

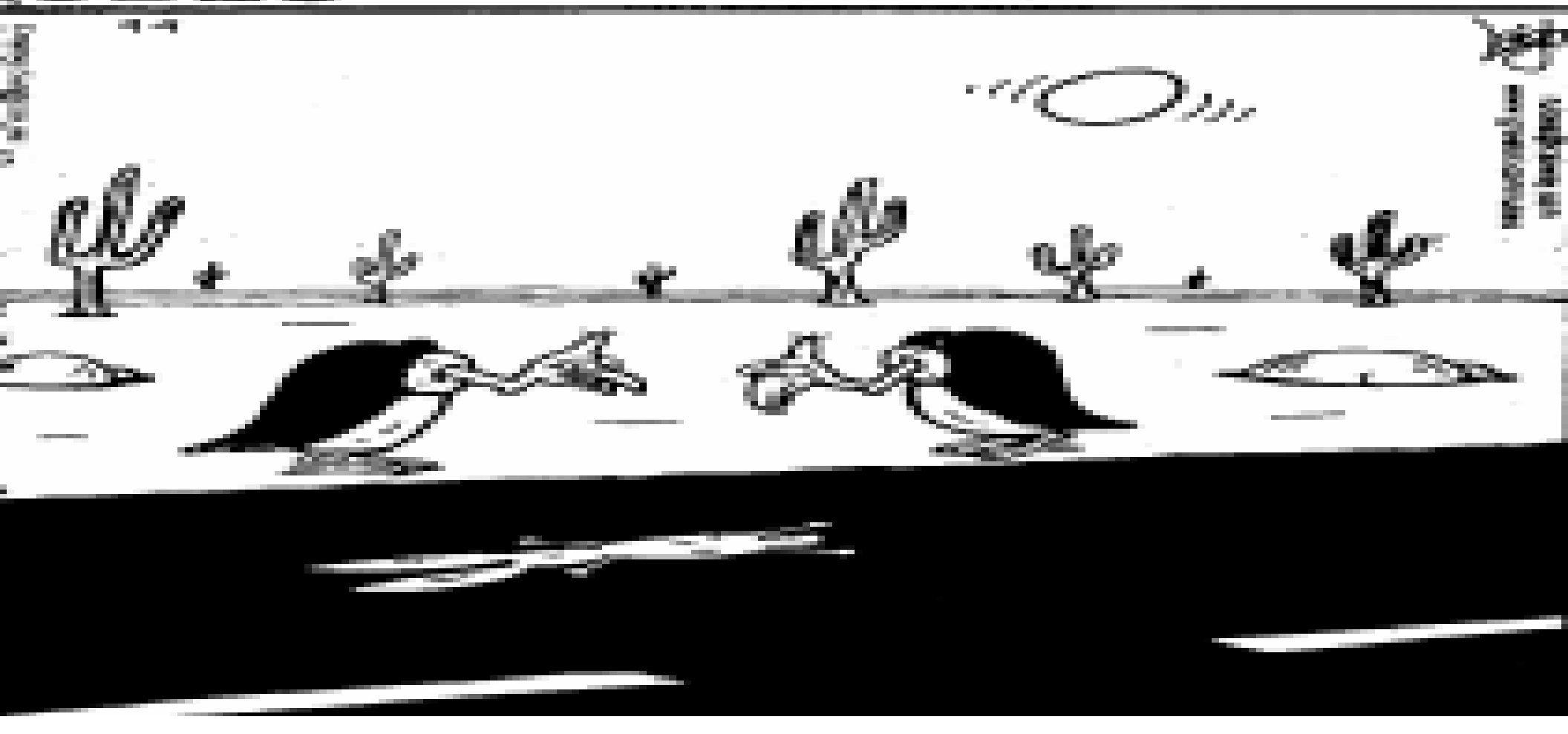
# Post-Packaging Pasteurization:

Will it work with  
country-cured hams?

Benjy Mikel  
Professor/ Coordinator  
Food Sciences

Perhaps we should let him fry a bit longer on the asphalt....You can't be too careful these days about undercooked meat!

**TUBES™**



# Listeria and 10240.4

- Is Listeria in your plant?
  - » Probably
- Is it on your RTE product?
  - » Hopefully not
- What measures can you take?
  - » Sanitation
  - » Anti-microbials
  - » Post-packaging pasteurization

# Risk Management Strategies

- Eliminate *L. monocytogenes* from the environment of processing plants that produce ready-to-eat foods
- Use a pasteurization processes to destroy *L. monocytogenes*
  - In-pack pasteurization, or
  - Immediately before packaging
- Use product formulations that prevent the growth of *L. monocytogenes*

# USDA-FSIS Alternatives

- Alt 1. Post-lethality AND Antimicrobial Agent
- Alt 2. Post-lethality OR Antimicrobial Agent
- Alt 3. Sanitation Only

# Post-Packaging Pasteurization



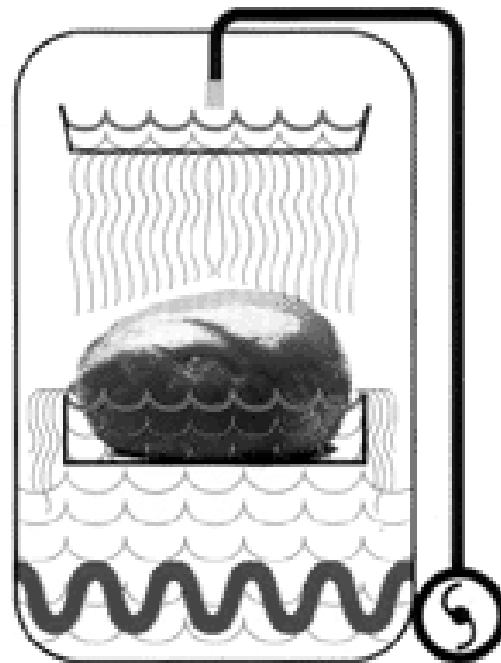
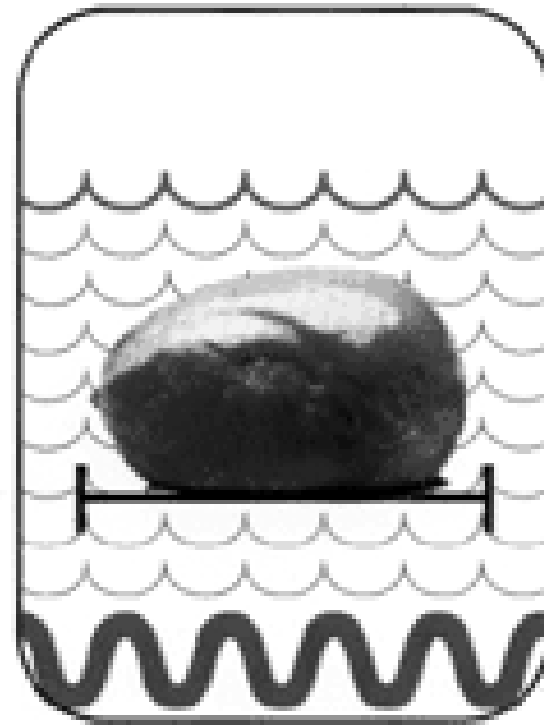
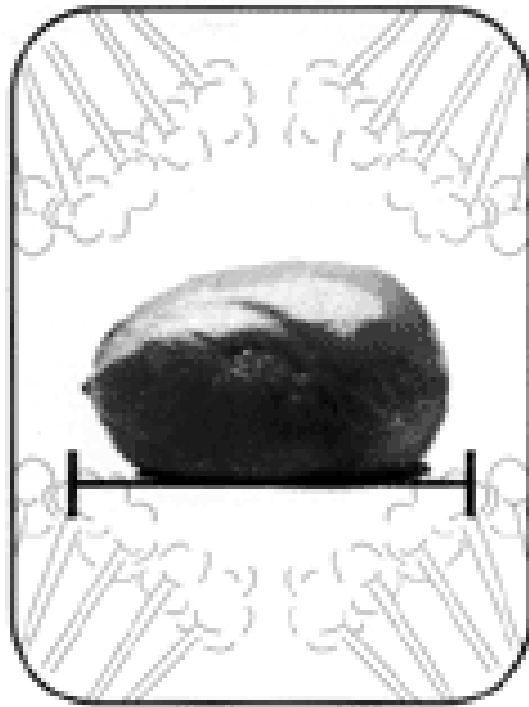
# Non-Thermal Post-Packaging Treatments

- **High Pressure (HPP)**
  - Expensive, batch process
- **Pulsed Electric Field (PEF)**
  - better with fluid products
  - Ultraviolet (UV) Light – Lm resistant, surface effect only
- **Electrolyzed oxidizing water**
  - Not near term
- **Irradiation**
  - some promise, not near term

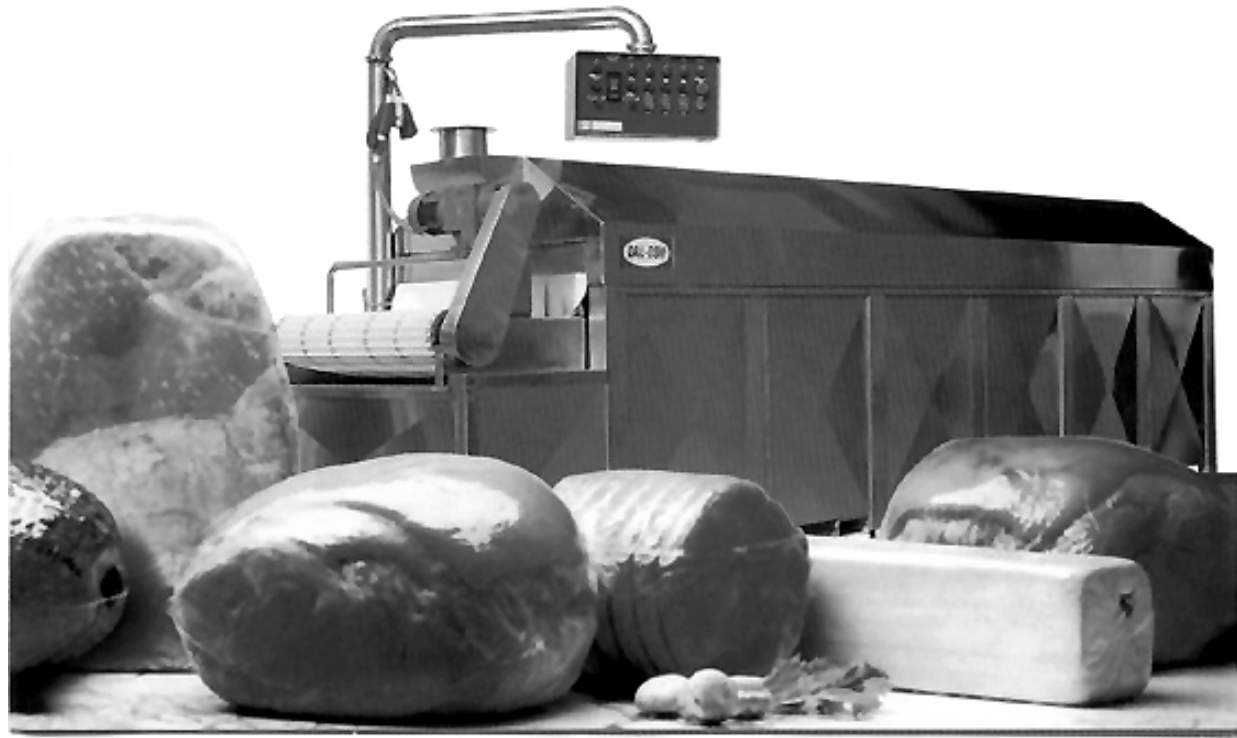
# **Post-Packaging Heat/Pasteurization**

- **Heat re-applied to package surfaces to destroy any surface cross contamination.**
- **Immerse pkg. in hot water**
- **Surface steam (205F, 15 sec)**
- **Hot air or infrared.**





- Pasteurization for 2 or 4 min at 96.1 C reduced LM by 2 and 4 logs (Gill et al., 2002)
- Reheat 60-90 sec @ 195-205 F
- Steam or H2O
- Goal: 2-3 mm of product to 160 F for 15-30 sec
- Immediate chill and 3-4 log reduction
- Shelflife- increase 25-33%



# **Post-Packaging Heat Disadvantages**

- **Difficult to heat all surfaces**
- **May adversely affect package.**
- **Product changes with heat (color, texture, purge, etc.)**
- **Expensive**
- **Apply heat/moisture in refrigerated room (condensation, etc.)**

# Individually-Wrapped Products are Easiest to Post-Package Pasteurize/Heat



# Comparison of Pasteurization Methods

## Hot Water Bath

Advantages: Simple method.

Disadvantages: Process time, approx. 8 minutes.  
Increases internal product temperature.  
Lack of uniform surface heat distribution.  
Heating large volumes of water.

## Steam Chamber

Advantages: Simple method.

Disadvantages: Long processing time, approx. 15 minutes.  
Increases internal product temperature.  
Lack of uniform surface heat distribution.  
Poor energy utilization.

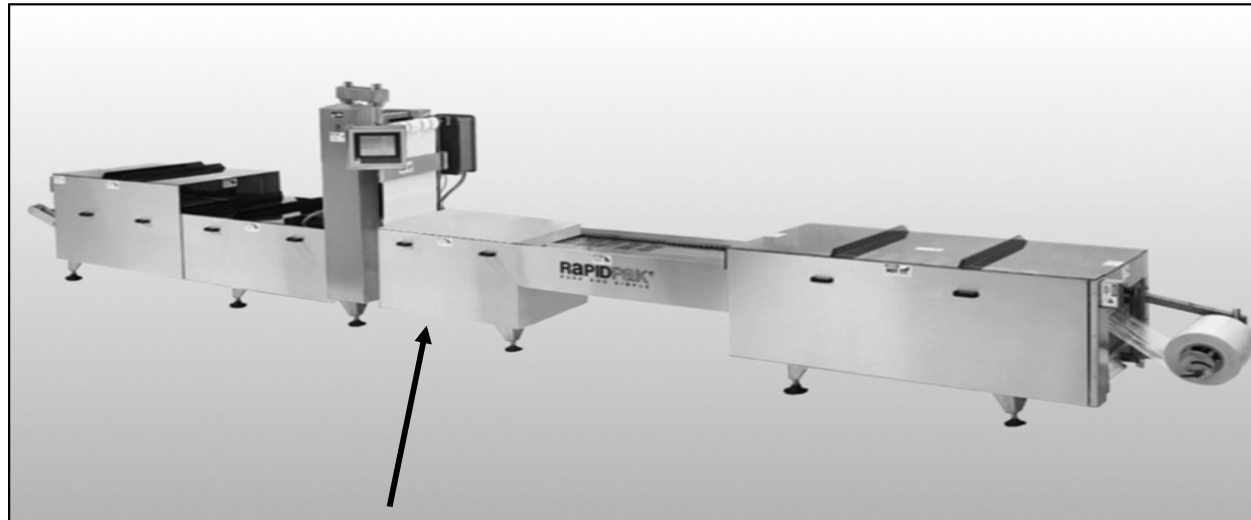
## Circulating Water

Advantages: Short processing time (3 minutes) does not affect product characteristics.

Very uniform surface heat distribution.  
Most efficient energy utilization  
Close ratio of water/product.

# Steam Surface Pasteurization\*

\* A joint development by ALKAR-RapidPak, Inc., Kraft/Oscar-Mayer and USDA-ERRC

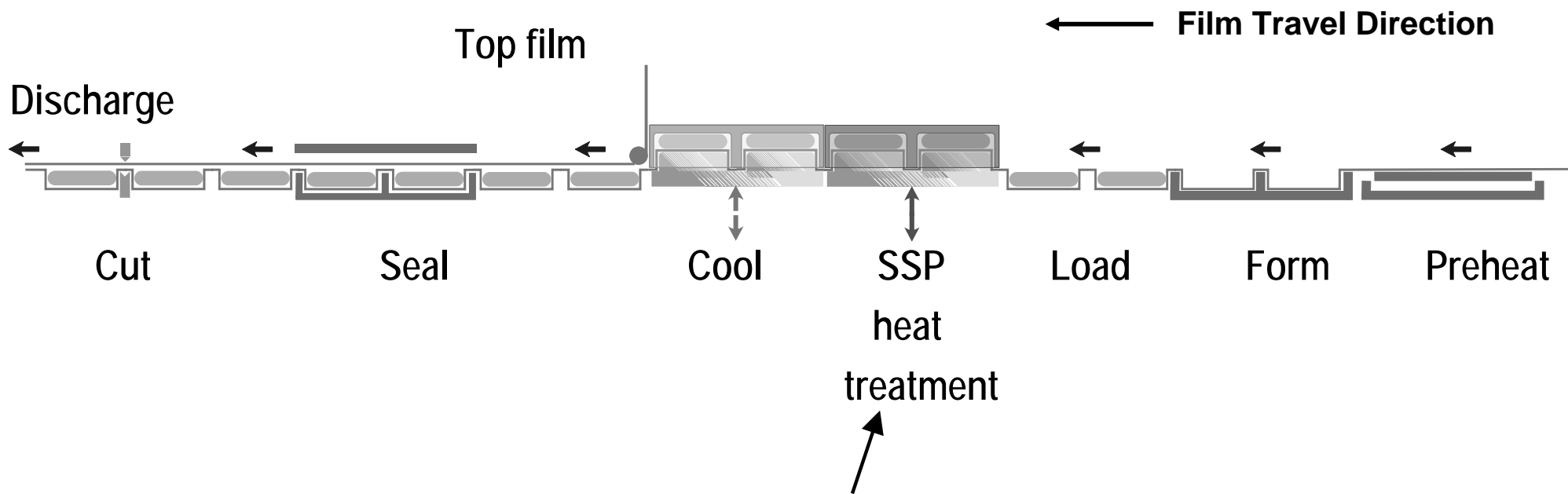


**SSP module  
extends length  
by two indexes**

- Provides a surface kill step immediately before packaging
- Adapts to existing line, no effect on line speed or packaging cost

# Steam Surface Pasteurization

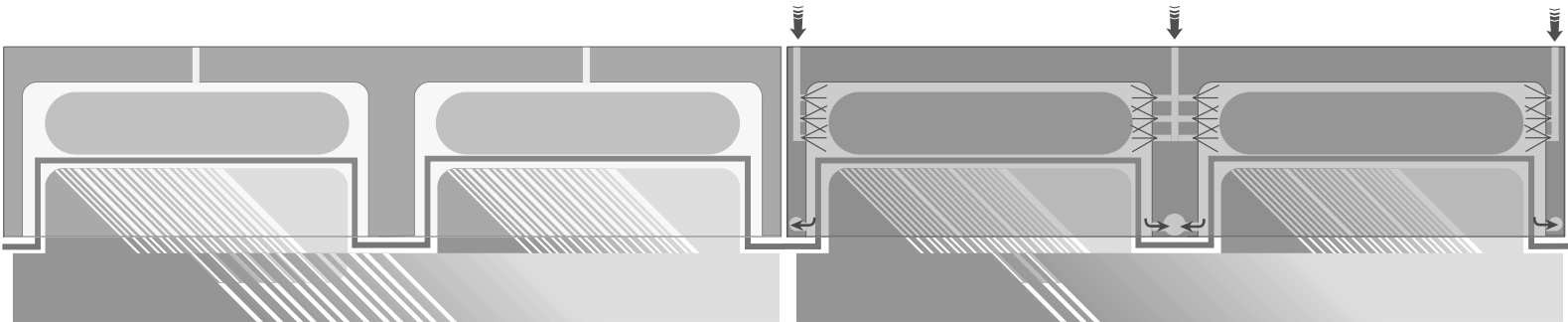
## Machine Configuration



SSP step = 1.5 sec of high pressure steam

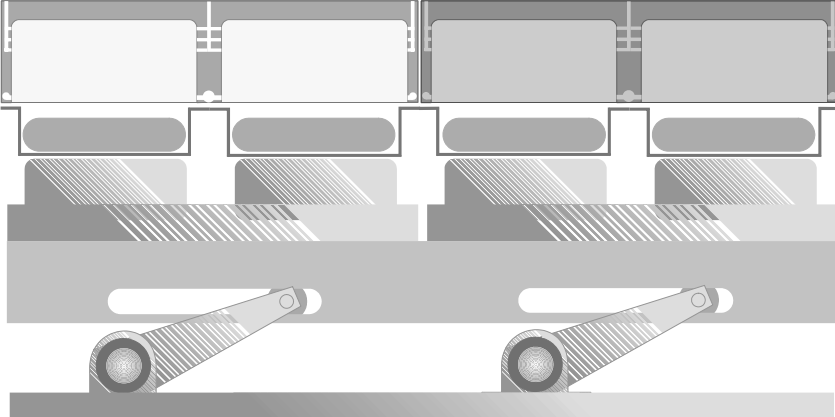


# Steam Surface Pasteurization

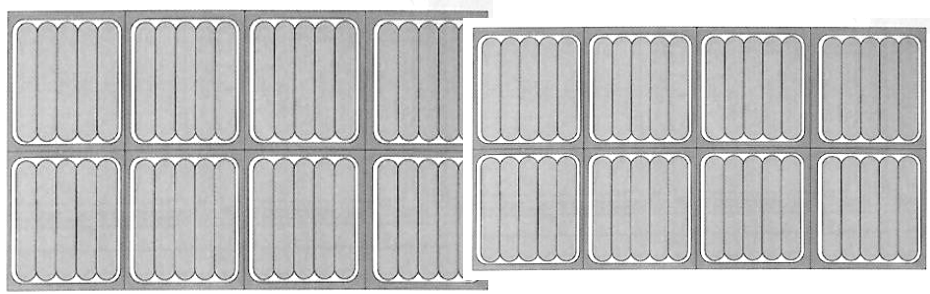


Vacuum Cooling

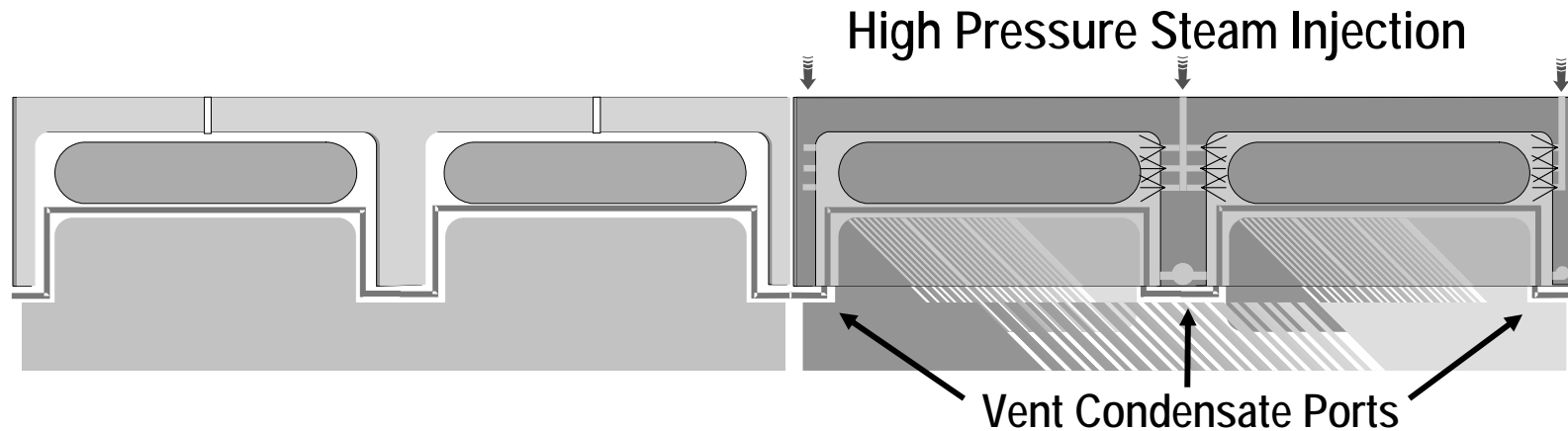
Steam Injection



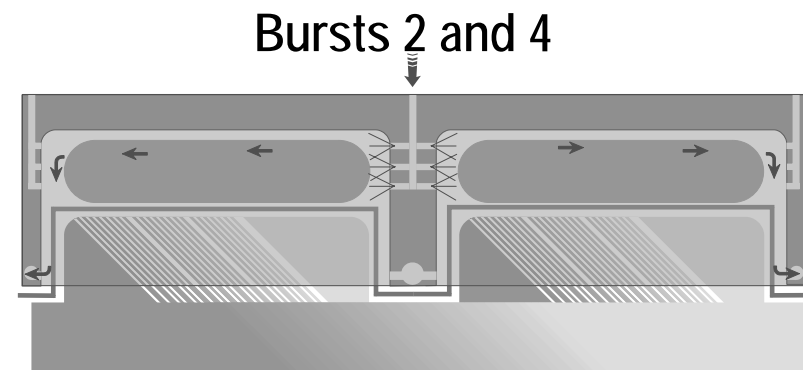
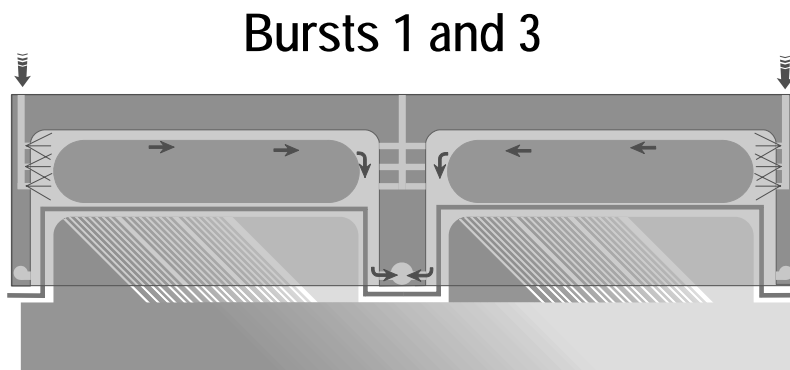
Servo lifts product pedestal up into SSP chamber



# Steam Surface Pasteurization



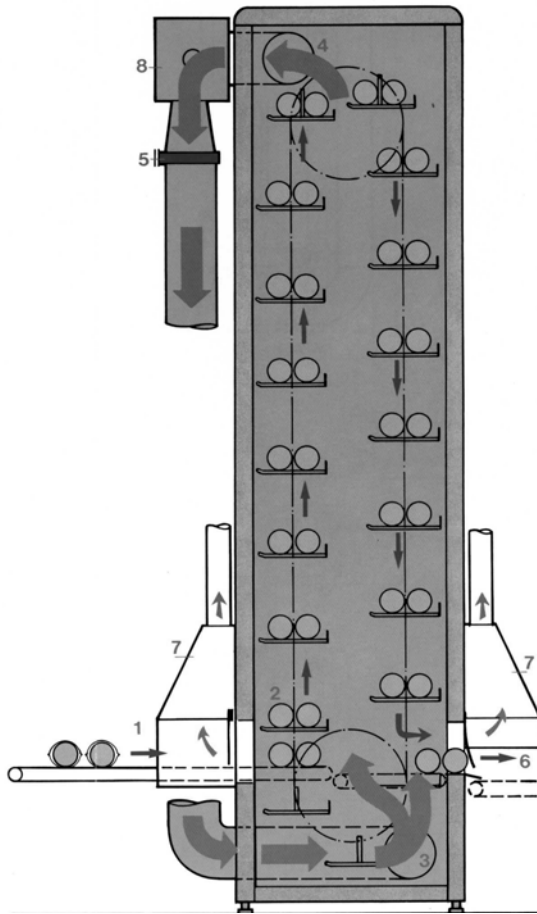
- Maximum contact time on most difficult area --- ends
- 1.5 second cycle time with 4 alternating steam bursts per cycle



# Steam Surface Pasteurization

- Hot dogs inoculated with indicator microorganism
- SSP treatment = 1.5 seconds
- 4-log reduction for single-layer package configuration
- Actual *Listeria monocytogenes* inoculated-pack tests ( $10^2$  per package) resulted in zero positives
- Double-layer package tests in progress
  - Preliminary findings show 2.0 - 2.5 log reduction

# In-Package Pasteurization



**Stork RMS-Protecon (Townsend) Steam-Based Post-Process Pasteurization System**

# In Package Pasteurization

Log cycle reduction of *Listeria monocytogenes* at 96.1°C

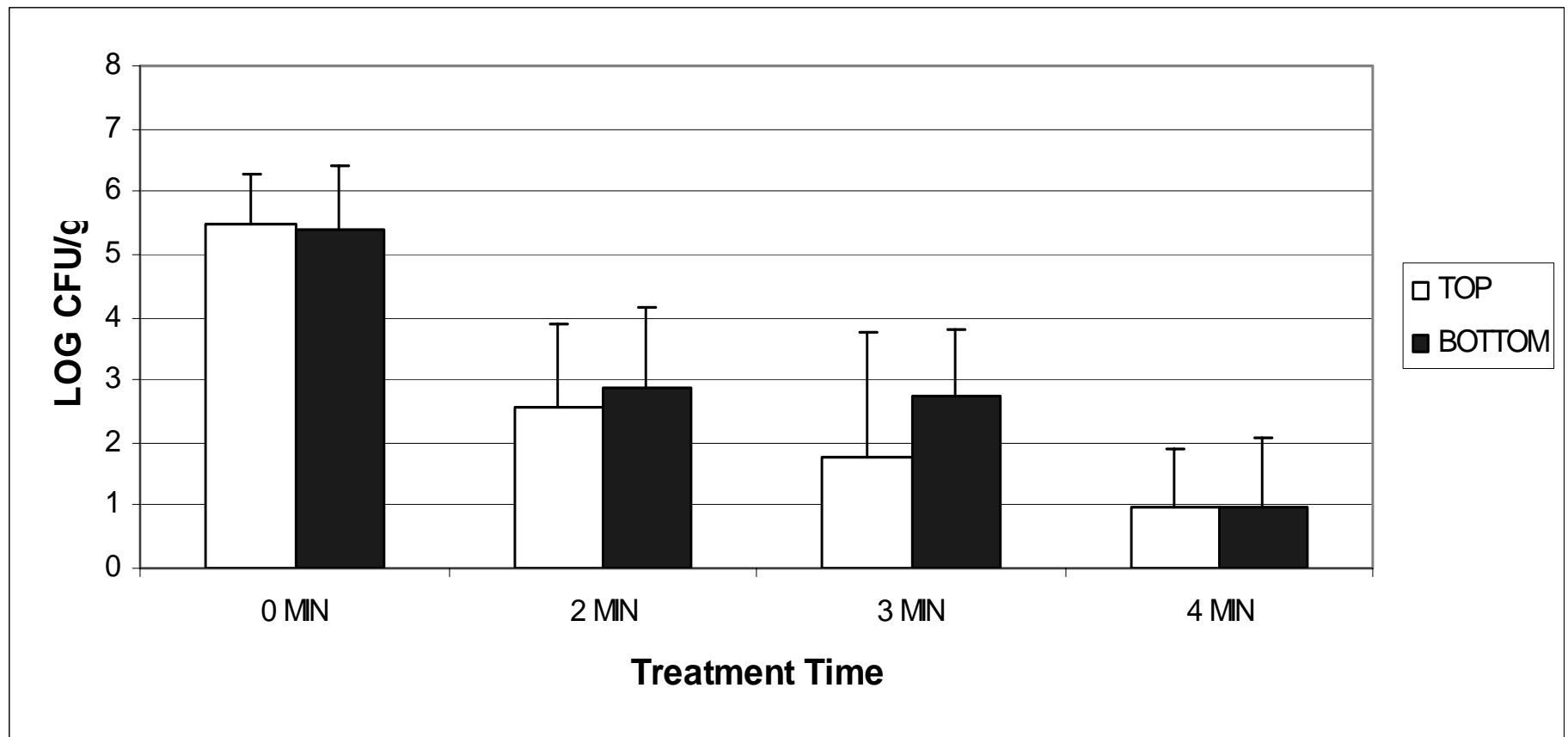


Table 3.1. Background bacterial populations and product characteristics on country ham slices.

<i>Listeria monocytogenes</i>	< DL <sup>a</sup>
<i>Staphylococcus aureus</i>	5.66 <sup>b</sup> (0.71) <sup>c</sup>
Lactic acid bacteria	6.44 (0.18)
Aerobic Plate counts	6.35 (0.35)
pH	6.27 (0.11)
Aw	0.88 (0.02)
Salt	6.65 (1.31)

<sup>a</sup> Below detectable limits.

<sup>b</sup> Bacterial populations are in Log<sub>10</sub> / gm.

<sup>c</sup> Numbers within parentheses are standard deviations.

Table 3.2. Minimum inhibitory concentration (MIC) and Activity Units (AU) of antimicrobial compounds.

Compound	MIC	AU (AU / ml)
Nisin	2.0 $\mu\text{g} / \text{ml}$	3,200
Liquid Smoke L (Charsol® Supreme Hickory) <sup>a</sup>	1 % soln v/v	1,600
Liquid Smoke P (Charsol® Supreme Poly Hickory & Polysorbate 80)	0.5 % soln v/v	1,600

<sup>a</sup> Liquid smoke compounds were graciously donated by the Red Arrow Co.

Table 3.4. Log<sub>10</sub> reductions of *L. m.* populations on non-steamed vs. steamed country ham slices.

Compounds	Non-steamed			Steamed		
	0	Days		0	Days	
		3	7		3	7
Nisin (2 µg/ml)	0.31 <sup>ab A</sup>	1.35 <sup>b B</sup>	1.45 <sup>b B</sup>	2.49 <sup>c C</sup>	2.40 <sup>bcd C</sup>	1.98 <sup>abc BC</sup>
N5x (10 µg/ml)	1.13 <sup>c A</sup>	2.27 <sup>c BC</sup>	1.96 <sup>c B</sup>	2.62 <sup>c BC</sup>	2.95 <sup>de C</sup>	3.00 <sup>bcd C</sup>
N10x (20 µg/ml)	0.86 <sup>bc A</sup>	2.04 <sup>c B</sup>	2.17 <sup>c B</sup>	2.33 <sup>c B</sup>	3.43 <sup>c C</sup>	3.72 <sup>d C</sup>
L (1% v/v)	0.14 <sup>ab A</sup>	0.88 <sup>a A</sup>	1.02 <sup>a A</sup>	0.63 <sup>ab A</sup>	2.43 <sup>cd B</sup>	3.28 <sup>cd B</sup>
L2 (3% v/v)	0.20 <sup>ab A</sup>	0.80 <sup>a AB</sup>	1.00 <sup>a AB</sup>	0.61 <sup>ab AB</sup>	1.62 <sup>abc BC</sup>	2.26 <sup>abc C</sup>
L4 (5% v/v)	0.11 <sup>ab A</sup>	0.92 <sup>a B</sup>	0.97 <sup>ab B</sup>	0.35 <sup>a A</sup>	1.55 <sup>abc C</sup>	1.73 <sup>ab C</sup>
P (0.5 % v/v)	0.18 <sup>ab A</sup>	0.90 <sup>a BC</sup>	0.93 <sup>a BC</sup>	0.72 <sup>ab B</sup>	1.24 <sup>a C</sup>	1.73 <sup>ab D</sup>
P2 (2.5 % v/v)	0.00 <sup>a A</sup>	0.75 <sup>a B</sup>	0.89 <sup>a B</sup>	0.74 <sup>ab B</sup>	1.50 <sup>ab C</sup>	1.04 <sup>a B</sup>
P4 (4.5 % v/v)	0.12 <sup>ab A</sup>	0.71 <sup>a B</sup>	0.79 <sup>a B</sup>	1.10 <sup>b B</sup>	1.29 <sup>a B</sup>	1.20 <sup>a B</sup>
Control (Buffer)	0.16 <sup>ab A</sup>	0.66 <sup>a B</sup>	0.78 <sup>a B</sup>	0.52 <sup>ab AB</sup>	1.43 <sup>a C</sup>	1.27 <sup>a C</sup>

<sup>abcd</sup> Different letters within the same column are significant (P < 0.05).

<sup>ABCD</sup> Different letters within the same row are significant (P < 0.05).



Table 3.6. Log<sub>10</sub> reductions of *L. m.* populations against control (buffer) at 0 time, in broths containing elevated levels of NaCL, dextrose, sodium nitrite and antimicrobials.

Compounds	Time (min)								
	0	0.5	1	2	5	10	15	30	60
Nisin (5x) (10µg/ml)	0.03 <sup>bA</sup>	0.09 <sup>bA</sup>	0.55 <sup>bB</sup>	0.89 <sup>dC</sup>	0.98 <sup>dCD</sup>	1.09 <sup>cD</sup>	1.68 <sup>dE</sup>	1.66 <sup>cE</sup>	2.60 <sup>dF</sup>
Nisin (10x) (20µg/ml)	0.10 <sup>aA</sup>	0.14 <sup>bB</sup>	0.38 <sup>bC</sup>	1.04 <sup>eD</sup>	1.62 <sup>eD</sup>	2.03 <sup>eEF</sup>	1.93 <sup>eE</sup>	2.24 <sup>dFG</sup>	2.34 <sup>cG</sup>
L 2 (3 % v/v)	0.08 <sup>bA</sup>	0.07 <sup>abA</sup>	0.09 <sup>aA</sup>	0.22 <sup>cAB</sup>	0.30 <sup>bcB</sup>	1.06 <sup>cC</sup>	1.10 <sup>cC</sup>	7.28 <sup>fD</sup>	7.28 <sup>eD</sup>
L 4 (5 % v/v)	0.03 <sup>bA</sup>	0.11 <sup>bA</sup>	0.07 <sup>aA</sup>	0.24 <sup>cB</sup>	0.41 <sup>cC</sup>	1.51 <sup>dD</sup>	1.66 <sup>dE</sup>	7.28 <sup>fF</sup>	7.28 <sup>eF</sup>
P 2 (2.5 % v/v)	0.03 <sup>bA</sup>	0.06 <sup>abA</sup>	0.00 <sup>aA</sup>	0.18 <sup>bcB</sup>	0.21 <sup>bBC</sup>	0.32 <sup>bC</sup>	0.63 <sup>bD</sup>	0.96 <sup>bE</sup>	1.31 <sup>bF</sup>
P 4 (4.5 % v/v)	0.01 <sup>bA</sup>	0.13 <sup>bAB</sup>	0.08 <sup>aAB</sup>	0.07 <sup>abAB</sup>	0.20 <sup>bBC</sup>	0.33 <sup>bC</sup>	1.09 <sup>cD</sup>	2.74 <sup>eE</sup>	7.28 <sup>eF</sup>
Control (buffer)	0.00 <sup>bA</sup>	0.01 <sup>aA</sup>	0.00 <sup>aA</sup>	0.00 <sup>aA</sup>	0.04 <sup>aAB</sup>	0.03 <sup>aAB</sup>	0.08 <sup>aAB</sup>	0.09 <sup>aAB</sup>	0.13 <sup>aB</sup>

<sup>abc</sup> different letters within the same column are significant (P < 0.05)

<sup>ABC</sup> different letters within the same row are significant (P < 0.05)

Table 3.12. Minolta L \* values of non-steamed vs. steamed country ham slices for 0, 3, and 7 days storage.

	Non-steamed			Steamed		
	0	Days 3	7	0	Days 3	7
<b><u>Treatments</u></b>						
<b>N5x</b> (10 µg/ml)	51.06 <sup>A</sup> (3.02) <sup>a</sup>	50.00 <sup>A</sup> (2.63)	49.00 <sup>A</sup> (3.32)	51.13 <sup>A</sup> (1.48)	51.77 <sup>A</sup> (2.94)	48.31 <sup>A</sup> (2.98)
<b>N10x</b> (20 µg/ml)	49.71 <sup>A</sup> (4.27)	49.04 <sup>A</sup> (3.72)	51.18 <sup>A</sup> (4.30)	48.04 <sup>A</sup> (2.58)	51.01 <sup>A</sup> (4.83)	49.99 <sup>A</sup> (3.76)
<b>L4</b> (5% v/v)	51.29 <sup>A</sup> (3.94)	45.86 <sup>A</sup> (5.27)	49.00 <sup>A</sup> (3.32)	50.22 <sup>A</sup> (2.92)	46.08 <sup>A</sup> (3.23)	50.17 <sup>A</sup> (4.64)
<b>P4</b> (4.5% v/v)	47.91 <sup>A</sup> (2.45)	51.95 <sup>A</sup> (1.41)	51.06 <sup>A</sup> (4.52)	53.64 <sup>A</sup> (3.32)	50.14 <sup>AB</sup> (1.84)	52.95 <sup>B</sup> (2.74)
<b>Control</b> (buffer)	49.82 <sup>A</sup> (2.36)	49.13 <sup>A</sup> (0.38)	45.78 <sup>B</sup> (1.17)	51.36 <sup>A</sup> (2.11)	50.00 <sup>A</sup> (2.52)	51.02 <sup>A</sup> (2.29)

<sup>a</sup> Numbers in the parentheses are the standard deviations.

<sup>ABC</sup> Different letters within the same row are significant (P < 0.05).

# UK Shrink Tank Study

Water Temp	Time (sec)	Product Temp
205	30	152
200	30	154
195	30	162
195	30	151
212	30	173
200	30	157
195	30	148
195	30	152
202	60	158
206	60	164
195	60	163
201	60	168
202	60	161
207	60	160
210	60	168
210	60	178



**Jim DAVID**

FARM FRESH MEATS

25

NET WT. \_\_\_\_\_ LBS. \_\_\_\_\_ OZS.

KEEP REFRIGERATED

DIVISION OF UNION CO. LIVESTOCK, INC. MORGANFIELD, KY 42437

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EST. 8630A

# Appreciation expressed to:

Don L. Zink, Ph.D.

Office of Plant and Dairy Foods and Beverages

Center for Food Safety and Applied Nutrition

Food and Drug Administration

Alkar