EVALUATION OF THE INACTIVATION CAPACITY OF LACTIC ACID AGAINST *E. COLI* O157:H7 ON WHOLE UNPEELED YELLOW ONIONS

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Background

Fresh cut onions have been associated with numerous multistate outbreak in the United States.

The source of contamination has not been identified, likely due to the complexity of supply chain.

Field contamination sources are difficult to identify and control. Implementing effective postharvest interventions strategies are essential to reduce microbial risk prior to fresh-cut processing.

Onions are commonly consumed raw, fresh-cut processing facilities must implement effective washing and sanitation interventions to reduce microbiological risks.

Background

Evaluating food-grade sanitizers under commercial processing conditions is essential to determine their antimicrobial performance and operational suitability for the fresh produce industry.

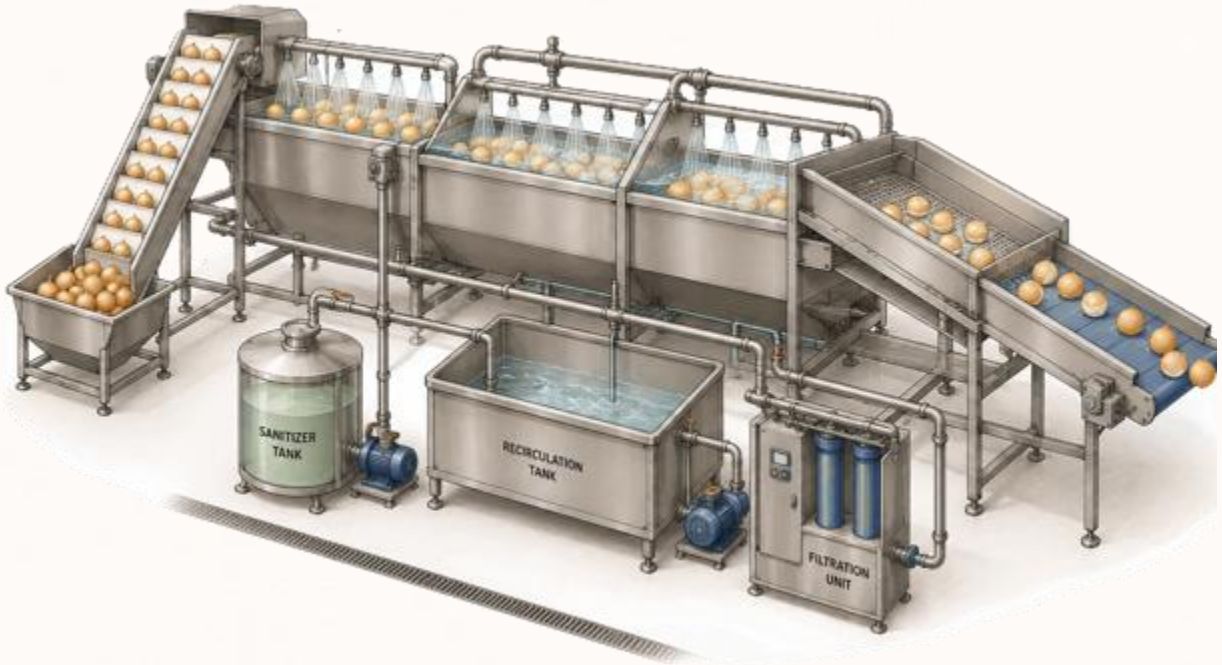
Lactic acid has emerged as a promising food-grade antimicrobial due to its broad-spectrum antimicrobial activity, biodegradability, and compatibility with fresh produce processing. In this study, 5% and 7% lactic acid were selected to evaluate their efficacy under industrial fresh-cut onion processing conditions.

Lactic acid has demonstrated antimicrobial efficacy in the presence of organic matter, although its effectiveness may still vary depending on the processing environment and organic load.

Objectives

Principal Objective:

Determine the effectiveness of lactic acid as a postharvest antimicrobial intervention for reducing Escherichia coli O157:H7 contamination on whole, unpeeled yellow onions under industrial-scale processing conditions.



Secondary Objectives:

Evaluate the efficacy of two lactic acid concentrations (5% and 7%) for inactivating E. coli O157:H7 on whole, unpeeled yellow onions under industrial-scale processing conditions.

Assess the survival of E. coli O157:H7 on treated whole, unpeeled yellow onions during refrigerated storage following lactic acid application.

Experimental Conditions

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Treatments

Treatments	Sanitizer	Concentration	Application
Control	Natural die-off **No** antimicrobial intervention		
T1	Lactic Acid	5.5%	15 seconds submersion
T2	Lactic Acid	7.0%	

Sampling Points

Trials	Sampling Points per trial		
5 Replicates	2 hours	24 hours	192 hours

Experimental Conditions

24 Onion bags (50 pounds each)

Control

Acid Lactic 5.5%

Acid Lactic 7.0%

8 Onions bags per treatment

2 hours | 24 hours | 192 hours

Sampling points (3)

Experimental Desing

1 Inoculum Preparation

Strains of E. coli O157:H7 (attenuated, rifampicin-resistant)

- ATCC #43888
- ATCC #700728

2 Onion inoculation (~12 h)

Target inoculum concentration Log 5.5 CFU/ml

3 Air – dried (60 min)

Experimental Design

3 Air – dried (60 min)

4.1 Contact with Acid Lactic (~15 seconds)

4.2 Natural Die-off

5 Refrigerated storage

Experimental Desing

5 Refrigerated storage

6 Bacterial recovery MicroTally®

7 Sampling Processing

6 Bacterial recovery - Mitt Sampling Aggregated Sampling

Eight onions = 1 replicate

One sterile MicroTally® Mitt per replicate

Five replicates per treatment

Experimental Design

5 Refrigerated storage

6 Bacterial recovery Mitt sampling

7 Sample Processing

7 Sample Processing

1 Sample homogenization

3 Centrifugation process (8000 RPM x 10 min)

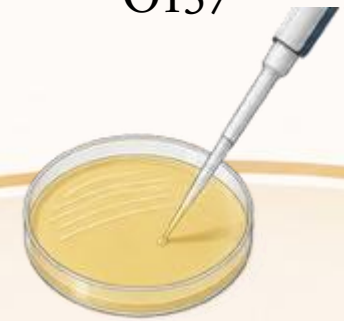
5 Pellet Suspension

7 Bacterial enumeration and confirmation (PCR)

2 Transfer bag liquid to a two 50 mL tubes

4 Supernatant removal

6 Resuspended pellet plated on CHROMagar™ O157



8 Most Probable Number (MPN)

Statistical Analysis

- Mixed-effects models were used to evaluate the effects of treatment, storage time, and sampling method.
- Pairwise comparisons were performed using Tukey's multiple-comparison adjustment.
- Statistical significance was declared at $P < 0.05$.

Results

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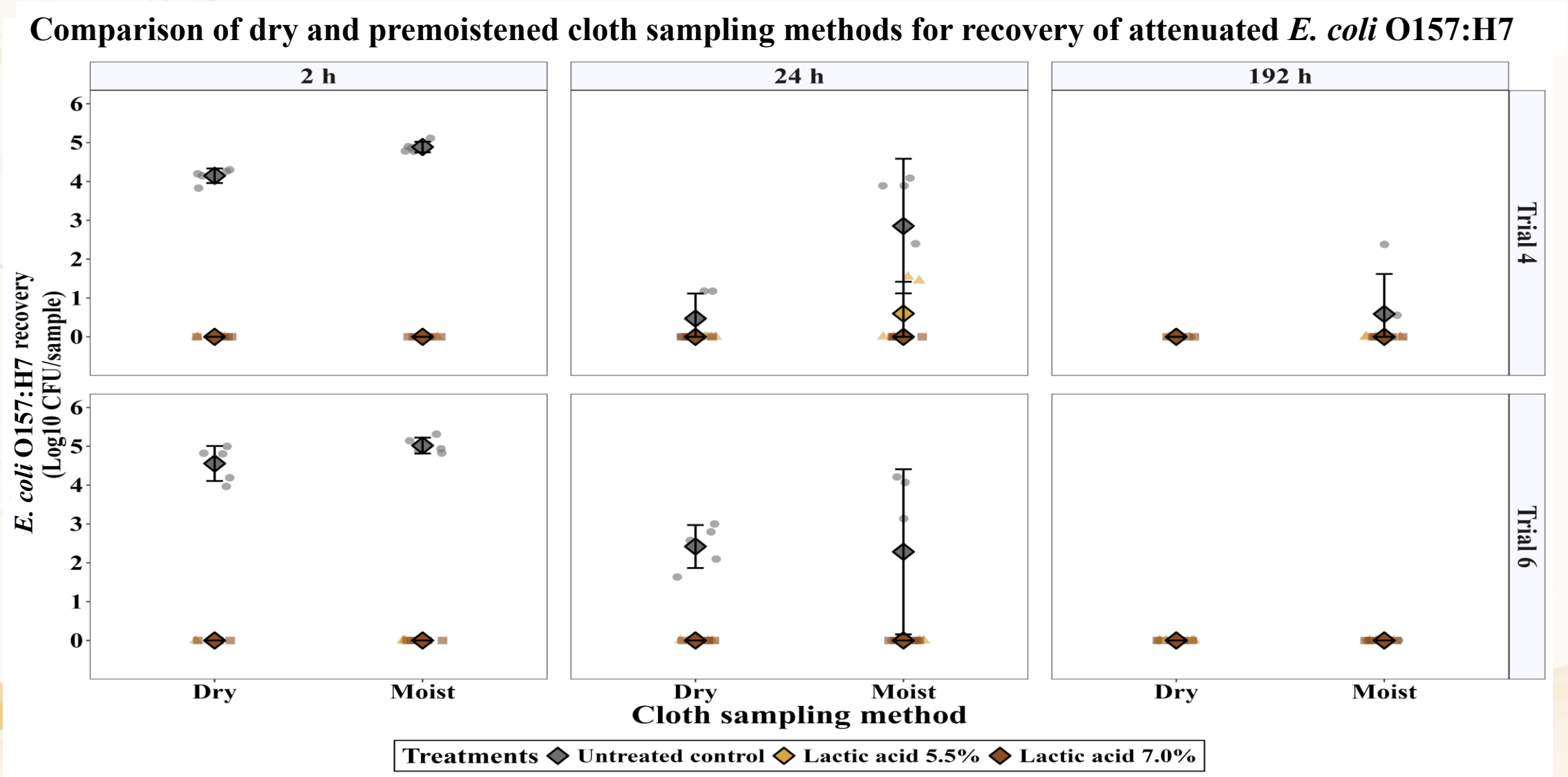
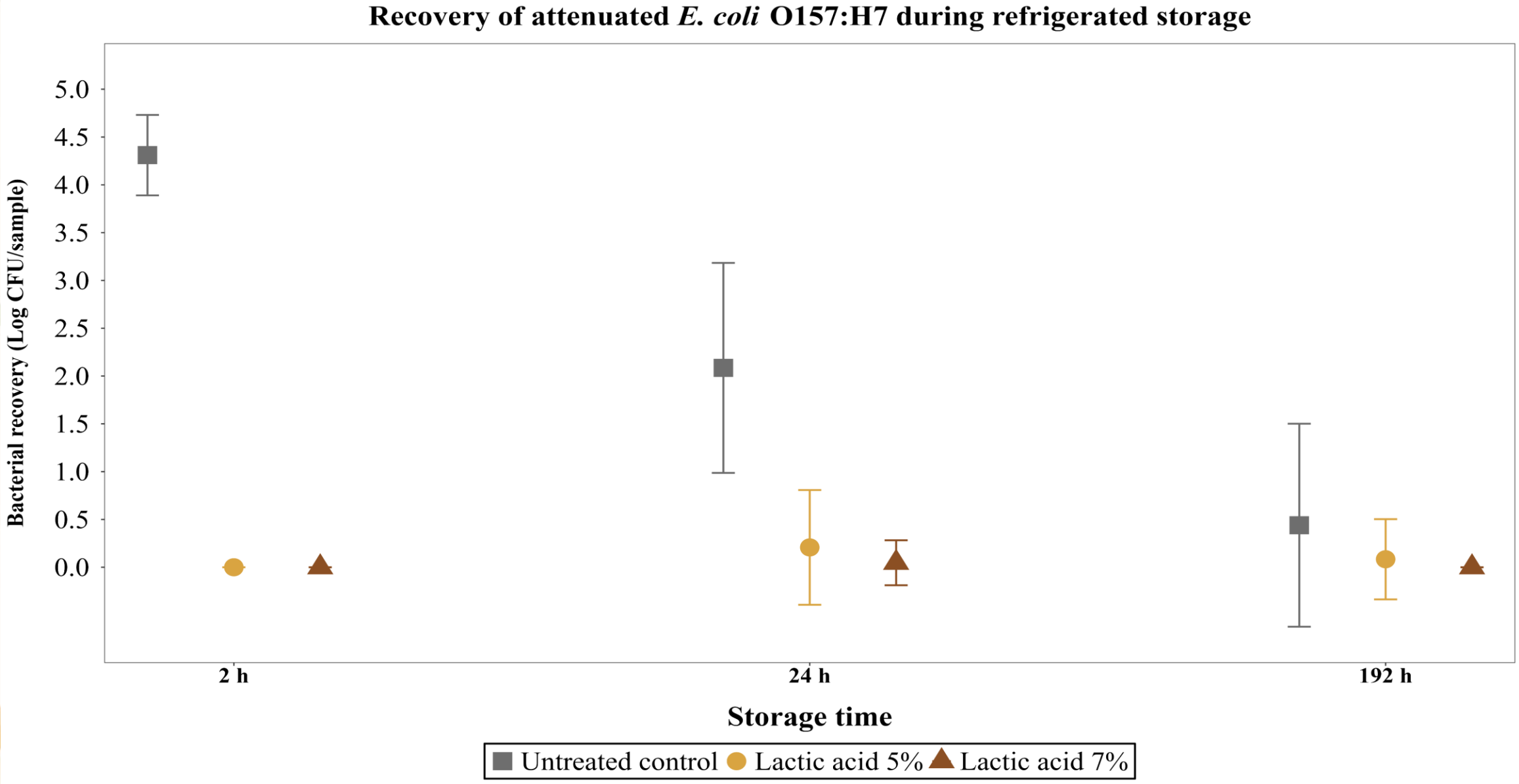
Bacterial recovery is independent of the sampling method (p>0.05).



Lactic acid treatments achieved >3-log reductions within 2 hours of treatment.



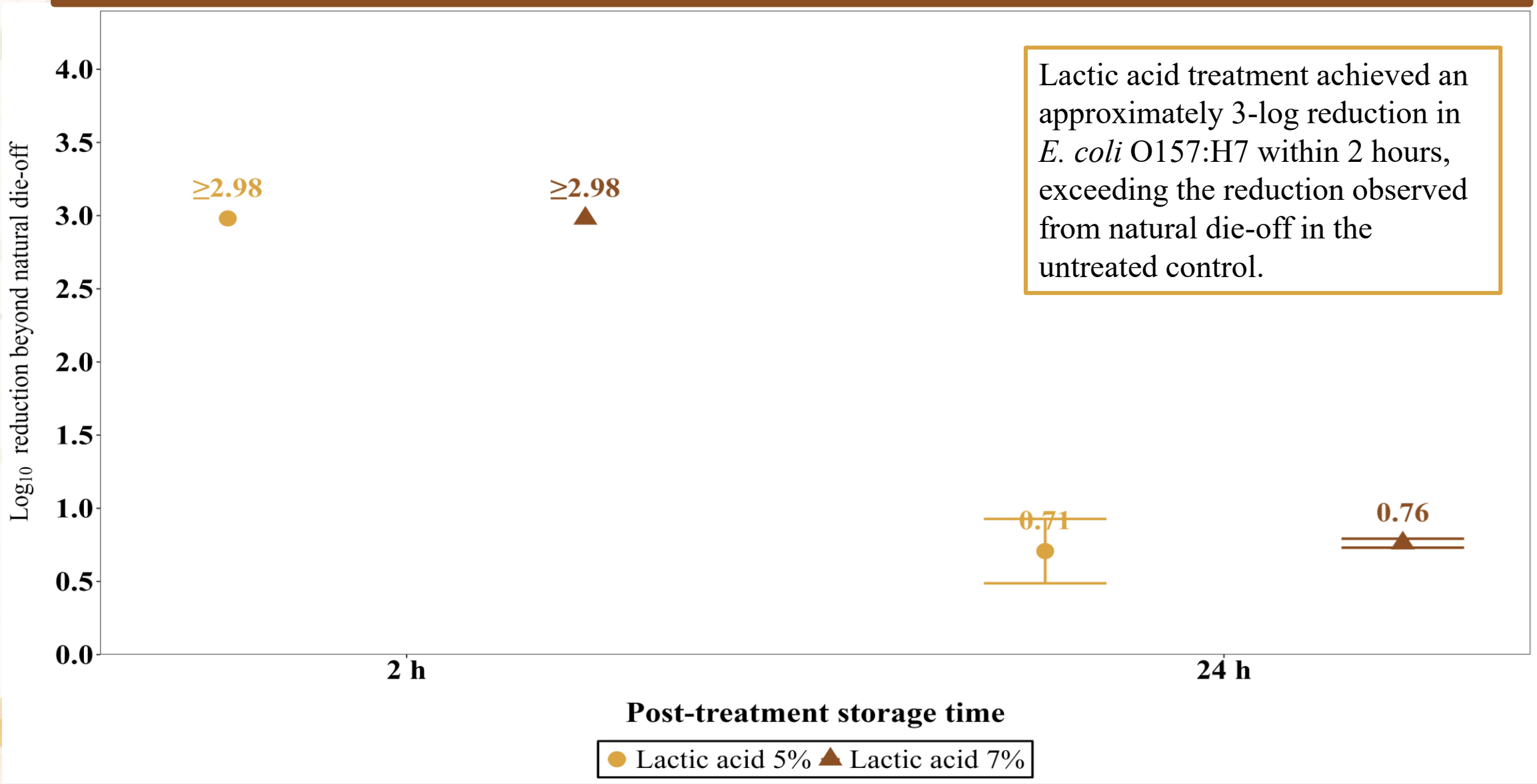
Both lactic acid concentrations maintained minimal bacterial recovery throughout storage and performed consistently across independent trials.

Table 1. Bacterial recovery across independent five trials

Treatments	Bacterial Recovery (Log CFU/sample)		
	2h	24h	192h
Control	4.31	2.09	0.44
Lactic Acid 5.5%	0	0.21	0.08
Lactic Acid 7.0%	0	0.05	0

- After 2 hours of exposure, lactic acid treatments exhibit a 0 Log CFU/sample recovery.
- There were no statistically differences between trials.

Lactic acid achieved rapid antimicrobial activity, exceeding natural die-off by >3 log within 2 hours.



Discussion

- Lactic acid effectively reduced *E. coli* O157:H7 on whole, unpeeled yellow onions, demonstrating its potential as a postharvest antimicrobial intervention for fresh-cut processing.

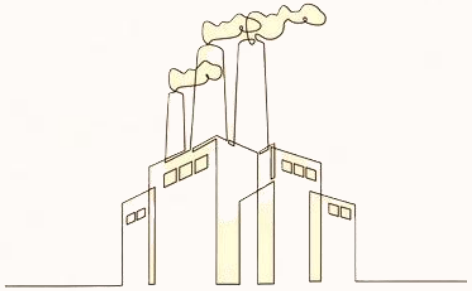
- A 15-second treatment with 5.5% or 7.0% lactic acid achieved approximately a 3-log CFU/sample reduction, with comparable antimicrobial efficacy between concentrations.

- No significant differences were observed between dry and pre-moistened cloth samplers, indicating both methods effectively recovered *E. coli* O157:H7 from onion surfaces.

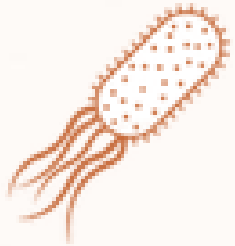
- Validated attenuated surrogate strains provided a safe and scientifically sound model for evaluating postharvest antimicrobial interventions under industrial-scale conditions.

Food Safety and Industry Implications

Lactic acid provides an effective additional hurdle for reducing *E. coli* O157:H7 on whole onions, strengthening food safety systems in commercial fresh-cut operations.



Comparable efficacy between the 5.5% and 7.0% treatments suggests that lower concentrations may provide effective microbial control while potentially reducing sanitizer use and operating costs. .



A contact time of 15-second lactic acid treatment significantly reduced *E. coli* O157:H7, supporting its use as a practical postharvest intervention within a multi-hurdle food safety system.

Conclusions

- Dry and pre-moistened cloth samplers provided comparable microbial recovery ($P > 0.05$), supporting the use of either sampling approach for environmental and product monitoring
- Across five independent trials, 5.5% and 7.0% lactic acid consistently reduced *E. coli* O157:H7 on whole, unpeeled yellow onions under industrial-scale processing conditions.
- Both concentrations achieved approximately a 3-log CFU/sample reduction within 2 hours, demonstrating effective postharvest antimicrobial activity.
- Comparable efficacy between the 5.5% and 7.0% treatments suggests that the lower concentration may provide effective microbial control while reducing sanitizer use and operating costs in commercial fresh-cut onion operations.

Future Work

Evaluate the efficacy of lactic acid against additional foodborne pathogens, including *Salmonella* spp. and *Listeria monocytogenes*, on whole onions under commercial processing conditions.

Optimize lactic acid concentration, contact time, and application methods (e.g., spray vs. dip) to maximize pathogen reduction while maintaining product quality and operational efficiency.

Develop and validate science-based implementation guidelines for integrating lactic acid into commercial fresh-cut onion processing and multi-hurdle food safety systems.

Thank you!

Questions?

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