Non-nutrients in Swine Health and Production

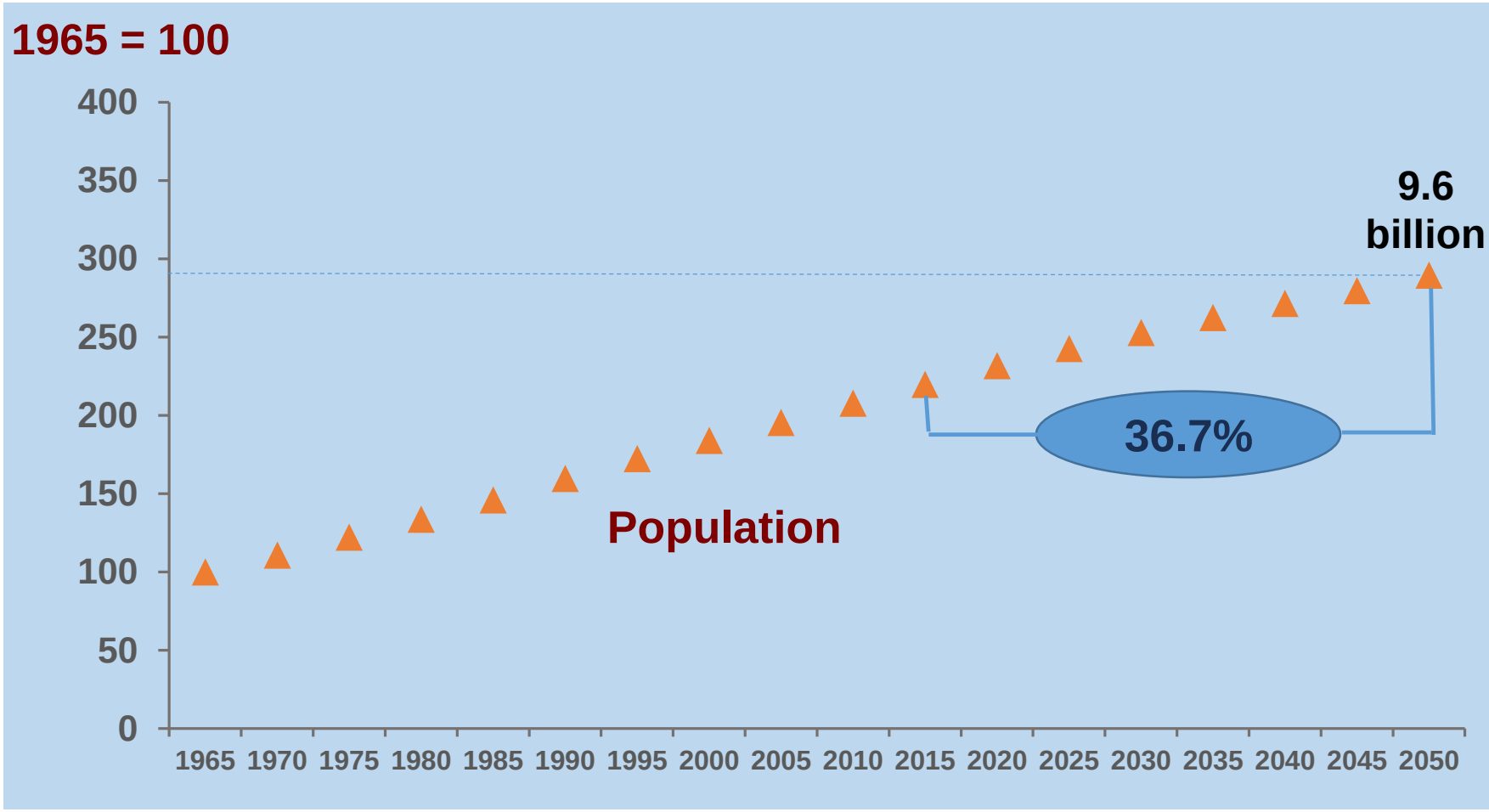
Yanhong Liu

University of California, Davis

Outline

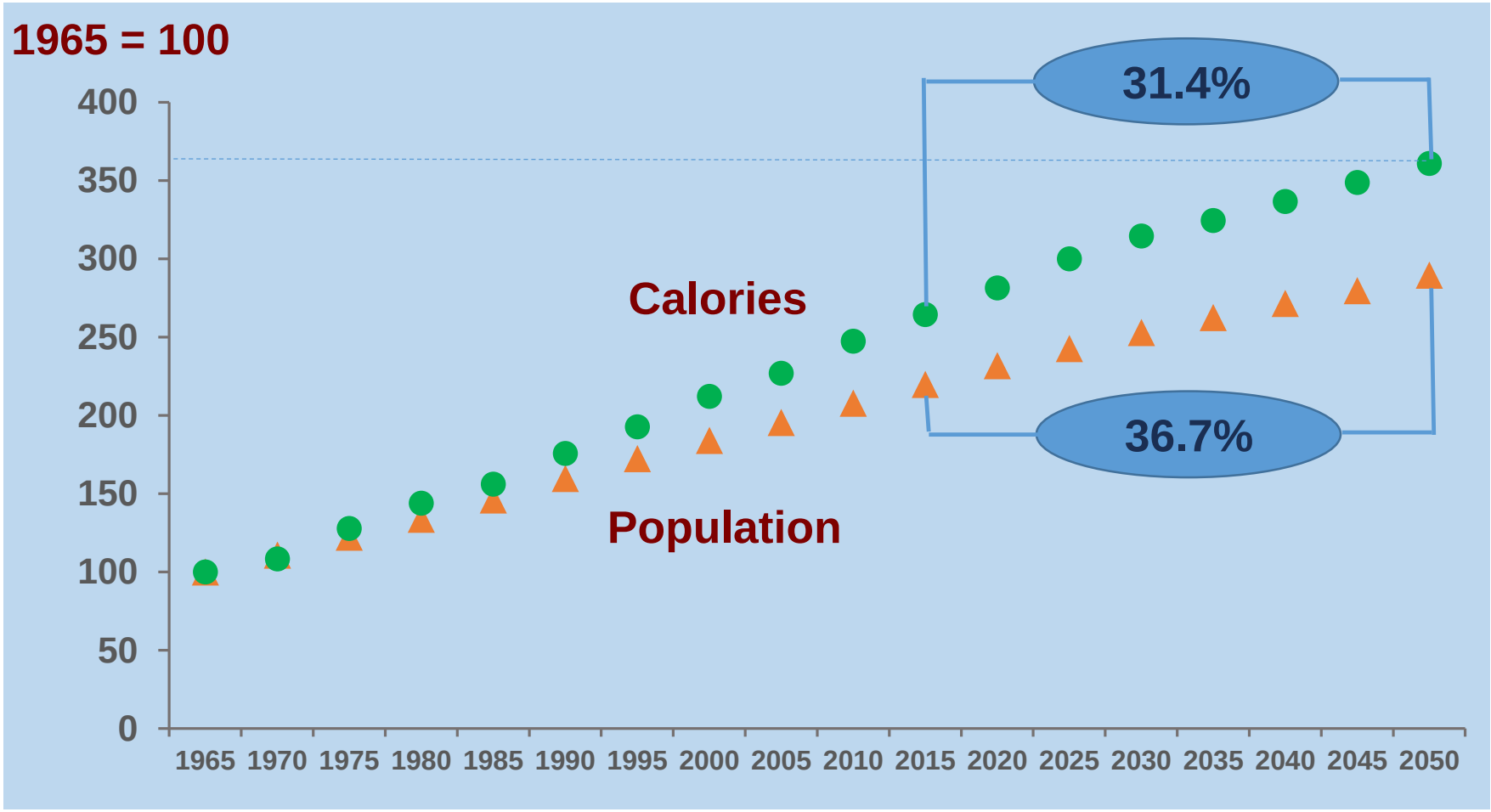
- World population & calorie demand
- Non-nutrients - a novel concept
- Examples
- Overall summary
- Take home message

World population



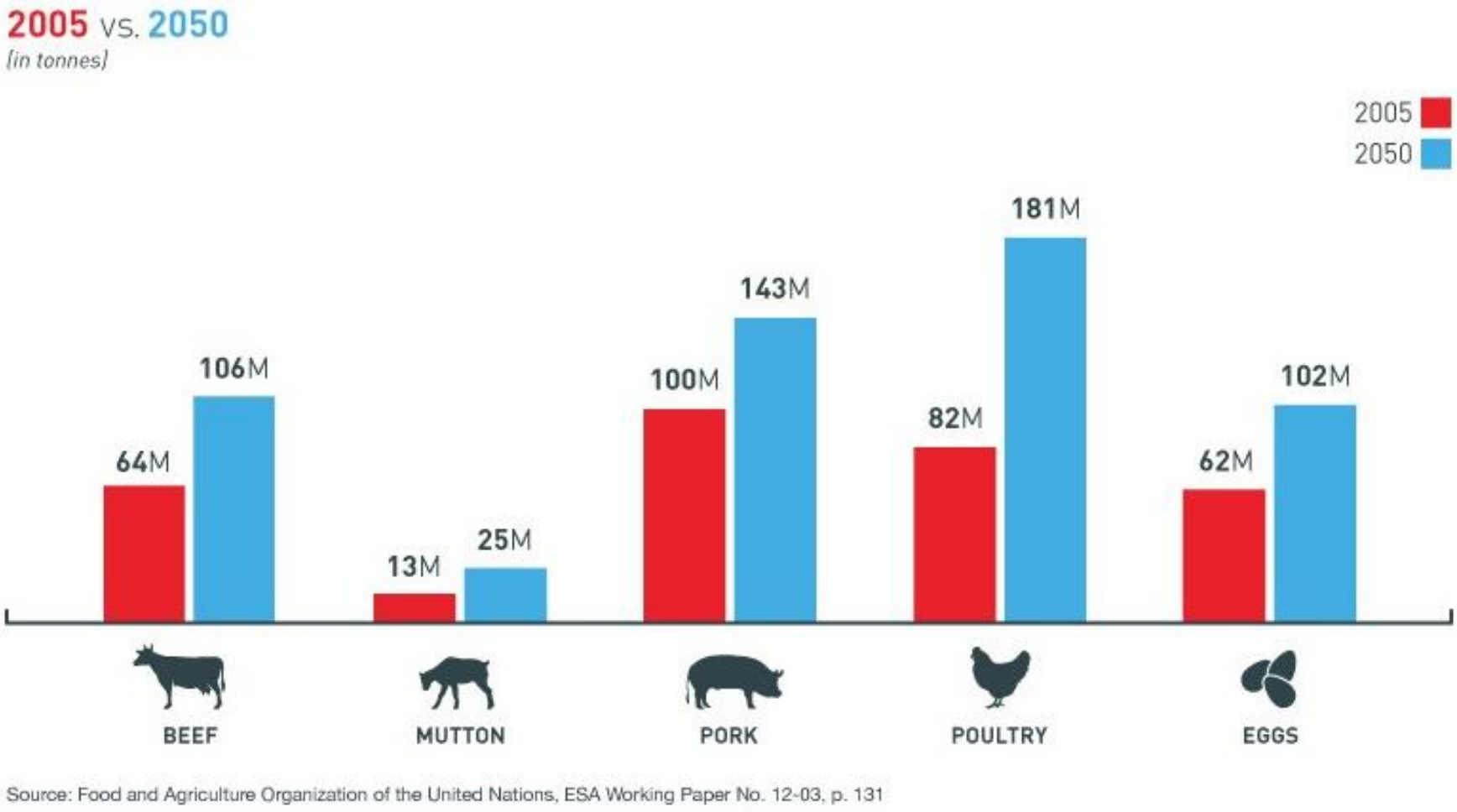
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2007)

Food calories



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2007)

Global demand for meat



Source: Food and Agriculture Organization of the United Nations, ESA Working Paper No. 12-03, p. 131

Swine production

- **Technologies**
  - ✓Genetics
  - ✓Management
  - ✓Reproduction
  - ✓Health
  - ✓Nutrition

Non-nutrients

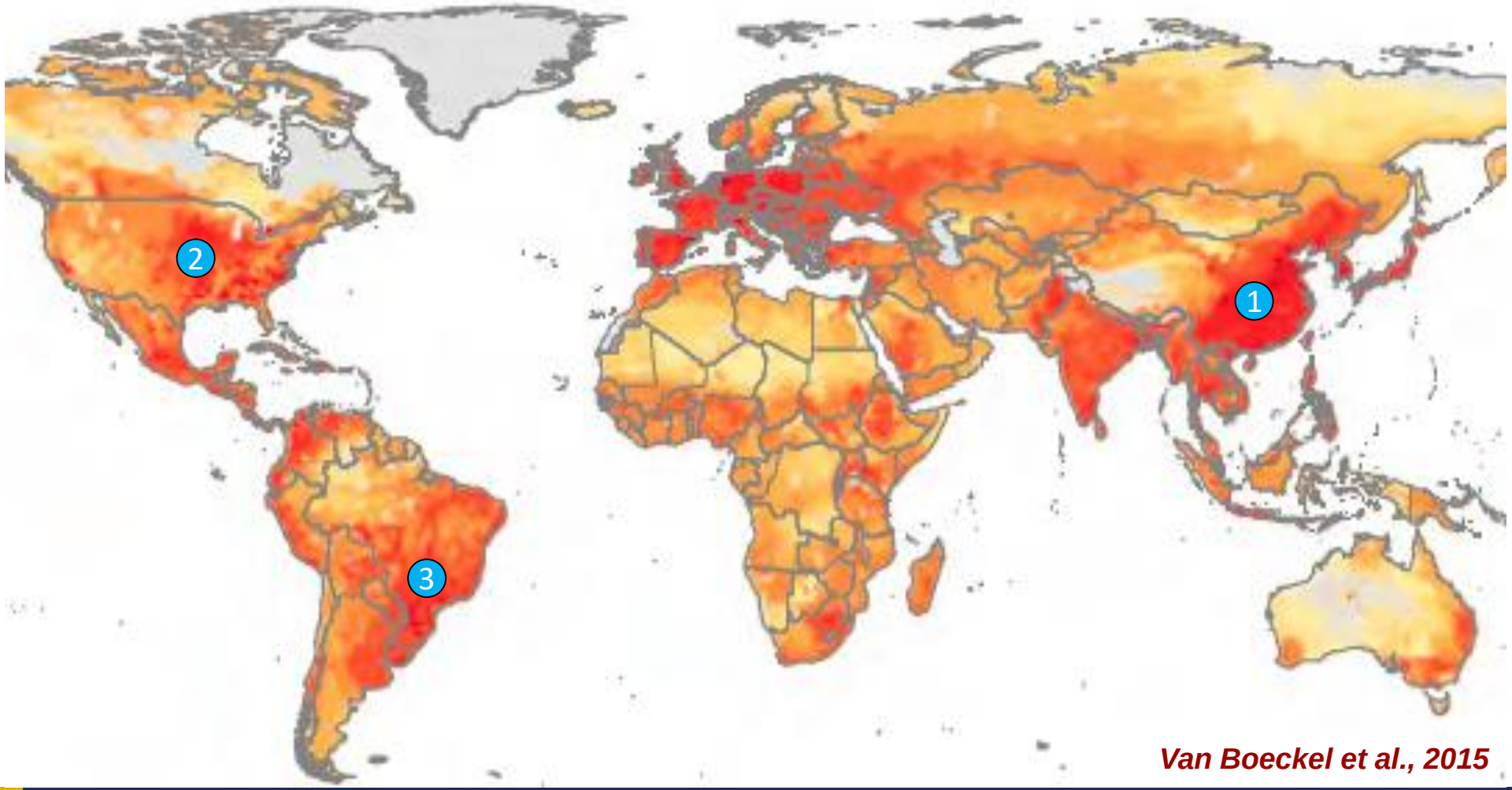
Non-nutrients

- Bioactive compounds
- No nutrient contribution to animals
- But, have physiological activities beyond provision of bioactive compounds

Antibiotics

Livestock antibiotics use

2010: 63,000 tons



Van Boeckel et al., 2015

Antibiotics in feed

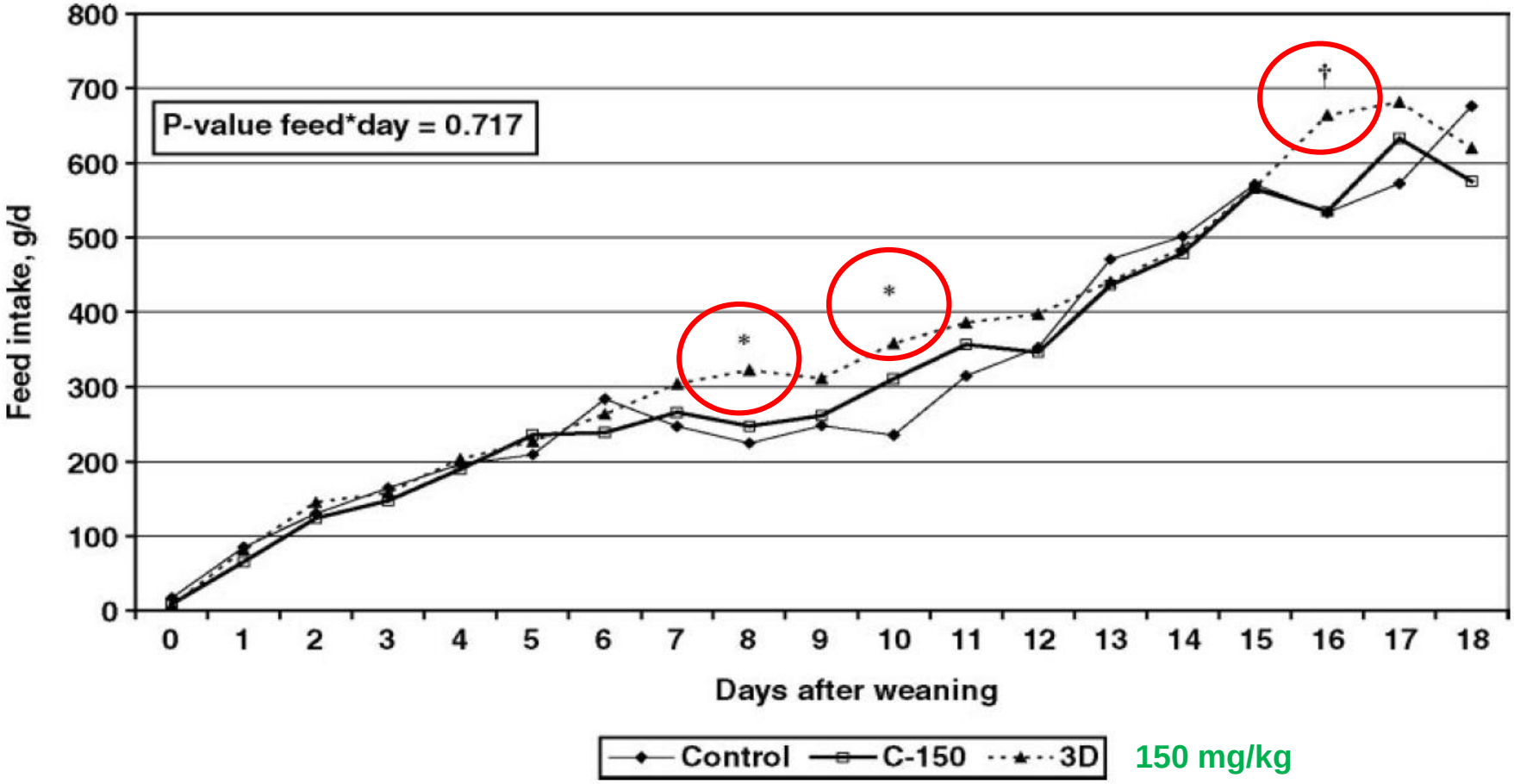
- Treat Disease
- Growth promoter
  - ✓Antibiotic resistance
  - ✓Banned in the European Union since 2006
  - ✓Increasing restricted in the U.S.
    - FDA's GFI #213

Non-nutritive sweeteners

Artificial sweeteners

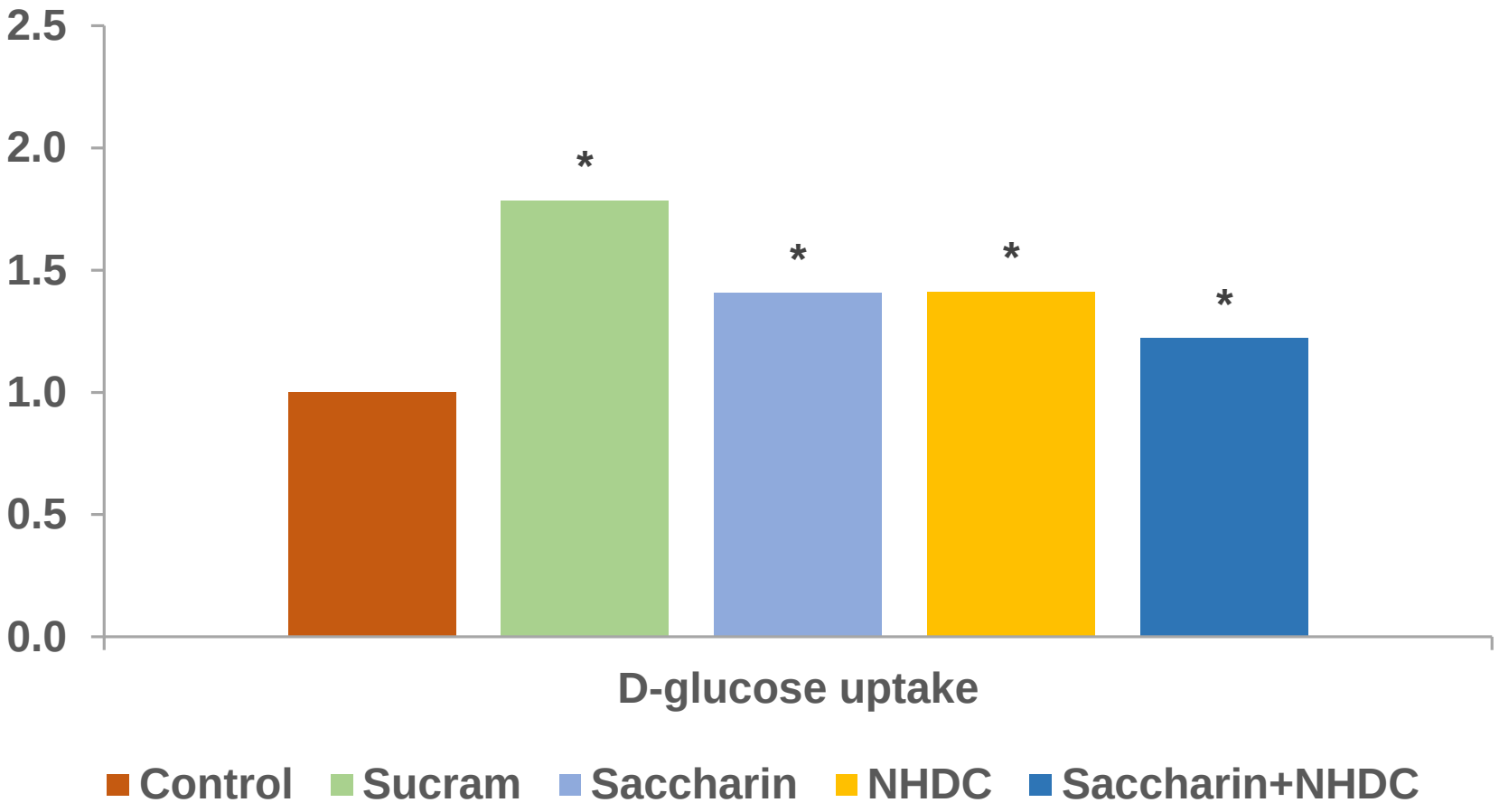
- Synthetic sugar substitutes
- Intensive sweeteners
- Pleasant taste, enhance palatability, reinforce taste preference, and promote consumption

Feeding artificial sweeteners increased feed intake of weaning pigs



Sterk et al., 2008

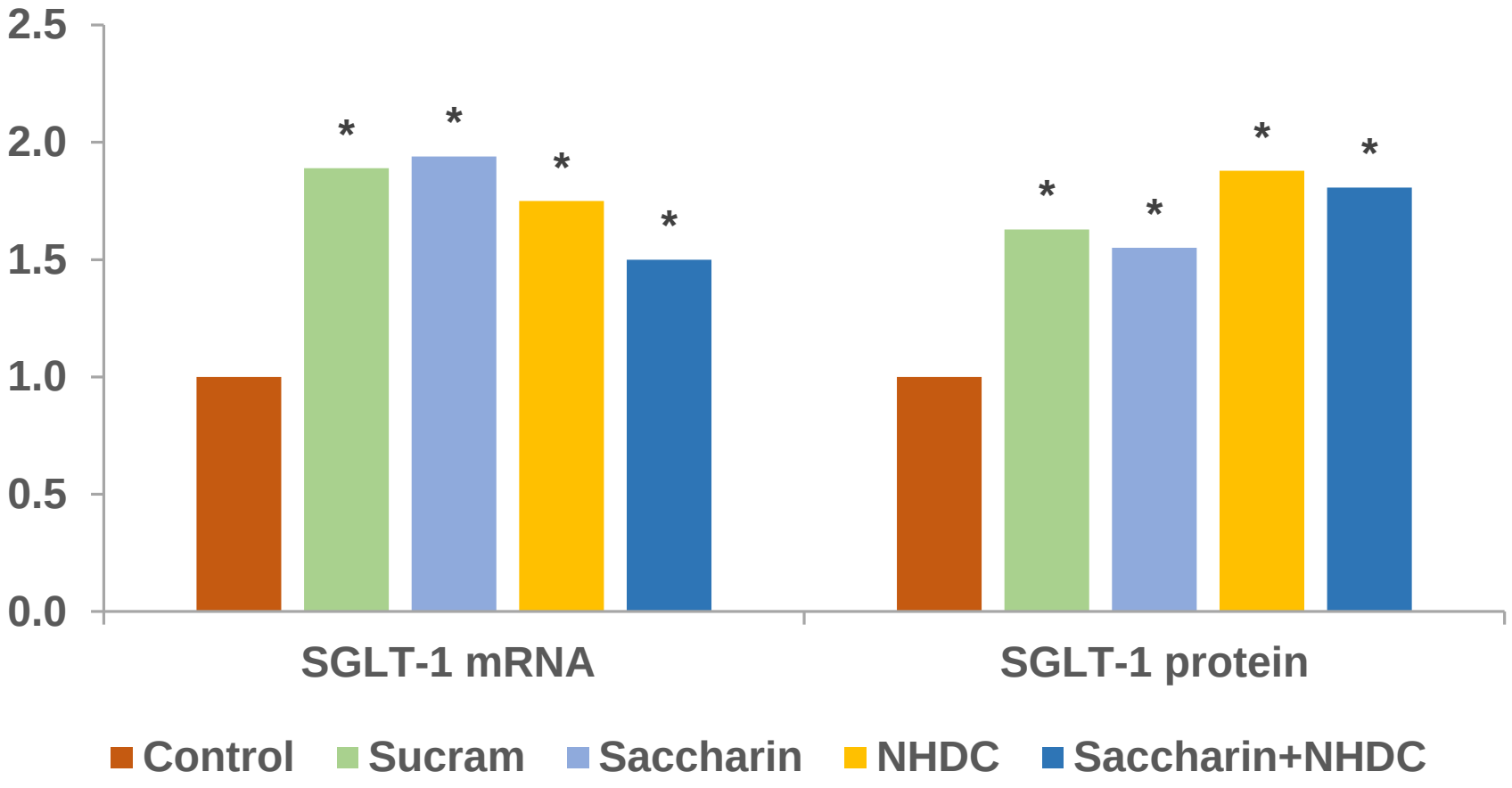
Sweeteners enhanced glucose uptake of weaning pigs



NHDC = neohesperidin dihydrochalcone

Moran et al., 2010

Sweeteners enhanced expression of glucose co-transporters in weaning pigs



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Moran et al., 2010

Artificial sweeteners

- Pre- & post-weaning periods
- Improve feed intake
- Improve feed efficiency
- Prevent weaning-related malabsorption

Exogenous enzymes

Anti-nutritional factors

- **Anti-nutritional factors in animal feed**
  - ✓**Examples: phytic acid, glucosinolates, non-starch polysaccharides**
  - ✓**Reducing amino acid digestibility**
  - ✓**Binding to various nutrients**
  - ✓**Disturbing intestinal functions**

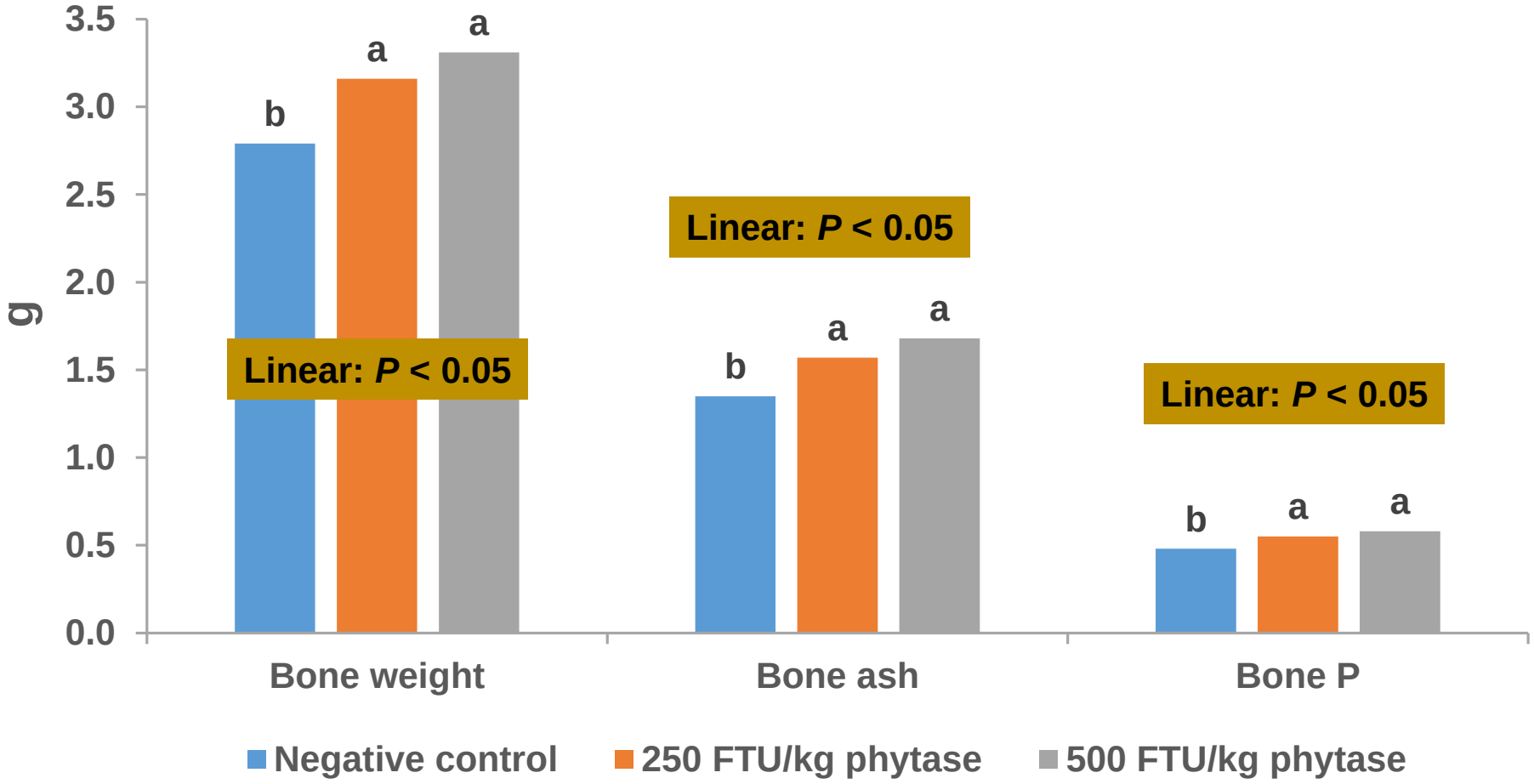
Exogenous enzymes

- **Exogenous enzymes help to degrade the indigestible components in diet and help to alleviate the negative effects of anti-nutritional factors**

Exogenous enzymes

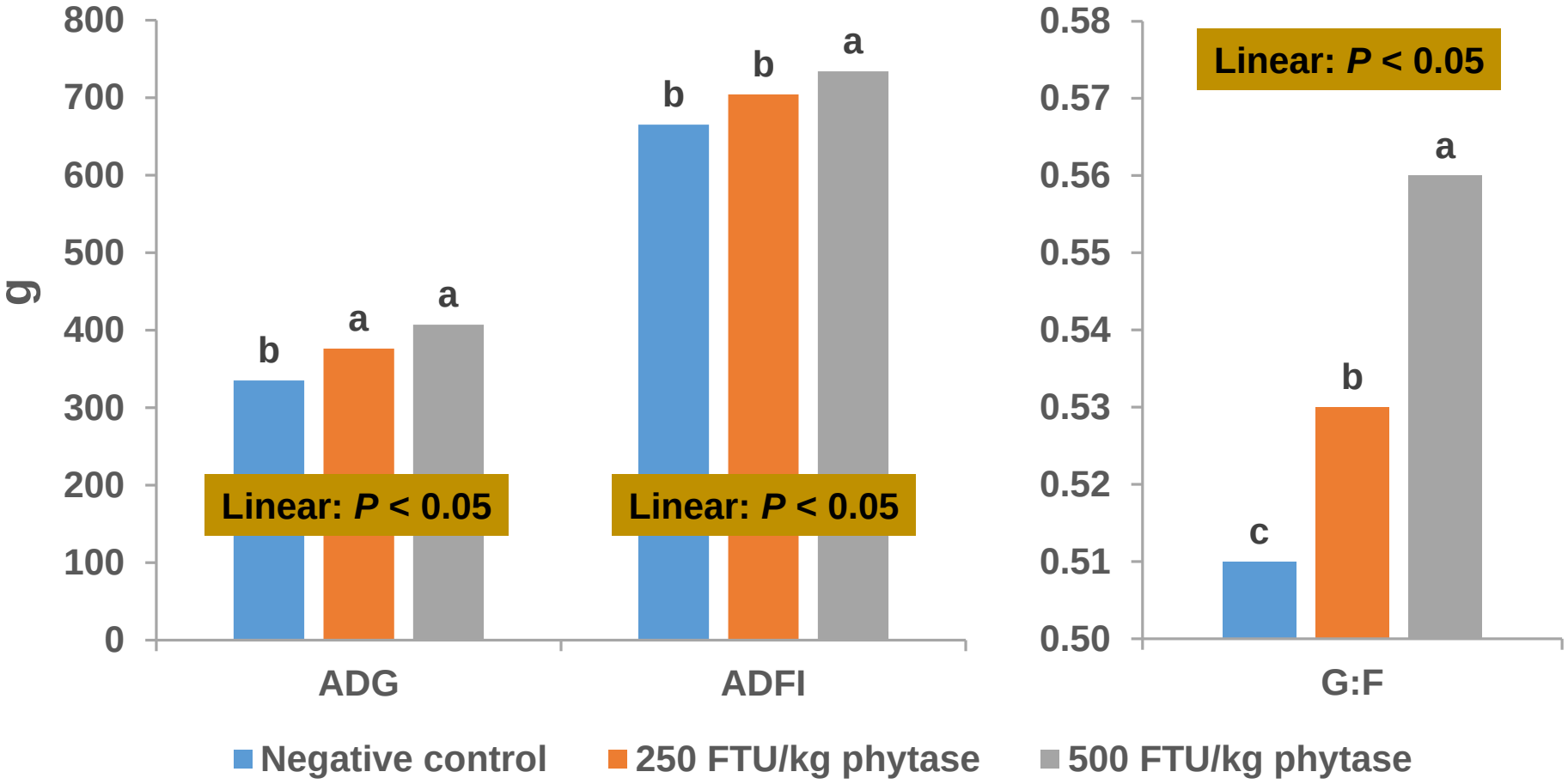
Enzyme	Main substrate
Phytase	Phytic acid
Xylanase	Arabinoxylans
Galactosidase	Galatosides
Mannanase	β-mannans
Protease	Proteins

Dietary phytase enhanced P utilization of weaning pigs



Liu et al., 2016

Dietary phytase improved growth performance of pigs fed P-deficient diets



Liu et al., 2016

Xylanase improved energy digestibility of pigs

Item	Full-fat rice bran	Defatted rice bran
NDF, %	10.36	13.29
ADF, %	5.65	6.61
Hemicellulose, %	4.71	6.68
ME without xylanase, kcal/kg	3,856	2,936
ME with xylanase, kcal/kg	4,198	3,225

ME: metabolizable energy Xylanase dose: 16,000 units/kg

Casas and Stein, 2016

Exogenous enzymes

- **Improve digestibility of nutrients and energy**
- **Improve sustainability of pig production by increasing the utilization of fibrous by-products in pigs**

Probiotics & prebiotics

Probiotics & prebiotics

- **Probiotics: live microorganisms that have beneficial effects on the host when ingested**
- **Prebiotics: compounds able to improve the growth of beneficial microbes in the GI tract**

Salminen et al., 1998
Gilson et al., 2004

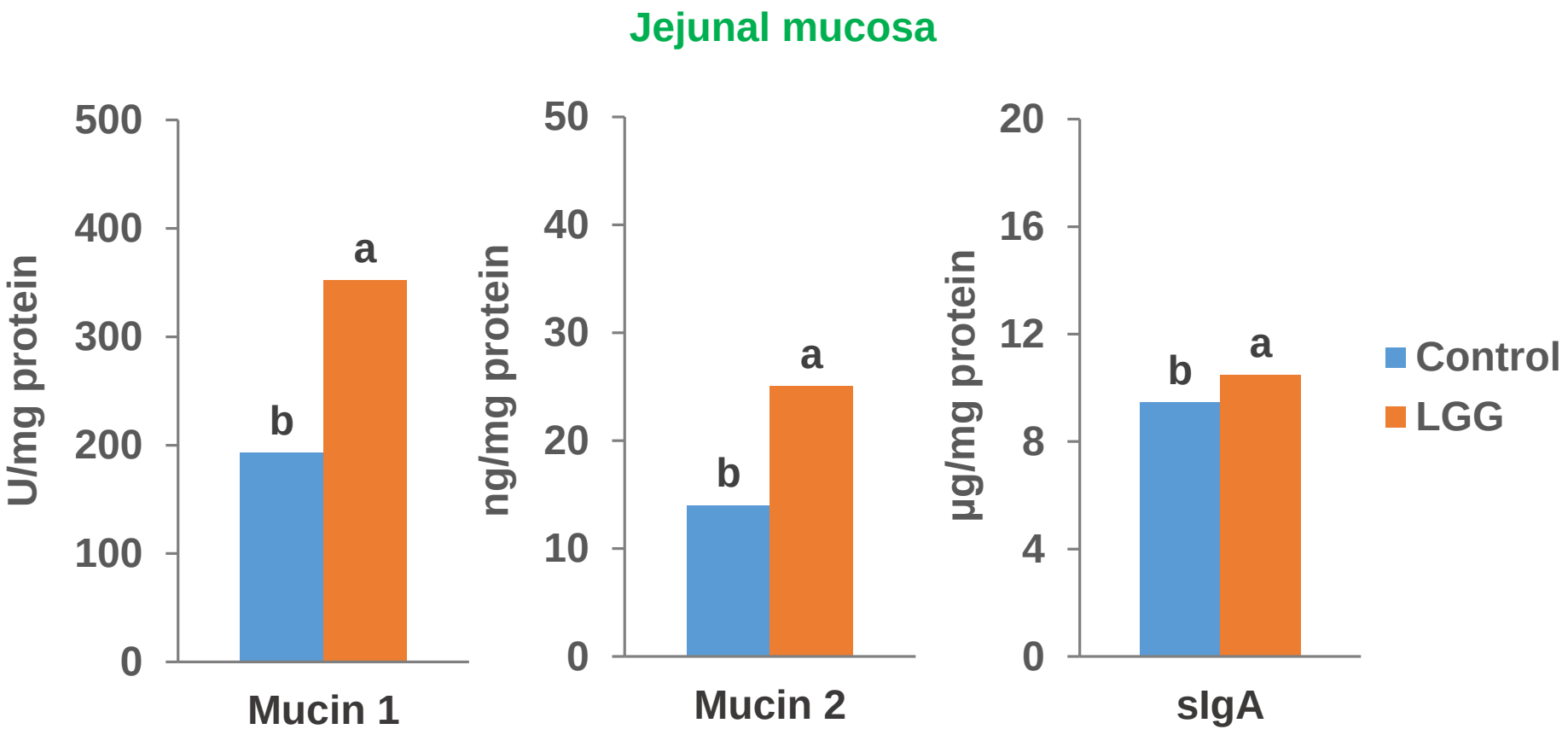
Probiotics

- **Main categories**
  - ***Bacillus (Gram +, spore-formers)***
  - ***Lactic acid-producing bacteria***
    - ***Lactobacillus, Bifidobacterium, Enterococcus***
  - ***Yeast***

Prebiotics

- Inulin
- Fructo-oligosaccharides
- Galacto-oligosaccharides
- Transgalacto-oligosaccharides
- Soy oligosaccharides
- Lactose
- etc.

Probiotics: LGG

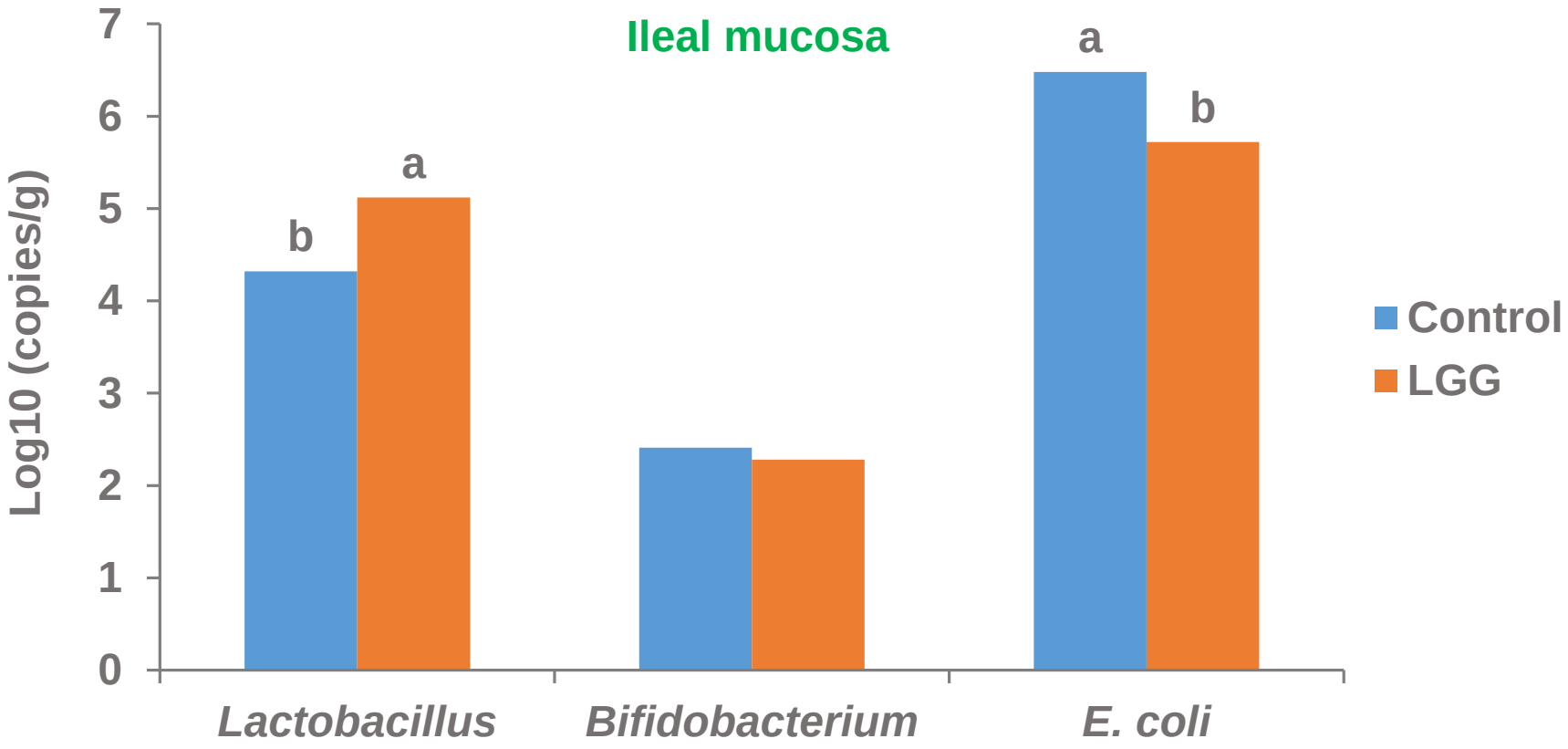


LGG = *Lactobacillus rhamnosus* *Dose: 10^9 CFU/g*

Weanling pigs: 6.7 kg BW

Mao et al., 2016

Probiotics: LGG



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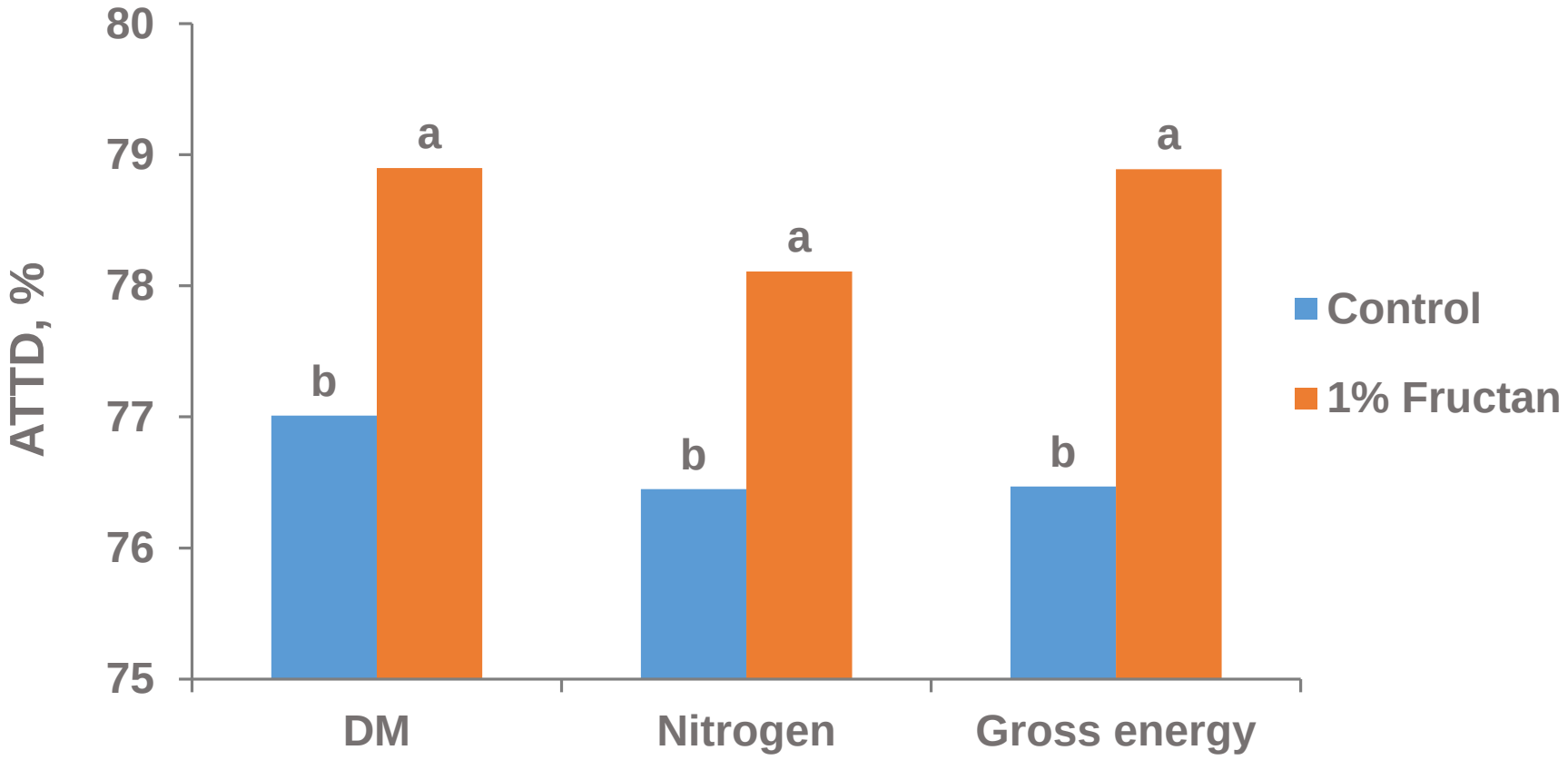
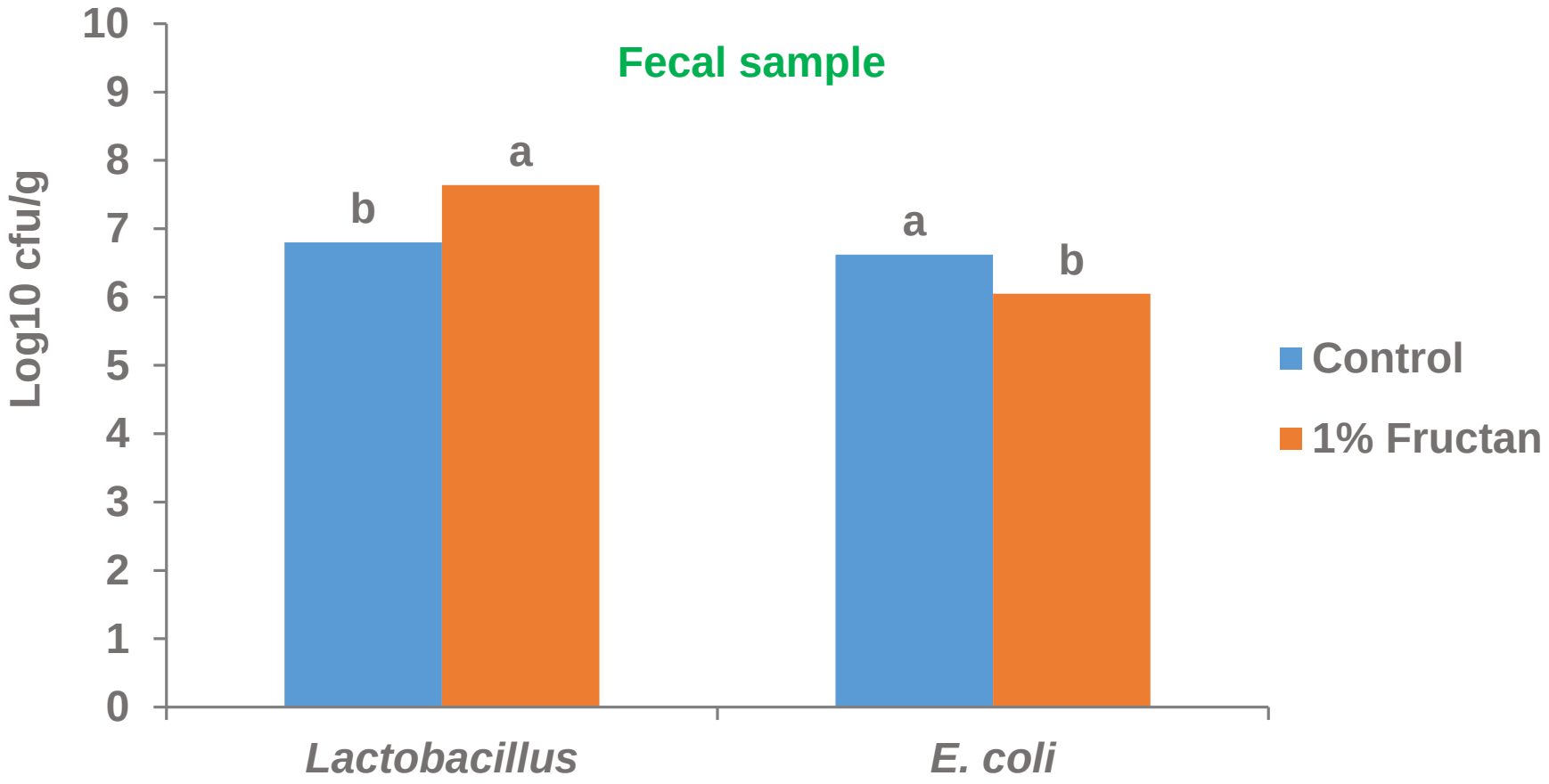
Prebiotics: fructan



Growing pigs: 73 kg BW

Zhao et al., 2013

Prebiotics: fructan

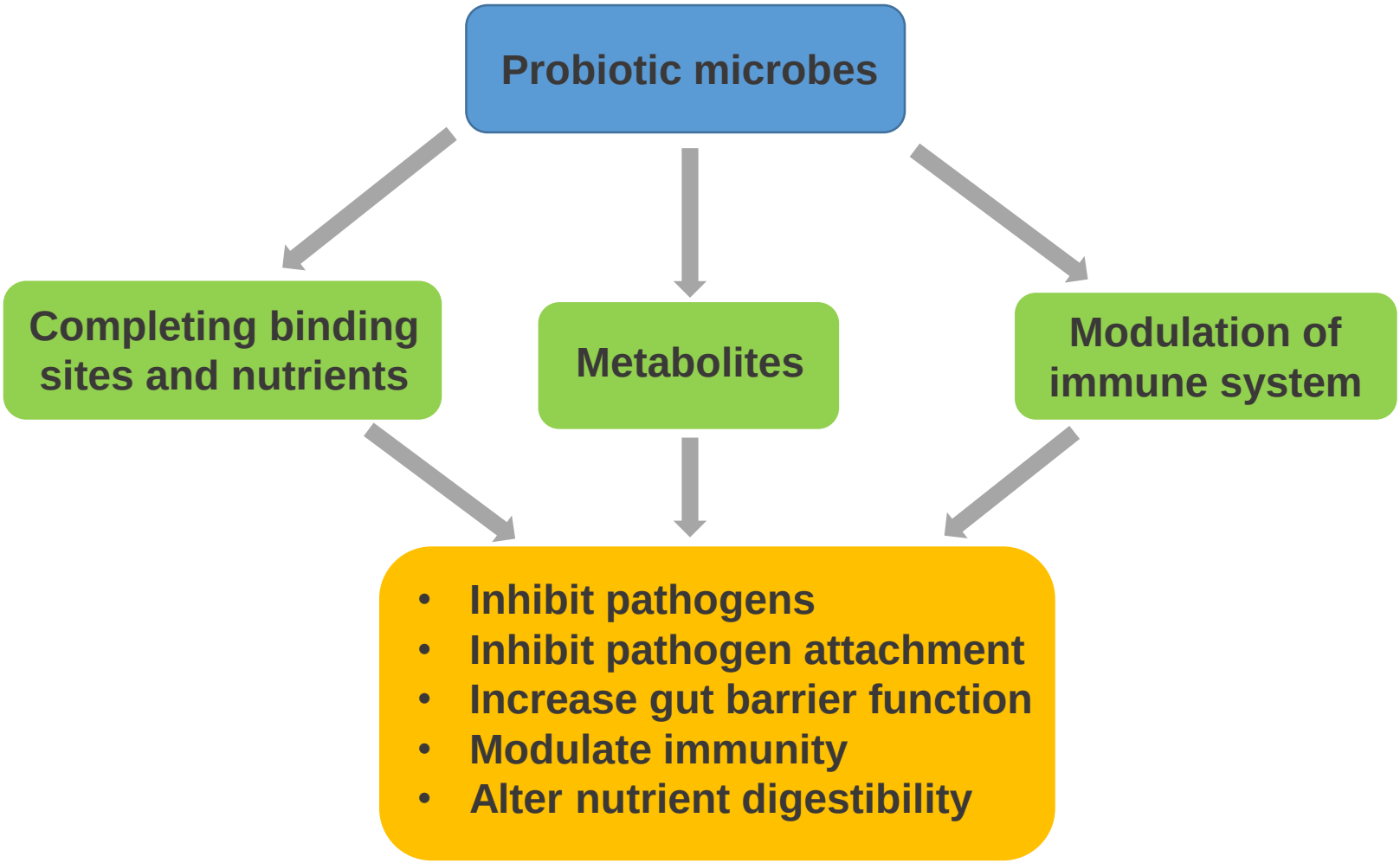


Growing pigs: 73 kg BW

Zhao et al., 2013

Probiotics & prebiotics

Potential mechanisms

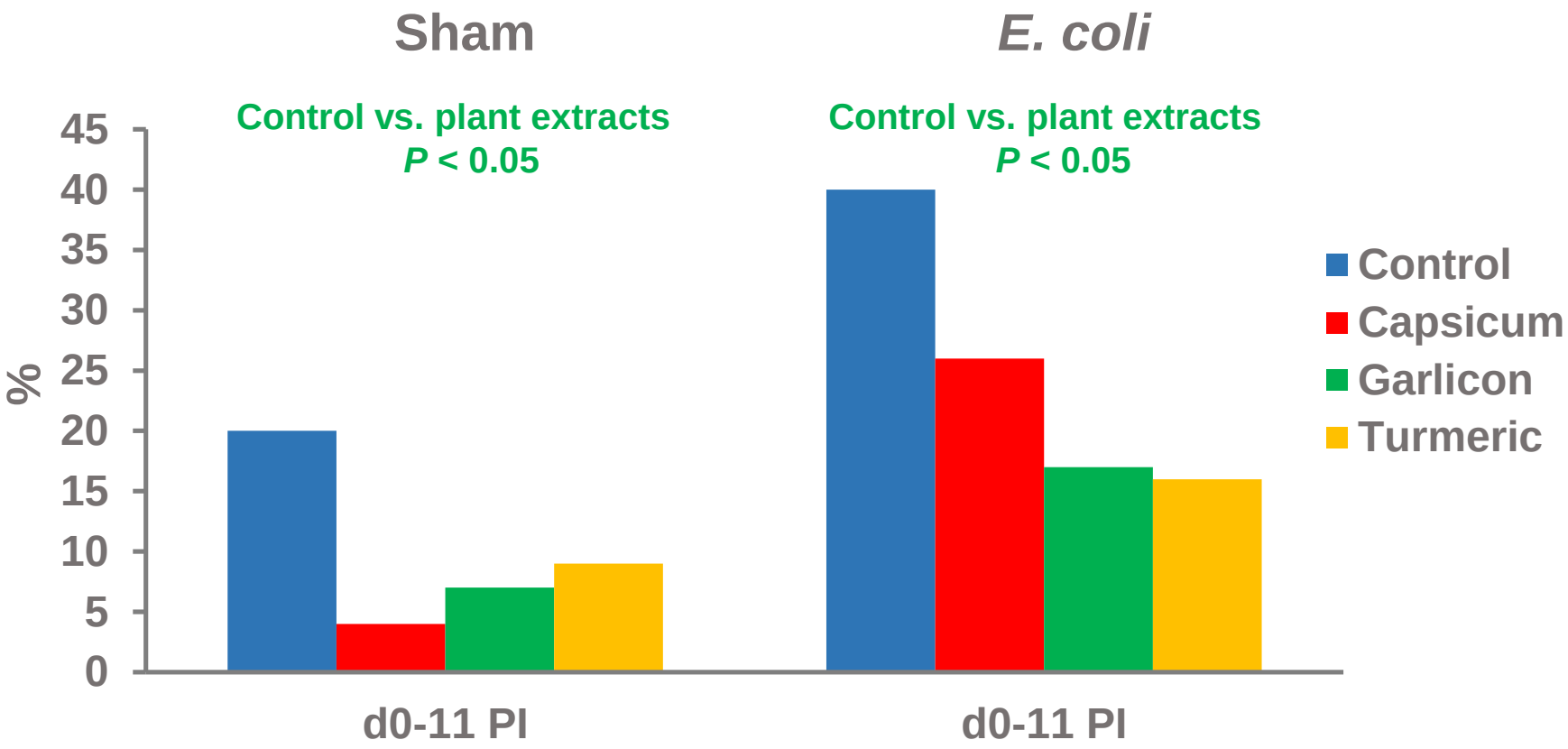


Plant extracts

Plant extracts

- **Concentrated, hydrophobic, volatile aroma**
- **Mixtures of secondary plant metabolites**
- **Biological effects:**
  - ✓ **Antimicrobial**
  - ✓ **Anti-inflammatory**
  - ✓ **Antioxidant**
  - ✓ **Others: Antiviral, Antifungal, Antiparasitic, Antitoxigenic**

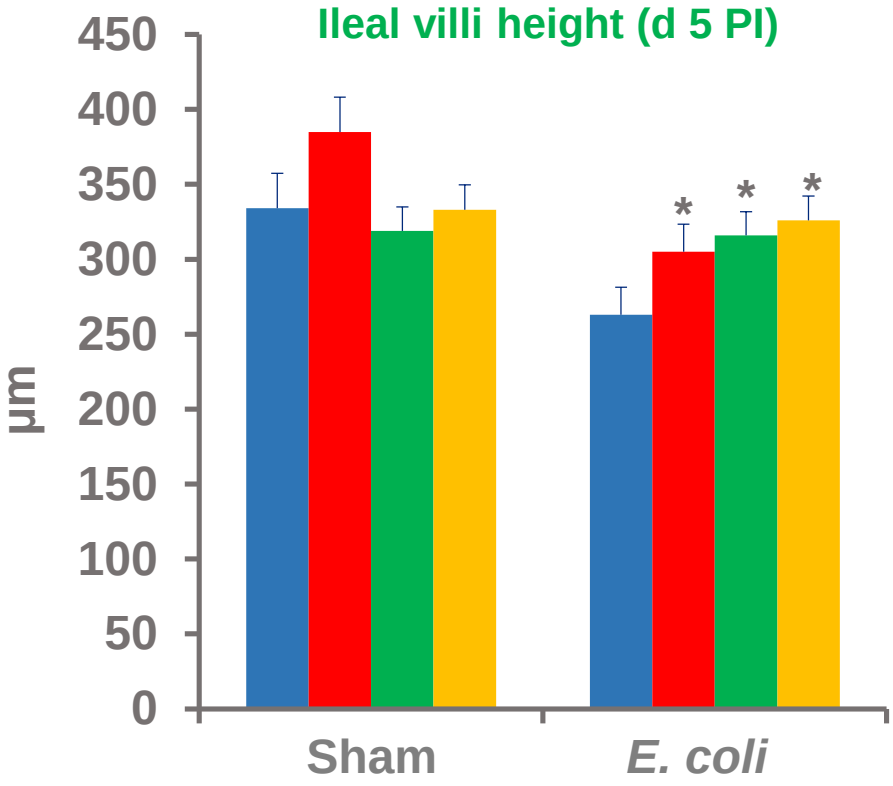
Frequency of diarrhea

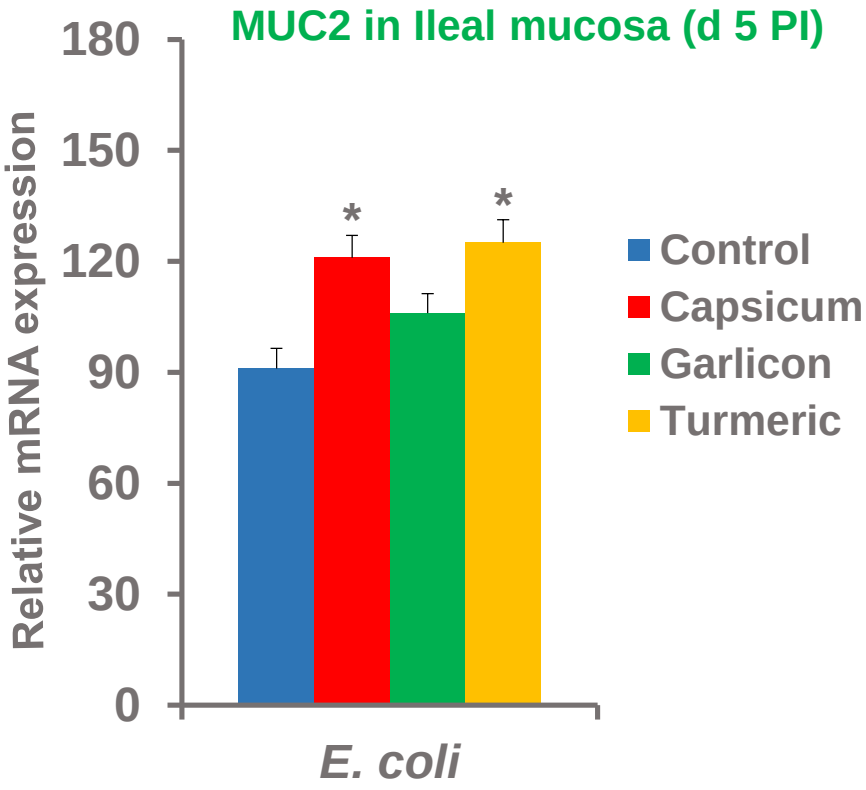


Pig days with diarrhea score ≥ 3
1, normal; 5, watery diarrhea

Liu et al., 2013

Possible mechanism for reduced diarrhea

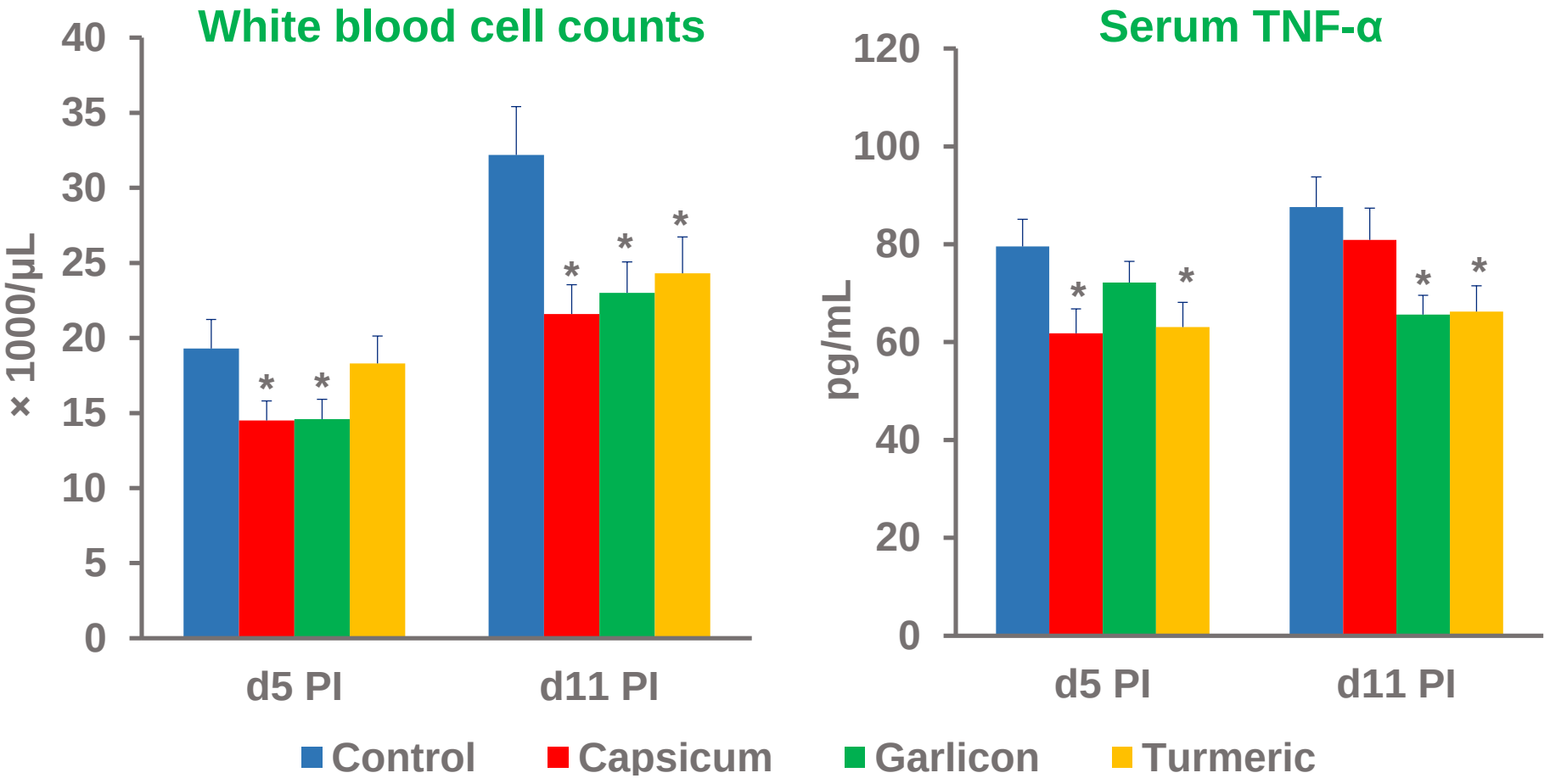




- **Possibly improved gut barrier function!**

Liu et al., 2013, 2014

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



Liu et al., 2013

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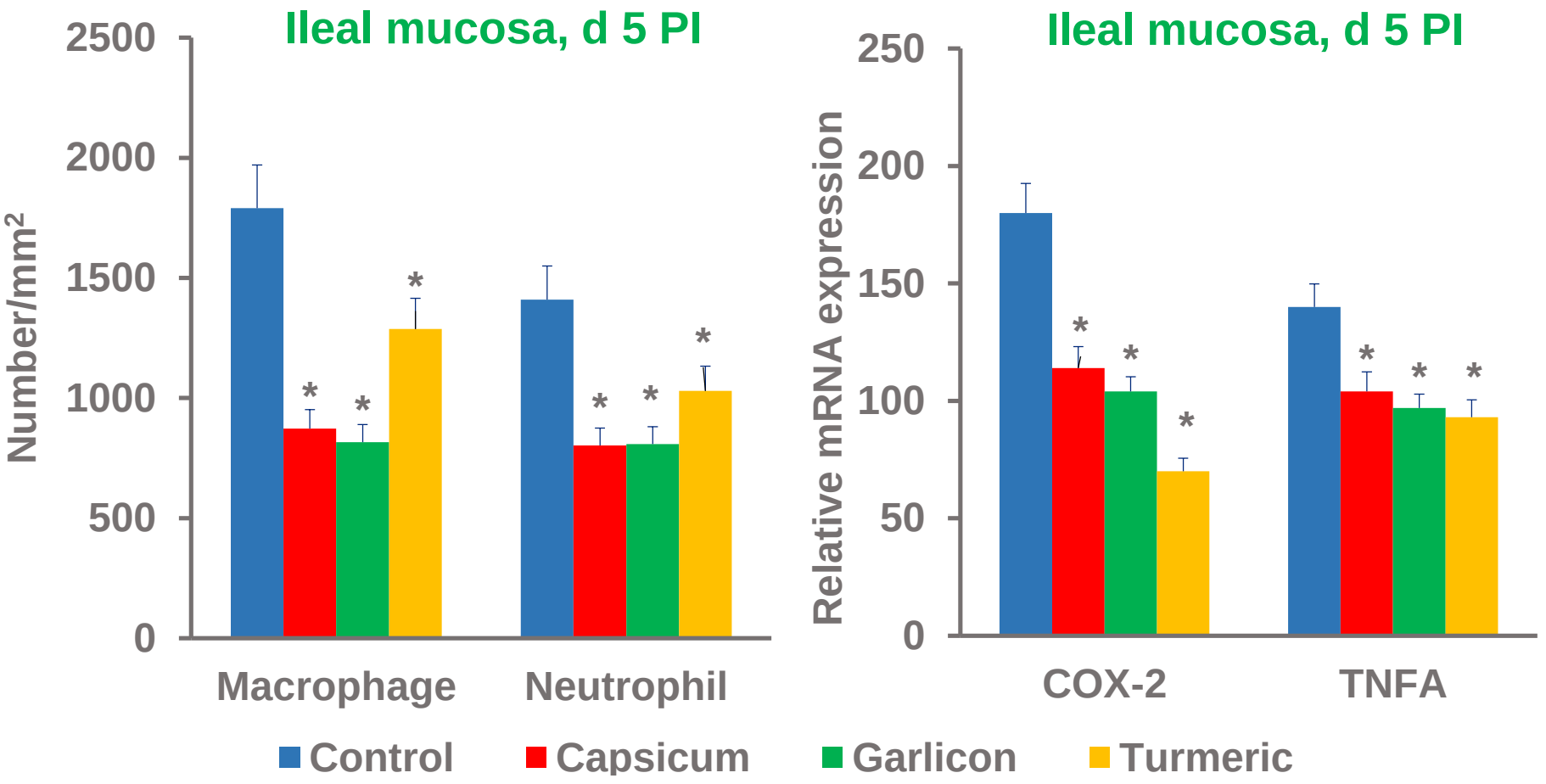


Liu et al., 2013

Plant extracts

- Weanling pigs
- Increase disease resistance
- Enhance gut barrier function
- Modify immune responses

Overall summary

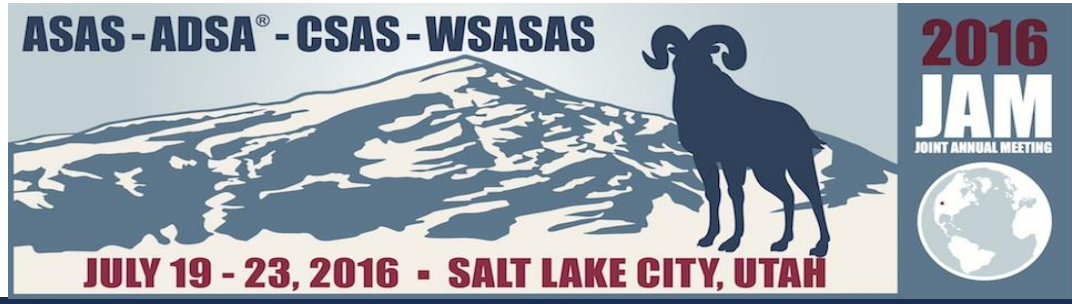
- **Non-nutrients**
  - ✓**Nutrient digestibility or absorption**
  - ✓**Gut microbial ecology**
  - ✓**Gut integrity and barrier function**
  - ✓**Host immune responses**

Take home message

- **The importance of using non-nutrients will be increased to maintain pig health and promote grow performance**
- **More research are needed for the best practical solutions for swine health and production**

Acknowledgement

- Dr. James Pettigrew's Lab at University of Illinois
- Dr. Hans Stein's Lab at University of Illinois
- Symposium committee
- Pancosma
- ASAS



Liu Animal Nutrition Laboratory

- **Nutrients & Non-nutrients on gut health of weaning pigs**

http://liu.faculty.ucdavis.edu/