

Effectiveness of Antimicrobial Food Packaging Materials

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Background

- Food Safety and Quality
- Antimicrobial Packaging – another hurdle
- Questions to ask for implementation
 - Regulatory Status
 - Economic – cost/benefit analysis
 - Technical Challenges

Antimicrobial Packaging

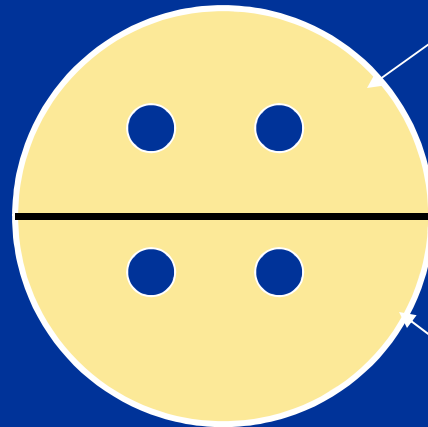
- Biopolymer films as carriers of antimicrobial agents.
- Biopolymer films as antimicrobial agents themselves.
- Incorporation of a antimicrobial delivery system for use in existing packaging systems.
- Utilize a multi-system approach.

Nisin

- Methylcellulose and Hydroxypropyl methylcellulose coating as a carrier
- LDPE or barrier bags used as substrate
- Tested antimicrobial potential
 - Drop assay
 - Diffusion assay
 - Direct application of coated film to inoculated plate
 - Inoculated hot dogs, individually wrapped in coated film

Release of Nisin from Film Coating into Peptone

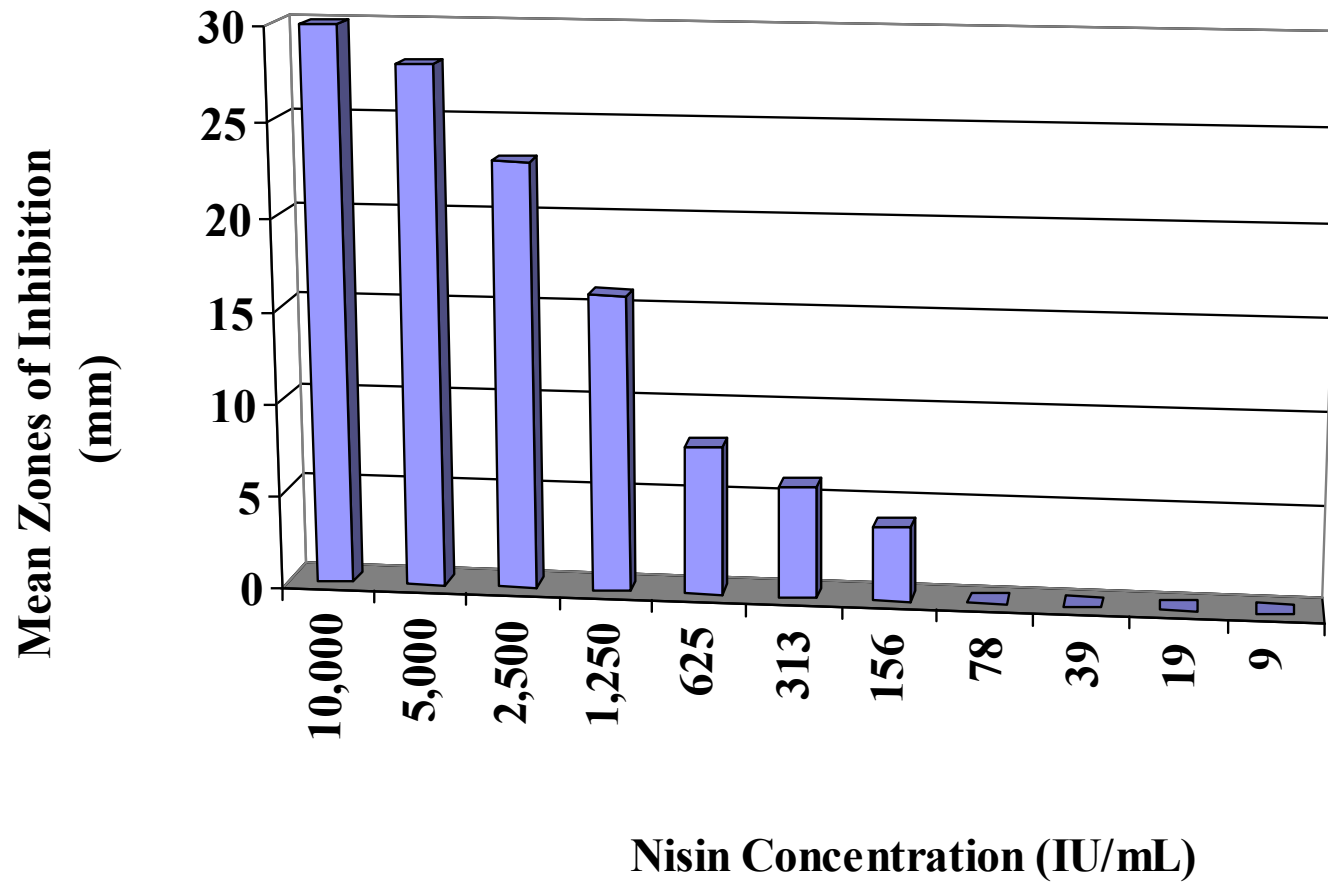
Spot on Lawn Assay



10µL drop taken from tubes
containing film samples in
buffer solution

buffer solution only

MIC of nisin in solution



Nisin

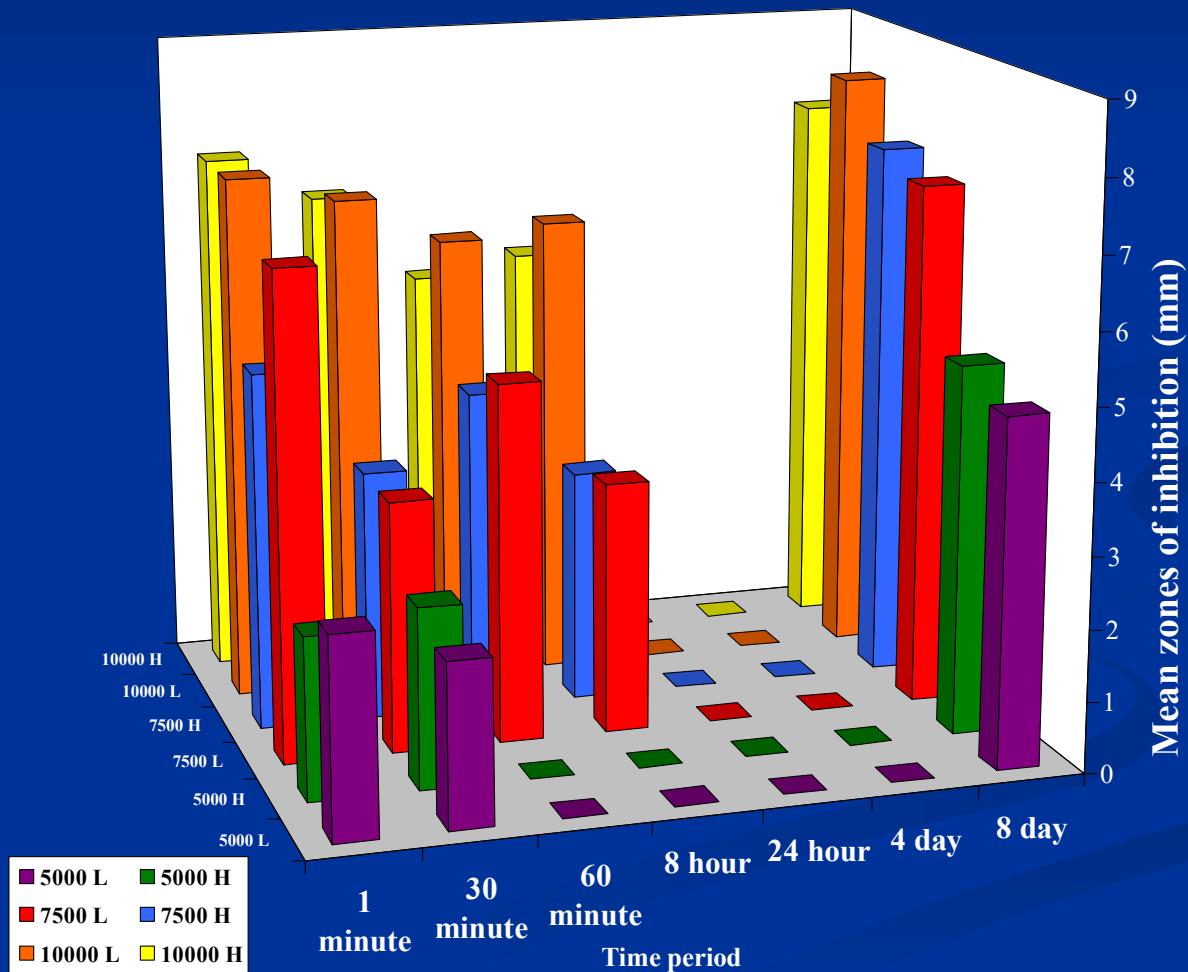
LDPE film coated with cellulose-based coating



No nisin

10,000 IU/g nisin

Release of Nisin from Film Coating into Peptone



Inhibition of LM using a packaging film coating containing nisin



Inhibition of LM using a packaging film coating containing nisin

	Zone of Inhibition (mm) – 10,000 IU/mL			
Population (log CFU/cm ²)	TSA (37°C, 48h)	TSA (4°C, 17d)	MOX (37°C, 48h)	MOX (4°C, 17d)
7	12.45 ^{A,,x}	17.81 ^{B,y}	*	**
8	12.26 ^{A, a,x}	18.48 ^{B,y}	25.4 ^{b,z}	**
9	11.70 ^{A, a,x}	17.93 ^{B,y}	25.32 ^{b,z}	**
10	11.22 ^{a,x}	17.15 ^y	23.19 ^{b,z}	**

Inhibition of LM using a packaging film coating containing nisin

Zone of Inhibition (mm)					
Nisin	Population (log CFU/cm ²)	TSA (37C, 48h)	TSA (4C, 17d)	MOX (37C, 48h)	MOX (4C, 17d)
7,500 IU/mL	8	11.66 ± 1.28 A, a, x	30.75 ± 2.28 B, x	26.53 ± 1.34^b	**
	9	11.46 ± 1.51 A, a, x	33.28 ± 1.79 B, x	22.12 ± 1.52^b	**
	10	11.16 ± 1.51 A, a, x	34.28 ± 1.79 B, x	22.67 ± 1.52^b	**

Similar results observed for 2,500 IU/mL

Nisin

- Inhibition of LM in Hot Dogs using Nisin Coated Packaging Film
 - Nisin levels tested 10000, 7500, 2500 and 156
 - Coated onto barrier bags, hot dogs individually vacuum packaged
 - 5 strain LM cocktail, 5 log inoculum
 - Measured LM populations at days 0, 7, 15, 21 28 and 60 days.

Listeria monocytogenes (5 strain cocktail)
populations on the surface of hot dogs
enumerated on TSA

Nisin (IU/mL)	Days of Storage					
	0	7	15	21	28	60
0	5.29 ^{a,x}	5.51 ^{a,x}	6.13 ^{a,x}	6.33 ^{a,y}	8.01 ^{a,y}	9.11 ^{a,y}
156.3	4.84 ^{a,x}	4.9 ^{b,x}	4.90 ^{b,x}	5.37 ^{b,y}	7.50 ^{b,y}	9.52 ^{a,y}
2500	ND ^b	ND ^c	ND ^c	ND ^c	ND ^c	ND ^b
7500	ND ^b	ND ^c	ND ^c	ND ^c	ND ^c	ND ^b
10,000	ND ^b	ND ^c	ND ^c	ND ^c	ND ^c	ND ^b

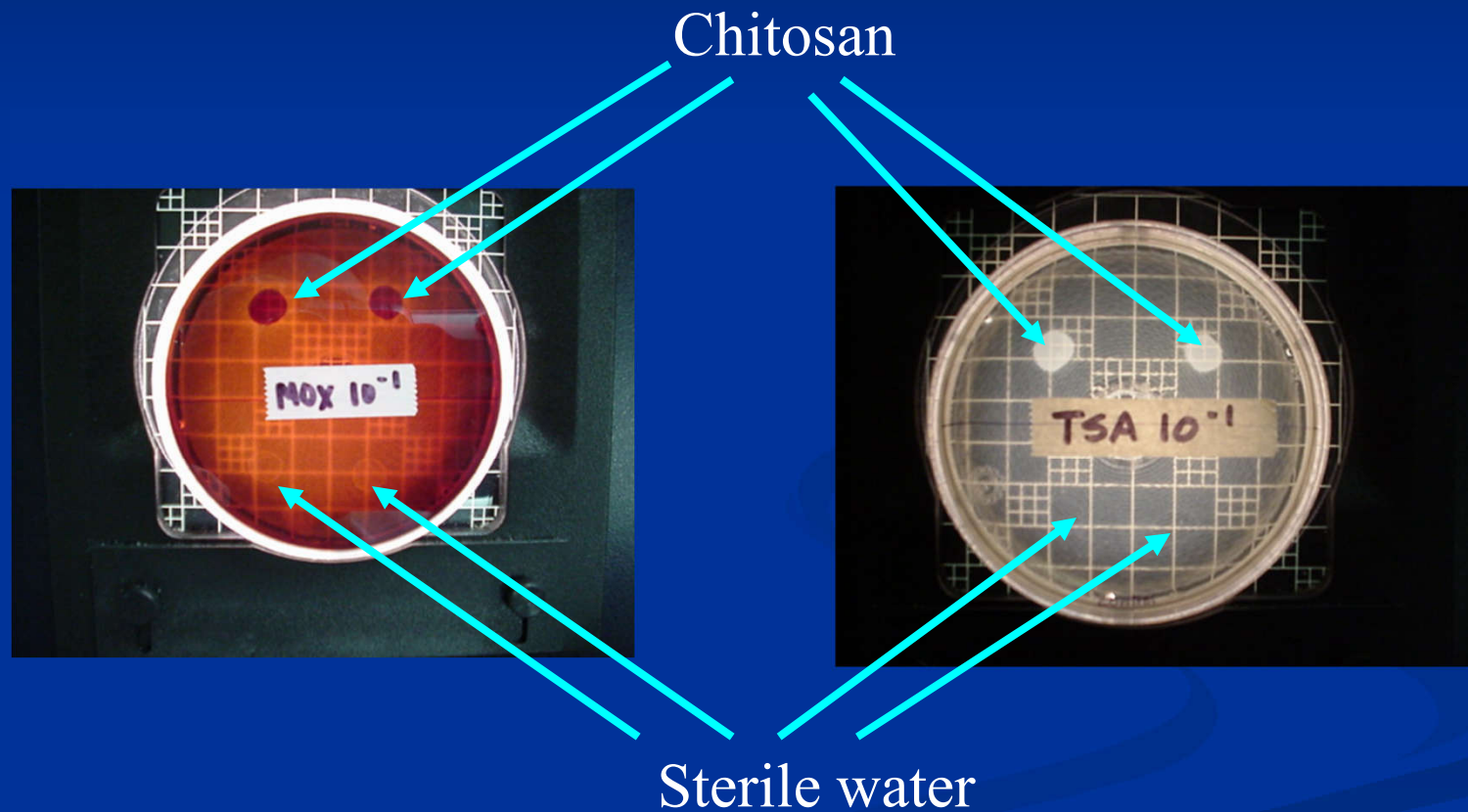
Nisin

- Overall summary
 - Effective at 2500 IU/mL or above
 - Diffuses from cellulose carrier over time
 - Affects visual and heat sealing properties

Chitosan

- Antimicrobial activity and film strength of chitosan with differing levels of %DA, viscosity and concentration
 - Obtained chitosan from Vanson Halosource with 90, 85 and 80% DA,
 - High (558 cps) and low (20 cps) viscosity
 - 1 and 2% chitosan solutions dissolved in acetic acid
 - measured antimicrobial properties with drop assay using *L. monocytogenes*

Research - chitosan



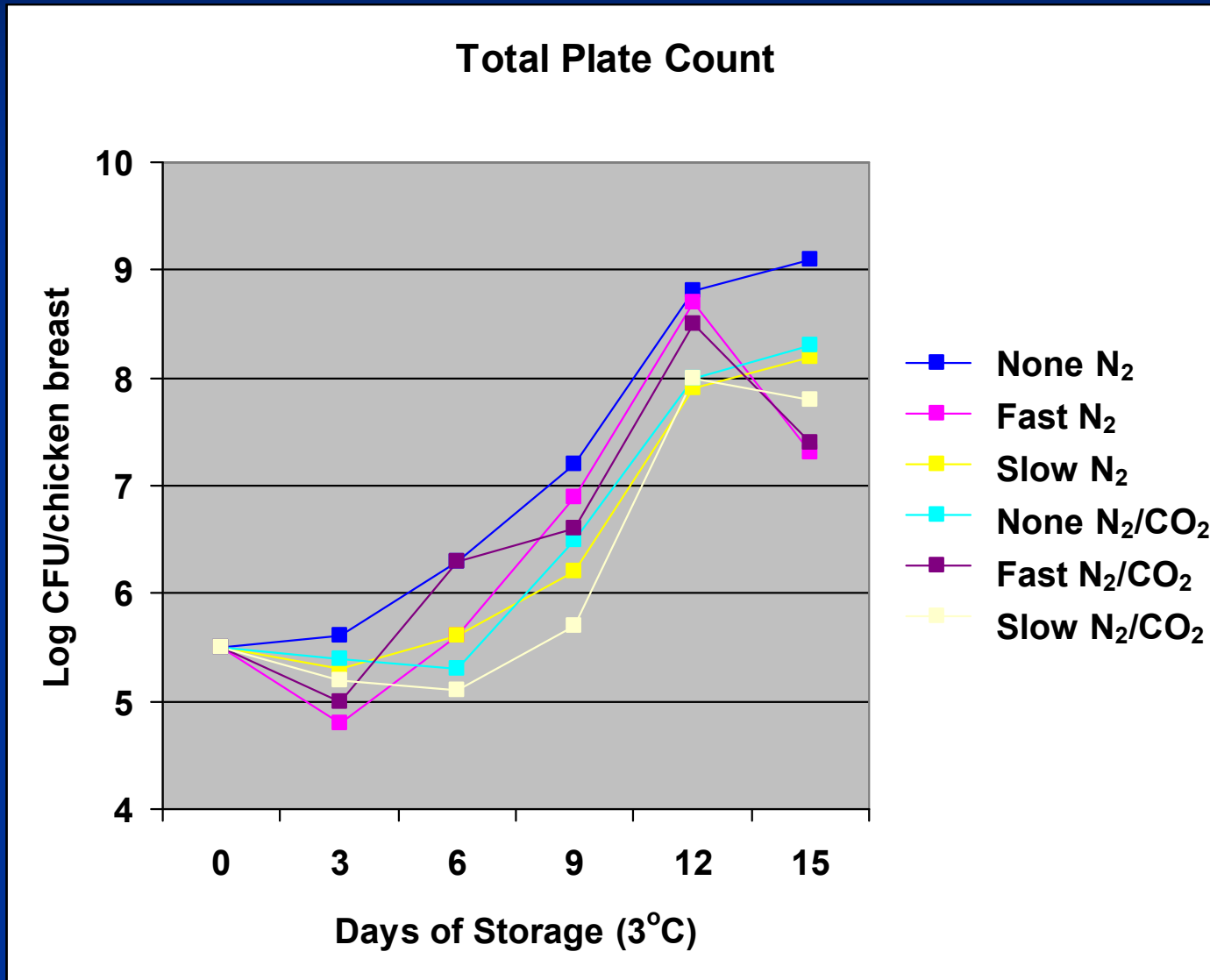
Inhibition of *L. monocytogenes* with differing chitosan solutions

%DA	Viscosity	Log CFU/mL		
		4	5	6
90	High	+	+	+
90	Low	+	+	+
85	High	+	+	+
85	Low	+	+	+
80	High	+	+	+
80	Low	+	+	+

Quality of Chicken using ClO₂ and MAP Packaging

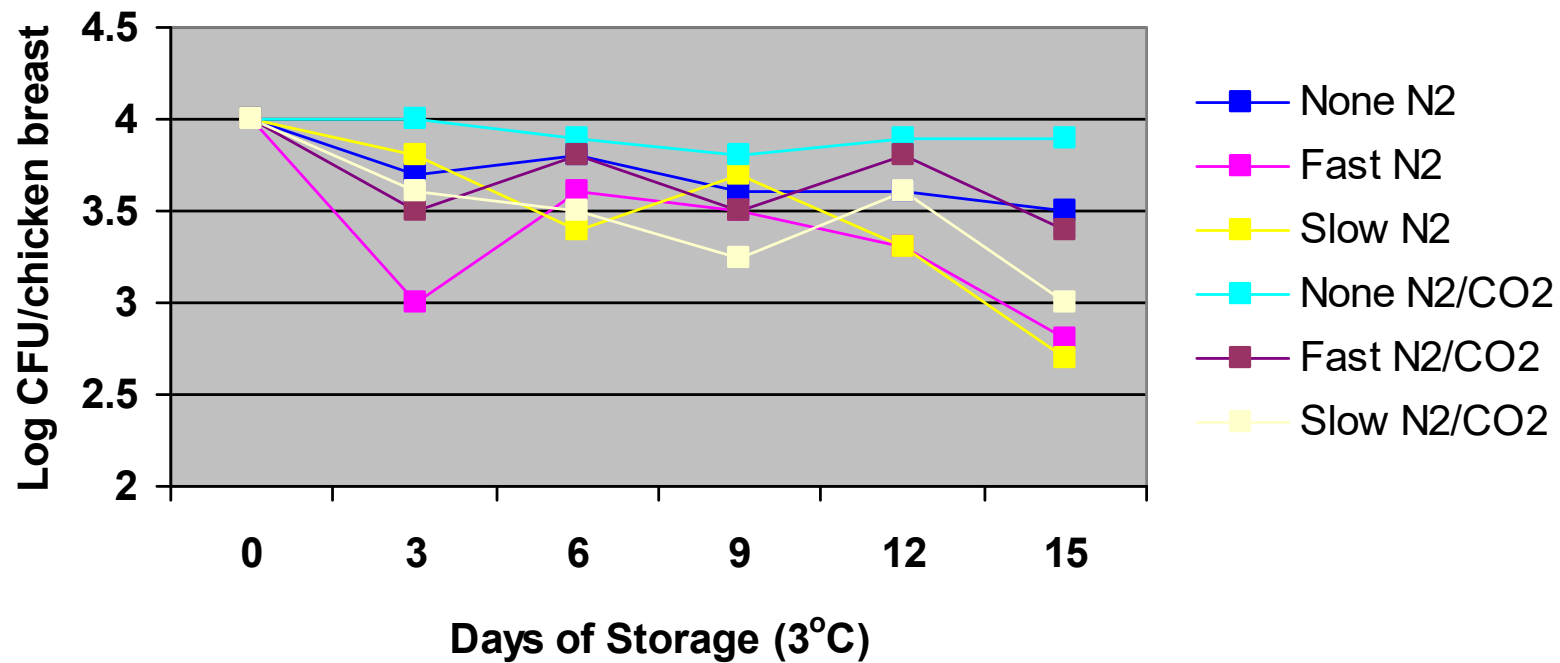
- Fresh chicken breasts inoculated with 4 log population *S. typhimurium* NAR
- Sachets:
 - Fast release (6.6mg, 26 hours)
 - Slow release (2.25mg, 22 days)
- Package atmosphere:
 - 100% N₂ or 75% N₂/25% CO₂
- TSA, TSA w/NA, L.a.b. color and sensory (odor and color) on days 0, 3, 6, 9, 12 and 15 of refrigerated storage.

Quality of Chicken using ClO_2 and MAP Packaging



Quality of Chicken using ClO_2 and MAP Packaging

S. typhimurium NAR populations



Sensory panel aroma values of chicken breasts

ClO ₂ Release	3		6		9		15	
	100% N ₂	75% N ₂ / 25% CO ₂	100% N ₂	75% N ₂ / 25% CO ₂	100% N ₂	75% N ₂ / 25% CO ₂	100% N ₂	75% N ₂ / 25% CO ₂
None	4.9 ± 8.75 a,y	6.2 ± 8.75 f,y	6.6 ± 11.7 a,x	5.5 ± 11.7 f,x	8.6 ± 10.1 b,y	6.0 ± 10.1 f,y	10.4 ± 12.0 b,y	9.8 ± 12.0 g,y
Fast	6.0 ± 8.75 a,x	5.5 ± 8.75 f,x	4.6 ± 11.7 a,w	5.4 ± 11.7 f,w	3.4 ± 10.1 a,x	3.8 ± 10.1 f,x	5.0 ± 12.0 a,x	5.7 ± 12.0 f,x
Slow	4.1 ± 8.75 a,z	5.6 ± 8.75 f,z	5.0 ± 11.7 a,y	7.4 ± 11.7 f,z	4.1 ± 10.1 a,z	6.6 ± 10.1 f,z	6.5 ± 12.0 a,z	7.5 ± 12.0 f,g,z

Research - ClO₂



Chicken breasts after 15 days at 2.8°C

Quality of Chicken using ClO₂ and MAP Packaging

■ Conclusions

- Total plate counts increased with storage time but those with ClO₂ were 1-1.5 log lower regardless of package atmosphere.
- After 15 days, *S. typhimurium* counts were significantly lower on samples treated with ClO₂ (fast and slow release sachets).

Quality of Chicken using ClO₂ and MAP Packaging

■ Conclusions

- Color was adversely affect but not reflected by instrumental or sensory evaluation due to statistical variability and sample location evaluated.
- Odor was significantly reduced by ClO₂ treated samples, a concern with regard to indication of spoilage.

Overall Summary

- Antimicrobial packaging can be effective.
- Rate of release over time is important.
- Vapor active compounds may have an advantage but come with some disadvantages.
- Combination systems show promise.
- Effect on food properties needs to be further studied.