Non antibiotic strategies to modify the microbial population of dairy cattle: impacts on milk production, animal health, and food safety

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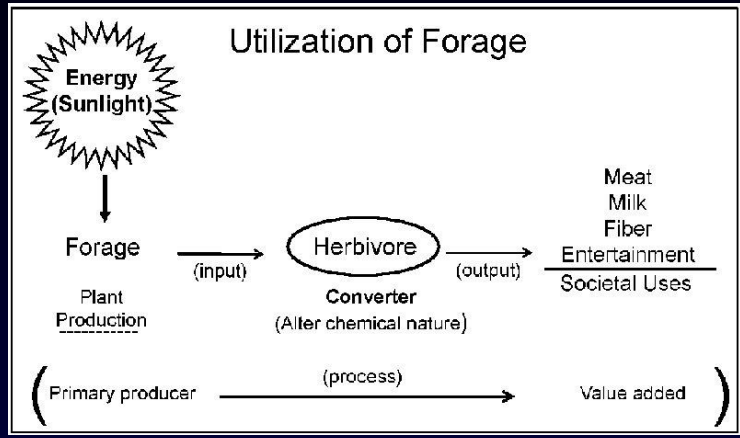
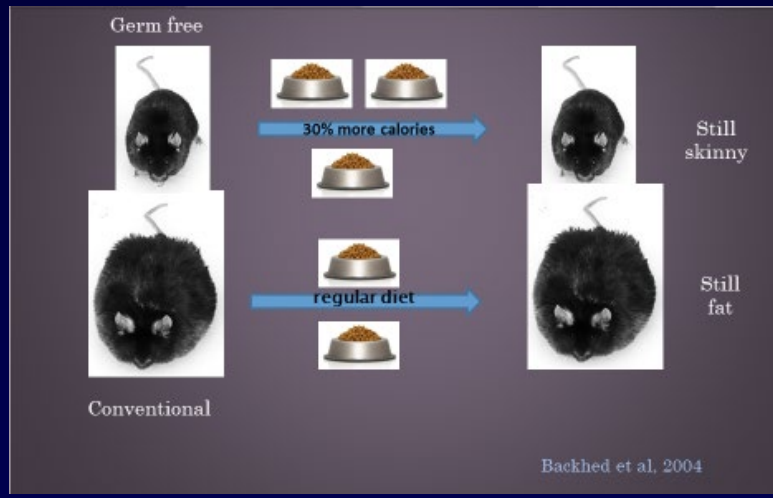
Ruminant Gut Microbiome

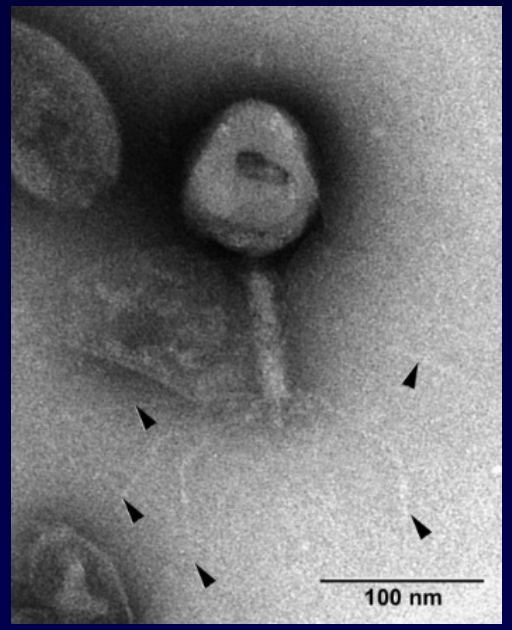
- The ruminant gut is dynamic and determines efficiency
  - Feed efficiency ranges from 1:3 to 1:7 (G:F)
  - > 16,000 bacteria, 10^{10} CFU/ml, protozoa/bacteria/fungi)
  - Biochemical and genetic reservoir (detoxification)
- How to improve the efficiency of the microbial fermentation to the animal?
  - Probiotics, prebiotics, organic acids, natural botanicals, diet changes, feed additives, ionophores…..
  - All do improve performance
  - But how? And why? And why not always?

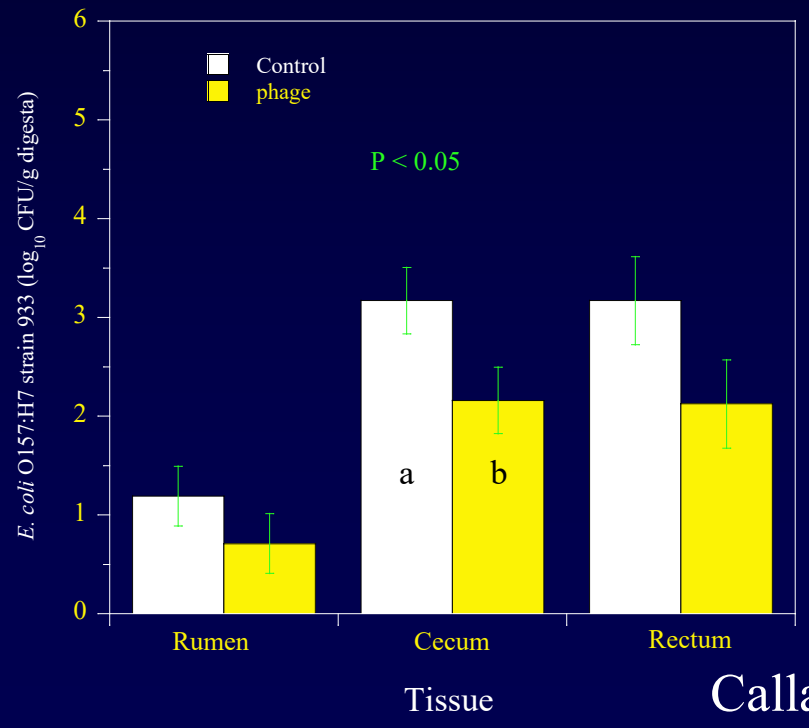


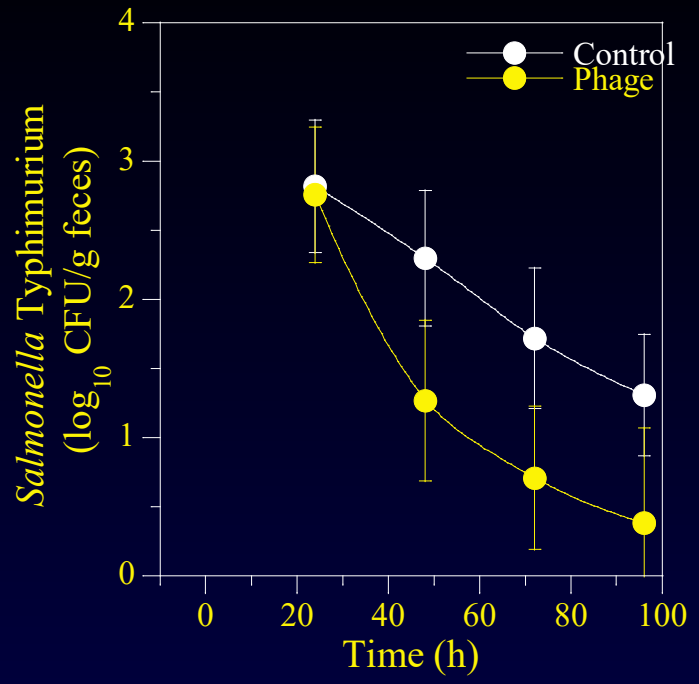


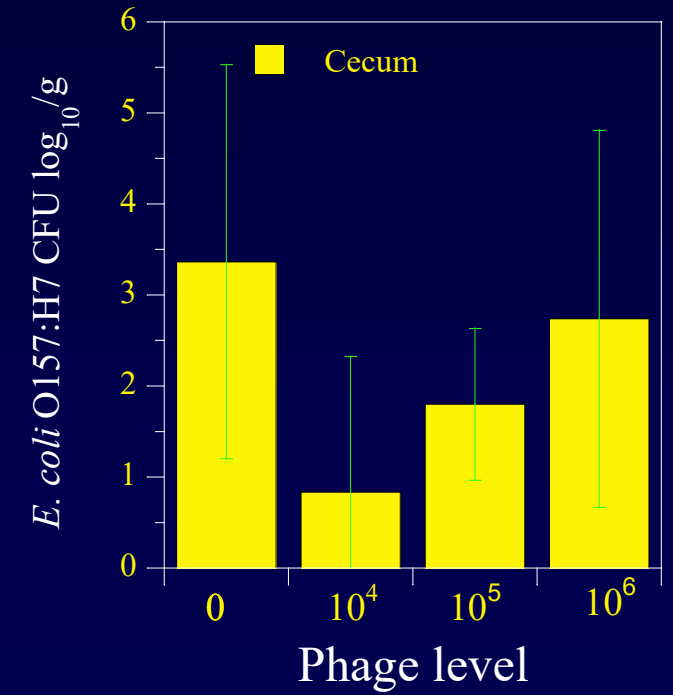
Bacteriophage

- Phage are viruses that prey upon bacteria
  - Specificity of the phage can be great
- Can reduce pathogen populations in and on food animals
- Many pathogens targeted in all food animal species

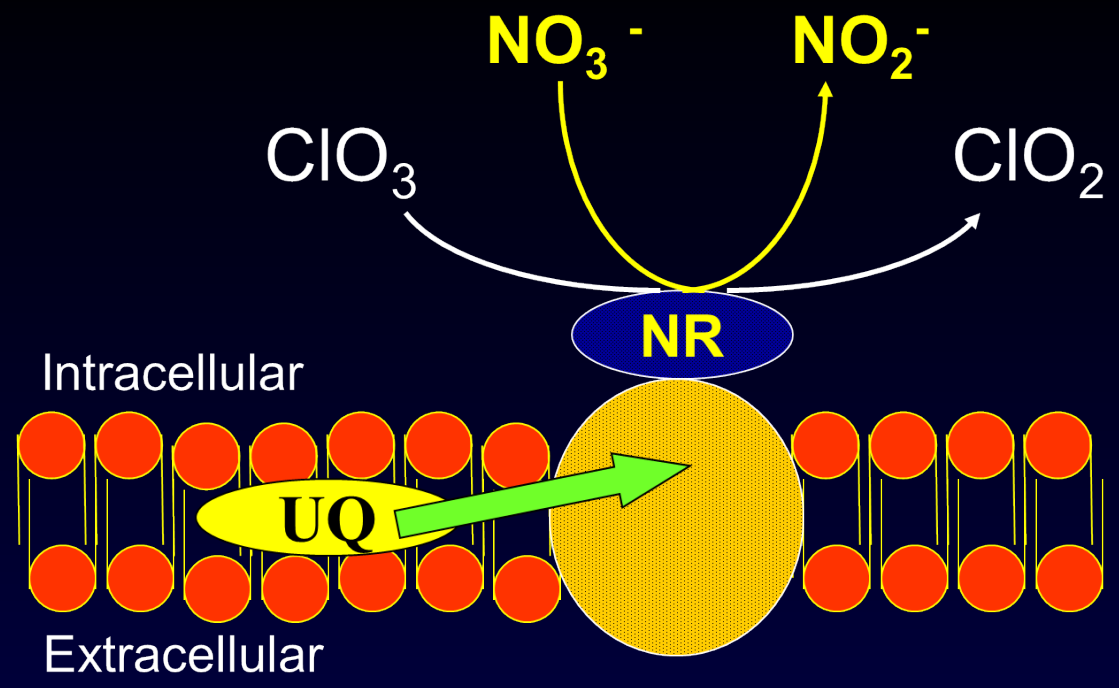






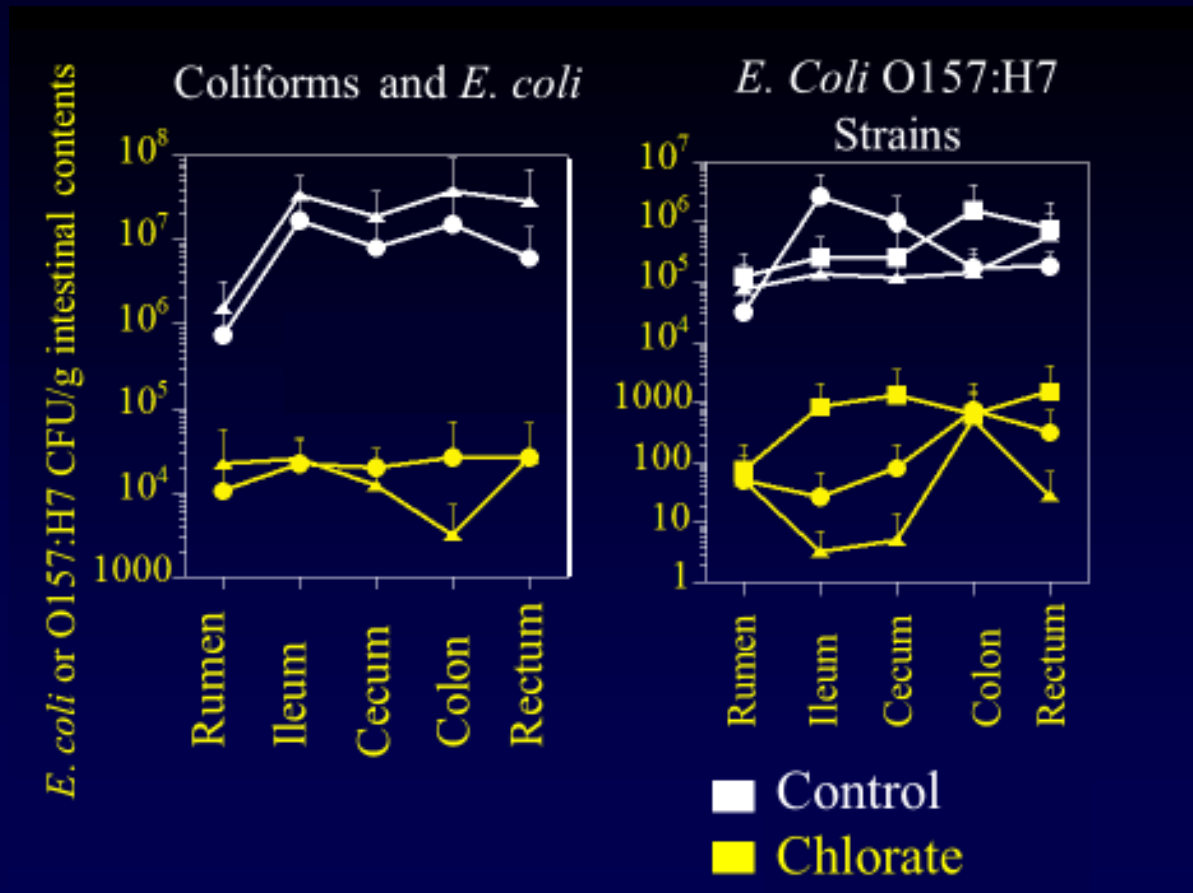


Callaway et al., 2008



Sodium Chlorate

- Chlorate reduces *Salmonella* and STEC/EHEC in the gut of animals
- Fed prior to shipment from farm
- Works during transport and lairage



Anderson et al., 2001; Callaway et al., 2003

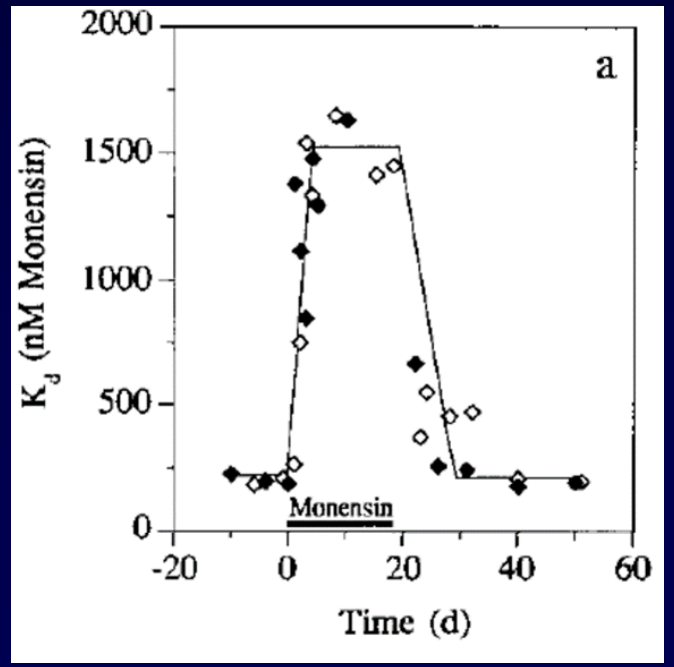
Ionophores and methane inhibitors

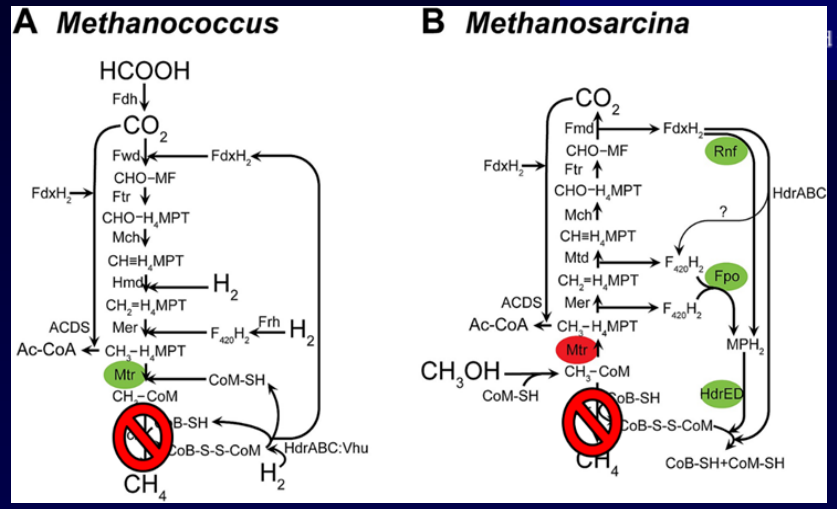
- Ionophores reduce wasteful endproducts of fermentation (Gram +)

Reduced sensitivity by adaptation (glycocalyx)

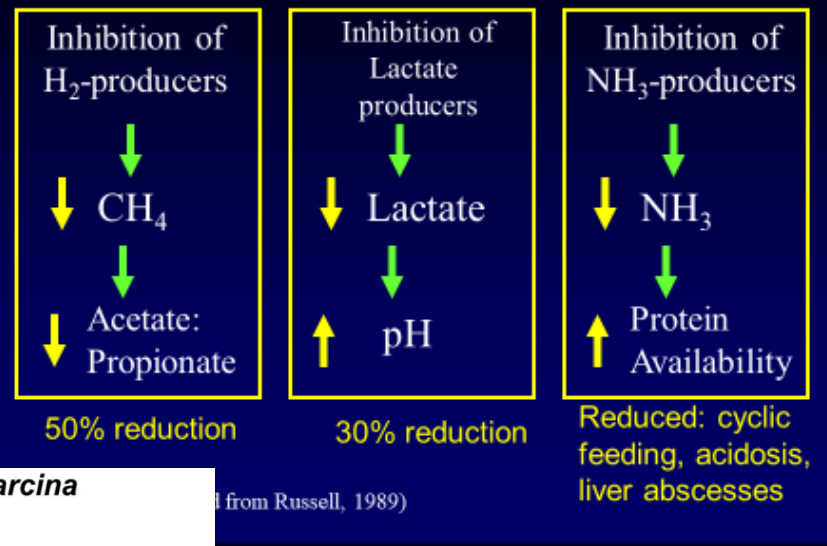
Induced by ionophore feeding

  - Disappears with removal
  - Little/no cross resistance





- 3 nitroxypropanol 3-NOP inhibits methyl coenzyme M reductase
  - Final step in methanogenesis
- Reduces CH_4 production and increases weight gain and milk production (Hristov et al., 2015)



Probiotics/DFM

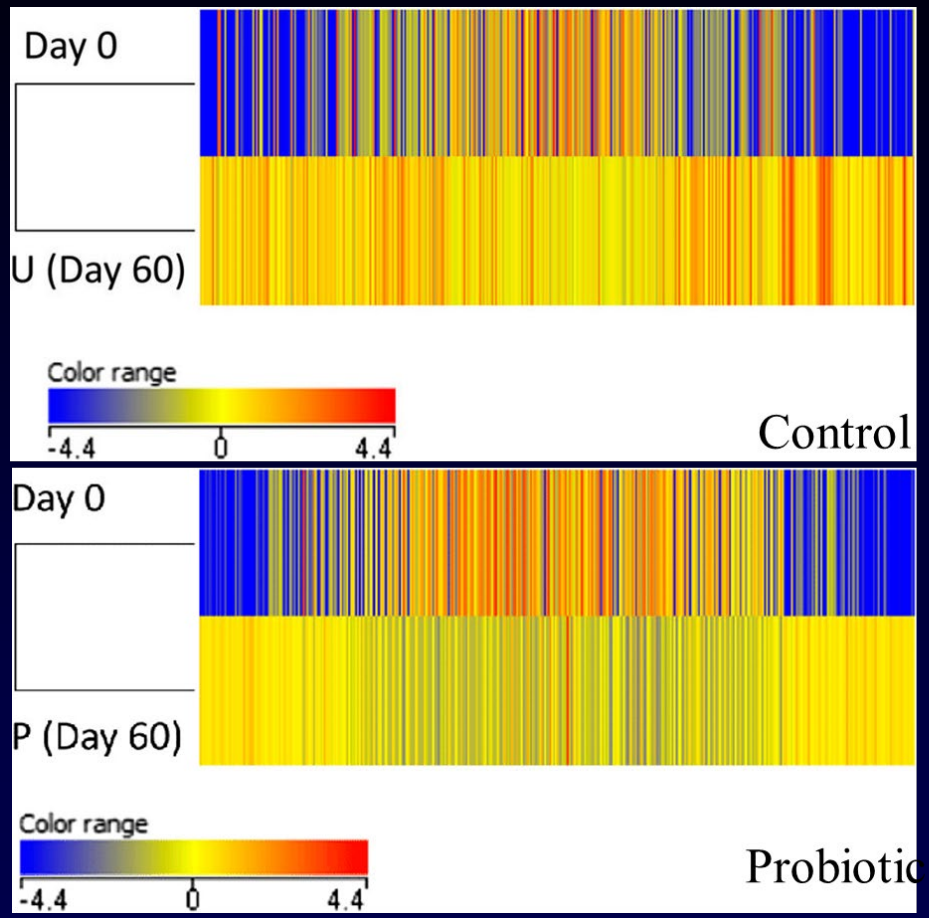
Probiotics
Implied curative properties

1) Probiotics
2) Direct Fed Microbials
- bacteria or fungi
- endproducts of fermentation
- mixtures

Prebiotics

Nutrients that are limiting in the intestinal ecosystem to specific members or groups. Colonic food

- fucose, lactose, inulin
- synbiotics

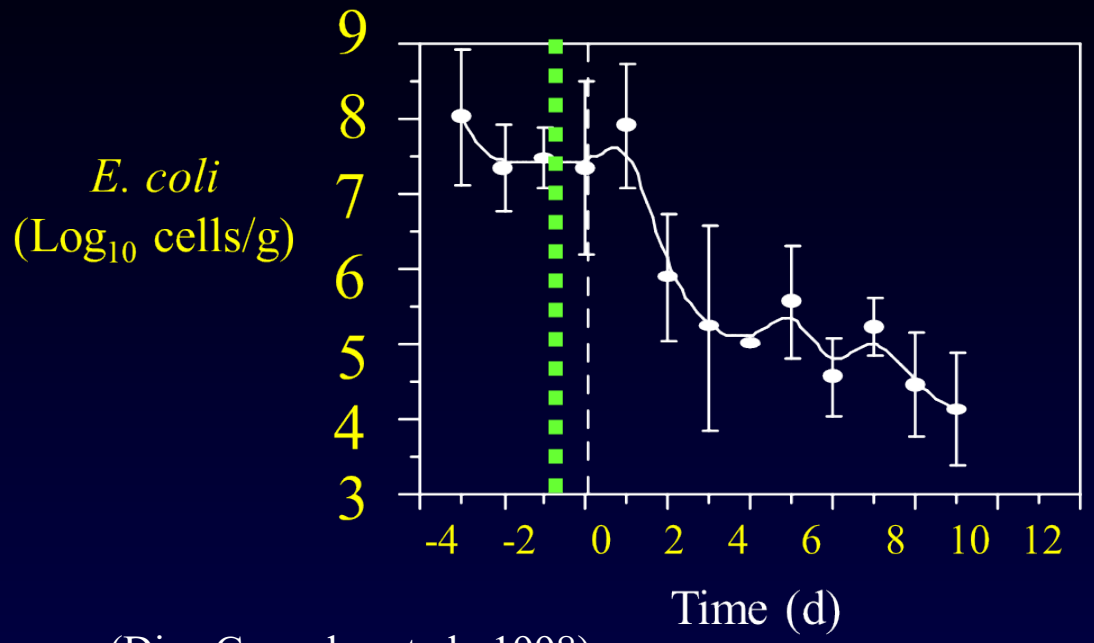


- Eubiotics are what are typical thought of as "traditional probiotics" (live)
- Nutraceuticals and postbiotics

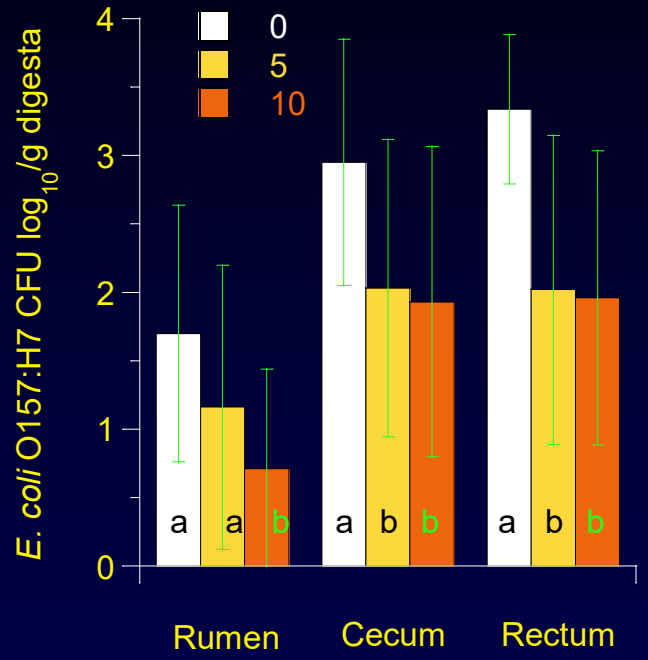
Adjei-Fremah et al., 2017

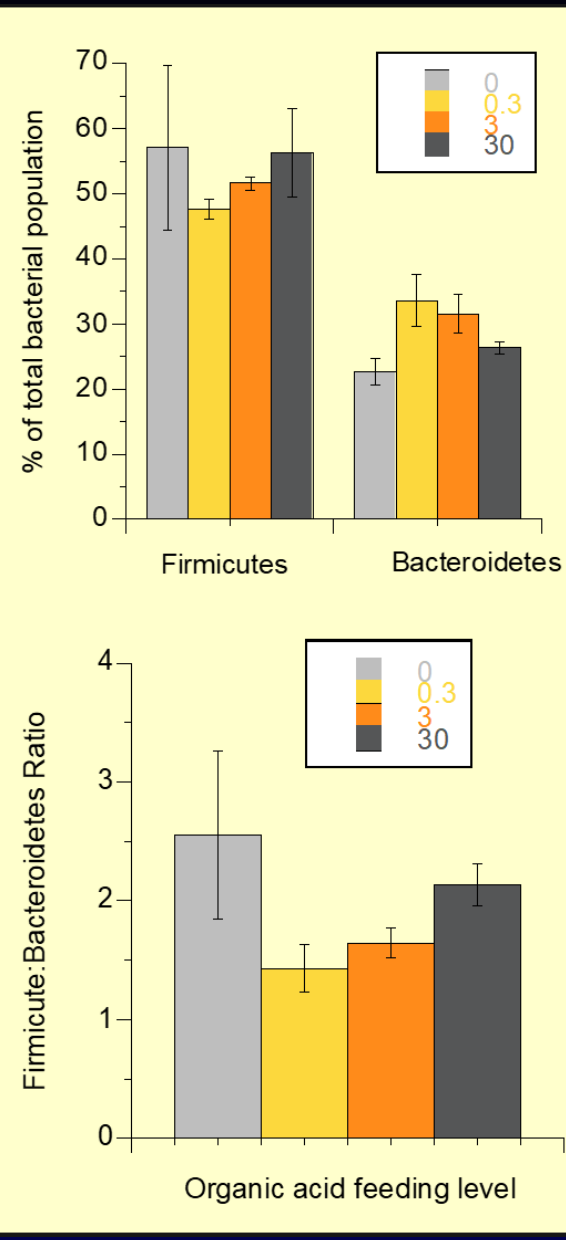
87 bovine pathways impacted
- Growth hormone signaling
- Inflammatory response downregulated

Effect of Diet on microbial populations



(Diez Gonzalez et al., 1998)





- Distiller grains fed to cattle increasingly
  - Increased *E. coli* O157:H7 and shifted microbial population
- Essential oils and organic acids are found in plants, and can be bactericidal & improve growth efficiency and food safety
  - Limonene, terpenes, thymol, oregano oils, and tannins can reduce methane production and alter efficiency

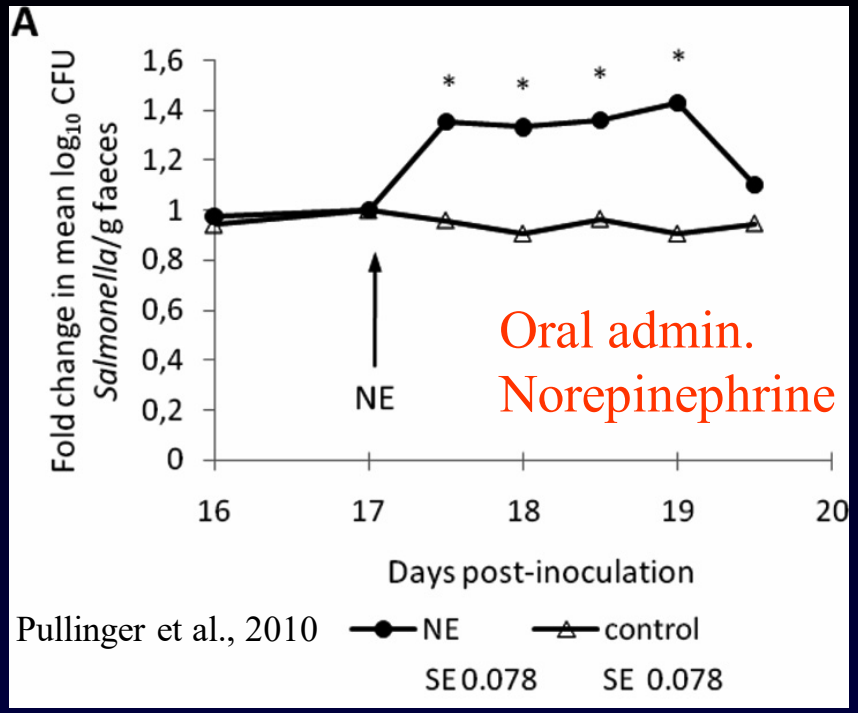
Stress impacts pathogens and microbiome

Transport and Social stresses

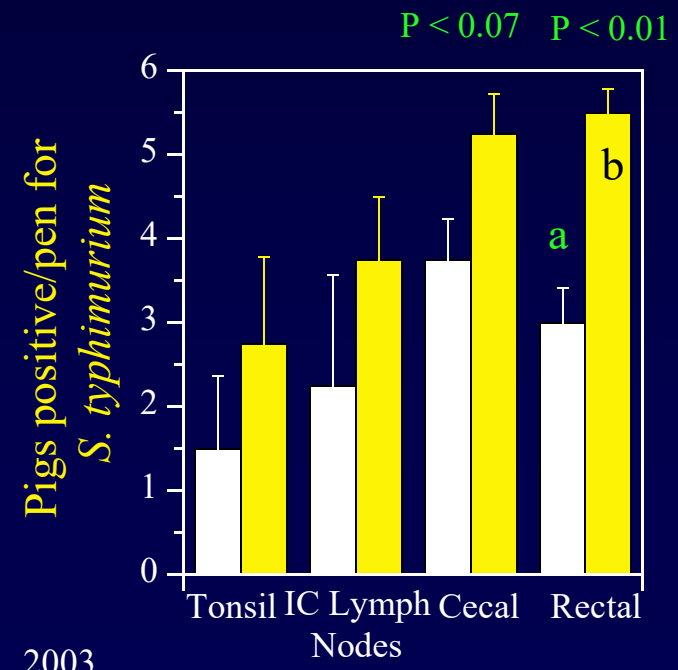
Impact total population of gut

Host and bacterial crosstalk (Microbial organ; Lyte)

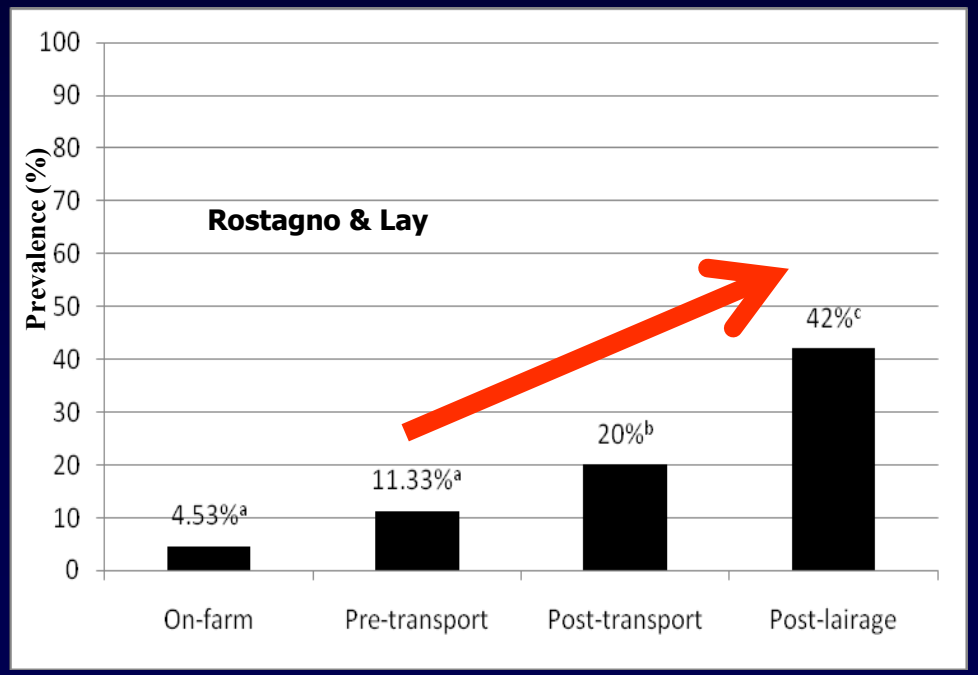
"Feed Me"and "opportunity"



Pullinger et al., 2010



Callaway et al., 2003



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Conclusions

- Sensitivity to Ab is a natural resource
  - Harness the power of microbiome competition
- We do not know what constitutes a "good" microbiome, or a "bad" one
  - Similar to class photo
  - May have to be individualized approach
- Combinations of anti-target, pro-competition, and good animal/manure management in a multiple-hurdle scheme can yield best results
  - No "Silver bullet" exists to improve AMRB or animal efficiency