

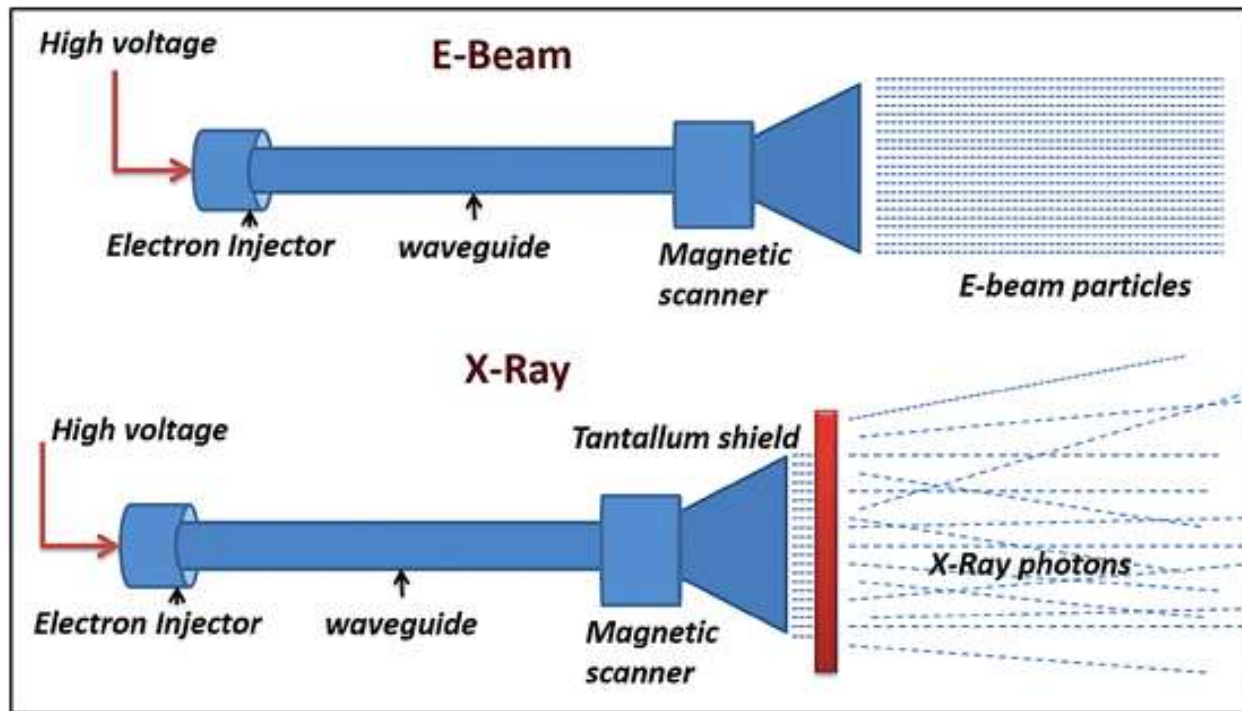
Electron Beam Irradiation Treatment to Reduce *Salmonella* Contamination on Pecan Kernels



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Electron Beam Irradiation



(Pillai and Shayanfar, 2016)

X-Ray vs E-Beam

- | | |
|---|---|
| <ul style="list-style-type: none">• Slow Processing Time• Lower Energy Efficiency• High penetration depth | <ul style="list-style-type: none">• Fast Processing Time• High Energy Efficiency• Low penetration depth |
|---|---|

Objectives

- Determine the effectiveness of electron beam irradiation (2.5 and 3.5 kGy) to reduce *Salmonella* on pecan halves in standard 30 lb. packaging.
- Evaluate how E-beam treatments influence the quality of pecan kernels after treatment and during storage.

Materials and Methods: Pecan Kernel Inoculation



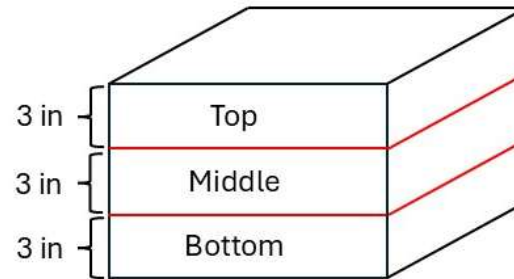
- Organism: *Salmonella*
- Spray inoculation
- Starting level $\sim 7.8 \pm 0.1$
- Aerobic Plate Count
- Starting level $\sim 2.0 \pm 0.2$
- 35 g of inoculated and aerobic samples were weighed into mesh bags.



Materials and Methods: Packaging

- Box 1: Untreated Control
- Box 2: Treated
 - Top-Corner, Middle-Edge, Bottom-Center
- Box 3: Treated
 - Top-Center, Middle-Corner, Bottom-Edge
- Box 4: Treated
 - Top-Edge, Middle-Center, Bottom-Corner

Box depth 3 in sections (top, middle, and bottom)



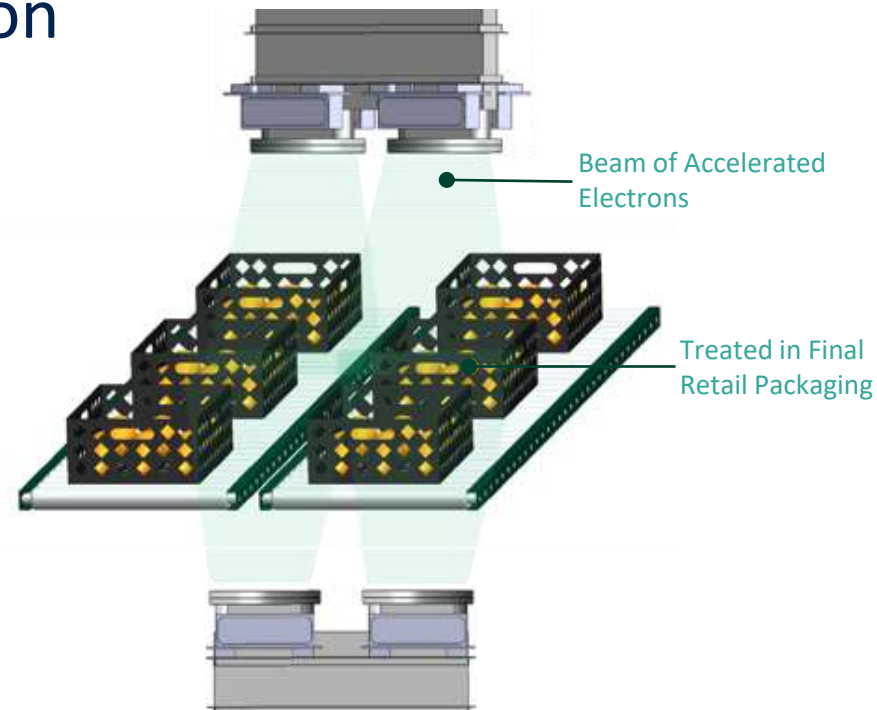
Corner	Edge	Corner
Edge	Center	Edge
Corner	Edge	Corner

Top view in sections (corner, center, and edge)



Materials and Methods: E-Beam Treatment

- Samples were sent to Reveam for E-Beam Treatment
- Electron Beam Irradiation Treatment for Pathogen Tests
 - 2.5 and 3.5 kGy
- Electron beam irradiation treatment for quality
 - <1 kGy
 - 1.5 kGy
 - 2.5 kGy
 - 3.5 kGy



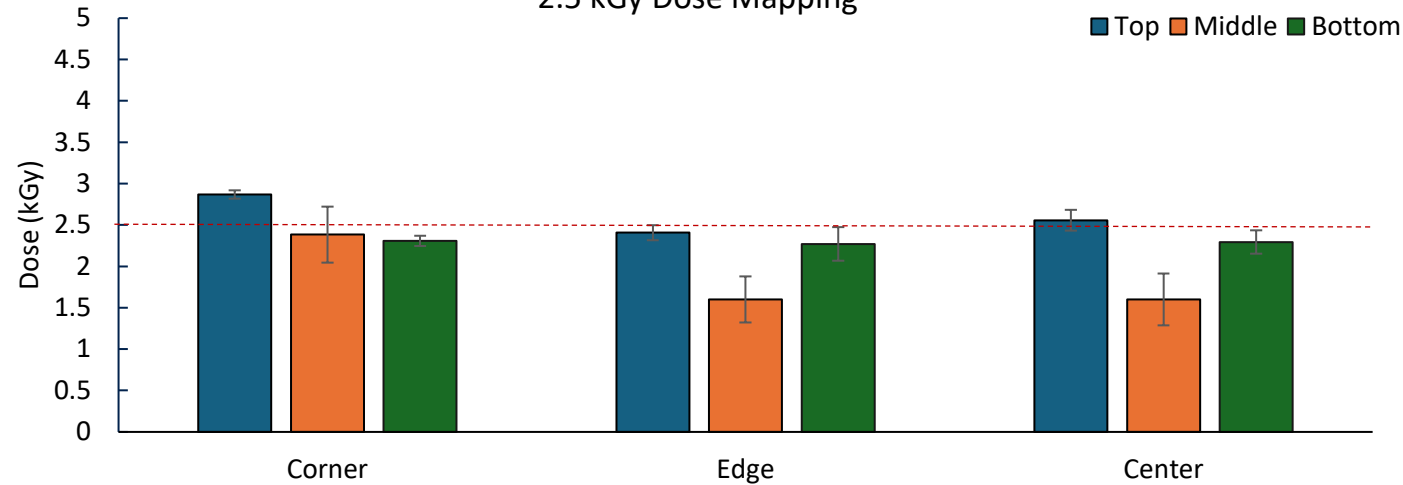
Materials and Methods: Quality Parameters

- E-beam Treatments
 - 1.5
 - 2.5
 - 3.5
 - 4.5
- Quality Tests
 - Color Change
 - Firmness
 - Oxidation
 - Free Fatty Acid
 - Peroxide Value
 - Total polyphenol content

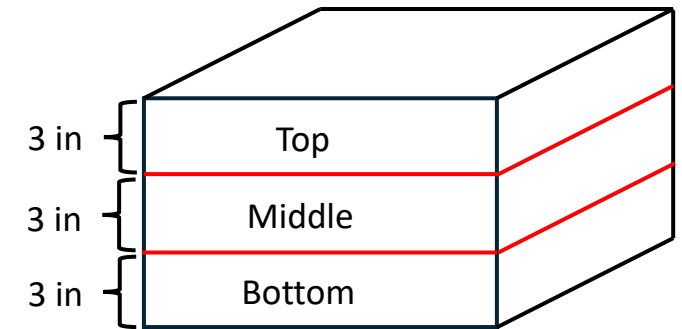


Results: E-Beam Dose Mapping

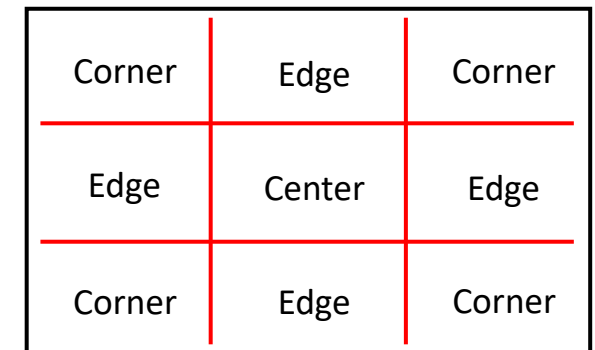
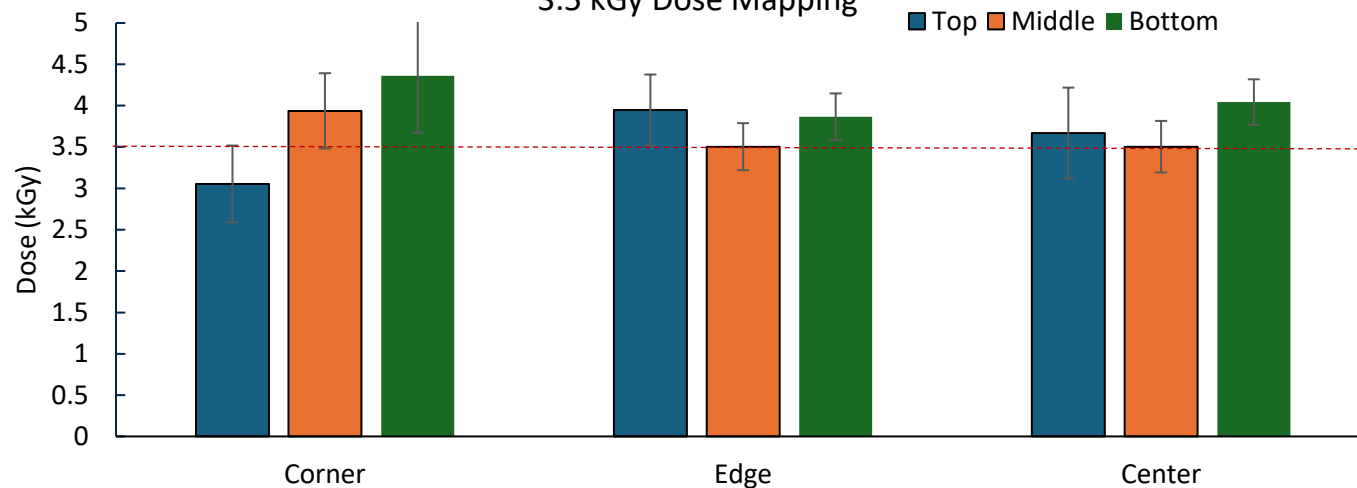
2.5 kGy Dose Mapping



Box depth 3 in sections (top, middle, and bottom)

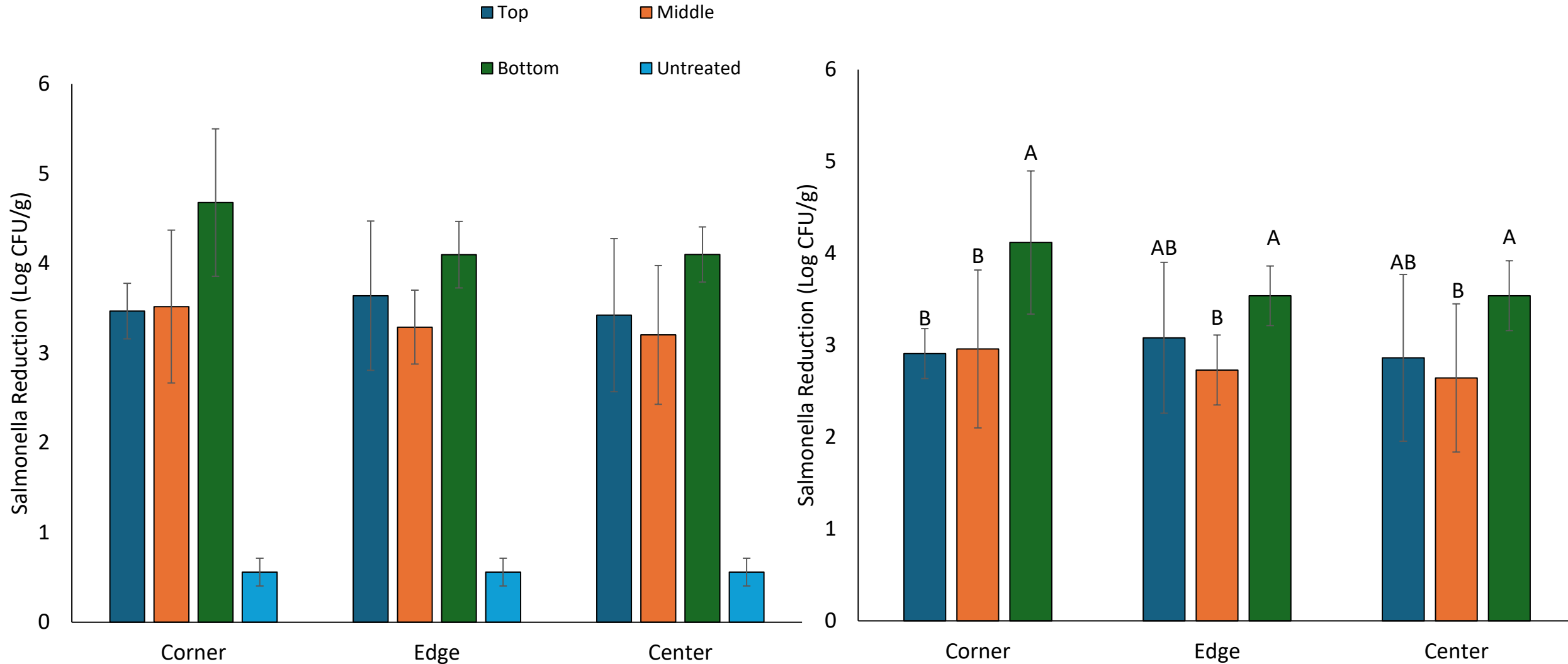


3.5 kGy Dose Mapping

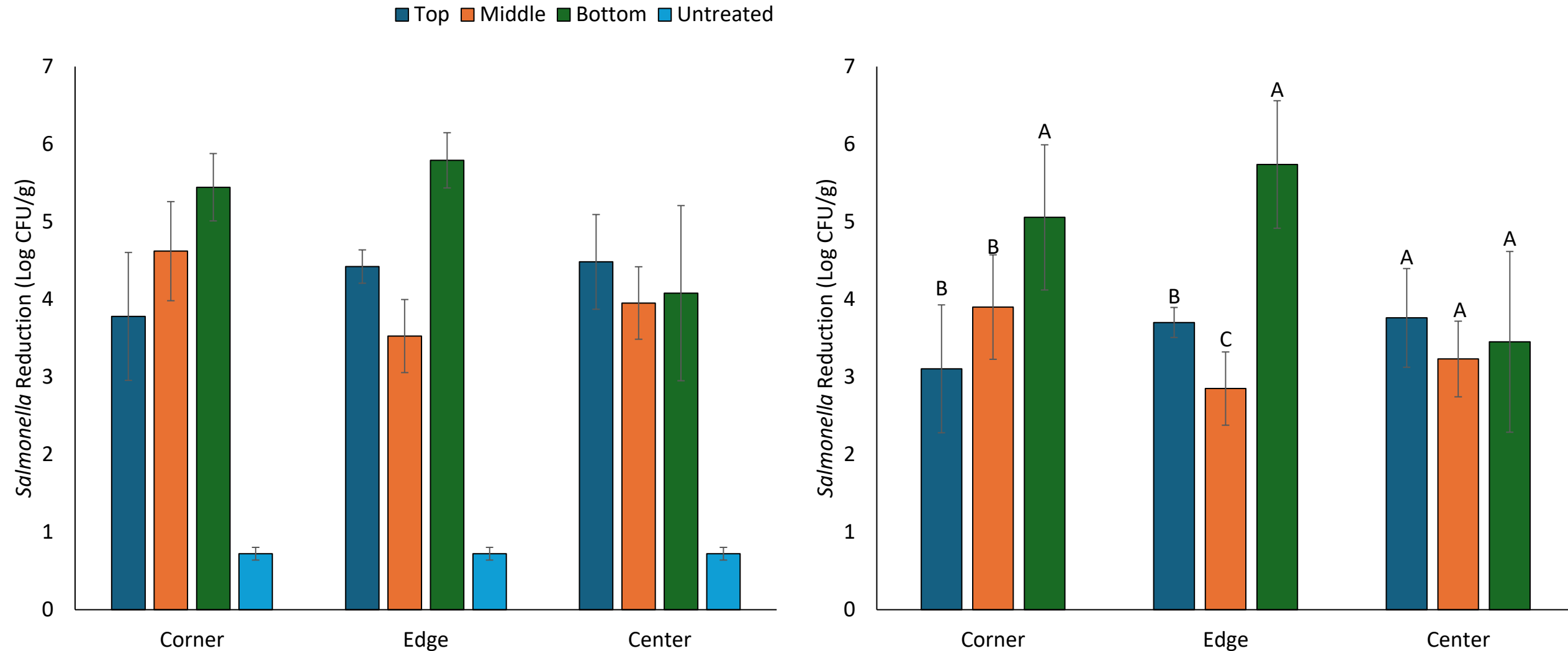


Top view in sections (corner, center, and edge)

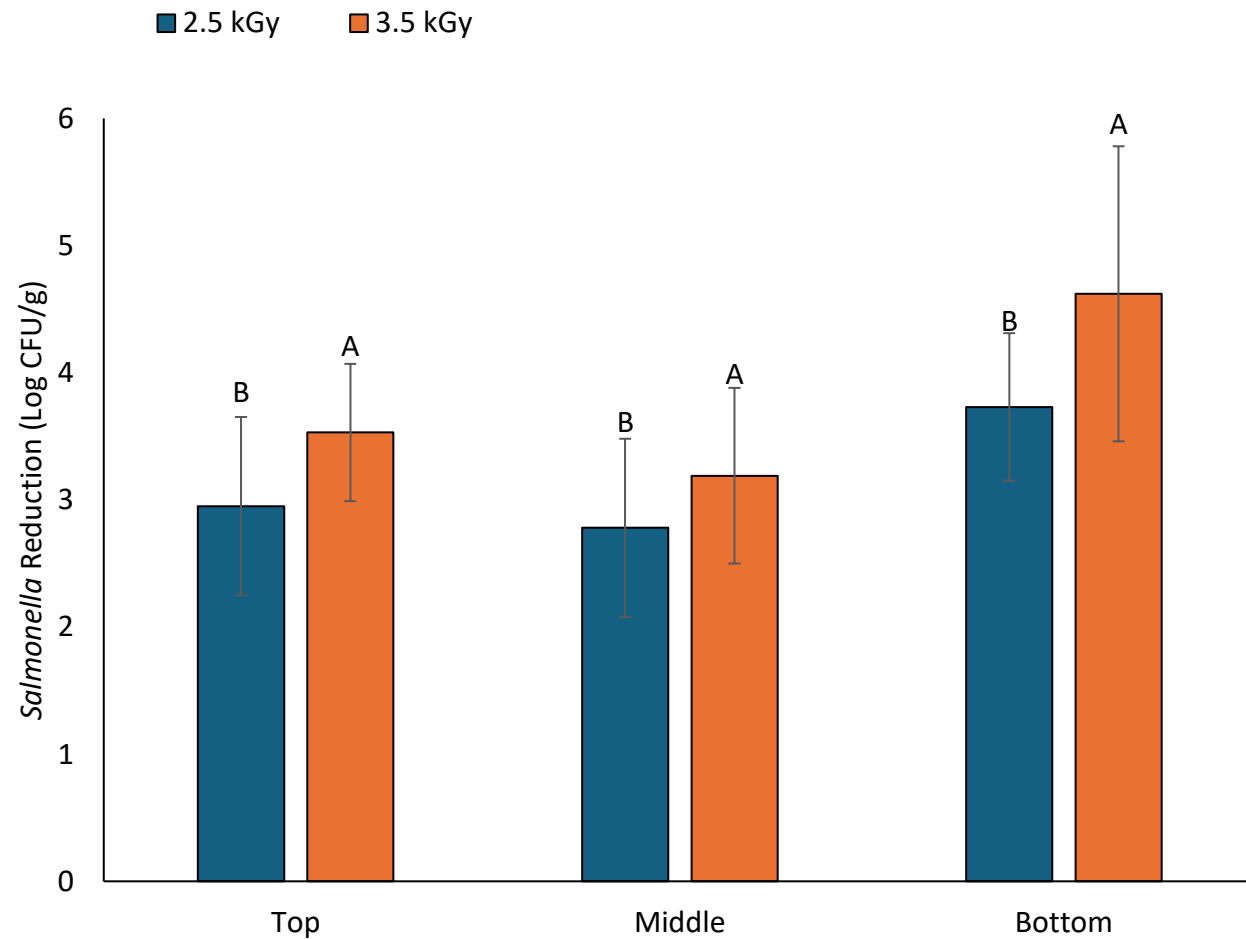
Results: *Salmonella* Reduction (2.5 kGy)



Results: *Salmonella* Reduction (3.5 kGy)



Results: *Salmonella* Reduction 2.5 vs 3.5 kGy



Source	Nparm	DFNum	DFDen	F Ratio	Prob > F
Depth	2	2	152.0	27.937687	<.0001*
Section	2	2	152.0	2.9379506	0.0560
Dose	1	1	152.0	664.34334	<.0001*
Depth*Section	4	4	152.0	6.2313018	0.0001*

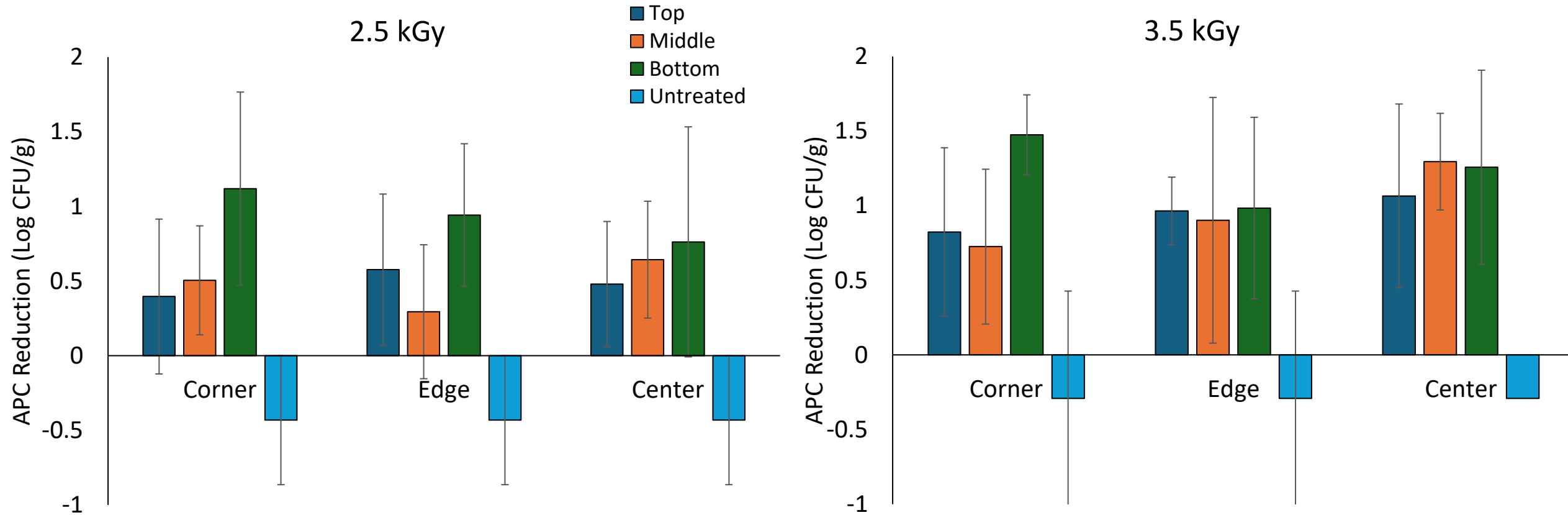
Multiple comparisons for depth

Depth		Least Squares Mean
Bottom	A	2.9671047
Top	B	2.2440805
Middle	B	2.0511298

Multiple comparisons for depth*section

Depth	Section		Least Squares Mean
Bottom	Edge	A	3.2961148
Bottom	Corner	A	3.2034155
Bottom	Center	B	2.4017838
Top	Edge	B	2.3920196
Middle	Corner	B	2.3841963
Top	Center	B	2.2721218
Middle	Center	B	2.0682766
Top	Corner	B	2.0681002
Middle	Edge	B	1.7009164

Results: Aerobic Plate Count Reduction



Results: Pecan Kernel Quality (Firmness & Color)

Firmness (g)

	Initial Treatment	2-month Storage (20 °C)
Control	2563±484 A	2490±408 A
<1 kGy	2748±571 A	2691±535 A
1.5 kGy	2598±506 A	2599±650 A
2.5 kGy	2641±515 A	2631±546 A
3.5 kGy	2544±612 A	2666±627 A

Color change (ΔE^*ab)

	Initial Treatment	2-month Storage (20 °C)
Control	3.39±1.73	4.34±2.04
<1 kGy	4.71±3.79	4.40±1.79
1.5 kGy	3.26±1.79	4.65±2.27
2.5 kGy	3.78±2.39	4.88±2.50
3.5 kGy	3.93±2.13	4.86±2.15

Results: Pecan Kernel Quality (Oxidation & Polyphenol)

Free Fatty Acid Levels (%)

	Initial Treatment	2-month Storage (20 C)
Control	0.10±0.00	0.22±0.01
<1 kGy	0.07±0.01	0.27±0.01
1.5 kGy	0.10±0.02	0.22±0.03
2.5 kGy	0.07±0.04	0.25±0.06
3.5 kGy	0.11±0.01	0.21±0.04

Peroxide values (meq O₂/kg)

	Initial Treatment	2 month Storage (20 C)
Control	6.26±0.40 A	3.26±0.33 A
<1 kGy	5.87±0.52 A	4.07±0.55 A
1.5 kGy	6.41±0.68 A	1.98±0.34 B
2.5 kGy	7.01±0.23 A	2.21±0.14 B
3.5 kGy	6.14±0.14 A	1.73±0.10 B

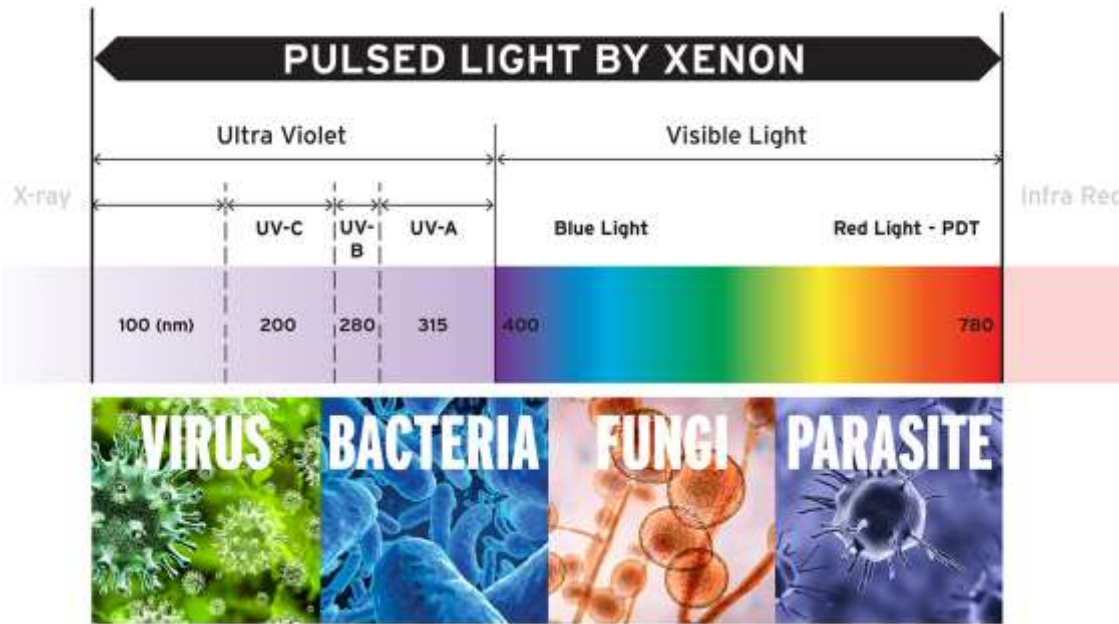
Total polyphenol content (mg GAE/g)

	Initial Treatment	2 month Storage (20 C)
Control	15.62±1.91	10.82±1.39
<1 kGy	16.72±2.87	10.83±0.96
1.5 kGy	16.68±5.18	10.89±1.99
2.5 kGy	16.07±5.29	10.62±1.98
3.5 kGy	12.04±1.94	10.32±1.59

Conclusions

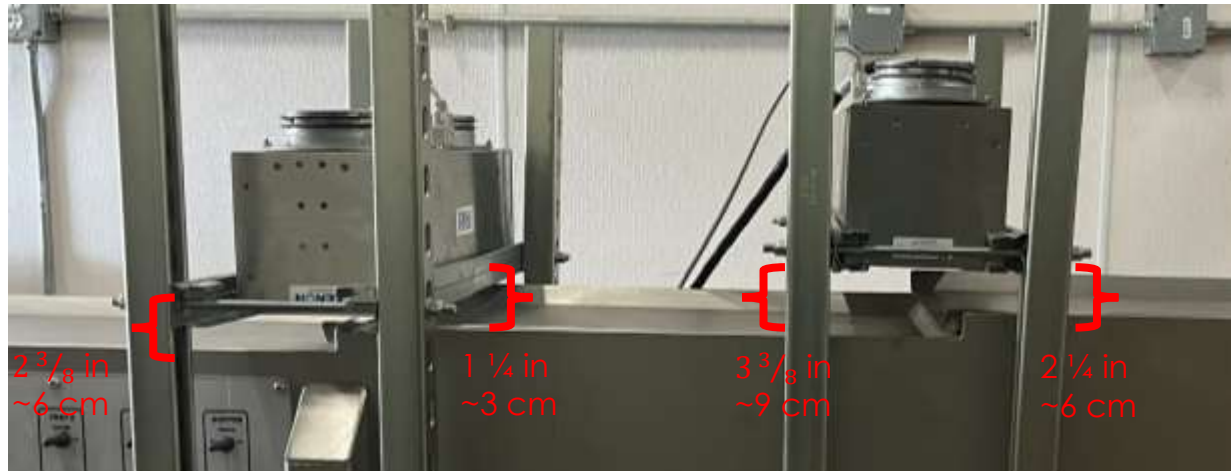
- 2.5 kGy treatment reduced *Salmonella* by 2.7-4.1 log CFU/g
 - Variation in the reductions were based on depth in the box with the bottom having higher reductions
- 3.5 kGy treatment reduced *Salmonella* by 2.9-5.7 log CFU/g.
 - Variation in the reductions were based on depth in the box with the bottom having higher reductions
- Electron beam treatments had no immediate impact on color, texture, and oxidation (rancidity) and after 2 months storage at 20 °C

Pulsed Ultraviolet Light

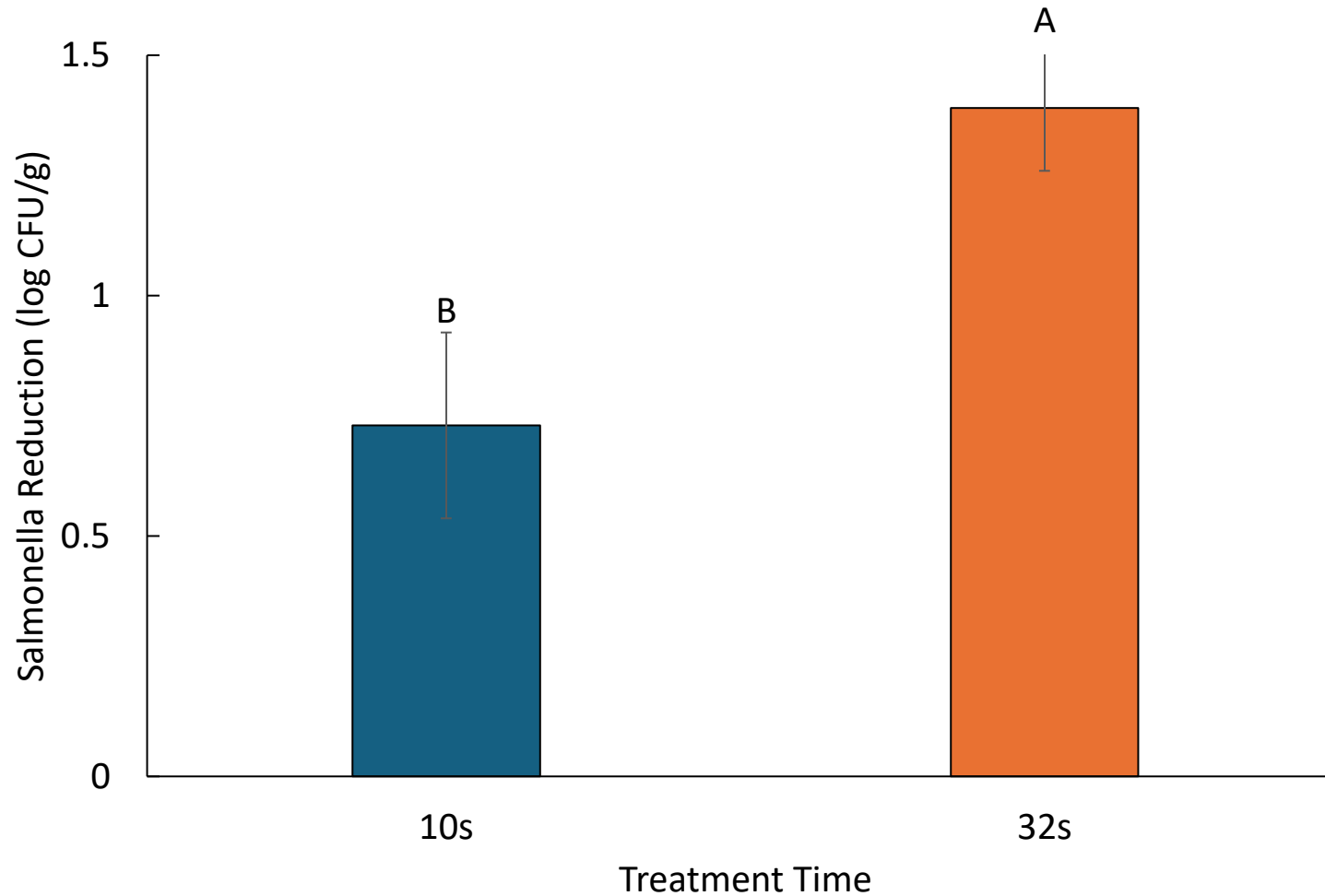


Materials and Methods: Pecan Kernel Inoculation

- Organism: *E. coli*
- Spray inoculation
- Starting level $\sim 7.8 \pm 0.1$
- Treatment Time:
 - 10s
 - Light A: 5s
 - Light B: 5s
 - Between: 11s
 - 32s
 - Light A: 14s
 - Light B: 18s
 - Between: 40s



Pulsed Light Treatment Preliminary Results



Questions



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