

# **Product Formulation and Post Packaging Technology**

# Introduction

- *L. monocytogenes* (LM) contaminates ready-to-eat products after cooking but before package closure
- If no LM multiplication, typically no health risk
- If no LM in the package, also no health risk (unless recontaminated!)
- Combination of growth-inhibiting formulation or process **and** post-lethality treatment results in the greatest reduction in risk

# Formulation Changes/Additions

- Some products will not support growth of LM (bacteriostatic or listeristatic)
  - High acid concentration ( $\text{pH} < 4.39$ )
  - Low water activity ( $A_w < 0.92$ )
  - High salt levels (salt  $> 10\%$ )
  - Fermented products
- If shelf-stable (country cured ham, pepperoni, salami, jerky), would be Alternative 1 – antimicrobial agent/process and post-lethality treatment

# Formulation Changes/Additions

- Some additives inhibit growth of LM
  - Acids
  - Smoke, liquid or natural
  - Spices, natural resins, oleoresins/glycerides
  - Preservatives
  - Bacteriocins

# Controlling LM Using Organic Acids

- Low pH adversely impacts the growth of LM
- Small organic acids (acetic, citric, and lactic acids) inhibit LM in culture and in meat products
- Concentrations of 2-4% of these acids or 0.2-0.8% of diacetate control LM on meat products
- Organic acids are more effective at lower product pH
- Can affect the flavor of the product
- Cost may be significant, depending on how the acid is deployed

# Lactate/Diacetate Combo

- Kraft/Oscar Mayer conducted studies, made available to Purac
- CD-ROM computer model
  - Free copy: 888-899-8229 or e-mail [pam@purac.com](mailto:pam@purac.com)
- Inhibition of LM growth throughout shelf life in cured products
- Organoleptic studies must be done
- Challenge studies on non-cured products, or products significantly different from those used to establish the model

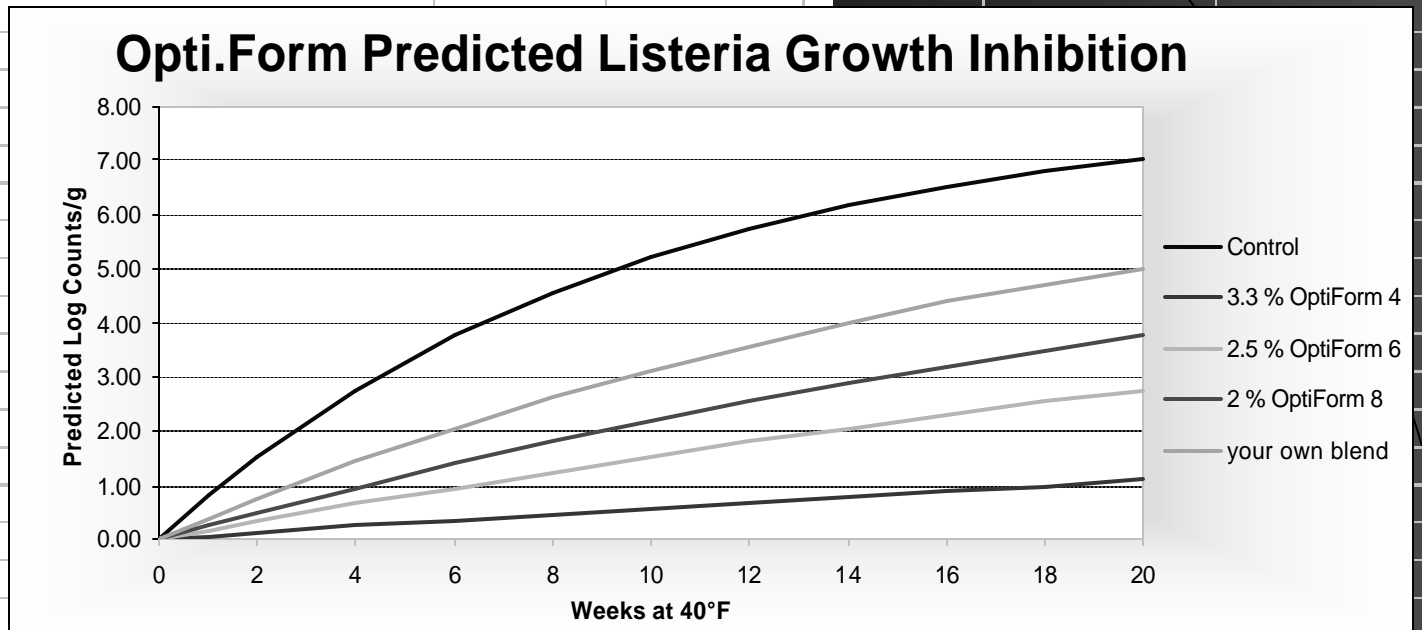
# Lactate/Diacetate Combo

- Up to 4.8% Lactate
- Up to 0.25% diacetate
- Can use sodium or potassium lactate
- Patent issues – be sure to check

# Product Formulation

Level of use		3.3	2.5	2	
	Control	% OptiForm 4	6	% OptiForm 8	your own blend
<b>Product Ingredients</b>	% of Finished Product	% of Finished Product	% of Finished Product	% of Finished Product	% of Finished Product
Salt (%) =	2.50	2.50	2.50	2.50	2.50
Sodium Diacetate (%) =	0.00	0.13	0.15	0.16	0.12
Potassium Lactate (%) =	0.00	1.85	1.35	1.04	1.00
Finished Product Moisture (%) =	55.00	55.00	55.00	55.00	69.00

Calculated 60% lactate solution used in your own blend:



# Uncured Roast Beef

- Lactate/diacetate combo successful in inhibiting growth in uncured roast beef (Birbari et al., Abstract P4-22, IAFP 2005)
- Did not work in uncured turkey, despite similar moisture, pH and salt levels
- For roast beef, moisture (pump) level is critical

# Sprays/Dips Vs. Incorporation

- Many studies have shown success with sprays or dips using organic acids
- Method of application needs to provide a uniform treatment, and needs to work at normal operational speeds
- Surface treatment of unsliced deli items may not afford protection from subsequent recontamination (during deli slicing)

# Organic Acids - Summary

- Lactate/diacetate combo effective in many cured products and some uncured products
- Some studies have shown lactate alone is effective
- Very dependent on formulation
- Incorporation into formula typically more successful than sprays/dips

# Natural Smoke and Liquid Smoke

- Smoking of meat and fish is a well known preservation technique
- Both natural smoke and liquid smoke have been shown to inactivate LM
- Antilisterial activity seems to result from phenols and acetic acid
- Natural and liquid smoke appear much less effective in processed meats, and may affect organoleptic properties of products
- A low-flavor smoke extract may have promise

# Spices, Natural Resins, Oleoresins/Glycerides

- Dried spices or essential oils have inhibited LM in several studies
- Concentrations required are 0.5% - 5%
- Inhibitory action of spices and natural resins much less in meats
- Some monoglycerides and sucrose monolaurate are inhibitory to many pathogenic bacteria, including LM
- Partitioning into the fat component of meat decreases their inhibitory action – works in the tube, not in the meat
- Cost of these types of inhibitors, plus their impacts on product taste and mouthfeel, may restrict their use

# Preservatives

- Preservatives (sodium benzoate, propyl paraben, and potassium sorbate) are listeristatic/cidal at high levels
- More effective as pH and holding temperature drop
- Antioxidants such as BHA, BHT, TBHQ, etc. also effective
- Performance of preservatives in meat products not uniform or well documented
- Limited approval for use in meat products

# Bacteriocins

- Natural products (polypeptides) from bacteria that inhibit other bacteria
- Bacteriocins of lactic acid bacteria, such as nisin and pediocin, inhibit LM in the lab and in some foods
- Nisin is the only bacteriocin approved for use in foods
- Bacteriocins are relatively expensive, and only nisin is commercially available on a “large scale”
- Studies show variable results

# Other Possibilities

## (Mostly Surface Applications)

- Acidified Calcium Sulfate
- Acidified Sodium Chlorite
- Buffered Sodium Citrate
- Sodium Acetate/Sodium Citrate
- Nisin/Hops B-acids or Nisin/lysozyme
- Cetlypyridium Chloride
- Ozone
- Bacteriophage
- Epsilon poly-lysine
- Ethyl Lauroyl arginate
- Mixed peracids

# Irradiation

- Destroy LM and other pathogens in meats at reasonably low dosages. Well studied technology
- Treatment results in insignificant (?) changes to product
- Product attributes, such as pH, salt level, and  $a_w$  have little impact on effectiveness of irradiation
- Relatively easy processes to control
- Can kill LM after final packaging

# Irradiation - Drawbacks

- Not approved for ready-to-eat products
- Consumer acceptance still unknown
- Considerable capital required
- Will require CCP and monitoring
- Expensive, costing at least \$.05 per pound
- Depth of penetration an issue with beam
- Lack of capacity in the industry



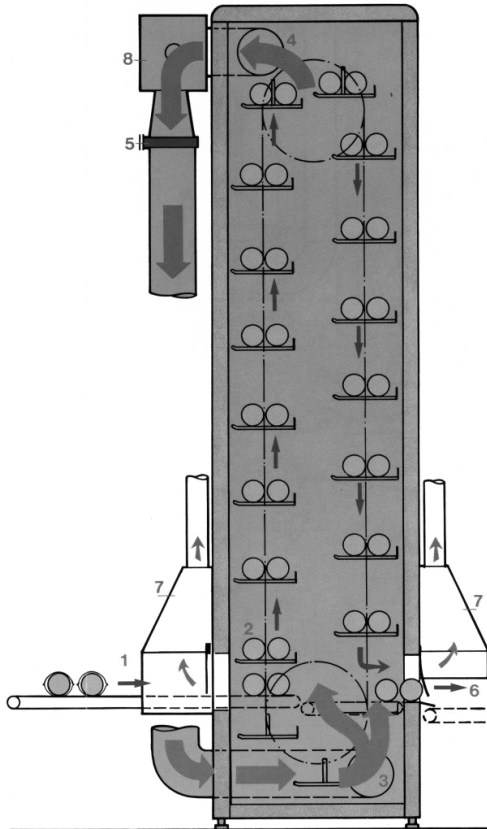
# Post-Lethality Heat/Pasteurization

- Several approaches available:
  - Hot water bath with product immersion
  - Surface steam
  - Vacuum in combination with steam
  - Hot air, radiant wall or infrared (IR)
  - Microwave or Radio Frequency (RF)
  - Combinations

# Unitherm Post-Package Heat Treatment System

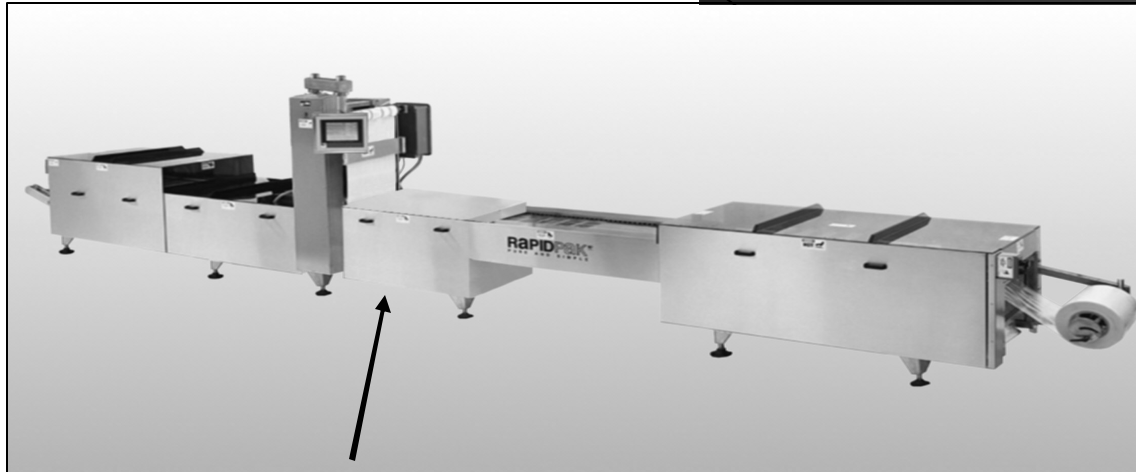


# In-Package Pasteurization



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

# ALKAR Steam Surface Flash Pasteurization



**SSP module  
extends length  
by two indexes**

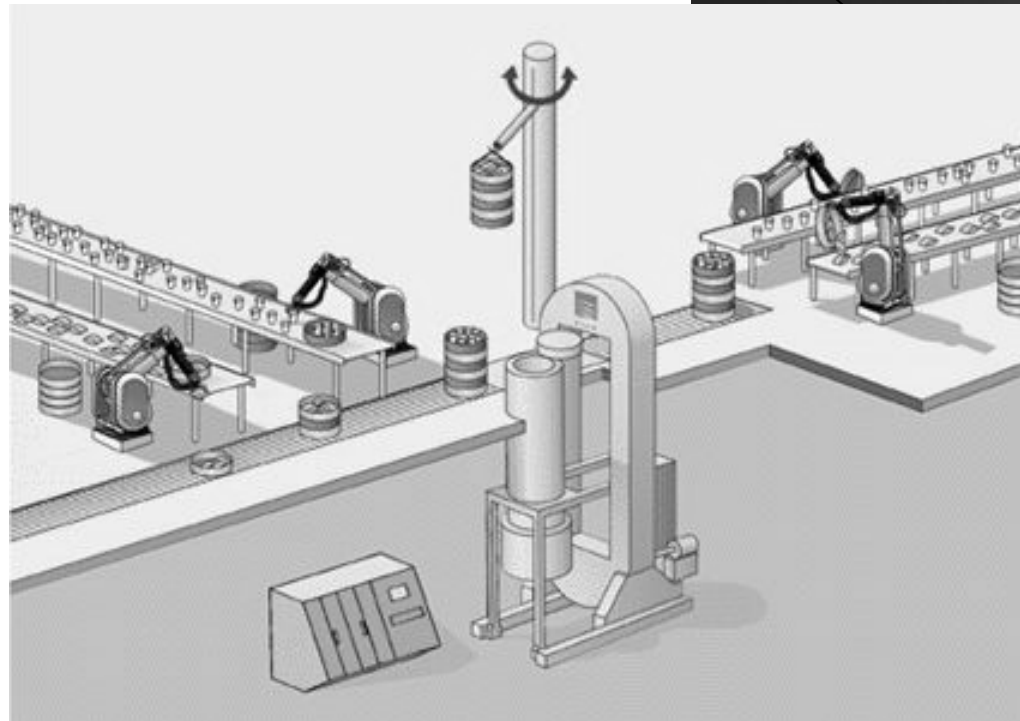
# Post Processing Heat/Pasteurization (Cont'd)

- Issues with heat pasteurization
  - May be capital intensive and a rate limiting step in production, expensive packaging materials
  - May cause undesirable attribute changes in product
    - Purge, Fat smears
  - May not always be effective, based on package style, microbial load, heat resistance of target bacteria, etc.
  - Difficult to manage if before packaging step
  - Must bring heat (and moisture) into a normally refrigerated environment, or else move product around

# High Hydrostatic Pressure

- Typical treatment is 87,000 PSI (600 Mpa) for 2 minutes
- > 5 log reduction of LM, but may be resistant strains, some tailing effects
- Significant shelf-life extension
- Considered by USDA to be a post-lethality treatment
- No change in most sensory attributes
- High capital cost, slow through-put, high repair costs lead to relatively high cost/lb
- Recent opportunities for third-party treatment

# Avure Robotic Batch High Pressure System



# Opportunities for Risk Reduction

- Studies to determine protective effect of antimicrobial formulations if recontaminated late in shelf life
- Continue to improve the cold chain
- Active labels that indicate temperature abuse
- Design consumer packaging to limit contamination in the home
- Safety-based use by dates
  - Days to opening at deli
  - Days from opening to sale
  - Days after sale

# Conclusions - Product Formulation and Post-Lethality Treatment

- Many additives are available, requires micro and organoleptic evaluation, products like uncured turkey breast are still problematic
- Post packaging heat pasteurization is effective for certain types of products
- Irradiation or high pressure may be viable alternatives
- Ultimate solution is probably in combination treatments
- An increase in product cost is inevitable; a change in product characteristics is likely