Dietary phytonutrients enhance disease resistance of pigs

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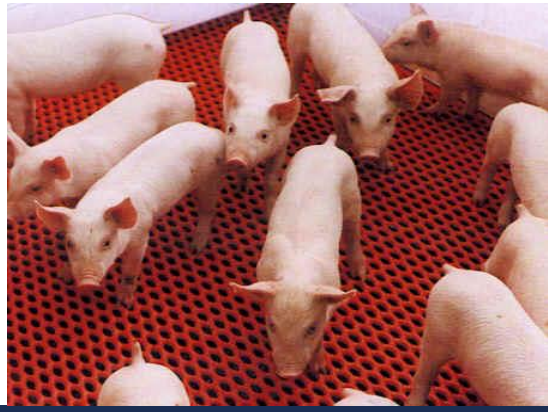
Outline

- Previous knowledge
- Hypothesis
- Test of hypothesis
- What does it mean?

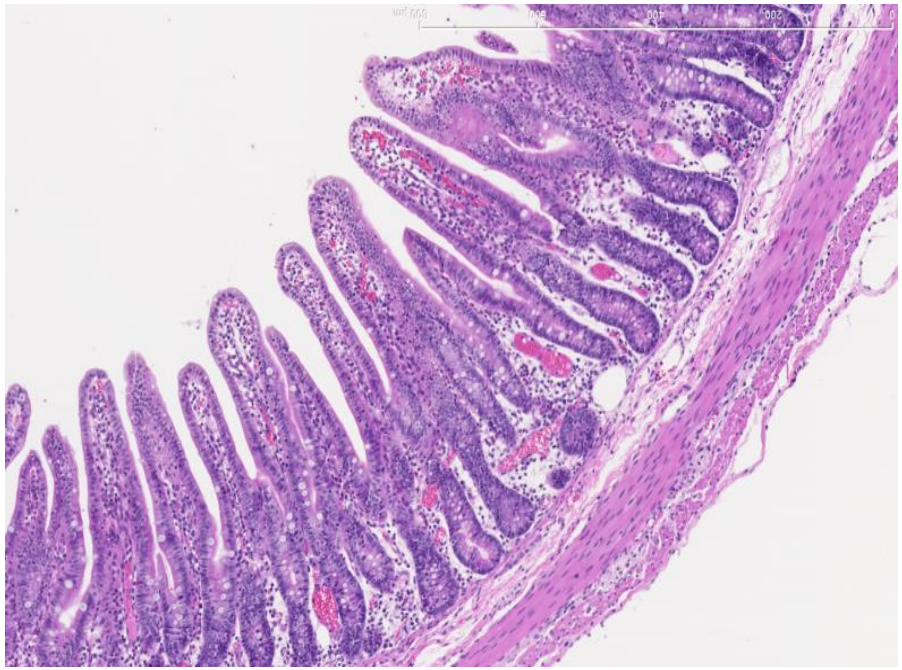
Weaning stress

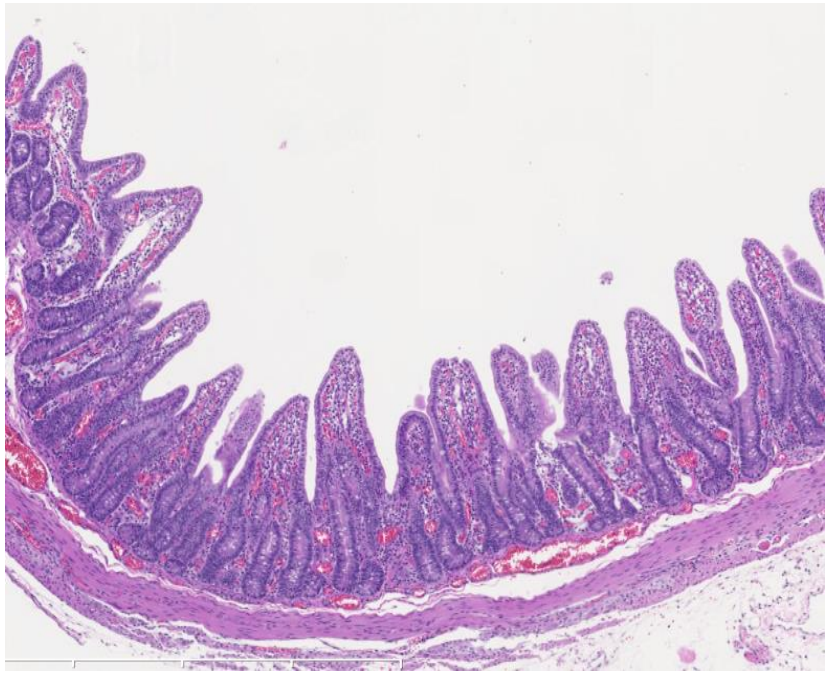
- Maternal separation
- Environmental change
- Increased exposure to pathogens
- Social hierarchy stress
- Move to solid feed
- Transportation stress



Gut morphology change of weanling pigs

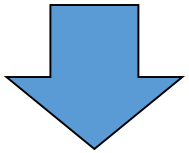
- **Reduced feed intake**
- **Negative effects on intestinal morphology**





Declined intestinal functions

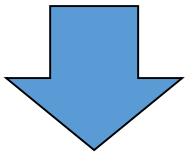
- Reduced brush-border enzyme activity
- Reduced absorption ability



- Diarrhea
- Poor growth performance

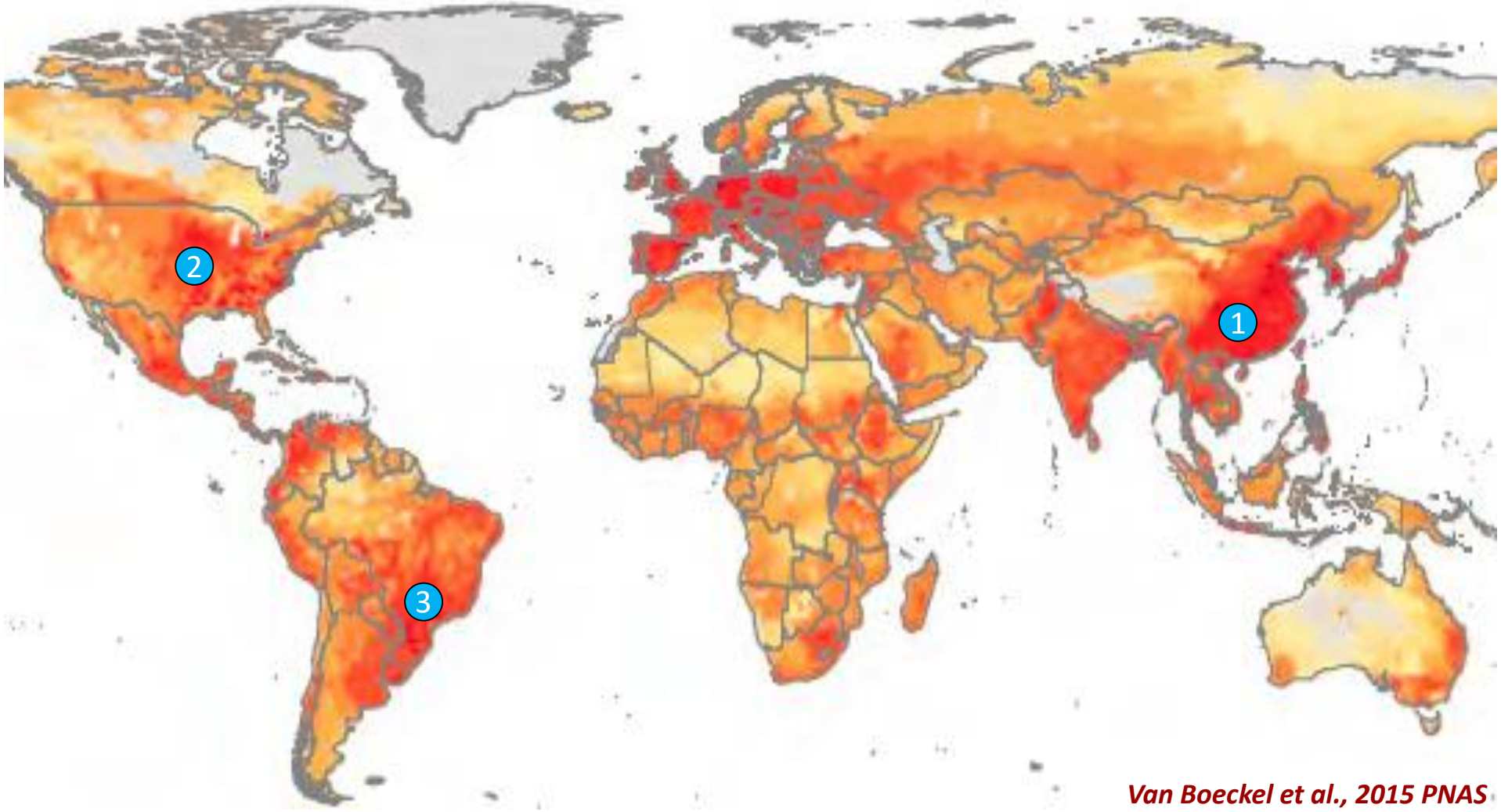
Immunity of weanling pigs

- Passive immunity is declining
- Active immunity is not fully developed



- Highly sensitive to infectious disease
- Divert nutrients away from growth to immune response
- Poor growth performance

Antibiotic use on farms



Van Boeckel et al., 2015 PNAS

Feed additives

- Mannan oligosaccharides
- Immune egg products
- Direct-fed bacteria
- Yeast/yeast products
- Plant extracts

Plant extracts

- Extracted from parts of plants or synthesized
- Concentrated, hydrophobic, volatile aroma
- Mixtures of secondary plant metabolites
- Liquid or powder
- Phenolic compounds

Plant extracts

- **Biological effects:**
  - ✓**Antimicrobial**
  - ✓**Anti-inflammatory**
  - ✓**Antioxidant**
  - ✓**Others: Antiviral, Antifungal, Antiparasitic, Antitoxigenic**

Hypothesis

1) Certain plant extracts modify immune function of pigs

2) This leads to increased disease resistance

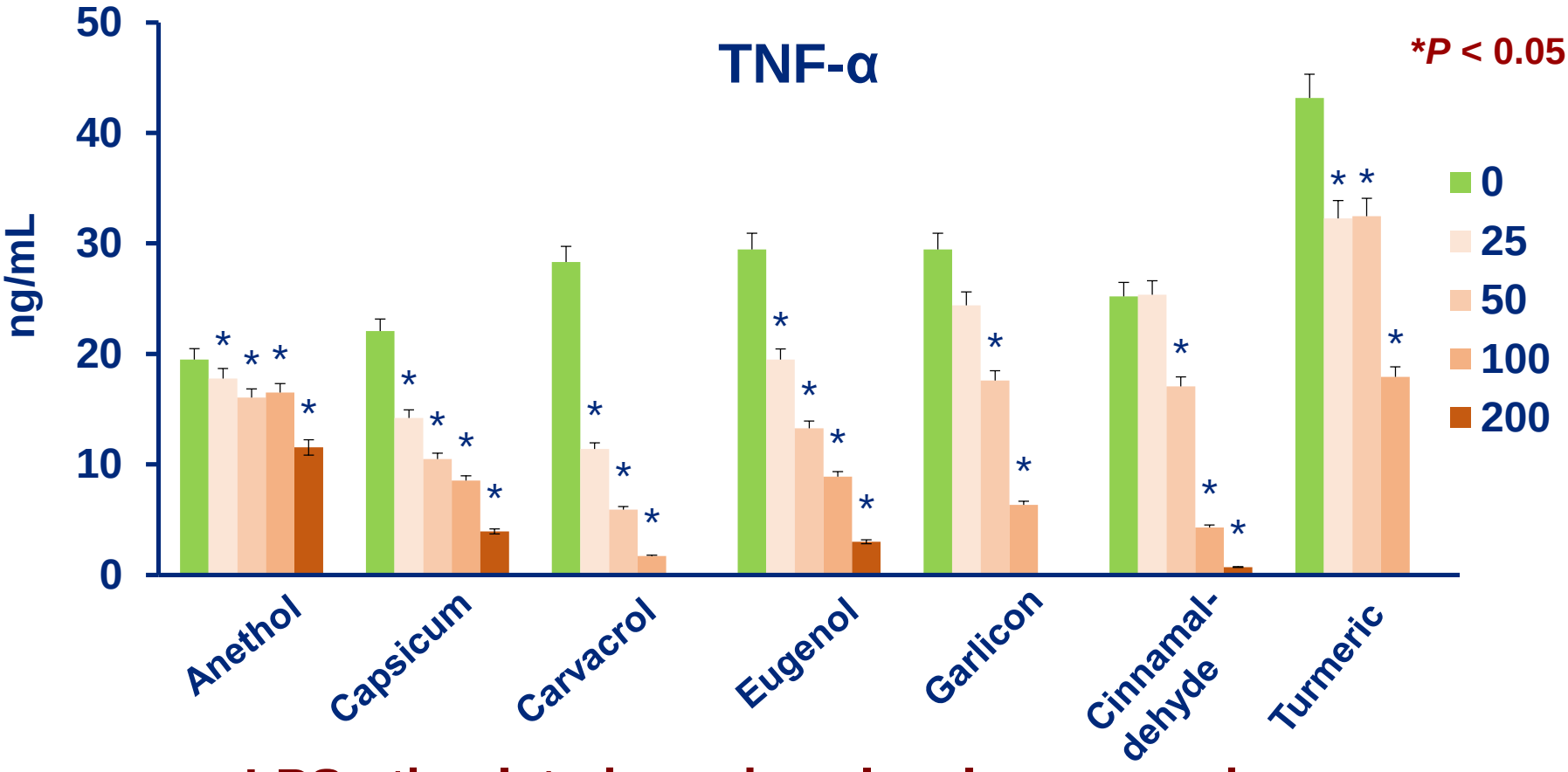
Test of hypothesis

- **Exp. 1: In vitro cell culture**
- **Exp. 2: *E. coli* challenge study**
- **Exp. 3: PRRS challenge study**

Experiment 1

In vitro cell culture assays

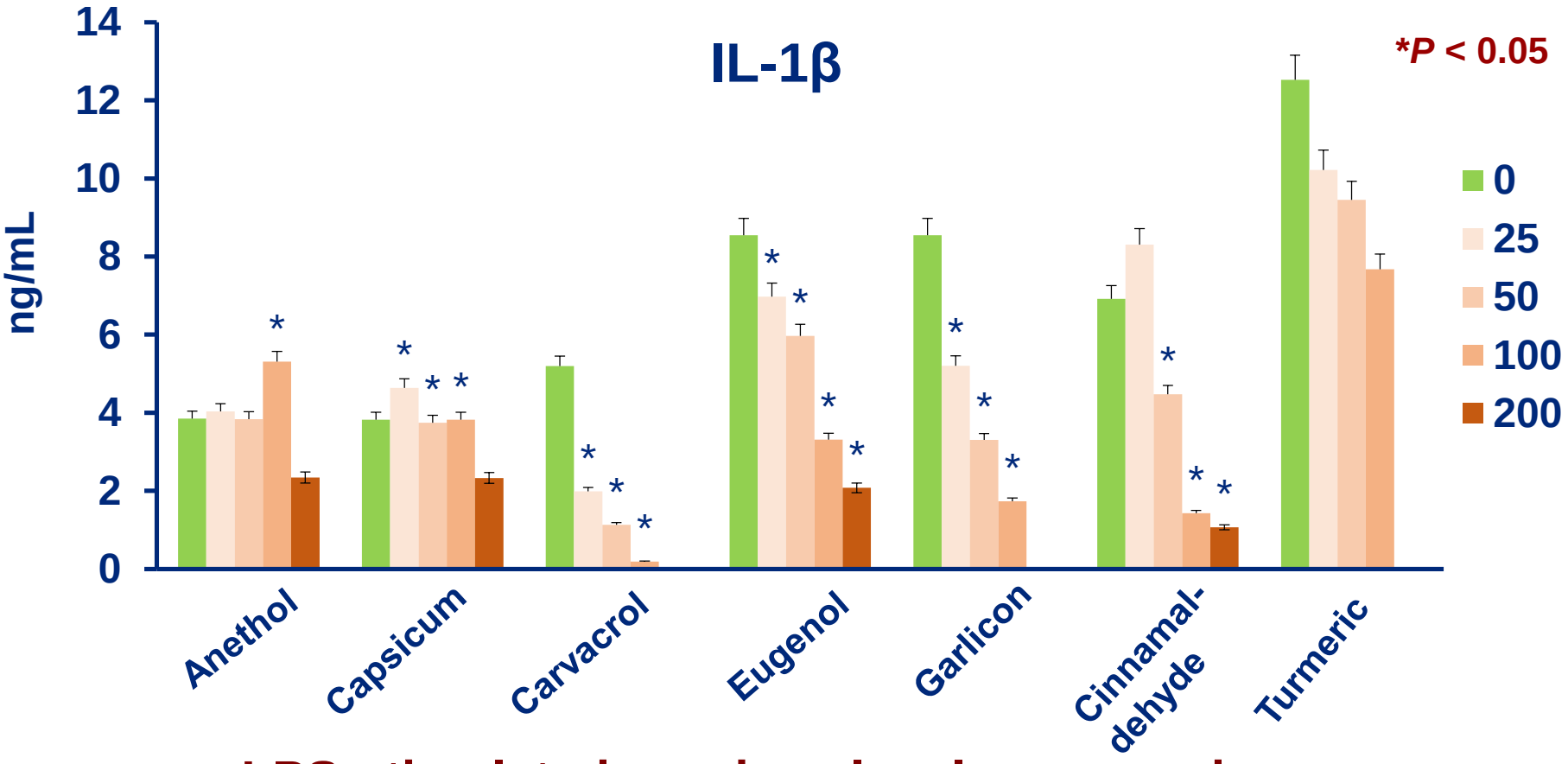
Anti-inflammatory effects



LPS-stimulated porcine alveolar macrophages

Liu et al., 2012

Anti-inflammatory effects



LPS-stimulated porcine alveolar macrophages

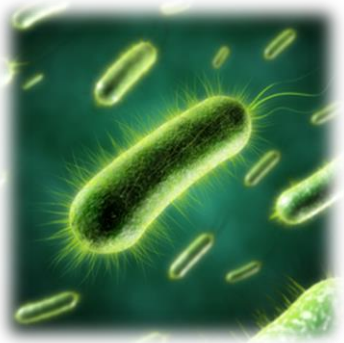
Liu et al., 2012

Conclusions – Exp. 1

- **All of plant extracts used in this experiment may have potent anti-inflammatory effects**
- **Carvacrol, cinnamaldehyde, eugenol, and garlicon might be the more powerful candidates**
- **Capsicum oleoresin, garlicon, and turmeric oleoresin were selected to do *E. coli* and PRRSV challenge studies**

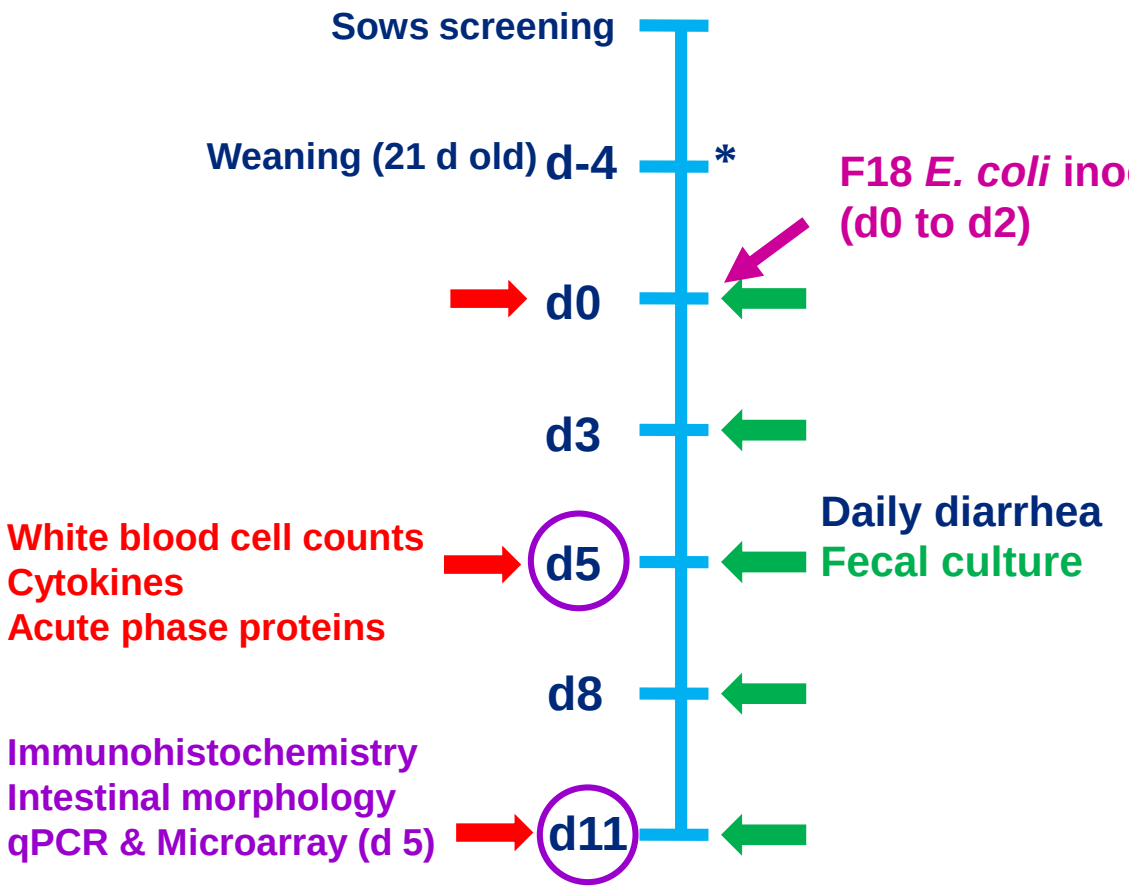
Experiment 2

In vivo *E. coli* challenge study




Liu et al., 2013a

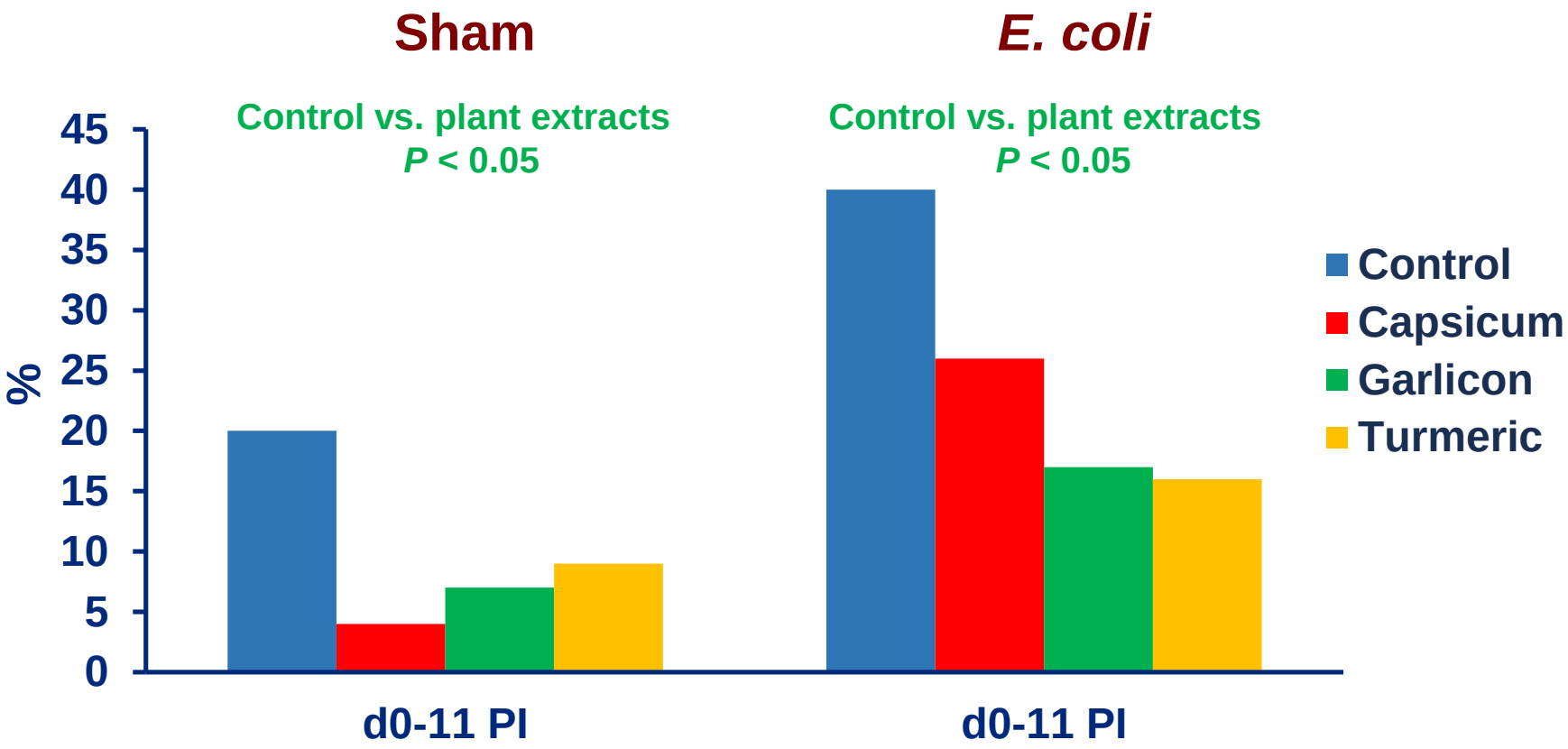
Procedures



* 4 diets: control, 10 ppm capsicum oleoresin, 10 ppm garlicon, 10 ppm turmeric oleoresin

Liu et al., 2013a

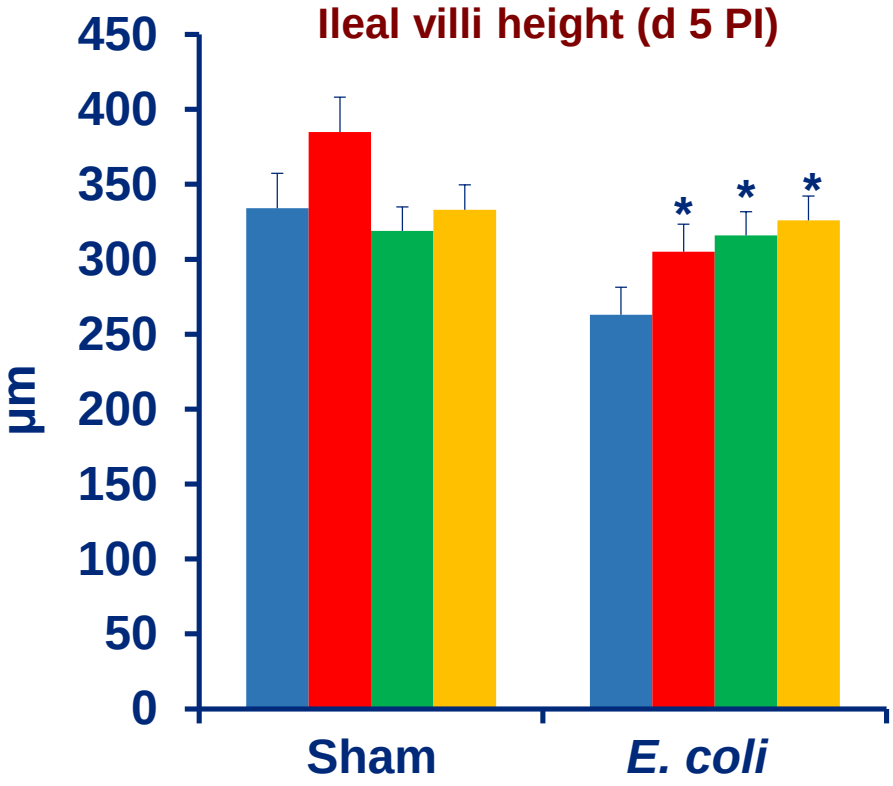
Frequency of diarrhea

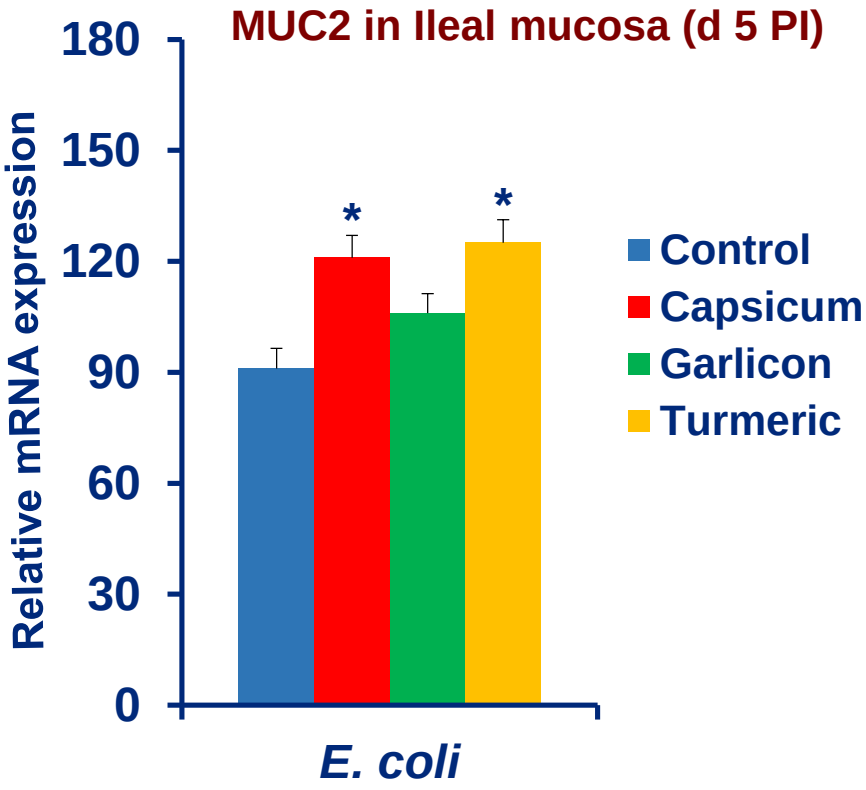


Pig days with diarrhea score ≥ 3
1, normal; 5, watery diarrhea

Liu et al., 2013a

Possible mechanism for reduced diarrhea

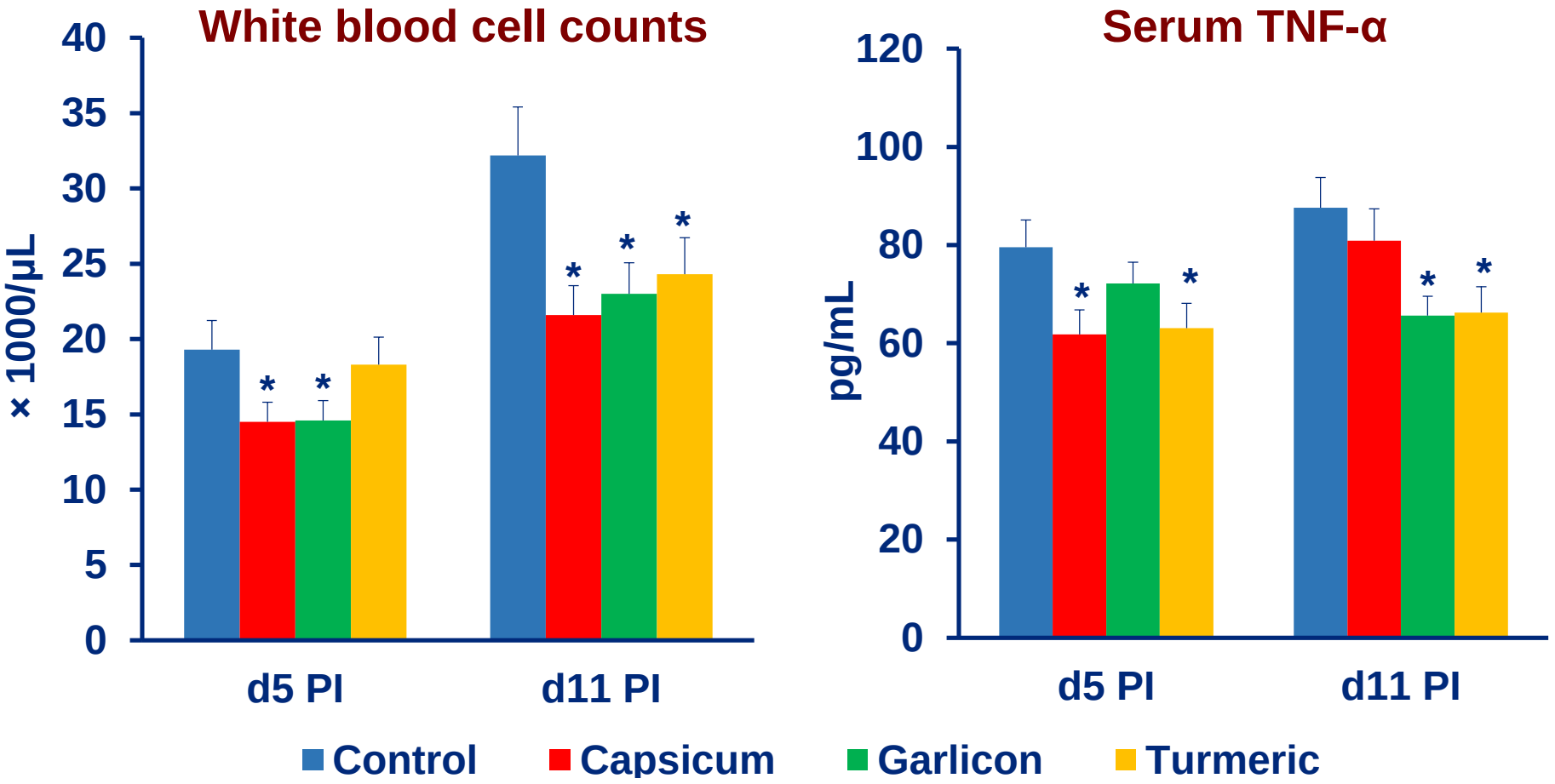




- **Possibly improved gut barrier function!**

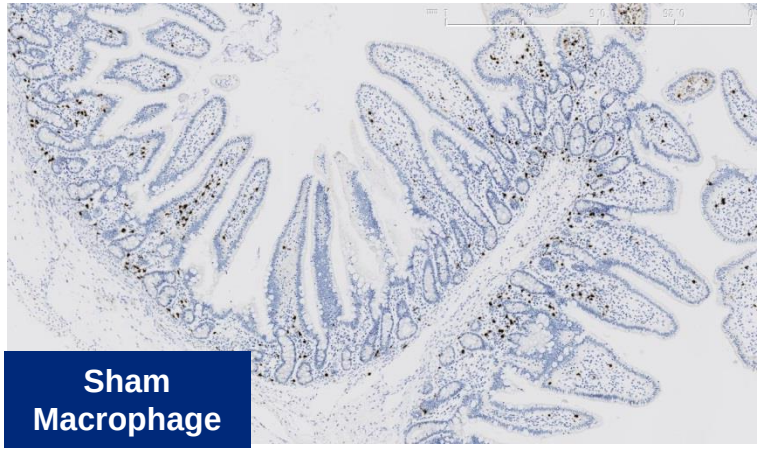
Liu et al., 2013a, 2014

Plant extracts reduced systemic inflammation caused by *E. coli* infection



Liu et al., 2013a

Plant extracts reduced gut inflammation caused by *E. coli* infection



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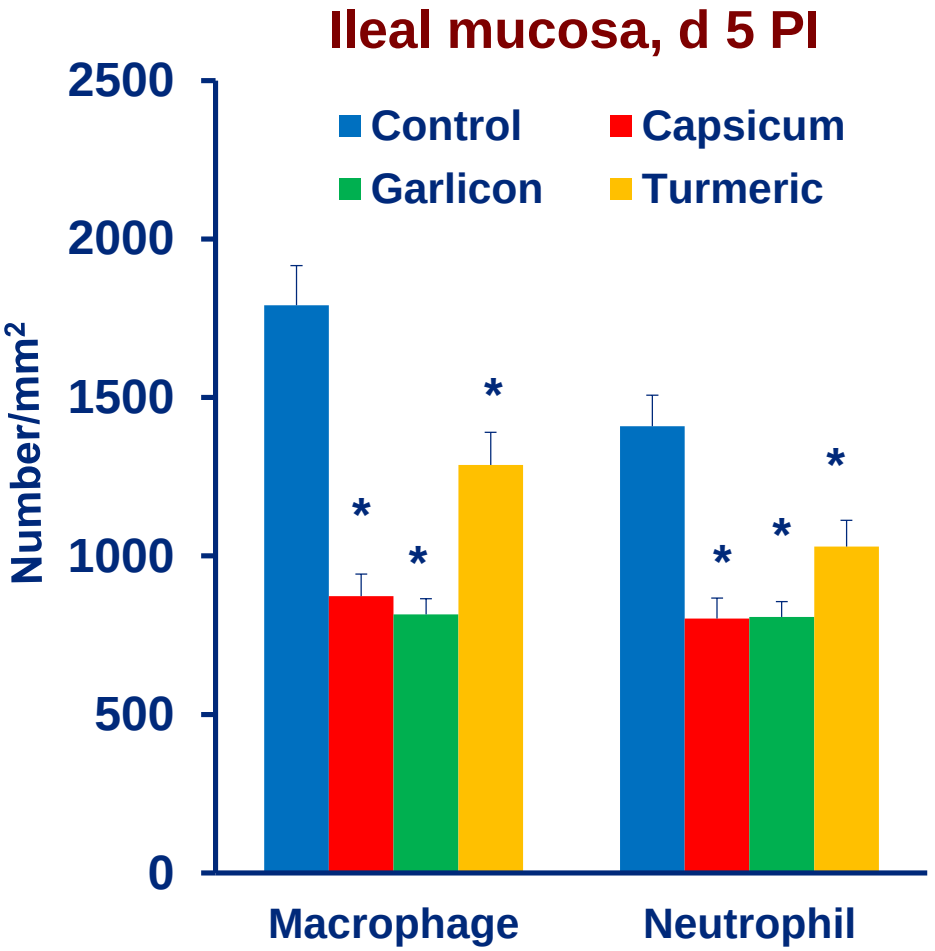
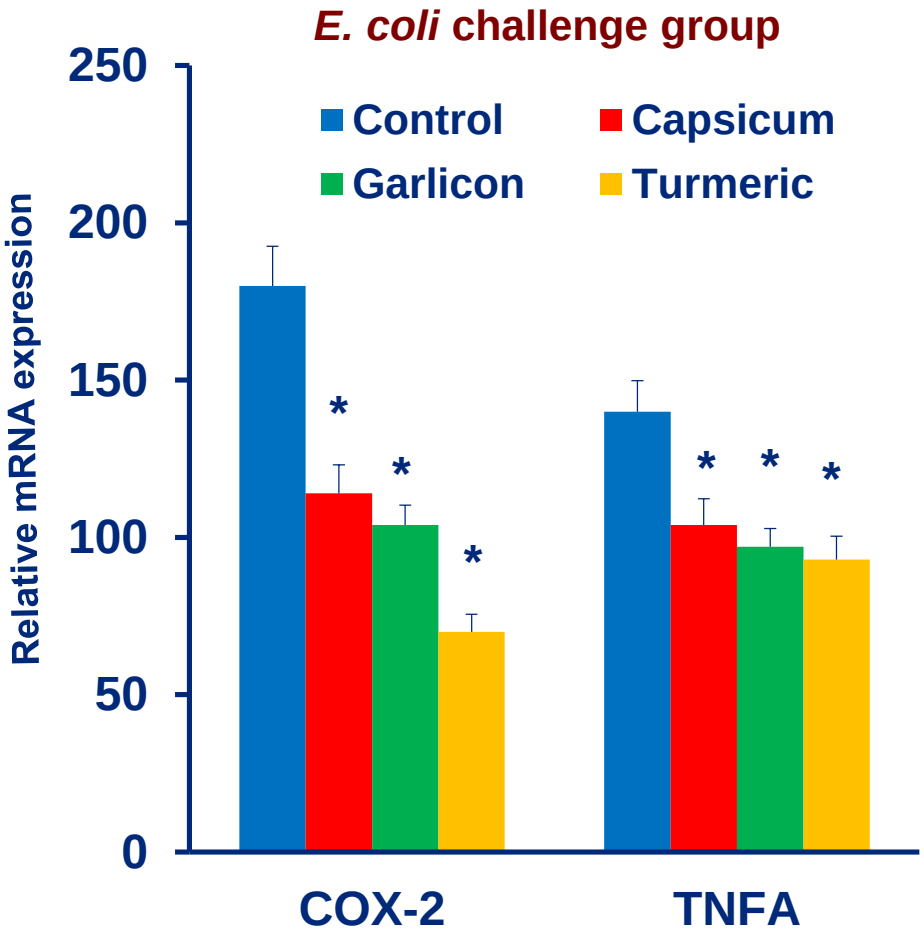
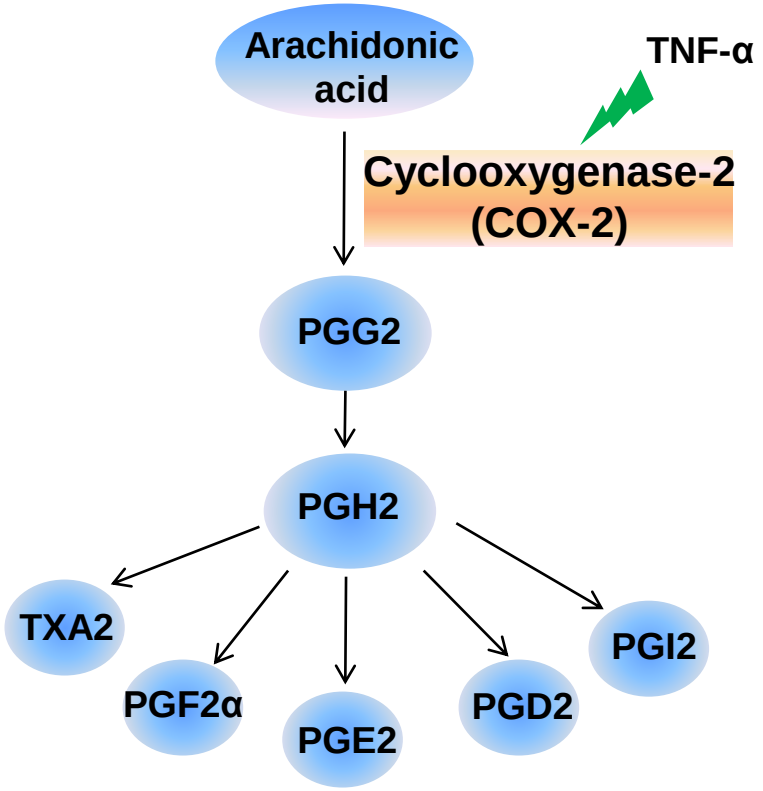


Liu et al., 2013a

Plant extracts reduced gut inflammation caused by *E. coli* infection



The Prostaglandin Pathway



⬆ Inflammation!

Liu et al., 2014

Conclusions – Exp. 2

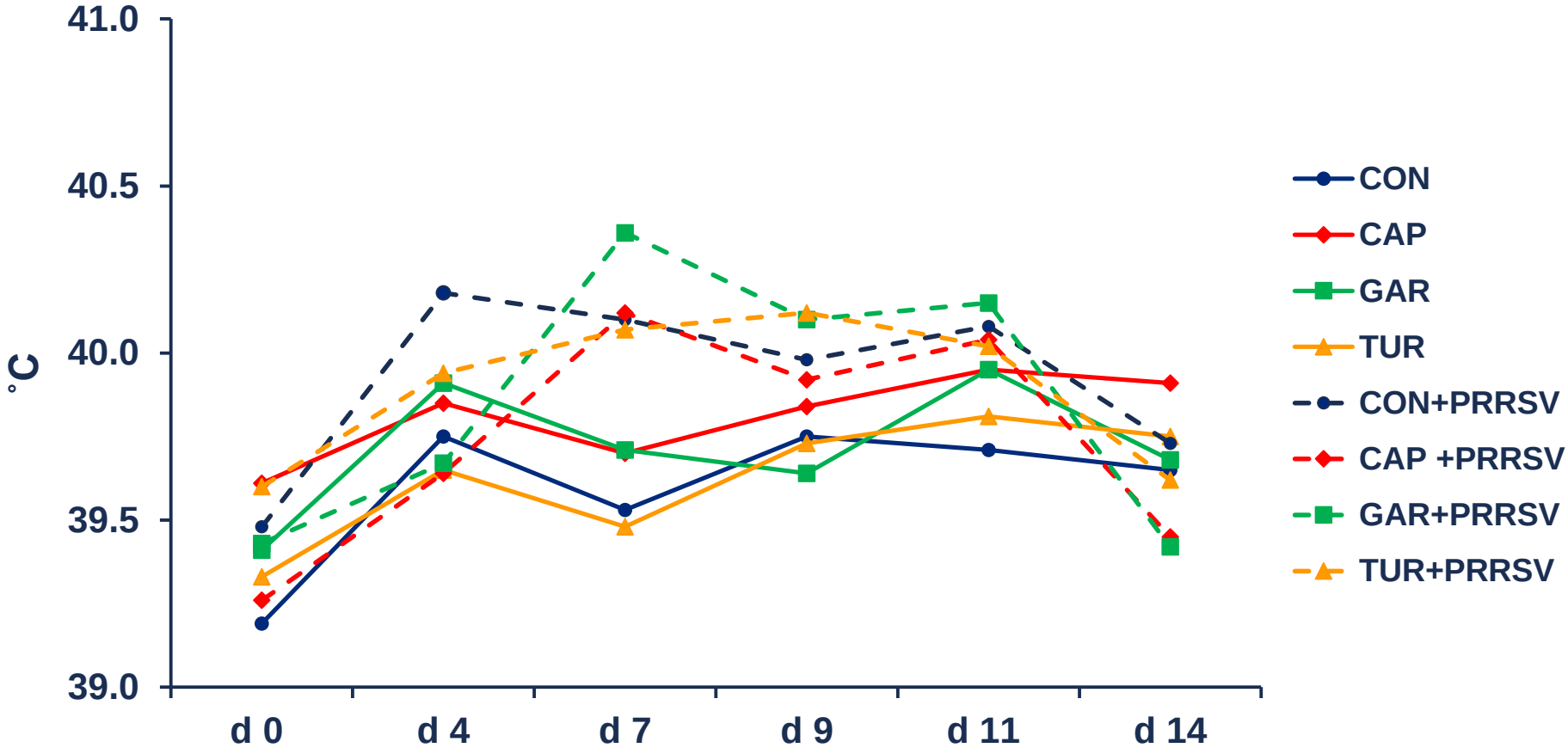
- **Feeding plant extracts reduced diarrhea and enhanced disease resistance of weanling pigs**
- **Possible mechanisms**
  - **Gut barrier function**
  - **Gut mucosa immunity**
  - **Systemic immunity**

Experiment 3

In vivo porcine reproductive and respiratory syndrome virus (PRRSV) challenge study

Liu et al., 2013b

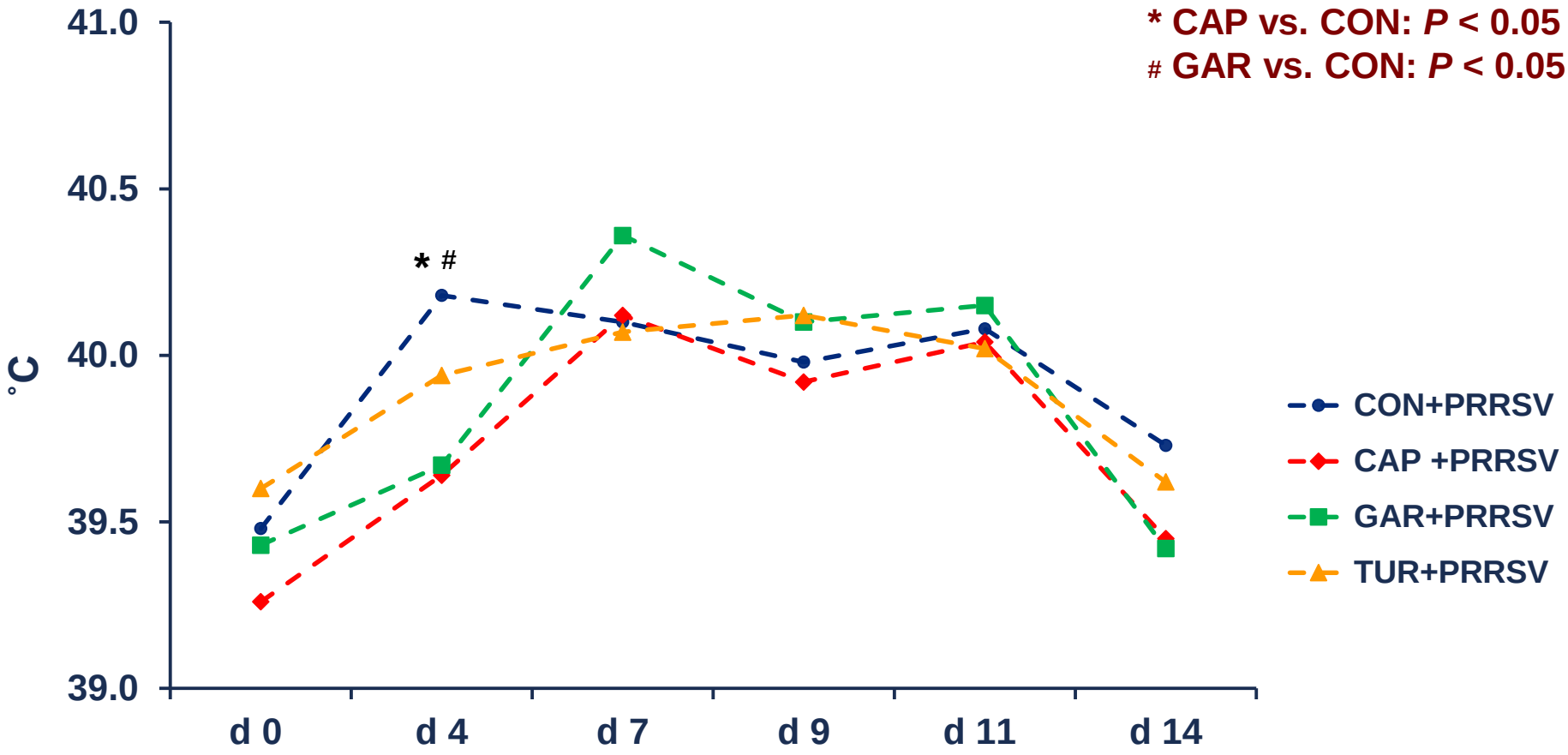
Rectal temperature



d 7, 9, 11: PRRSV: *P* < 0.01

Liu et al., 2013b

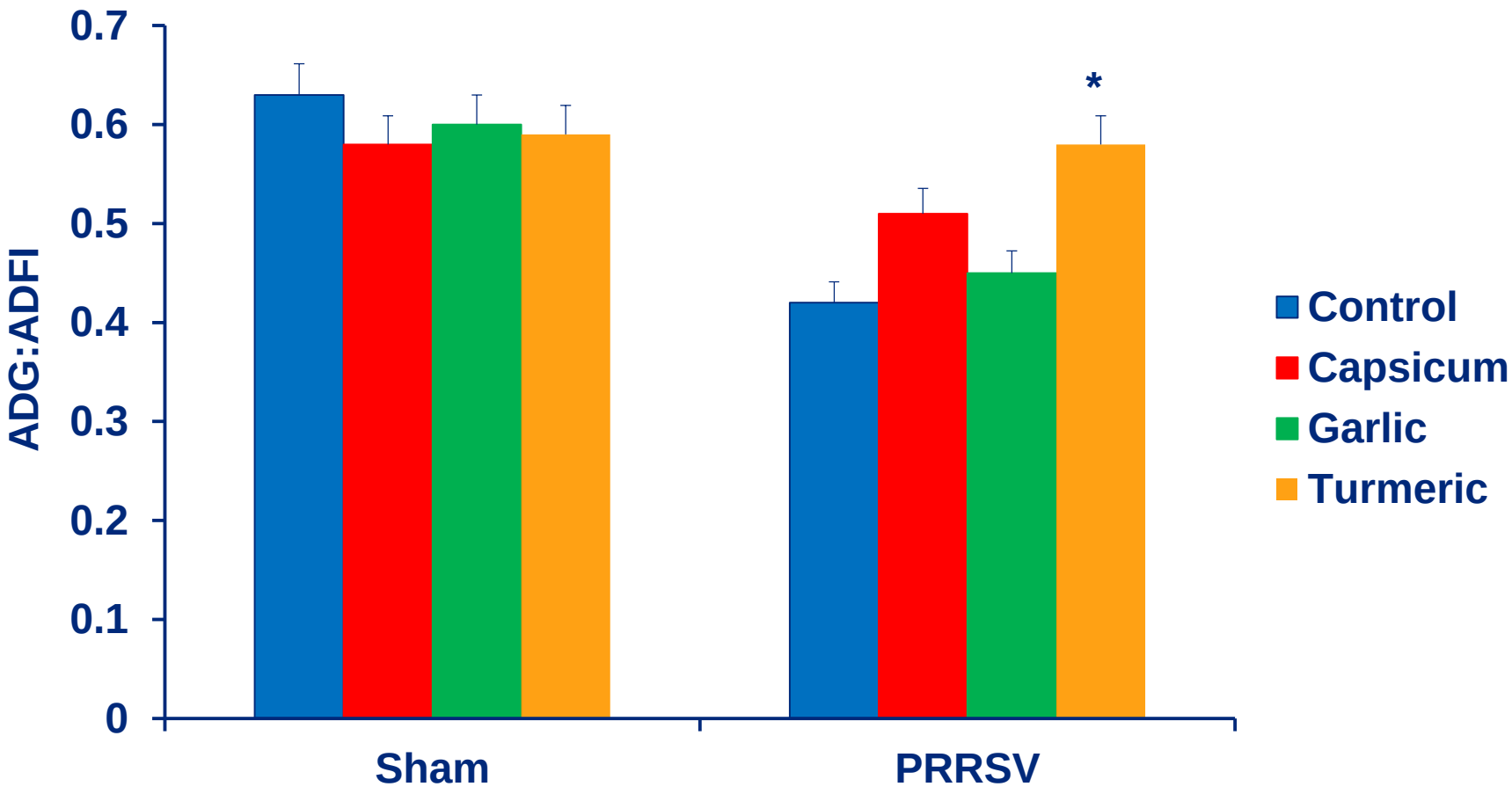
Rectal temperature



d 7, 9, 11: PRRSV: *P* < 0.01

Liu et al., 2013b

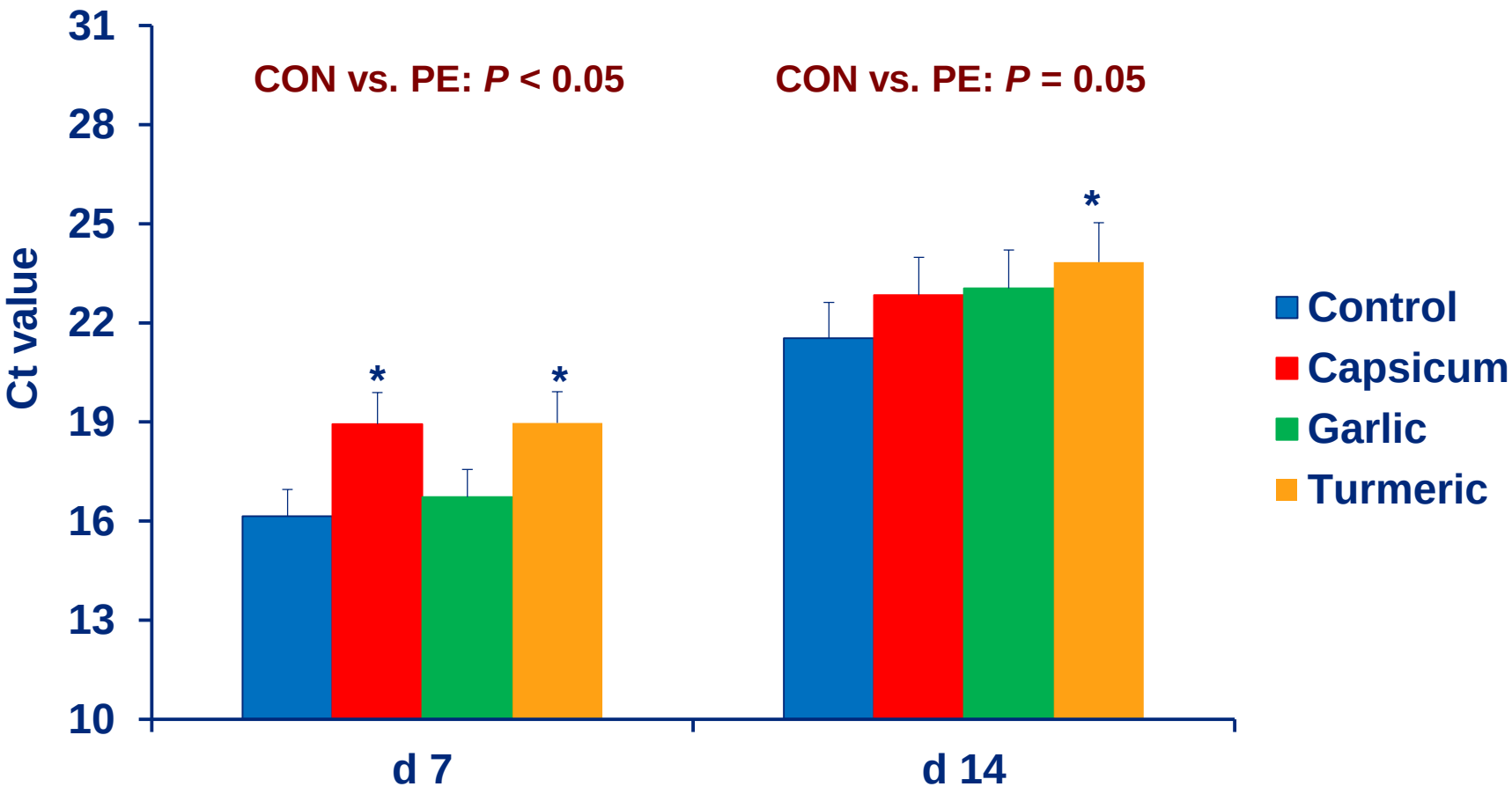
Feed efficiency, d 0-14



PRRSV: *P* = 0.07

Liu et al., 2013b

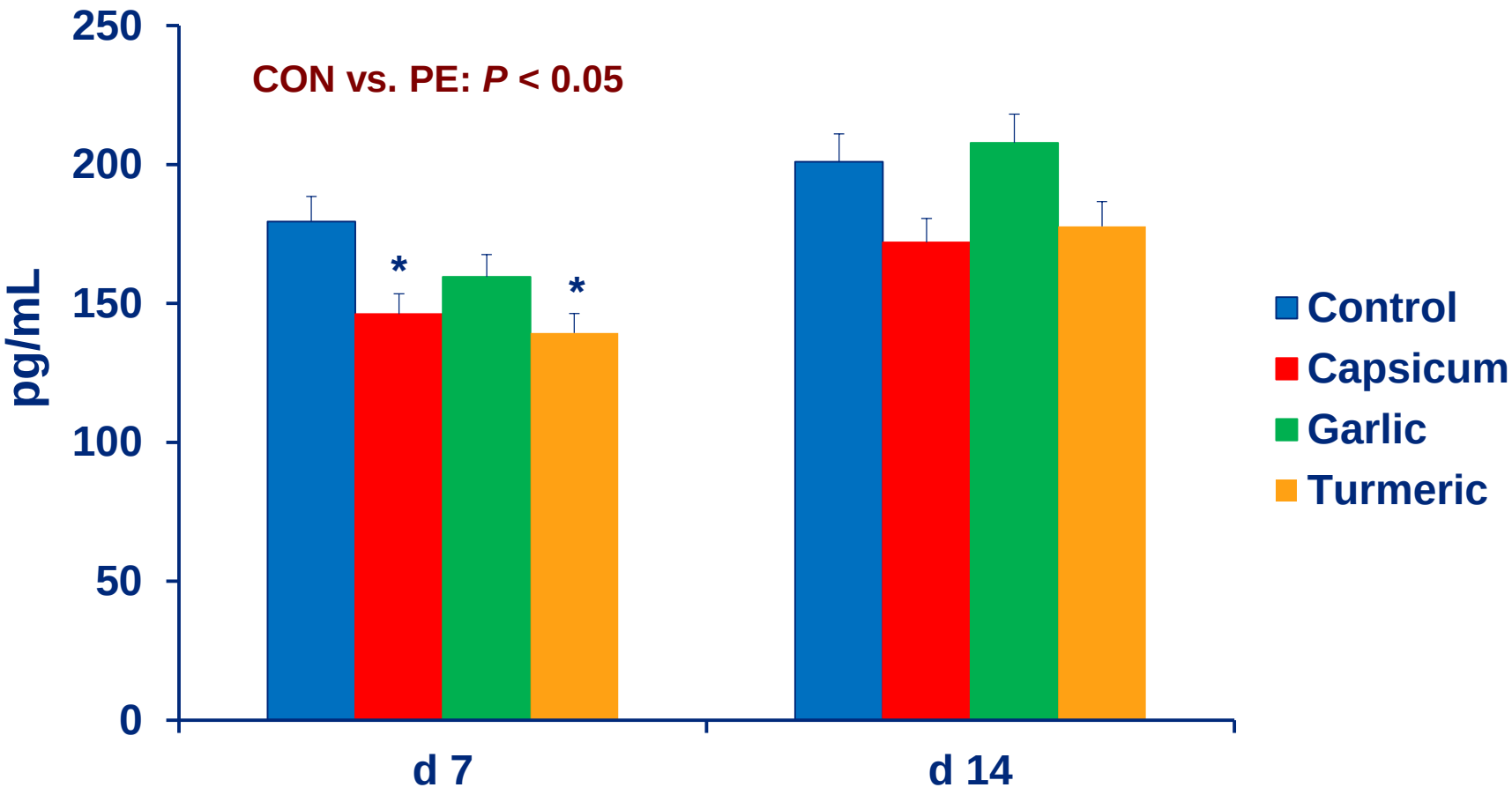
Serum viral load-PRRSV



d 7 & 14: PRRSV: *P* < 0.01

Liu et al., 2013b

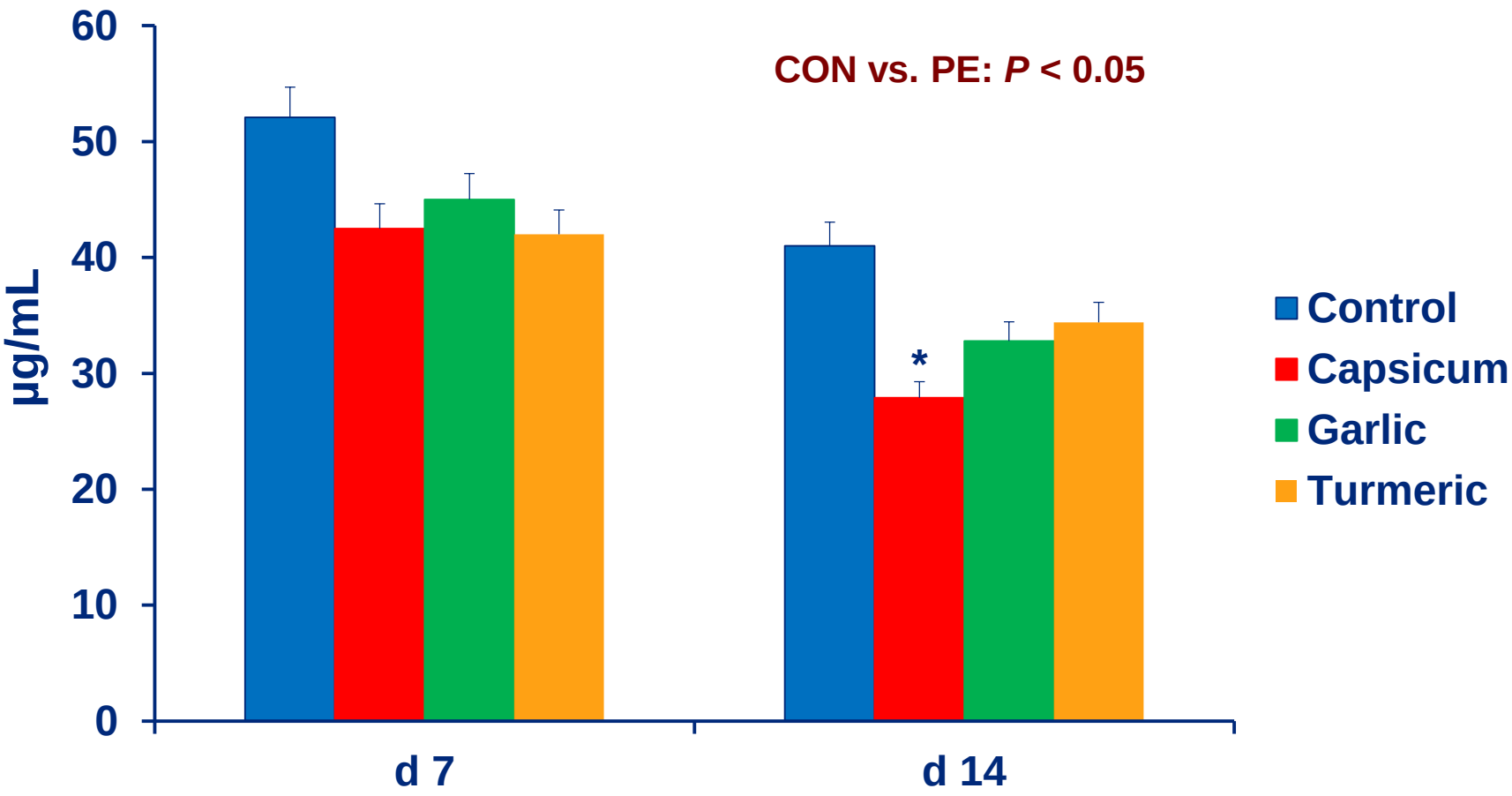
Serum TNF-α - PRRSV



d 7 & 14: PRRSV: *P* < 0.01

Liu et al., 2013b

Serum C-reactive protein- PRRSV



d 7 & 14: PRRSV: *P* < 0.01

Liu et al., 2013b

Conclusions – Exp. 3

- **Feeding plant extracts delayed fever caused by PRRS infection**
- **Feeding plant extracts improved feed efficiency of pigs**
- **Possible mechanisms**
  - **Reduced viral load**
  - **Reduced systemic inflammation**

Hypothesis

1) Certain plant extracts modify immune function of pigs Accept

2) This leads to increased disease resistance Accept

Acknowledgements

- **Dr. Pettigrew lab – University of Illinois**
- **Pancosma**

Pancosma
just makes sense

Comparative Animal Nutrition & Physiology Laboratory

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