

Evaluation of Lactic Acid and Blue Light for Inactivating *Salmonella* and *Listeria* *monocytogenes* on Pecan Halves

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Tree Nut Recalls and Outbreaks

- **Outbreak:** *E. coli* in walnuts (2024)
- **Recalls:** *Listeria* in macadamia nuts (2024); *Salmonella* in pecans (2025)
- **Key concern:** Tree nuts can carry serious foodborne pathogens, highlighting the need for strong food safety controls

2024 E. coli Multi-state Outbreak Linked to Organic Walnuts

[Foodborne illness webpage](#) | [Link to all outbreaks](#)

Last updated: April 30, 2024

Overview

Organic walnut halves and pieces sold in bulk containers have been identified as the source of E. coli O157:H7 infection in 6 Washington residents. The Washington State Department of Health worked with local, federal and California public health partners to investigate this outbreak which has infected 12 people (6 in Washington and 6 in California) between February and April 2024.

Over 32,000 Pounds of Pecans Have Been Recalled in 5 States Due to Potential Salmonella Exposure

The FDA recall notice has been categorized as Class 1, the highest risk level that can lead to adverse health affects and death

By **Mona Thomas** | Published on August 7, 2025 02:23PM EDT

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Macadamia nuts recalled over Listeria contamination

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Objectives

- Evaluate the efficacy of **lactic acid** in inactivating *Salmonella* spp. and *Listeria monocytogenes* on pecan kernels
- Evaluate the effect of **405-nm blue light** in inactivating *Salmonella* spp. and *Listeria monocytogenes* on pecan kernels
- Evaluate the effect of these treatments on **pecan quality**

Methods

Salmonella enterica

S. Enteritidis PT 9c (raw almond isolate)
S. Montevideo (Pistachio isolate)
S. Saintpaul (Walnut isolate)
S. Newport (raw almond kernel isolate)

Listeria monocytogenes

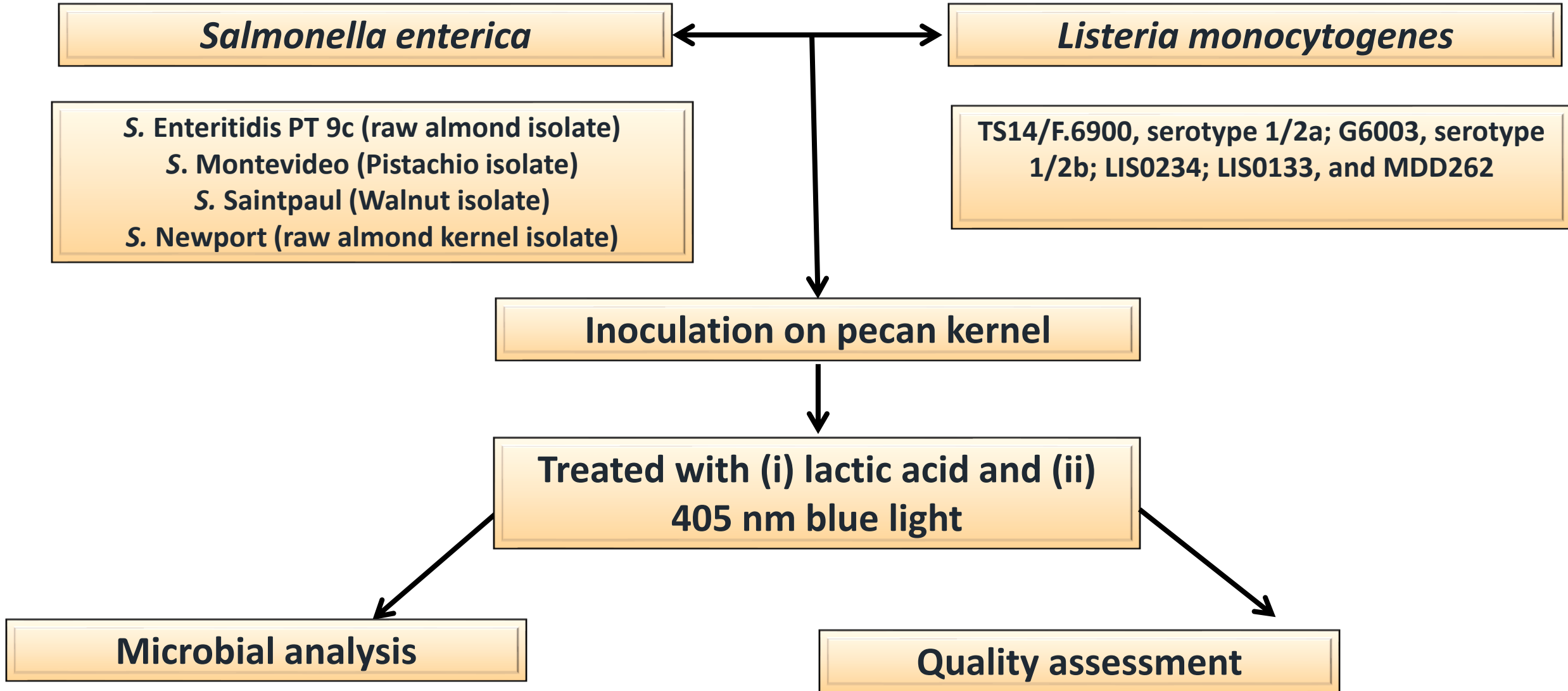
TS14/F.6900, serotype 1/2a; G6003, serotype 1/2b; LIS0234; LIS0133, and MDD262

Inoculation on pecan kernel

Treated with (i) lactic acid and (ii)
405 nm blue light

Microbial analysis

Quality assessment



Culture Inoculation and Lactic Acid Treatment



Bacteria were spot inoculated



Pecan kernel $\approx$ 2g



Dried for 45 min



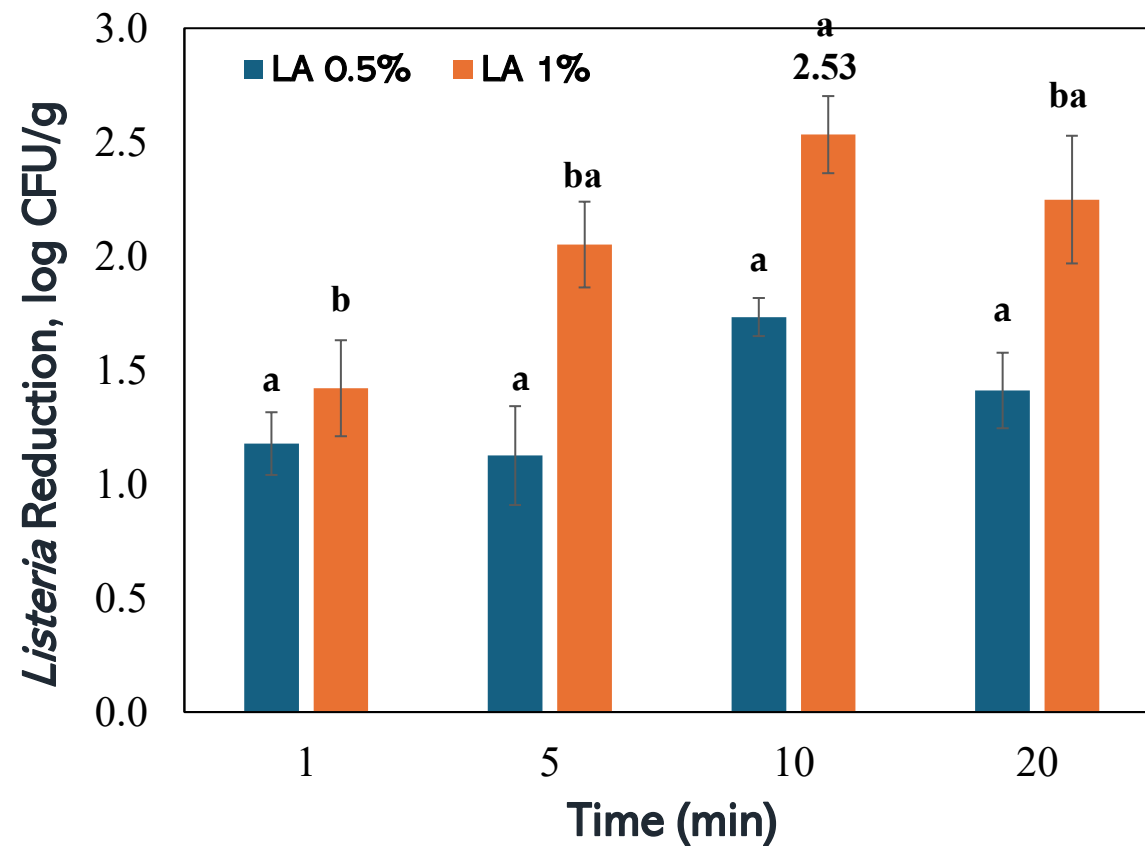
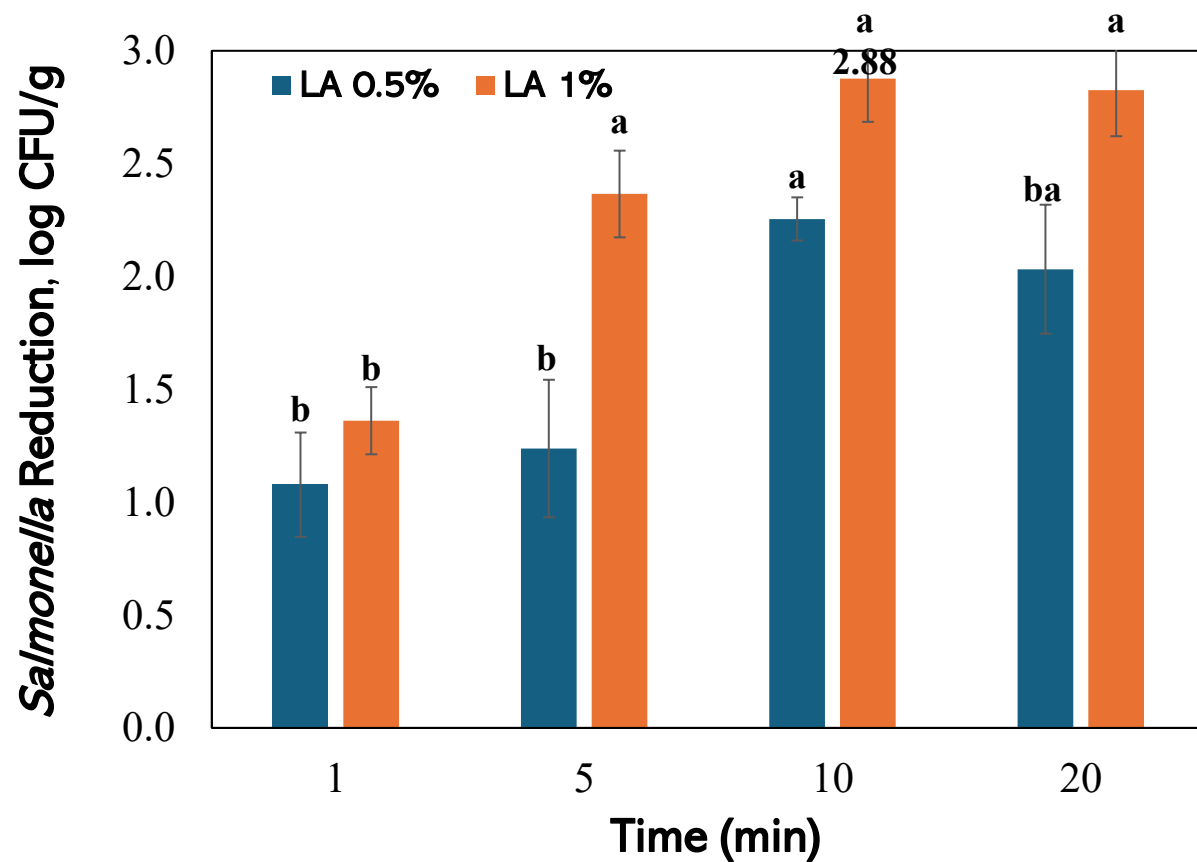
Lactic acid



50 μ l of *Salmonella* and *Listeria* ($\approx$ 6 log CFU/g) inoculated individually considering five kernels as one sample (10 μ l of inoculum per kernel)

Treated with LA 0.5, 1.0% for 0, 1, 5, 10, and 20 min

Results: Lactic Acid (LA) Treatment



Results: Quality Assessment

Table 1. Effect of LA on moisture content and water activity of the sample (Mean $\pm$ SE, n = 9)

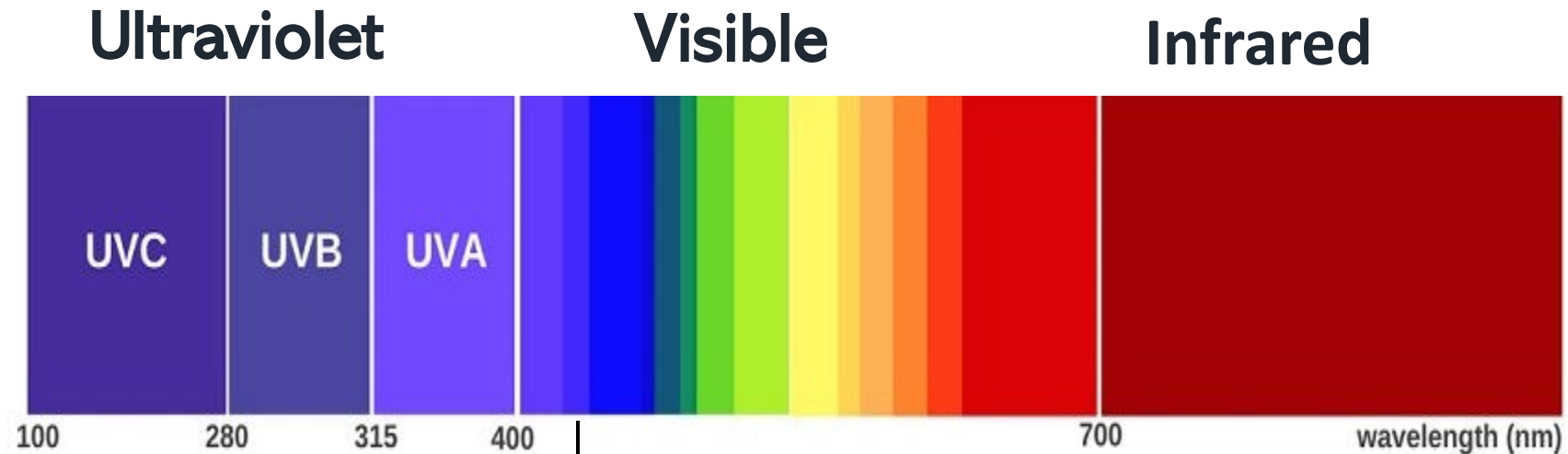
Moisture Content, %	
Control	2.04 $\pm$ 0.01 ^a
Treated (1%, 20 min)	2.18 $\pm$ 0.01 ^b
Water activity, a _w	
Control	0.40 $\pm$ 0.11
Treated (1%, 20 min)	0.40 $\pm$ 0.06

Different superscript letters within the same row indicate significant differences (p < 0.05)

Table 2. Effect of LA on the firmness of pecan kernels (Mean $\pm$ SE, n = 9)

Texture/Firmness, N	
Control	30.28 $\pm$ 3.37
Treated (1%, 20 min)	30.18 $\pm$ 3.39

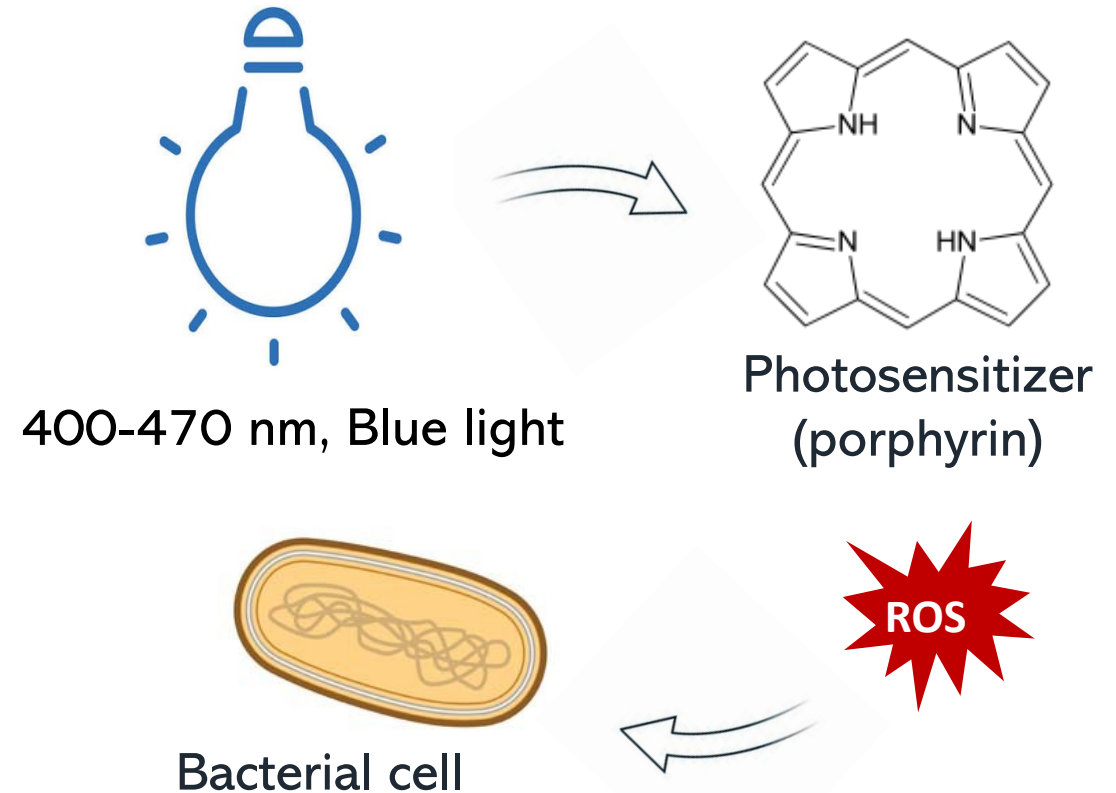
Spectrum of Light



400-470 nm: Visible blue light (antimicrobial blue light)

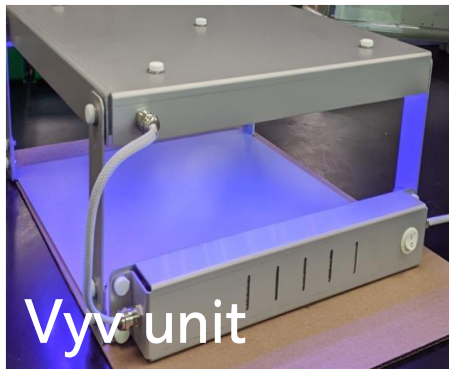
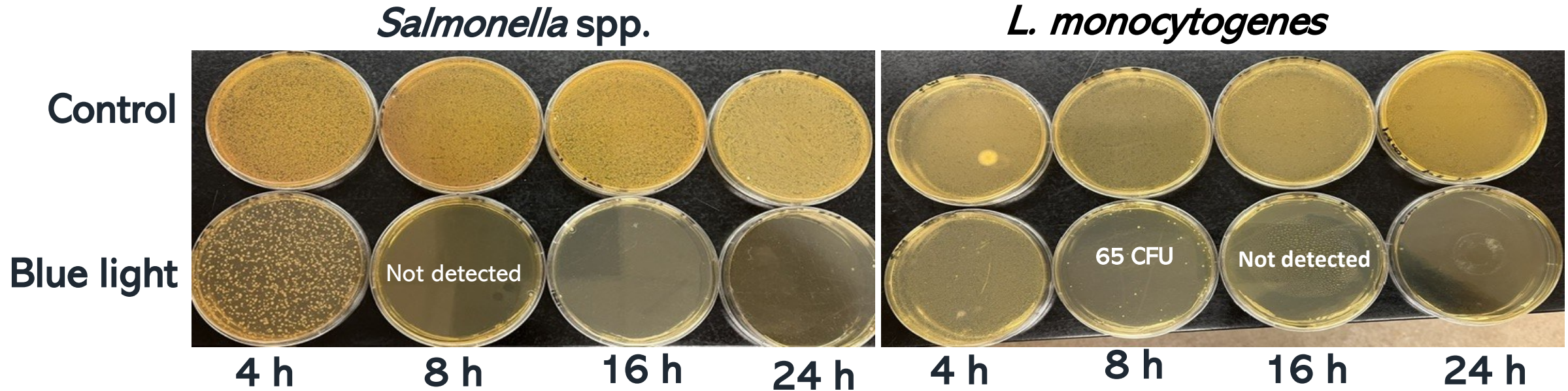
How Blue Light Kills Microbes?

Blue light → Activates porphyrin molecules → Generate Reactive Oxygen Species (ROS) → Become toxic to the cell.



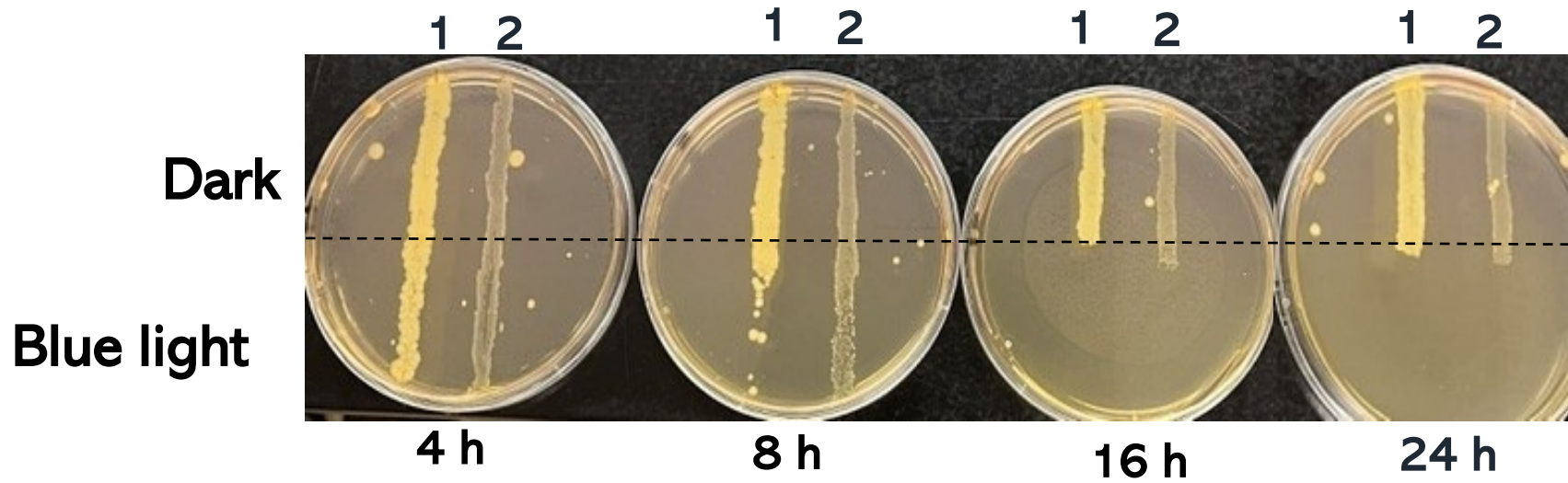
Oxidative damages to nucleic acids, lipids, and proteins.

Quantitative Agar Surface Exposure



Initial population = $\sim 6 \log$ CFU/ml

Qualitative Agar Surface Exposure



Qualitative representation of the bactericidal effect of 405 nm blue light, with half of each plate being exposed to blue light and the other half is non-light-exposed control. 1. *Salmonella* spp. 2. *Listeria monocytogenes*.

Culture Inoculation and Blue Light Treatment



Spot inoculation



Pecan kernel $\approx$ 2g

100 μ l of *Salmonella* and *Listeria* ($\approx$ 6 log CFU/g) inoculated individually considering five kernels as one sample (20 μ L of inoculum per kernel)



Dried for $\sim$ 45 min

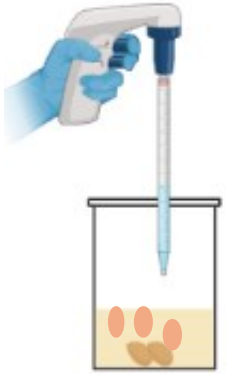
Vyv's LED microbiology test bench unit
(Vyv Inc., Latham NY)



Treatment time: 4, 8, 16, 24, 48 & 72 h

- Output emission spectrum at 405 nm.
- LED unit- DC power supply (100–240 V, 12W)
- Irradiance of $\sim$ 0.65 mW/cm² at 16.5 cm

Microbial Analysis



Add 20 ml peptone water,
hand rub for 30 s
(5 pecan halves per sample
bag)



Sample homogenization
(230 RPM, 2 min)

Serial dilutions and
plating

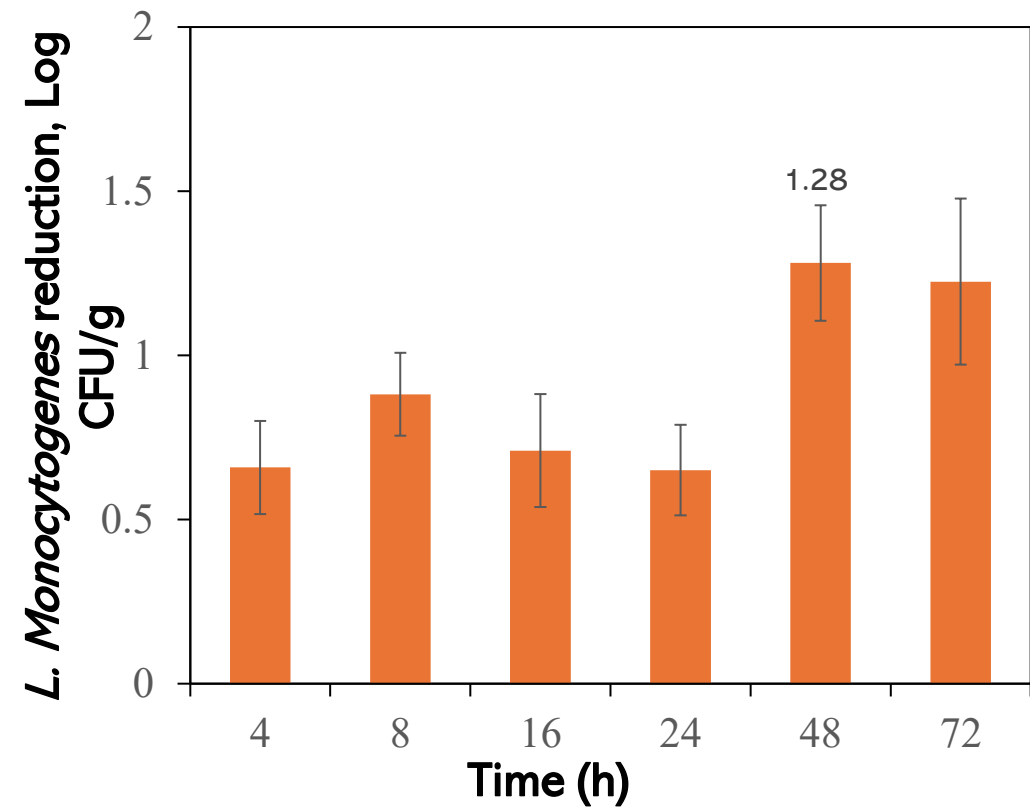
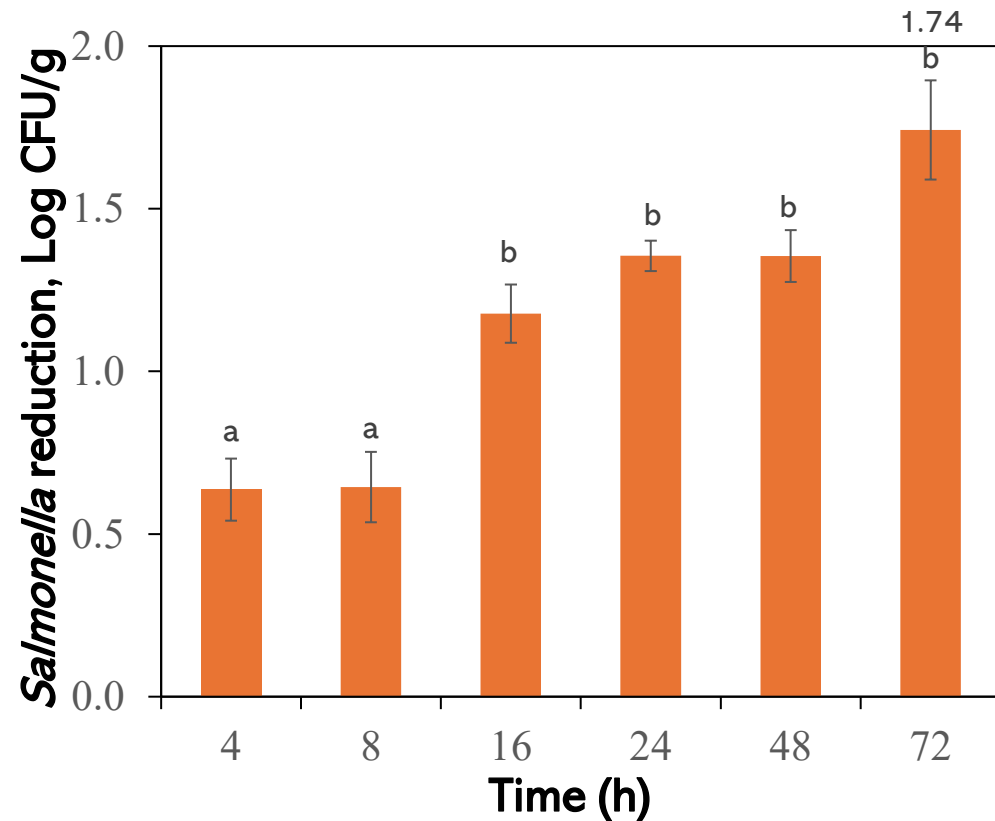


Incubate at 35-37 °C for 24 - 48 h



Bacterial count

Reduction of *Salmonella* and *L. monocytogenes* by Blue Light



Time (Fluence, J/cm²) = 4 h (9.36), 8 h (18.72), 16 h (37.44), 24 h (56.16), 48 h (112.32), 72 h (168.48)

Color Evaluation-Blue Light Treated Pecans



4 h



8 h



16 h



24 h



48 h



72 h



USDA standards: Golden,
Light brown, Medium brown,
or Dark brown

No increase in pecan surface
temperature over 72 h.

Pecan Kernel Texture Analysis



- Load: 50 kg
- Trigger force: 0.15 N
- Test speed: 4mm/s
- Deformation: 20 mm

Table 1. Firmness (N) of blue light treated pecan halves (Average $\pm$ SD, n=10)

Control	26.84 $\pm$ 2.54 ^b
16 h	28.49 $\pm$ 2.14 ^{ab}
24 h	28.94 $\pm$ 2.92 ^{ab}
48 h	32.26 $\pm$ 2.66 ^a
72 h	30.12 $\pm$ 3.16 ^{ab}

Conclusions

- Lactic acid at 1% significantly reduced pathogens within just 10 min
- Lactic acid had no negative effect on pecan quality
- Blue light achieved modest (1-2 log) pathogen reduction
- Extended blue light exposure did darken pecans but that fell within the natural color variability already present in commercial pecans
- Firmness of the kernel increased after 24 h of light exposure

Ongoing and Future Research

- Investigate **blue light** effect with other photosensitizer compounds
- Physical, chemical, and thermal properties of pecan kernels for the optimization of pulsed light systems.
- We are evaluating **sonication** as a decontamination method for inshell pecans.
- Applying gaseous **chlorine dioxide** (ClO_2) to reduce aflatoxin levels in pecan kernels while preserving nut quality.

Acknowledgement

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Thank You!

Questions/comments?