
Antimicrobial Agents to Control *Listeria monocytogenes.*

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University of Wisconsin-Madison

Topics

- Why use antimicrobials
- Lactate/Diacetate
- Antimycotics
- Newer technologies
- Final thoughts

Preservative Methods to Reduce Foodborne Pathogen Risk*

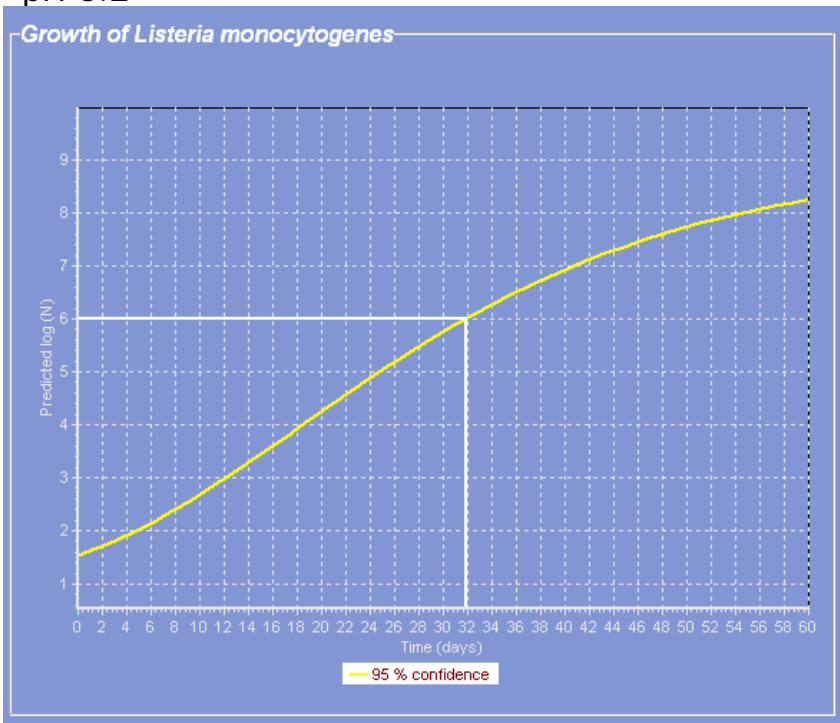
- Prevent inadvertent contamination
- Removal of contamination
 - Thermal destruction by cooking
 - Surface treatments at packaging
 - Post-package pasteurization treatments
- **Inhibit Growth**

* Adapted from Sofos, et al., 1998

What happens with no growth inhibitors and Lm contamination

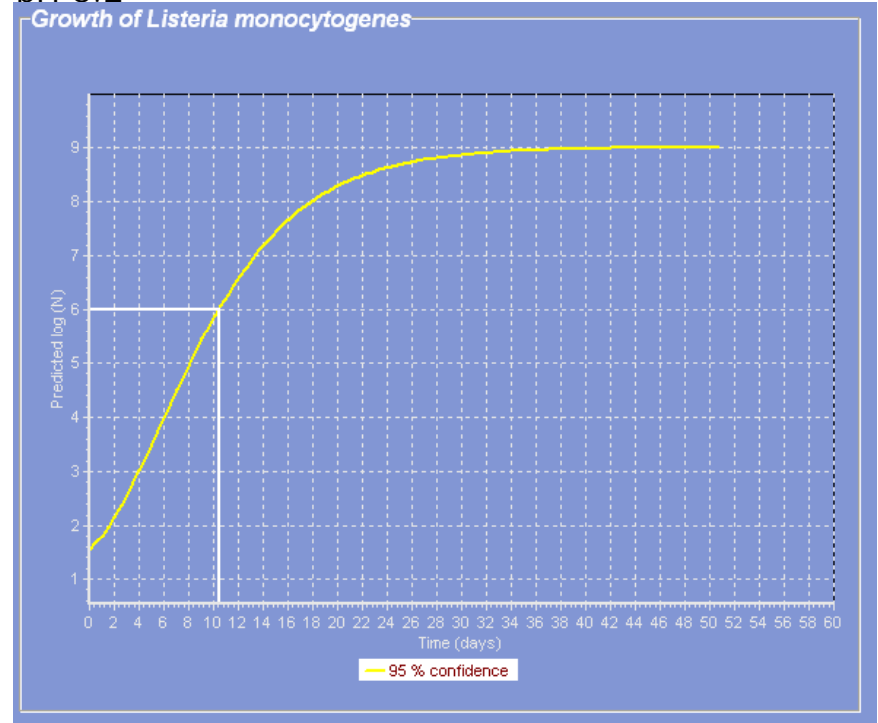
Ham at 4C

2.5% Salt, 75% Moisture, Sodium Tripolyphosphate
pH 6.2



Turkey Breast at 4C

1.6% Salt, 75% Moisture, Sodium Tripolyphosphate
pH 6.2



How can we inhibit growth of *L. monocytogenes* in RTE meats?

- Extend the lag-phase or diminish the rate during log-phase of growth
- Cured meats
 - Nitrite makes the effort easier
- Uncured meats
 - More difficult to achieve

Lactate and Diacetate

- Most widely used Lm growth inhibitors in the US
- ~ 70% of RTE cured meats use this approach

Sodium and Potassium Lactate

- Weak acids
- Produced from fermentation of sugar
- Usage level of 2 - 4% (of 60% solution)
- Slight salty flavor
- Disrupts bacterial membrane pH gradients
- Inhibits energy metabolism
- Antibotulinal agent

Sodium Diacetate

- Half neutralized vinegar
- Dissociates into 40% acetic acid and 60% sodium acetate
- Lower product pH due to presence of acetic acid
- Usage levels, 0.10 - 0.15%

Why is a combination needed?

- Lactate salts alone are only bacteriostatic at high concentrations (>3-4%)
 - Flavor quality impacted
 - Sodium?
- Sodium diacetate alone only is bacteriostatic at high concentrations
 - Product stability impacted - purge, texture
 - Flavor quality impacted
 - Legal maximum in U.S. is 0.25%

The Purac Opti.Form® Model

- Developed in 2001-2002
 - Growth model
 - Factors – Salt, Product Moisture, Lactate, Diacetate
 - No cured model
- Updated in 2003
 - Boundary “time to failure” presentation
- Refined – Expanded in 2007
 - Returned to a growth model
 - Added pH and temperature as inputs
 - Includes cured and uncured predictions



Opti.Form® Listeria Control Model 2007

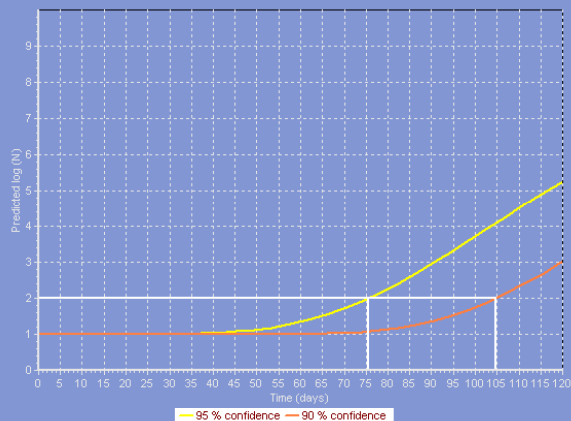
PURAC Ingredient
 Select PURAC ingredient: **PURASAL Opti.Form PD4**
 Opti.Form PD4 (%w/w): **3.5** <http://datasheet>

Finished Product Data
 Name: **Typical ham**
 Temperature (°F): **39**
 pH: **6.2**
 Salt (%w/w): **2.5**
 Moisture (%): **75**
 Product contains nitrite:

Microorganism Data
 Initial level (Log numbers): **1**
 Maximum level (Log numbers): **2**

Predictions—(90% and 95% confidence intervals)—
 Lag time: **Between 39 and 95 days** Doubling time: **91.3 hours**
 Increase from log(1) to log(2): **Between 76 and 105 days** Growth rate: **0.008 per hour**

Growth of *Listeria monocytogenes*



Two Ham Scenarios at 4C Storage

2.5% Salt, 75% Moisture, 2% Potassium Lactate
 .14% sodium diacetate, sodium tripolyphosphate
 pH 6.2



Opti.Form® Listeria Control Model 2007

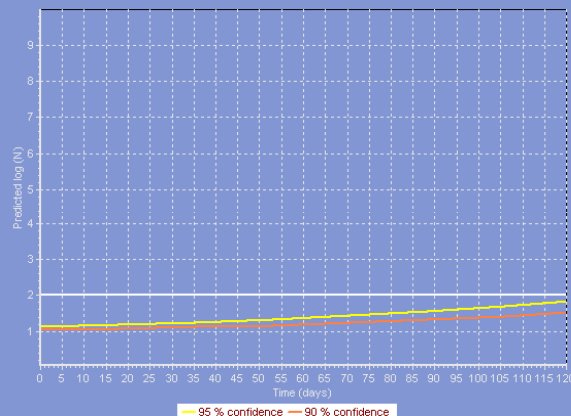
PURAC Ingredient
 Select PURAC ingredient: **PURASAL Opti.Form PD4**
 Opti.Form PD4 (%w/w): **3.5** <http://datasheet>

Finished Product Data
 Name: **Typical ham**
 Temperature (°F): **39**
 pH: **5.8**
 Salt (%w/w): **2.5**
 Moisture (%): **75**
 Product contains nitrite:

Microorganism Data
 Initial level (Log numbers): **1**
 Maximum level (Log numbers): **2**

Predictions—(90% and 95% confidence intervals)—
 Lag time: **Between 49 and 120 days** Doubling time: **473.9 hours**
 Increase from log(1) to log(2): **Between 135 and 172 days** Growth rate: **0.001 per hour**

Growth of *Listeria monocytogenes*



2.5% Salt, 75% Moisture, 2% Potassium Lactate
 .14% sodium diacetate,
 pH 5.8



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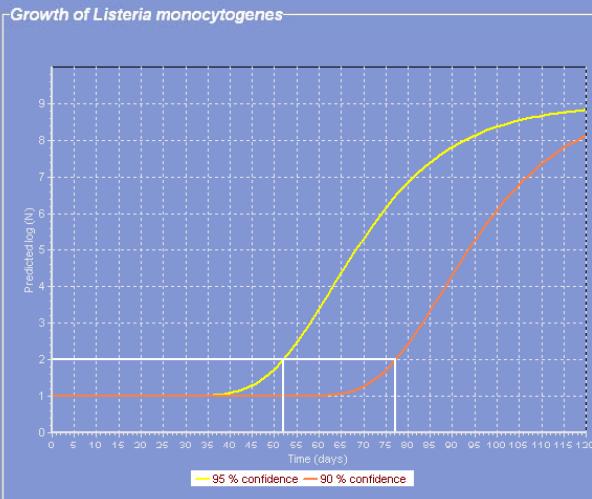
Opti.Form[®] Listeria Control Model 2007

PURAC Ingredient
 Select PURAC ingredient: PURASAL Opti.Form PD4
 Opti.Form PD4 (%w/w): 3.5 <http://datasheet>

Finished Product Data
 Name: Typical Turkey Breast
 Temperature (°F): 39
 pH: 6.2
 Salt (%w/w): 1.6
 Moisture (%): 75
 Product contains nitrite:

Microorganism Data
 Initial level (Log numbers): 1
 Maximum level (Log numbers): 2

Predictions—(90% and 95% confidence intervals)—
 Lag time: Between 24 and 73 days
 Doubling time: 36.4 hours
 Increase from log(1) to log(2): Between 52 and 77 days
 Growth rate: 0.019 per hour



Two Uncured Turkey Breast Scenarios at 4C Storage

1.6% Salt, 75% Moisture, 2% Potassium Lactate
 .14% Sodium Diacetate, Sodium Tripolyphosphate
 pH 6.2



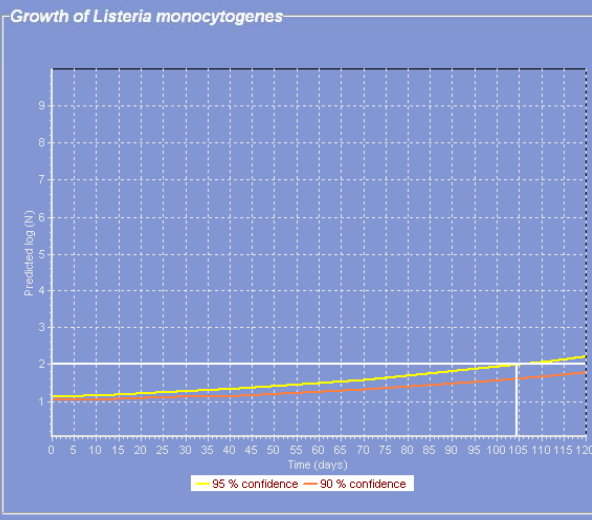
Opti.Form[®] Listeria Control Model 2007

PURAC Ingredient
 Select PURAC ingredient: PURASAL Opti.Form PD4
 Opti.Form PD4 (%w/w): 3.5 <http://datasheet>

Finished Product Data
 Name: Typical Turkey Breast
 Temperature (°F): 39
 pH: 5.8
 Salt (%w/w): 1.6
 Moisture (%): 75
 Product contains nitrite:

Microorganism Data
 Initial level (Log numbers): 1
 Maximum level (Log numbers): 2

Predictions—(90% and 95% confidence intervals)—
 Lag time: Between 34 and 95 days
 Doubling time: 377.1 hours
 Increase from log(1) to log(2): Between 105 and 137 days
 Growth rate: 0.002 per hour



1.6% Salt, 75% Moisture, 2% Potassium Lactate
 .14% Sodium Diacetate,
 pH 5.8



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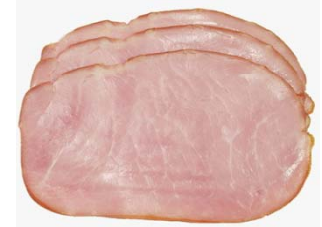
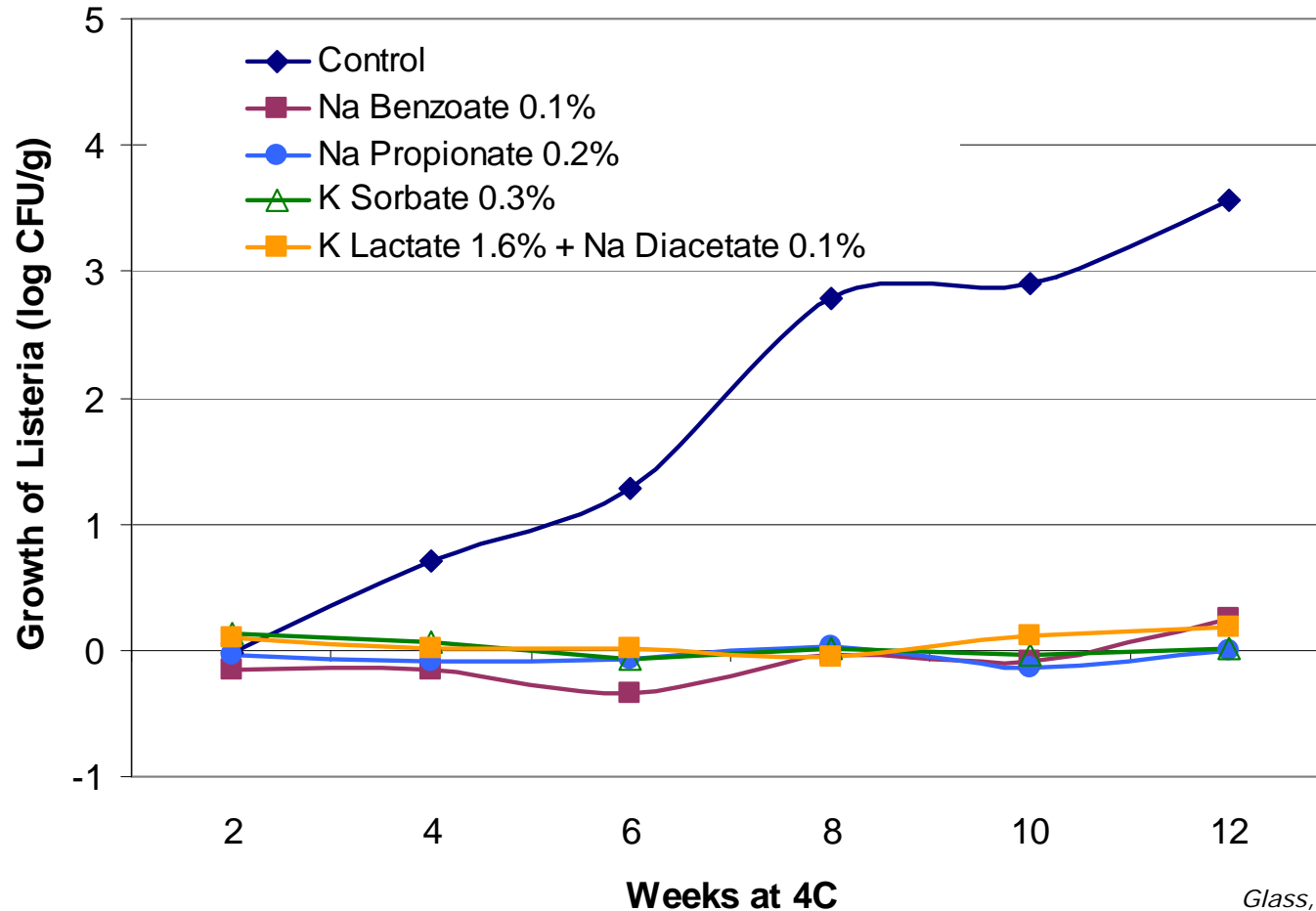
Advantages of Lactate/Diacetate

- Proven effective and reliable
- Easy to verify
- Relative low cost
- Tested with consumers and widely accepted
- Protects vs. risk of contamination by consumer after package is opened

Antimycotics

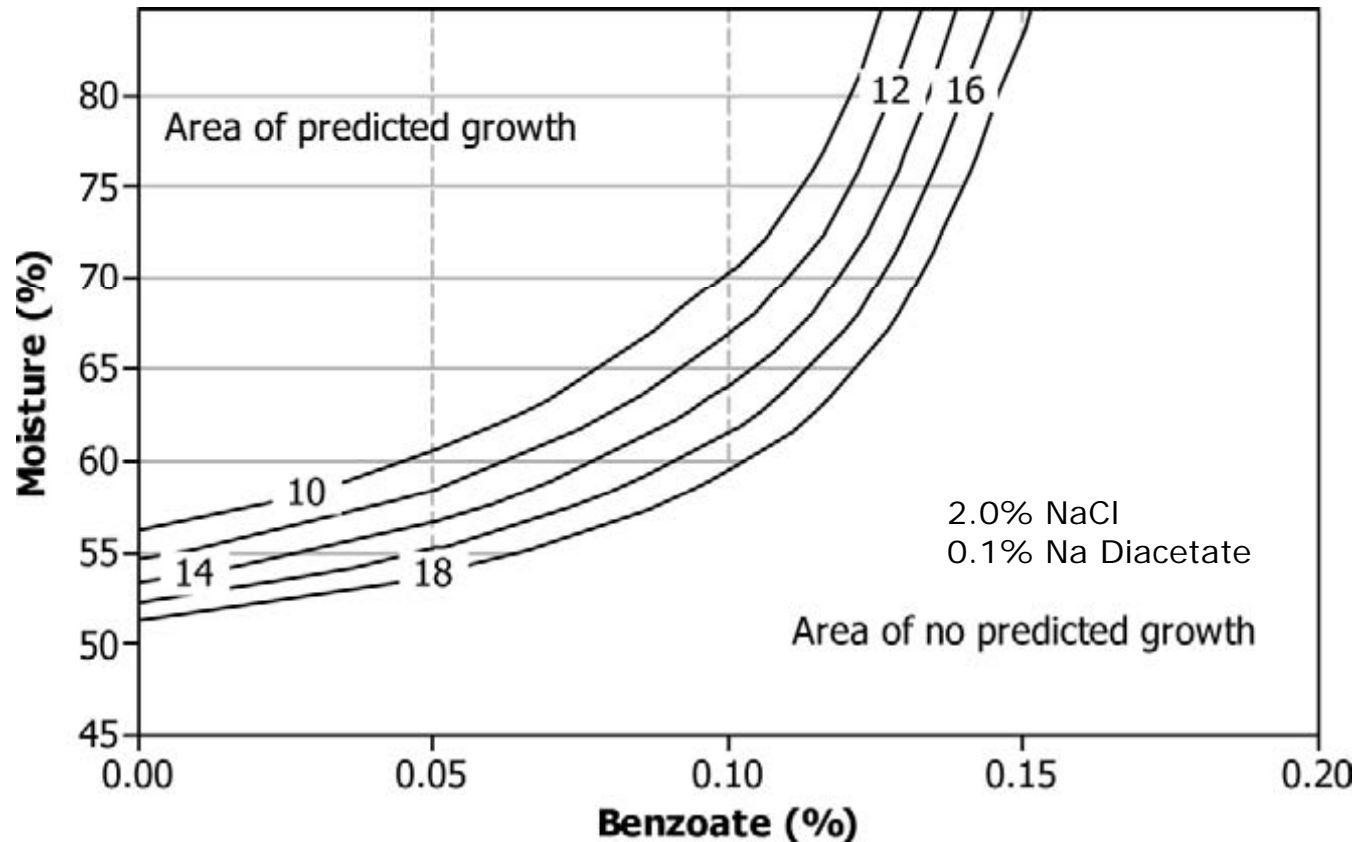
- Benzoate
- Sorbate
- Propionate

Control of *Listeria* on Cured Ham stored at 4°C (2.2% NaCl whole; 156 ppm nitrite, 75% moisture)



Glass, et al, JFP 2007

Effect of benzoate, moisture, NaCl, Diacetate on *Lm* in cured RTE meats



Seman et al., 2008 JFP 71: 1386

Differences from Glass et al, extended testing time to 18 wks; decrease NaCl

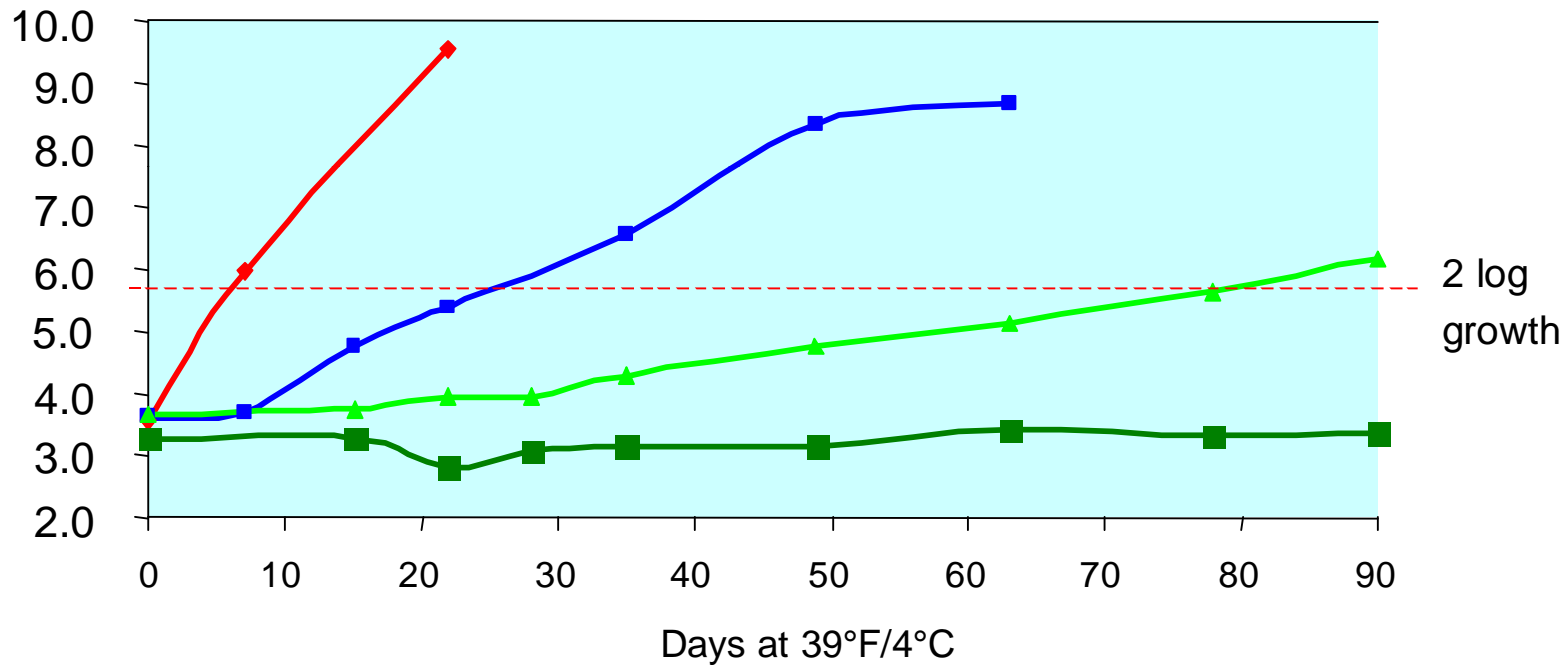
Other antimicrobials

- Fermentation & Fermentation Blends
 - Danisco – MicroGARD™, NovaGARD™
 - Kemin - SHIELD®
 - Kerry – Alta®
 - Purac - Verdad®
 - WTI - Ional®



Uncured Turkey Listeria Testing

3.5 % VERDAD NV55 controls Listeria for 80 days
Compared to 26 days for *Opti.Form* PD4



- Control
- 2.5% *Opti.Form* PD4
- 3.5% Verdad NV55
- 4.5% Verdad NV55



Source: Courtesy of Purac America

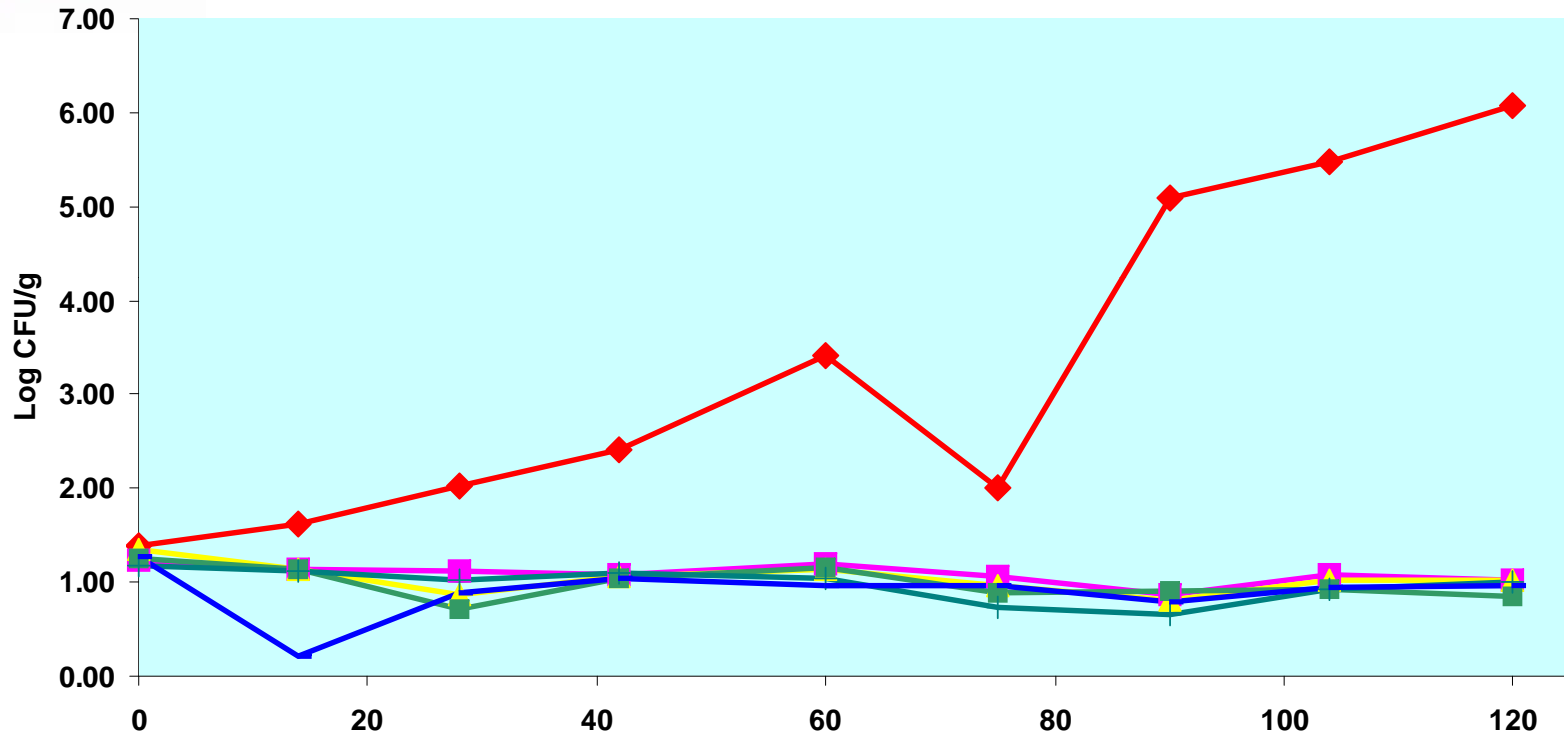


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Frankfurter Listeria Testing

Effect of Verdad NV15 and NV55 on *Listeria monocytogenes* in frankfurter



Control 2% Verdad NV15 3% Verdad NV15
2% Optiform PD4 2% Verdad NV55 3% Verdad NV55



Source: Courtesy of Purac America



Surface Applied Agents

- Flexibility
 - Low Levels
 - Multiple possibilities
 - Organic Acids, Spice Extracts, Bacteriocins Lauric Arginate.....
- Equipment is available
 - USDA's SLIC™ concept
 - RapidPak™ surface application during packaging
 - Capital costs?
- May help achieve Alternative 1 status
- Requires ongoing verification/validation
- Not easy to do on sliced products
 - Slicing speed
 - Surface area to cover

Resources for Information

- Academia
- Suppliers
- USDA Directive 7120.1
- FDA GRAS notices
 - <http://www.accessdata.fda.gov/scripts/fcn/fcnNavigation.cfm?rpt=grasListing>

UNITED STATES DEPARTMENT OF AGRICULTURE
 FOOD SAFETY AND INSPECTION SERVICE
 WASHINGTON, DC

CHANGE TRANSMITTAL SHEET

Γ DIRECTIVE

Γ REVISION

XΓ AMENDMENT

Γ OTHER

Safe and Suitable Ingredients Used in the Production of
 Meat and Poultry Products

7120.1,
 Amend 19

7/1/09

Antimicrobials

An aqueous solution of sodium diacetate (4%), lactic acid (4%), pectin (2%), and acetic acid (0.5%)	Cooked meat products	Not to exceed 0.5 percent of finished product formulation.	Acceptability determination	Listed by common or usual name in the ingredients statement (2)
Bacteriophage preparation (a mixture of equal proportions of six different individually purified lytic-type	Various RTE meat and poultry products	Applied as a spray at a level not to exceed 1 ml of the additive per 500 cm ² product surface area	21 CFR 172.785	Listed by common or usual name (i.e., bacteriophage preparation) in the ingredients
A blend of encapsulated nisin preparation (90.9 percent), rosemary extract (8.2 percent) and salt (0.9 percent)	Frankfurters and other similar cooked meat and poultry sausages	Not to exceed 550 ppm of the product formulation	Acceptability determination	Listed by common or usual name in the ingredients statement (4)
Skim milk or dextrose cultured with <i>propionibacterium freudenreichii</i> subsp. <i>Shermanii</i>	Meat and poultry sausages including those with standards of identity which permit the use of antimicrobial agents	Not to exceed 2 percent by weight of the finished product	GRAS Notice No. 000128	Listed by common or usual name in the ingredients statement (2)

GRAS Notice Inventory

FDA Home > GRAS Notice Inventory > GRAS Notice Inventory > GRAS Detail

GRN No. 218

EBI Food Safety B.V.

Johan v. Oldenbarneveldtlaan 9, 2582 NE Den Haag, The NETHERLANDS

[Return to Listing](#)

Substance:	Bacteriophage P100 preparation from <i>Listeria innocua</i>
Intended Use:	For control of <i>Listeria monocytogenes</i> in foods in general, including meat and poultry products, at levels up to 10 ⁶ plaque forming units per gram
Basis:	Scientific procedures
Date of filing:	12/17/2006
Date of closure (select to view letter):	6/22/2007
GRAS Notice (disclosable information):	GRN 218

GRAS Notice Inventory

FDA Home > GRAS Notice Inventory > GRAS Notice Inventory

GRAS Notice Inventory

The inventory of GRAS notices provides information about GRAS notices filed within each year since 1998, when FDA received its first GRAS notice. Once FDA has responded to a GRAS notice, the text of FDA's response will also be available as part of the record for that notice. We will update this information approximately monthly. More information about this inventory is available on the [GRAS Notice Inventory Introduction page](#).

Records shown on this page: This page is a partial listing of all records in the database. Additional pages/records are available for selection at the bottom of the page. To view all records in the database select the **All** button at the bottom of the page. To search for a specific food ingredient, enter the term in the **Search Criteria** box and select **Show Items** to display only those records that contain the selected term. To view the text of the agency's response to the GRAS notice, select the text in the **FDA's Letter** column describing the response. Select the specific GRN number in the **GRN No.** column to view additional detail about any GRAS notice, including in some cases the submission itself. The agency has removed nondisclosable information from these submissions. All copyrighted information has also been removed and the bibliographic information listed in a reference table at the end of the submission.

Search Criteria

Show Items

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Sort by:

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No of Records Found: 301

GRN No. (select GRN No. for detailed record)

Substance

FDA's Letter (select to view letter)

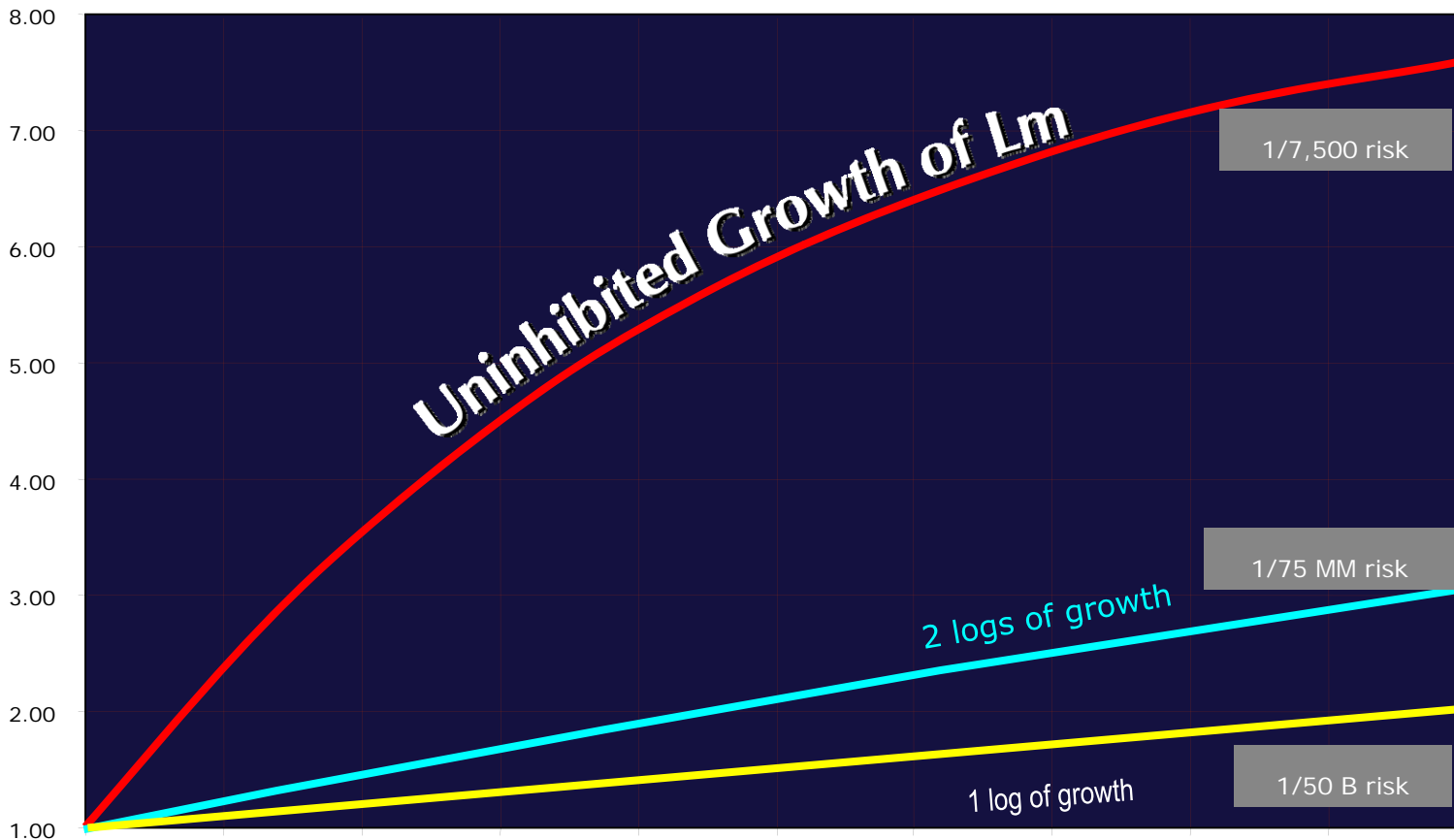
251	Carbon monoxide	Pending
250	Plant sterols and stanols from pine trees	FDA has no questions
249	Synthetic dihydrocapsiate	FDA has no questions

Lm Growth Inhibitors, Regulations and Public Health

- Do not change likelihood of Listeria contamination in products
- Do not kill Listeria
- By inhibiting growth expect less likelihood of related Listeriosis

Listeria Growth Inhibition Estimated Benefit to Public Health*

Predicted Log Counts/gm



*Based on Growth Model for 50 gm of RTE cured processed meat and median mortality risk for neonates published by FDA/USDA Fall 2003 *Listeria monocytogenes* Risk Table IV-12 and Figure IV-7

Summary

Environmental monitoring and preventative equipment interventions or process changes that minimize contamination in finished product

PLUS

Listeria Growth inhibitors in product

EQUALS

Effective reduction in Lm risk