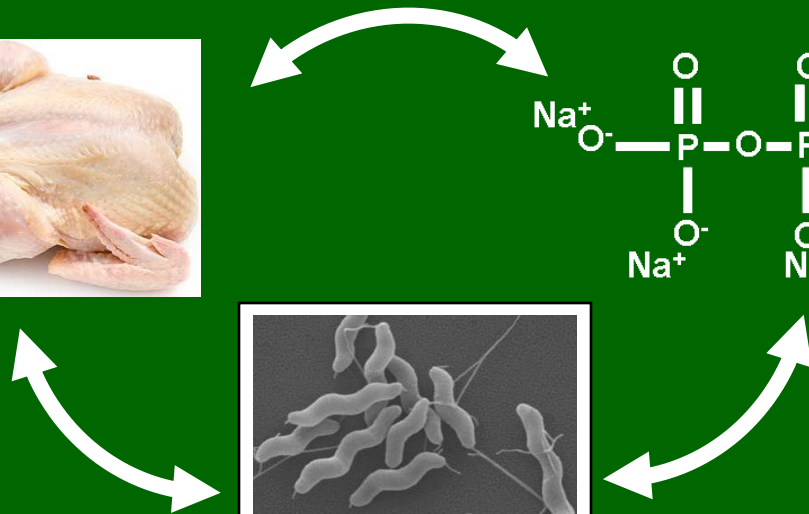
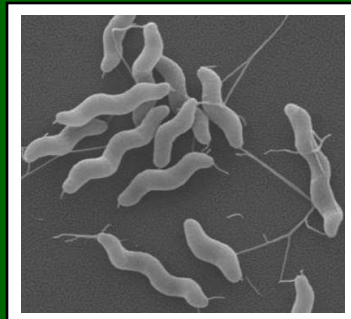
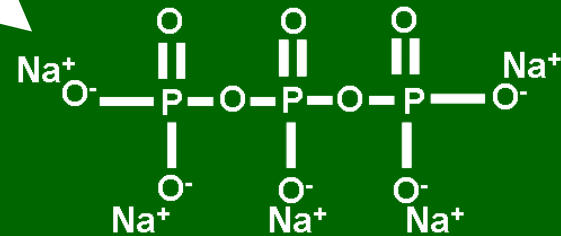




The Effects of Polyphosphate Additives on *Campylobacter* Survival in Processed Chicken Exudates

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Campylobacter and the Food Supply



- Responsible for the largest annual number of foodborne bacterial gastrointestinal infections in the developed world
- Vast majority of campylobacteriosis cases are caused by *Campylobacter jejuni* and *Campylobacter coli*
- Most common methods for transmitting *Campylobacter* to humans
 - Improperly cooked poultry
 - Cross contamination of other foods by raw poultry
- Nutritionally fastidious and sensitive to normal atmospheric oxygen levels
- *Campylobacter* conundrum: How can a bacteria apparently unfit for survival within food processing environments persist in sufficient numbers to cause such a large amount of disease

Polyphosphate Marinades in Commercial Poultry Processing



- **Polyphosphates are food-grade chemicals used in poultry marinades:**
 - Improve water holding capacity (plumps product with water)
 - Stabilizes color and flavor, and improve tenderness
 - Reduces product loss during cooking (keeps it from drying out)
- Poultry products can be injected with or vacuum tumbled in marinades comprised of polyphosphates, dried chicken broth powder and water
- Polyphosphates demonstrate antimicrobial action against a range of bacterial species and appear most effective against dividing cells
- Producers are currently permitted to use polyphosphates in poultry at concentrations up to 0.5% (by weight)
- ~15% of all boneless chicken breast products are marinated

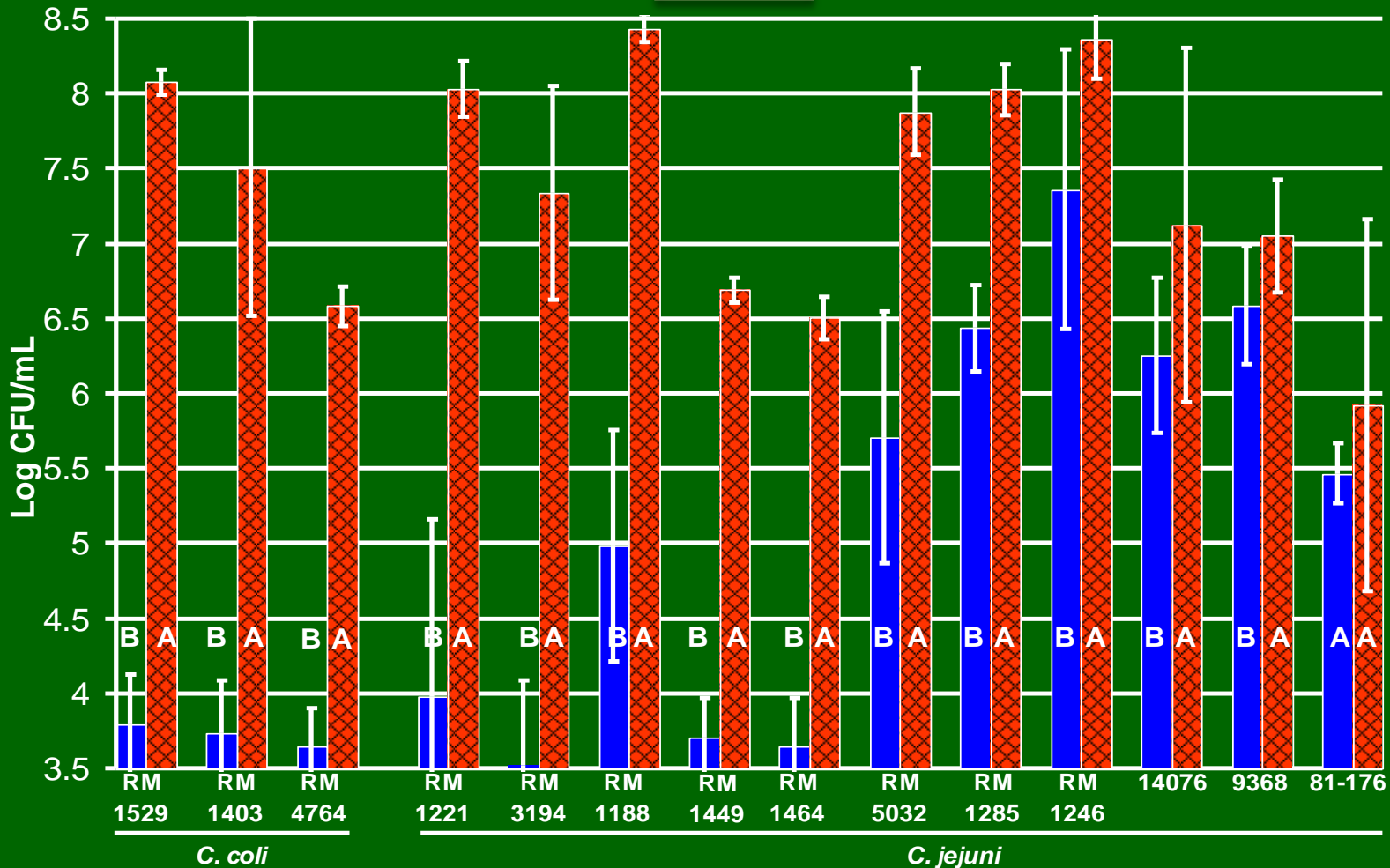
Campylobacter CFU/mL at 42°C 24 Hours

Exudate vs. Exudate Plus Marinade

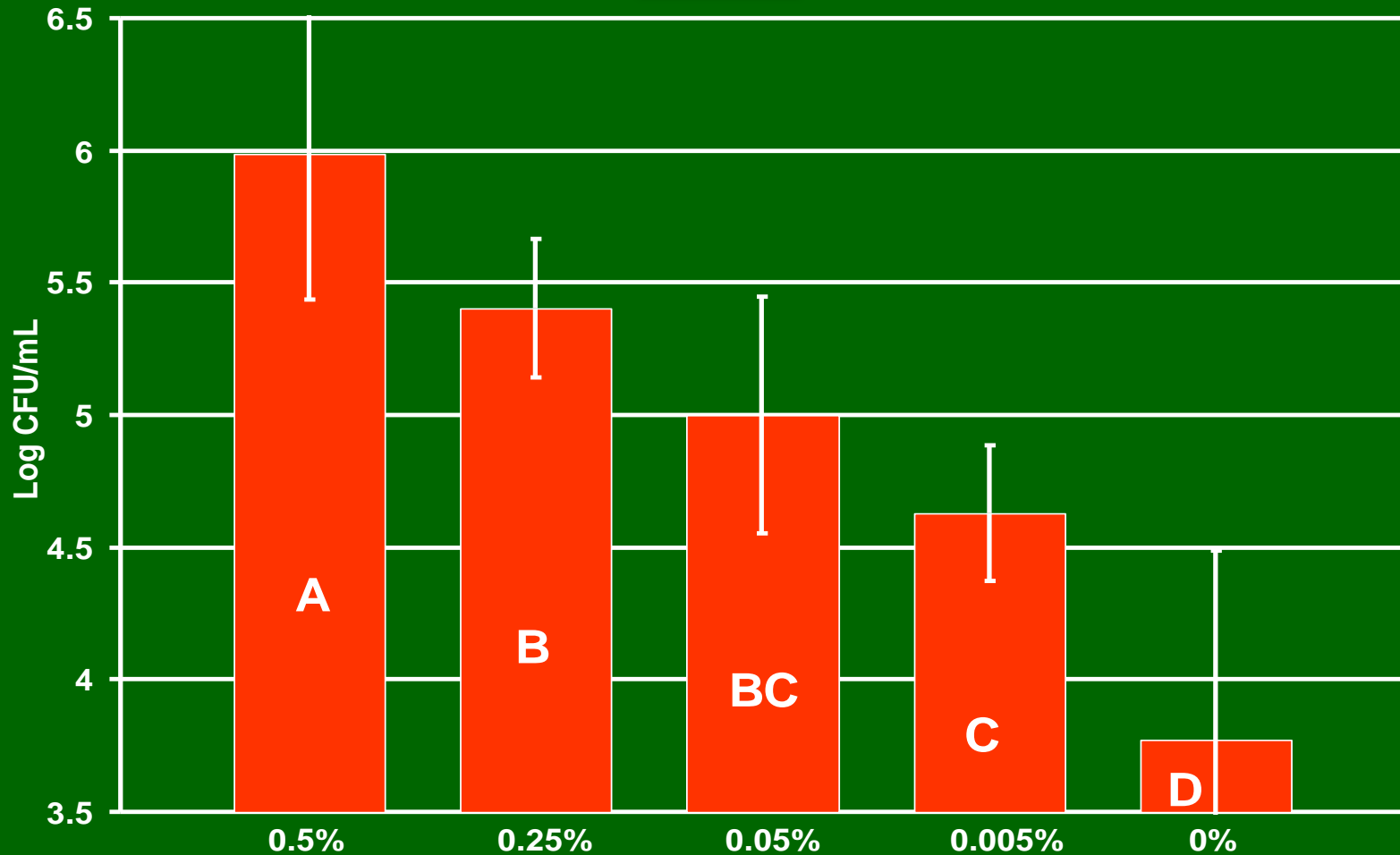
■ = Exudate



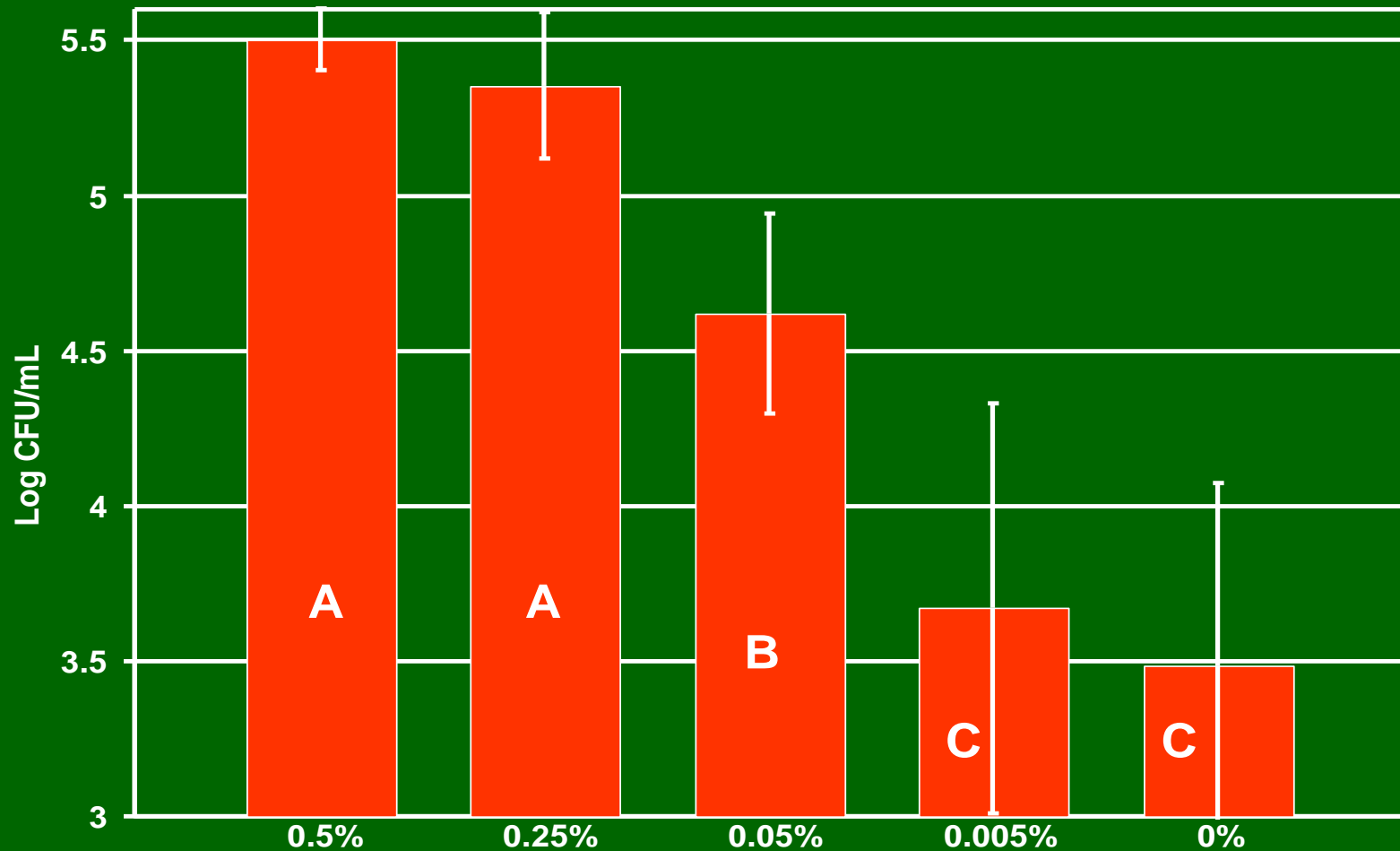
■ = Exudate plus marinade



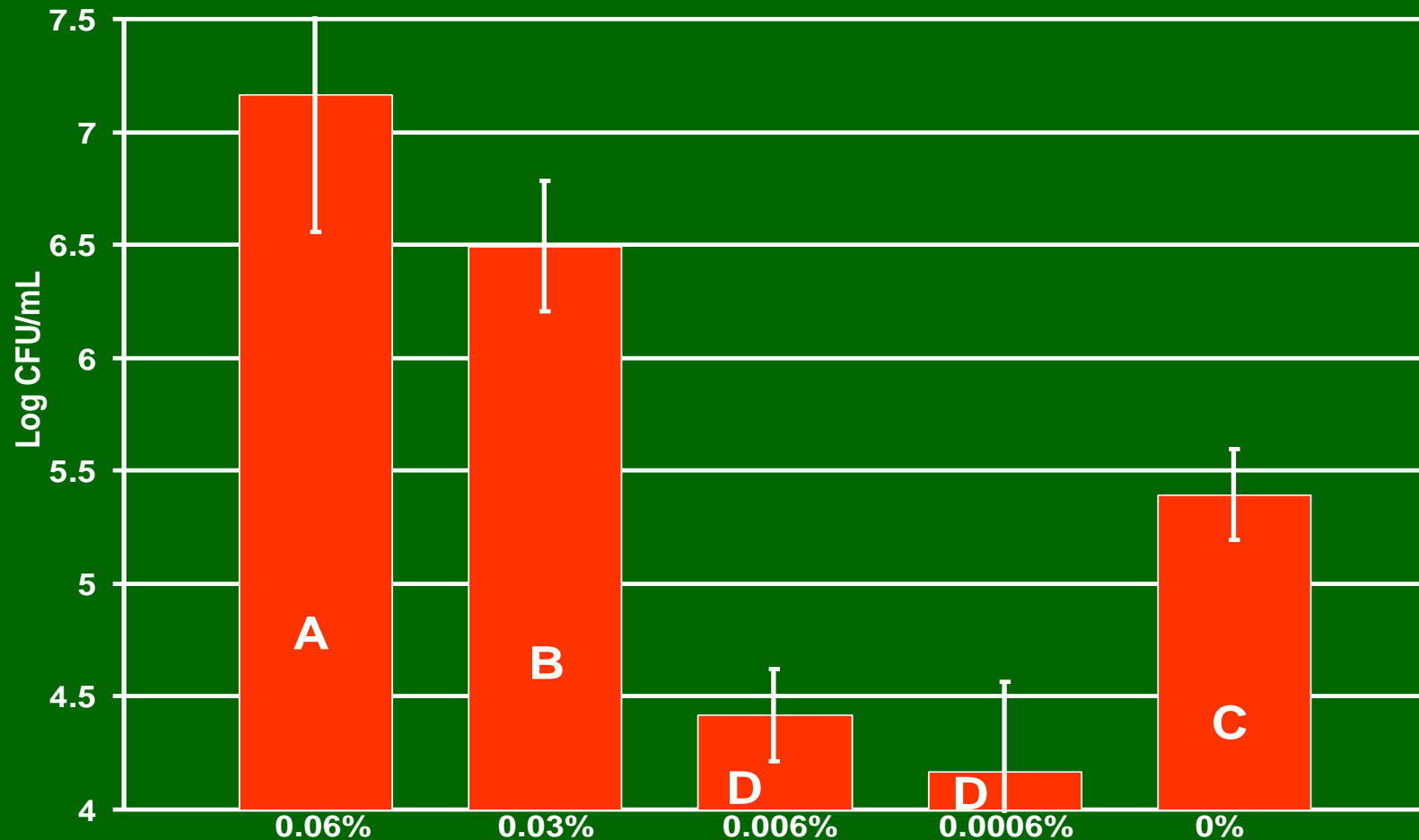
C. jejuni CFU/mL at 42°C for 24 Hours Titration of Polyphosphate Concentration



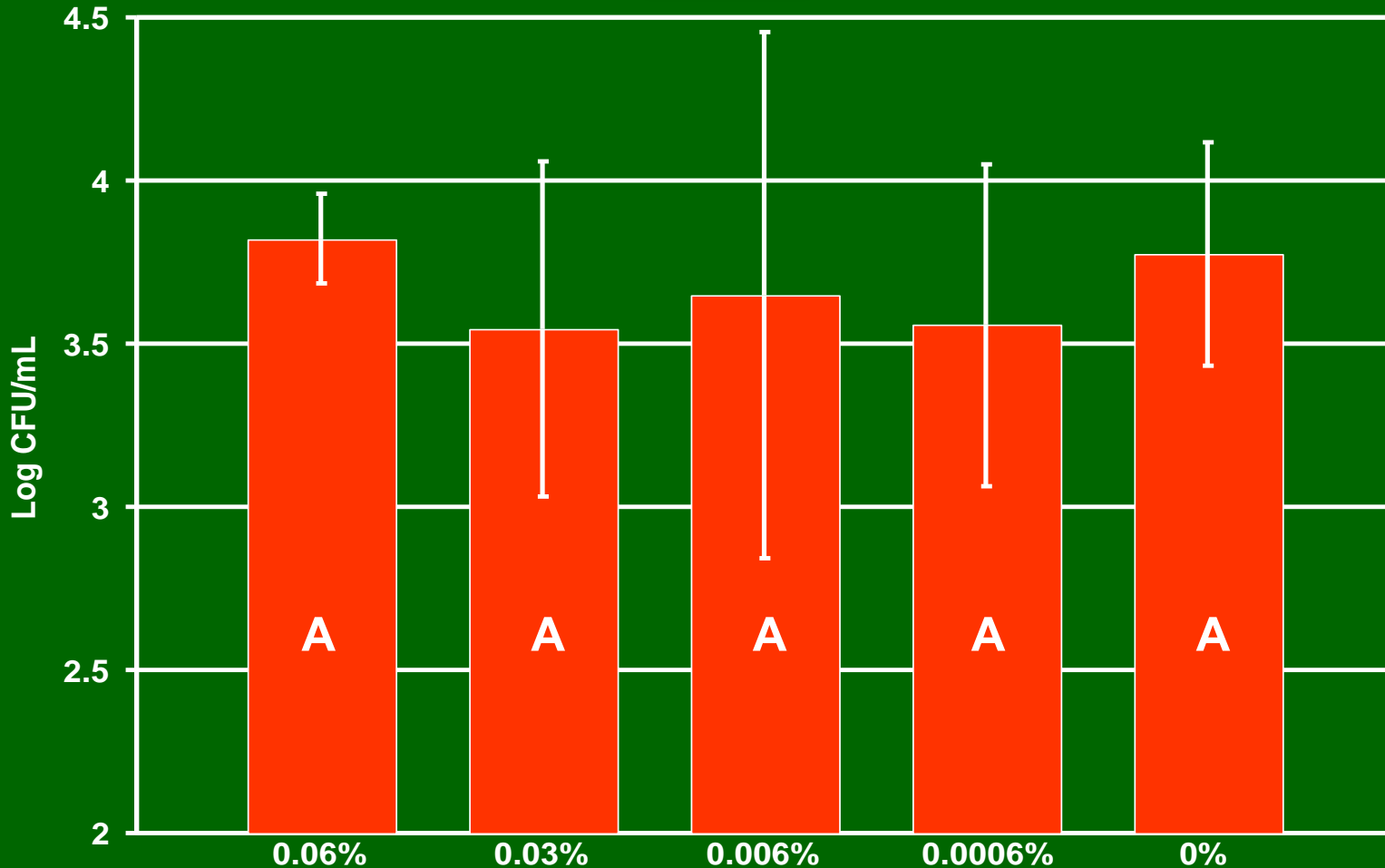
C. coli CFU/mL at 42°C for 24 Hours Titration of Polyphosphate Concentration



C. jejuni CFU/mL at 42°C for 24 Hours Titration of Dried Chicken Broth Powder



C. coli CFU/mL at 42°C for 24 Hours Titration of Dried Chicken Broth Powder

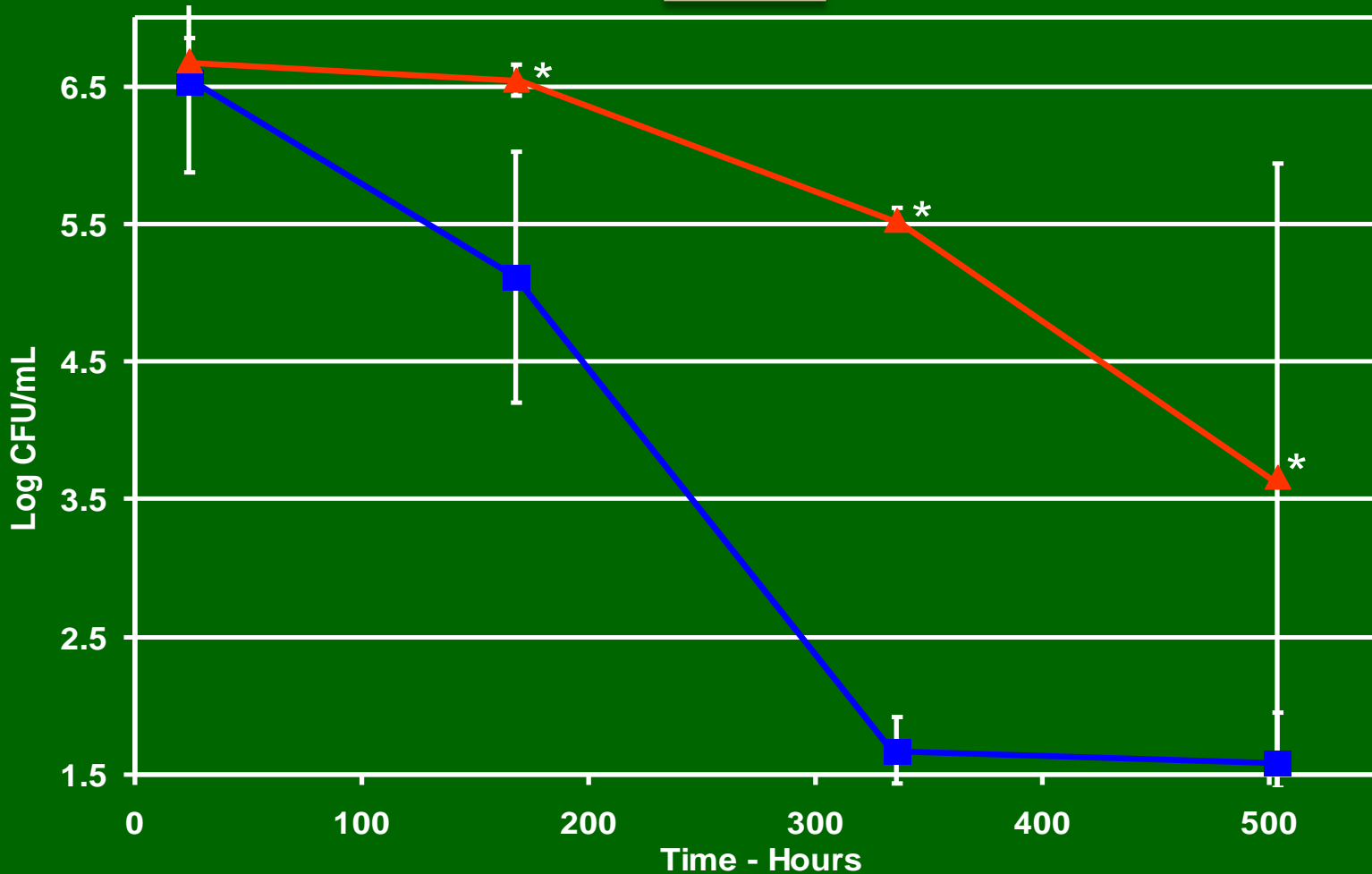


C. jejuni CFU/mL at 4°C, Normal Atmosphere Exudate vs. Exudate Plus Marinade

■ = Exudate



▲ = Exudate + Marinade

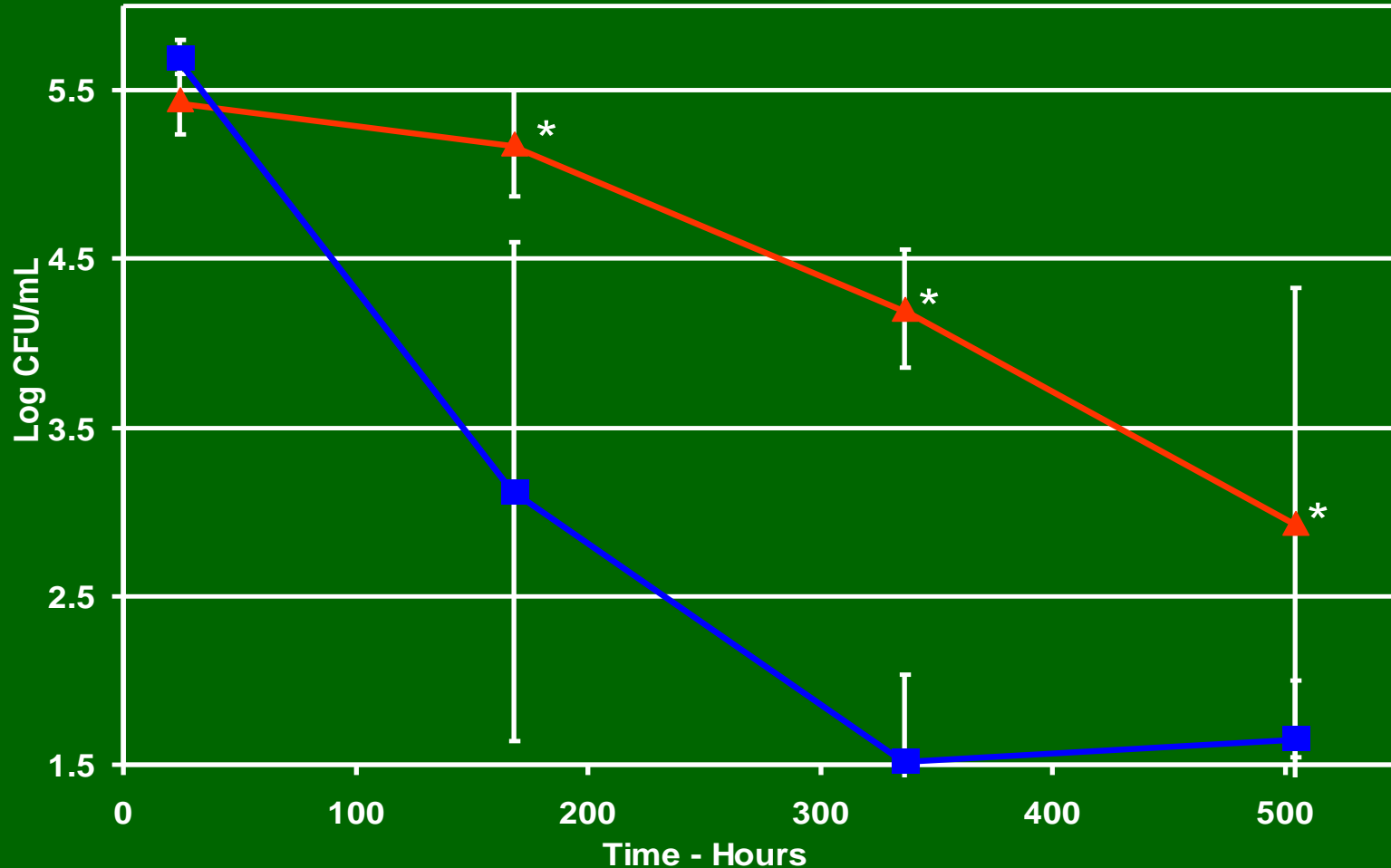


C. coli CFU/mL at 4°C, Normal Atmosphere Exudate vs. Exudate Plus Marinade

■ = Exudate



▲ = Exudate + Marinade



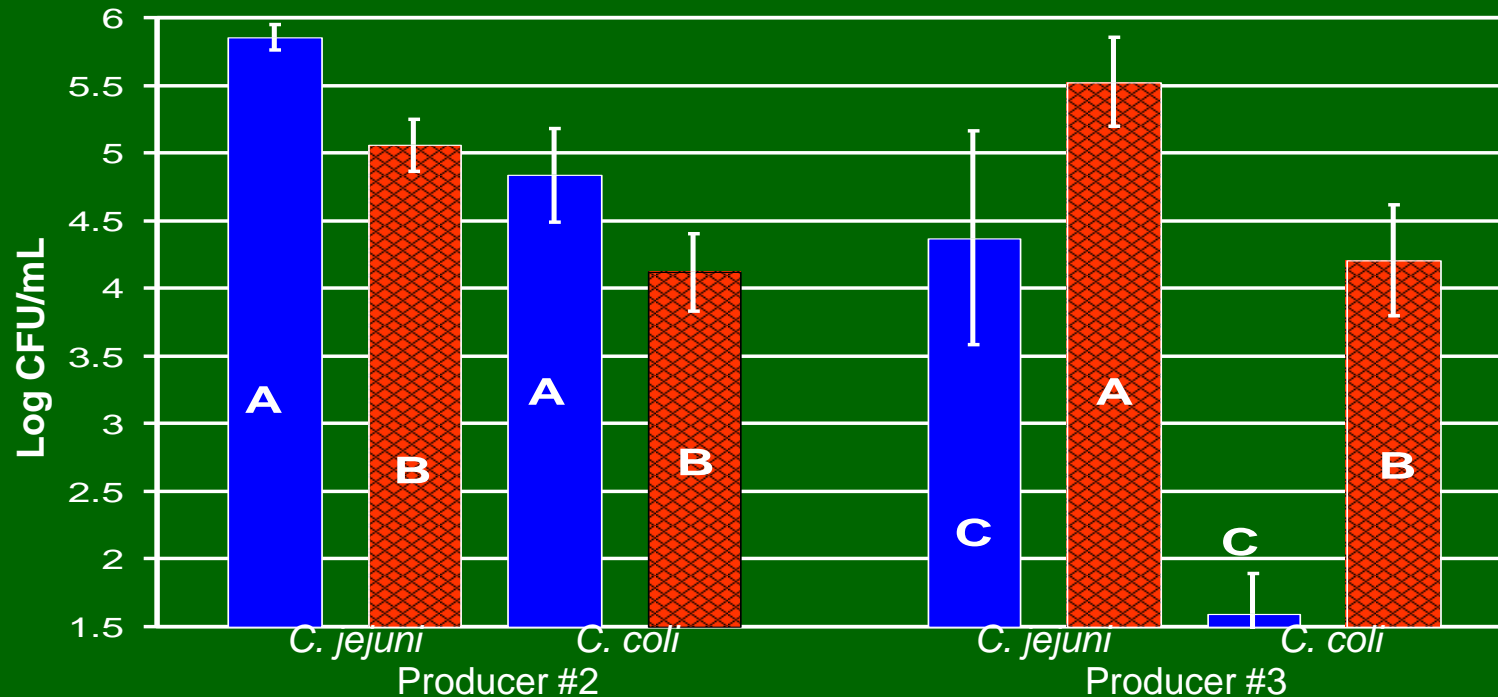
Comparison of Exudate vs. Exudate Plus Marinade from Other Producers

■ = Exudate



■ = Exudate + Marinade

Poultry Producer	pH of Exudate	pH of Exudate Plus Marinade
Producer #1	5.76	6.42
Producer #2	6.80	6.70
Producer #3	6.00	7.40

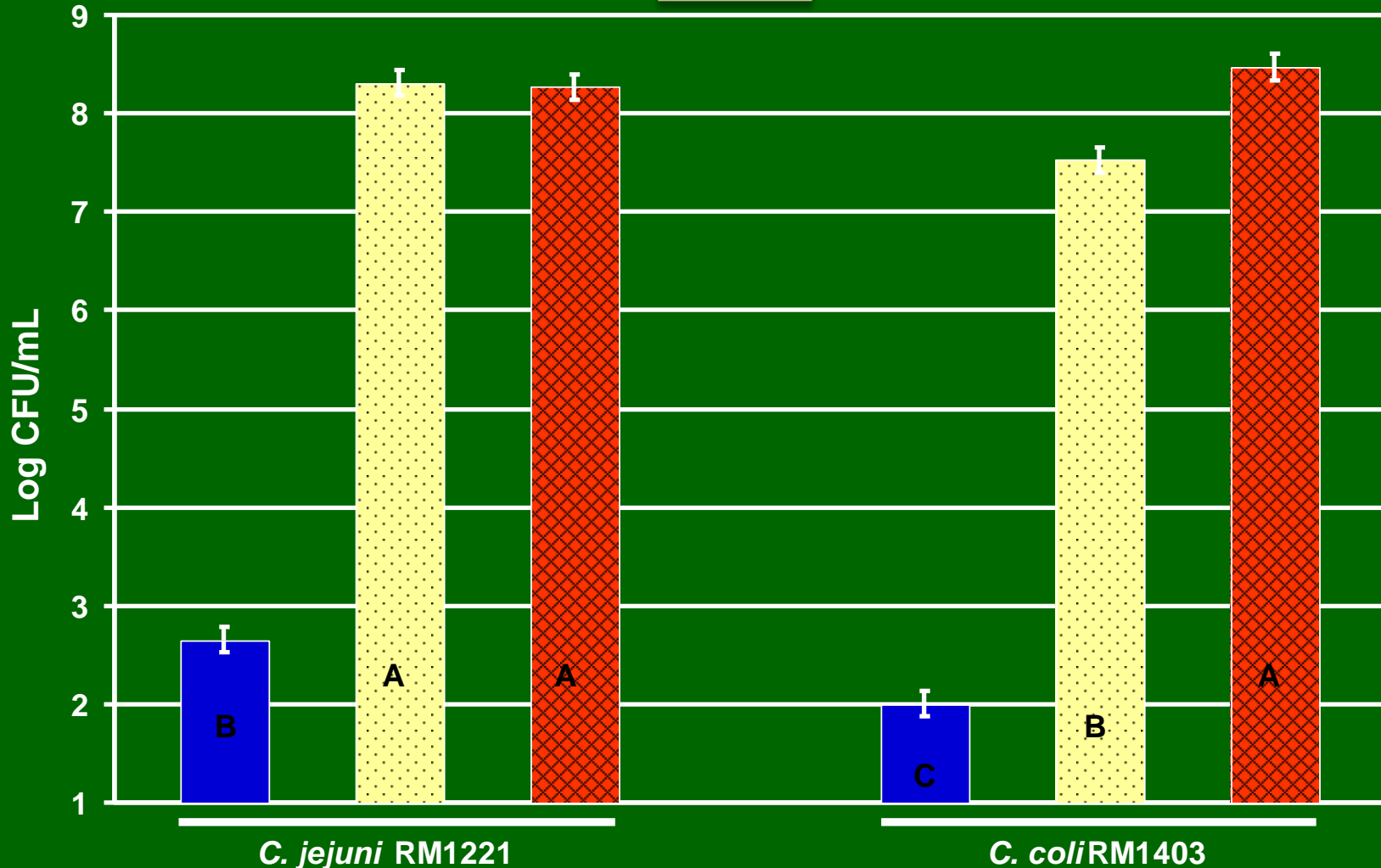


Chicken Exudate with the pH raised to the pH of Exudate Plus Marinade

■ = Exudate (pH 5.76)

■ = Exudate (pH 6.42)

■ = Exudate + Marinade (pH 6.42)



C. jejuni RM1221

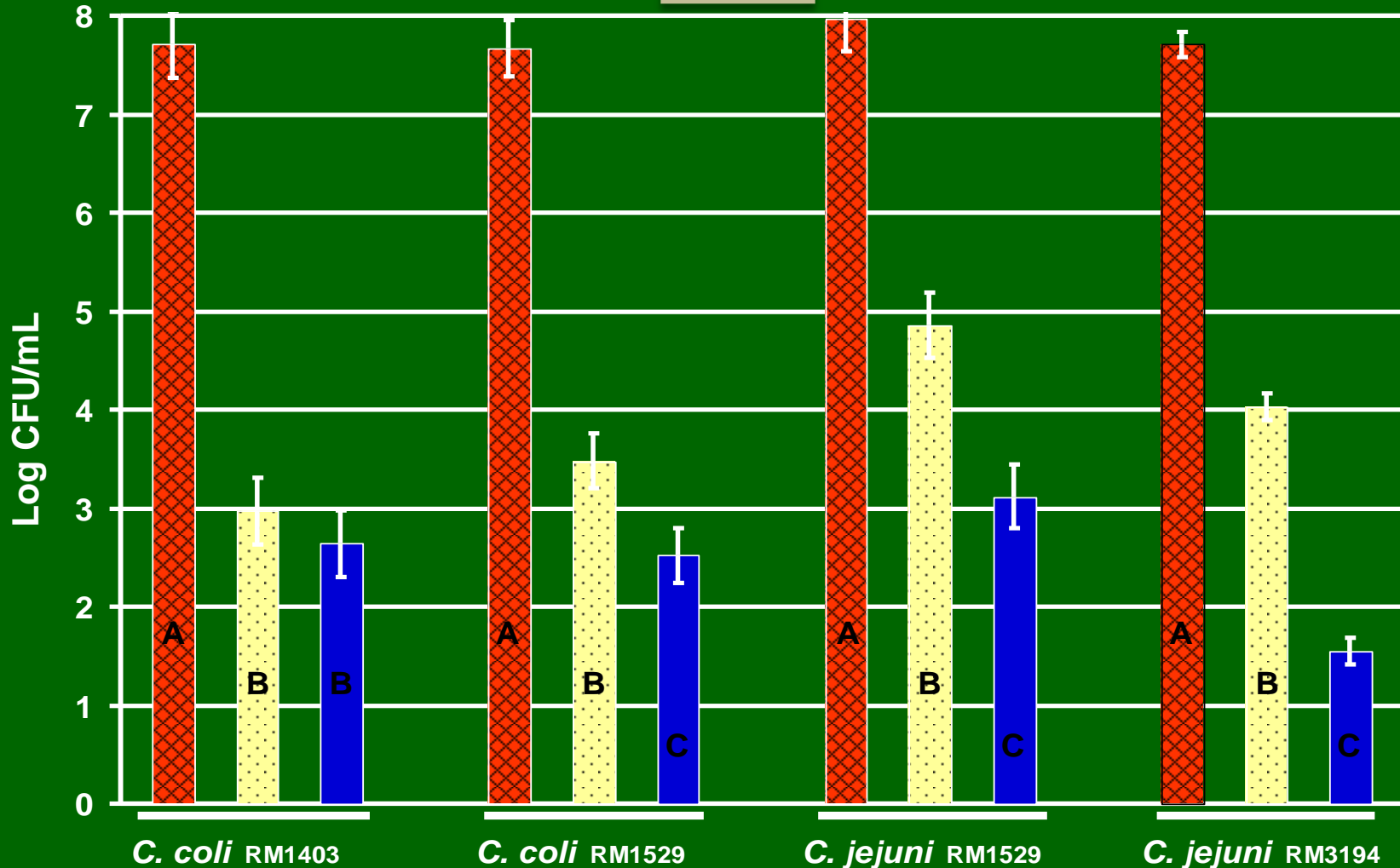
C. coli RM1403

Chicken Exudate Plus Marinade with the pH Lowered to the pH of Exudate Alone

☒ = Exudate + Marinade (pH 6.42)

■ = Exudate (pH 5.76)

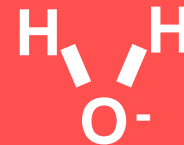
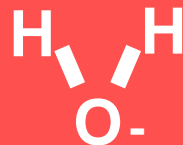
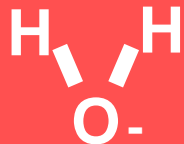
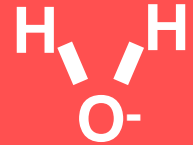
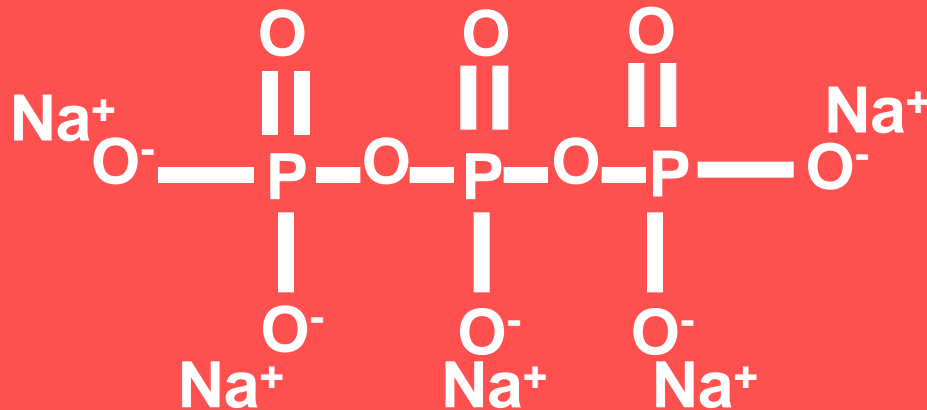
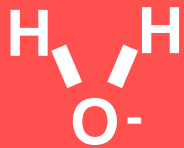
▨ = Exudate + Marinade (pH 5.76)



Model: How Sodiation Effects the pH of Exudate



Chicken Exudate pH 5.70

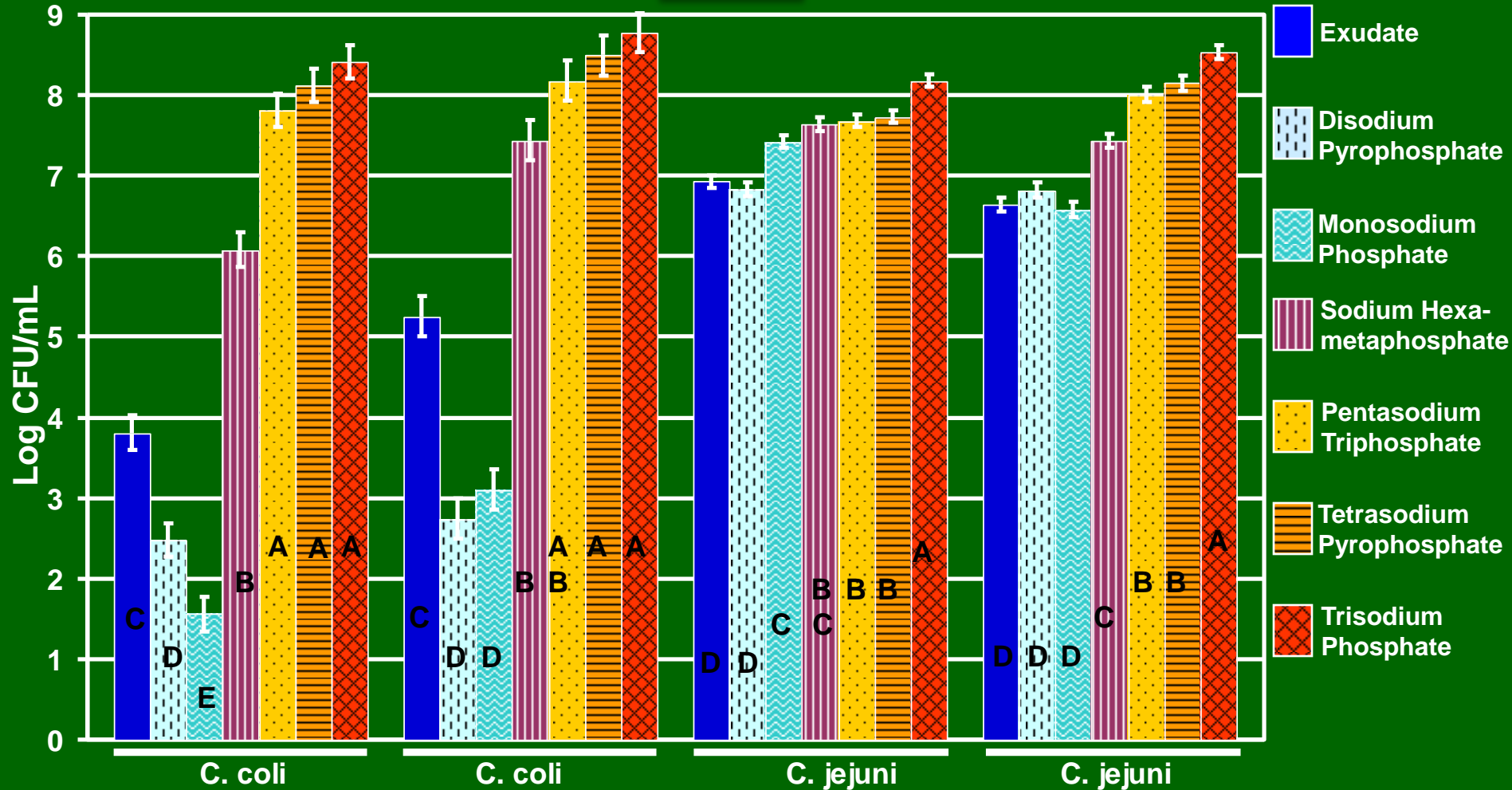


pH of Food Grade Polyphosphates in Exudate and Sodium:Phosphate Ratios

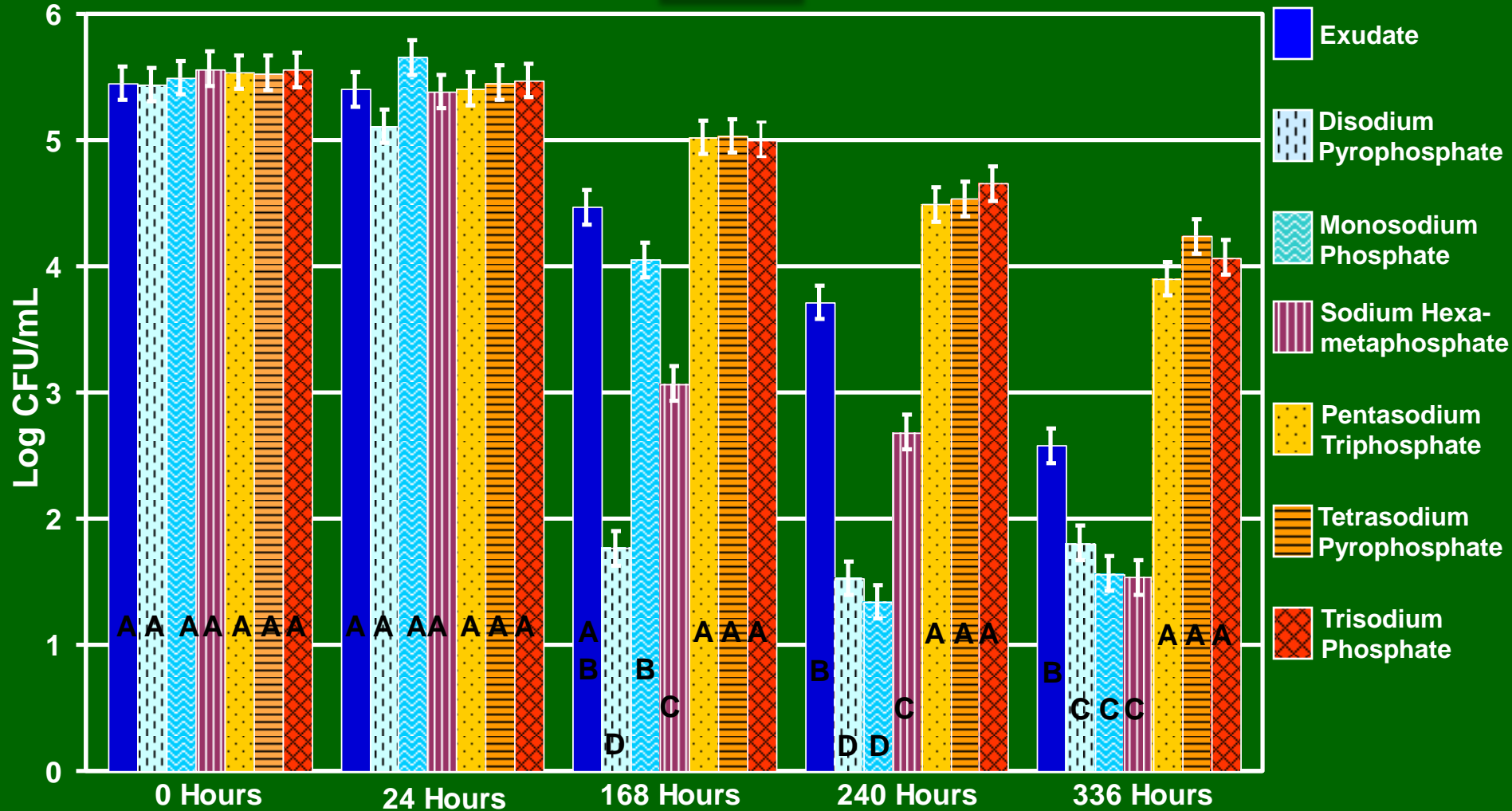


Polyphosphate	pH of Exudate Plus 0.5% Polyphosphate	Sodium:Phosphate Ratio
No polyphosphate control	5.8 (± 0.07)	N/A
Disodium dihydrogen pyrophosphate	5.43 (± 0.04)	1:1
Monosodium dihydrogen phosphate	5.63 (± 0.07)	1:1
Sodium hexametaphosphate	5.88 (± 0.06)	1:1 (+2)
Pentasodium triphosphate	6.28 (± 0.04)	5:3
Tetrasodium pyrophosphate	6.51 (± 0.1)	2:1
Trisodium phosphate	7.06 (± 0.04)	3:1

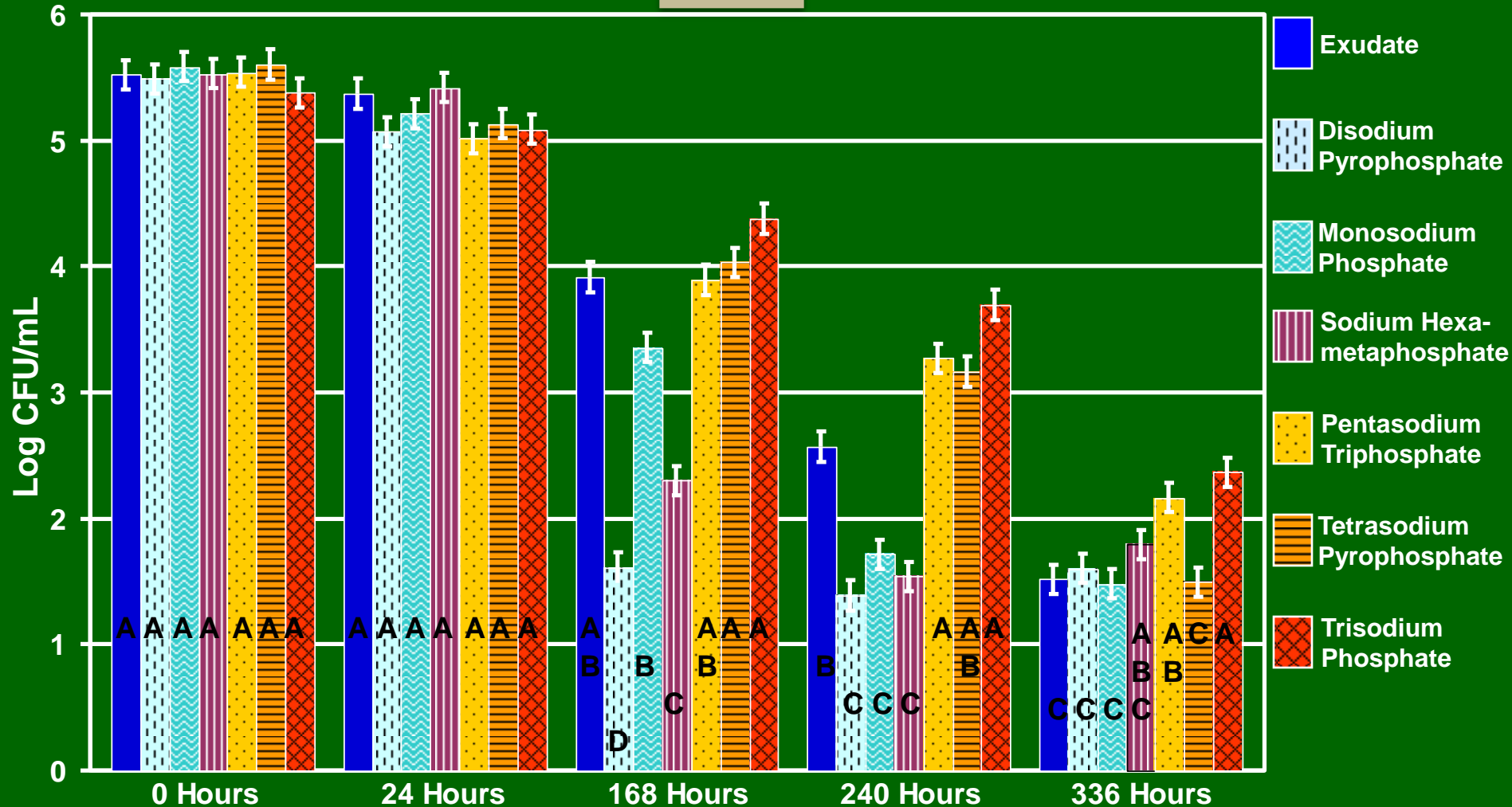
Campylobacter CFU/mL at 42°C for 24 Hours with Different Food Grade Polyphosphates



C. jejuni CFU/mL at 4°C (Normal Atmosphere) with Different Polyphosphates



C. coli CFU/mL at 4°C (Normal Atmosphere) with Different Polyphosphates



Conclusions



- Marinades added during poultry processing significantly increase the survival of *C. jejuni* and *C. coli* under relevant food storage conditions
- Polyphosphates are responsible for a large portion of the marinades observed effects on *Campylobacter* survival
- Polyphosphate appear to increase *Campylobacter* survival by increasing the pH of the chicken exudate to a level preferred by the organism
- Polyphosphates with differing levels of sodiation change the pH of chicken exudate to greater or lesser degrees
- Some polyphosphates have limited effects on exudate pH, and therefore, are safer for use in foods where *Campylobacter* is present

Future Directions



- Determine how polyphosphate mediated pH changes affect *Campylobacter* survival at the molecular level
 - Microarray studies
 - Comparative proteomics
- Determine if the microbial ecology (other than *Campylobacter*) of poultry exudate is affected by polyphosphates
 - 16s rRNA sequence survey
- Determine if, and how, other bacteria present in poultry exudate affect *Campylobacter* survival within poultry products
 - Co-incubation survival experiments

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