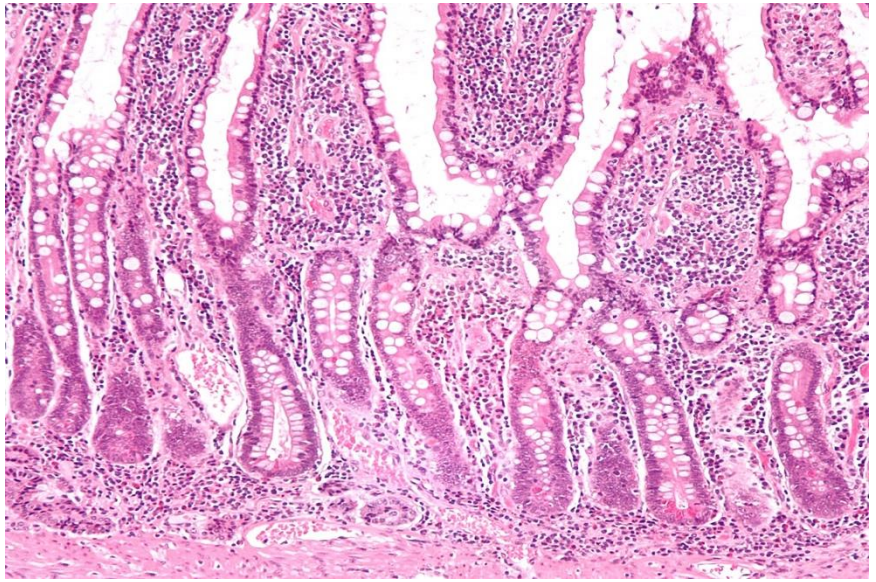
Dietary supplementation with *Bacillus subtilis* and plant extracts may help

- Improve growth performance during the early weaning stage
- Reduce the incidence and severity of diarrhea in the post-weaning period

Future Research

ELISA Assays

- Proinflammatory cytokines
- Stress response biomarkers
- Acute phase proteins



Intestinal Development

- Villi height
- Villi width
- Crypt depth

Acknowledgments

JH Biotech, Inc.

Michigan State University's Animal Nutrition, Health, and Physiology Lab

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Thank you for your attention!