International Association for Food Protection WEBINAR

Using Science and Technology to Reduce Food Waste and Ensure Food Safety

Moderator: Joyjit Saha, Kerry

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International Association for Food Protection

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- All attendees are muted. Questions should be submitted to the presenters during the presentation via the Questions section at the right of the screen. Questions will be answered at the end of the presentations.
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Using Science and Technology to Reduce Food Waste and Ensure Food Safety

Donald W. Schaffner, PhD.
Rutgers University, Speaker

Eelco Heintz, MSc.
Kerry, Speaker

Joyjit Saha, PhD.
Kerry, Moderator

More About the Speakers:

Donald W. Schaffner, PhD.

Distinguished Professor and Extension Specialist at Rutgers University.

Past president of IAFP.

Podcast host.

Eelco Heintz, MSc.

Global RD&A Manager, Kerry Food Protection & Preservation.

Product & Innovation Manager at Niacet.

20 years of experience in food and beverage preservation.

RUTGERS
New Jersey Agricultural Experiment Station

Food Waste: Case Studies and Modeling

Donald W Schaffner, PhD

Distinguished Professor and Extension Specialist

Overview

- Summary of four case studies
  - Milk
  - Potatoes
  - Bananas
  - Bread
- Modeling tools
  - Chicken

Milk – safe after boiling

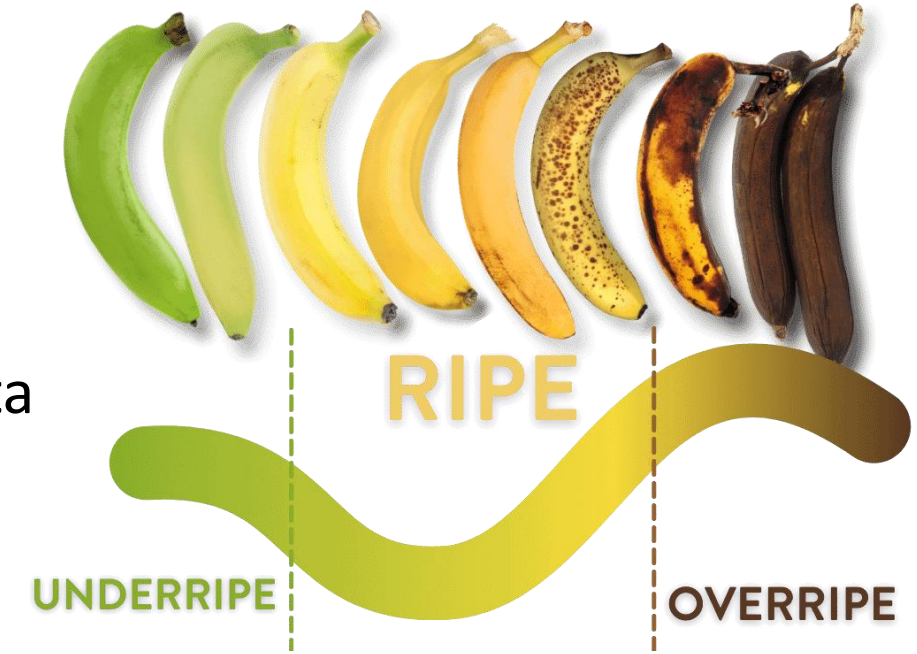
- 8 log CFU/ml at 14-17 days spoiled by *Pseudomonas*
  - Some strains may cause diarrhea in immunodeficient individuals
- 4 log CFU/ml at 14 days spoiled by *Paenibacillus*
  - Species appears to lack many virulence genes and toxins common in *B. cereus*
- 6 log CFU/ml at 17 days spoiled by *Bacillus*
  - Strains that produce toxin unable to grow at temperatures less than 10 °C

Potatoes

- Poisonings from glycoalkaloids can occur
  - relatively rare in recent history
- Bitter taste can be associated with glycoalkaloid poisoning
- Toxicological limits have not been set
  - levels of less than 100mg/kg potatoes do not appear to be of concern
- Sprouting and green color have been associated with elevated glycoalkaloids
  - green color itself is not a specific marker for glycoalkaloids
- Old potatoes ok if sprouts, green color, skin, and peels plus the area under skin are discarded
- Cooked old potatoes which taste bitter should not be consumed

Bananas

- Risks of bacterial disease from bananas appear to be very low
  - based on CDC data and limited published data
- Bacterial foodborne pathogens do not grow on the surface of peels
- Some risk of fungal growth and possibility of mycotoxin production
- If banana looks or smells moldy, it should be discarded
- Bananas that do not look or smell moldy can be safely consumed



Bread

- Literature on mycotoxin formation in breads is limited and conflicting
- Most reports indicate that mycotoxins formed on bread products inoculated with mycotoxigenic strains
  - Most say little diffusion away from fungal hyphae.
  - Others report mycotoxin diffusion away from hyphae
- Bread with extensive mold should be discarded
- Bread with few mold colonies can be salvaged
- If the mold has penetrated the loaf, it should be discarded

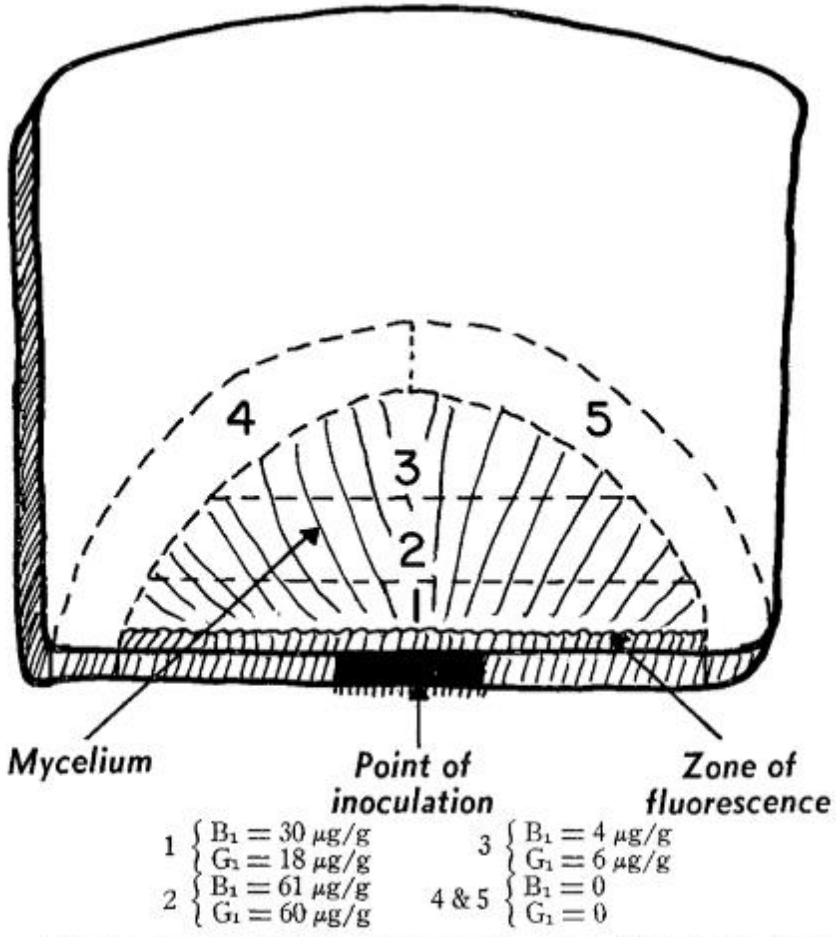


Fig. 2. Growth of Aspergillus flavus *strain No. 373 on bread and distribution of aflatoxins after 6 days at 30°C.*

Modeling

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Available online at www.sciencedirect.com
ScienceDirect
International Journal of Food Microbiology 120 (2007) 287–295

INTERNATIONAL JOURNAL OF
Food Microbiology
www.elsevier.com/locate/ijfoodmicro

Development and validation of a mathematical model to describe the growth of *Pseudomonas* spp. in raw poultry stored under aerobic conditions

Silvia A. Dominguez, Donald W. Schaffner *

Journal of Food Protection, Vol. 71, No. 12, 2008, Pages 2429–2435

Modeling the Growth of *Salmonella* in Raw Poultry Stored under Aerobic Conditions

SILVIA A. DOMINGUEZ AND DONALD W. SCHAFFNER*

School of Biological and Environmental Sciences, Rutgers, The State University of New Jersey, Food Science Department, 65 Dudley Road, New Brunswick, New Jersey 08901-8520, USA

MS 08-197: Received 26 April 2008/Accepted 25 July 2008

Model choice matters

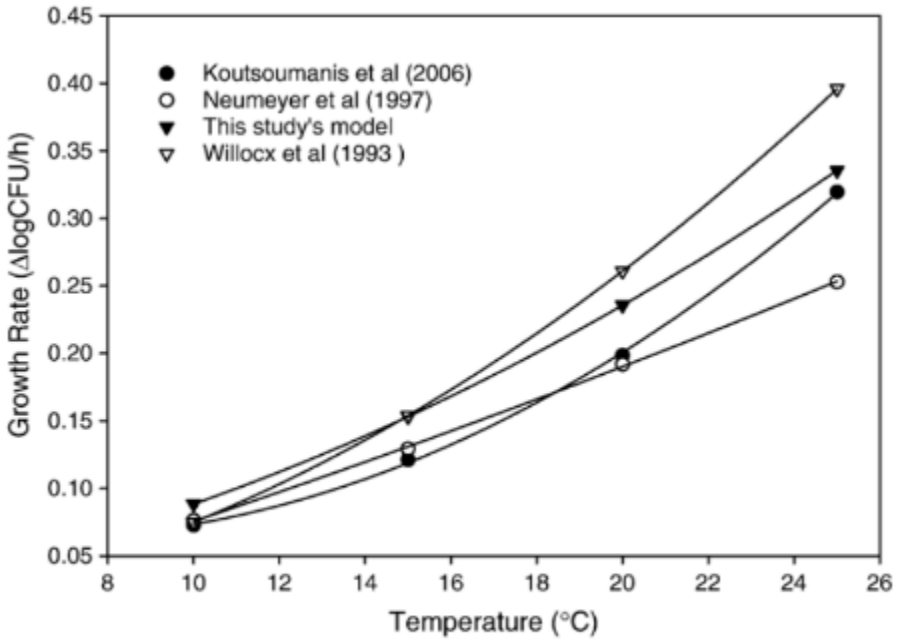


Fig. 8. Graphic comparison of selected *Pseudomonas* spp. growth models.

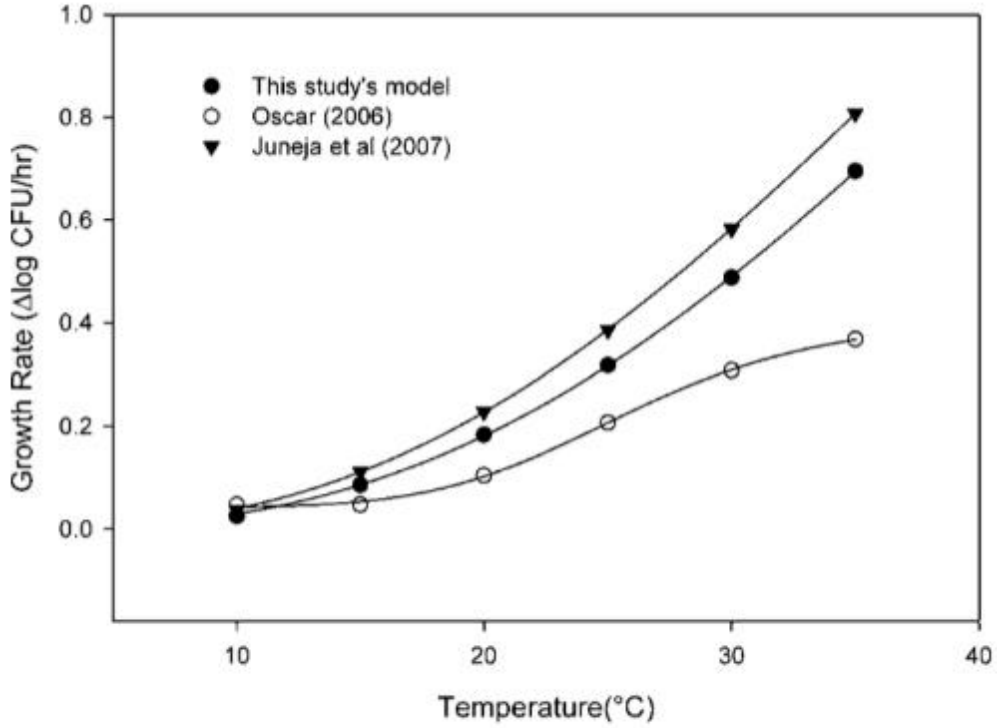


FIGURE 3. *Predicted growth rates by the models of Juneja et al. (15) and Oscar (29) and the model developed in this study.*

Temperature matters

Table 4
Predicted raw poultry shelf-life at different storage temperatures

Storage temperature (°C/°F)	Predicted growth rate (ΔlogCFU/h)	Predicted shelf-life [a]
0/32	0.01	17 days
4.4/40	0.04	6 days
10/50	0.09	2 days
25/77	0.34	15 h

[a] End of shelf-life=time to reach 10^7 CFU/cm^2. Based on experimental data, an initial concentration of 10^2 CFU/cm^2 is assumed.

- ~ 3x faster at 10 °C
- ~ same at 25 °C

TABLE 4. *Predicted and experimental antibiotic-resistant and nonresistant* Salmonella *(initial population ≤10 CFU/cm²) growth rates on raw poultry at temperatures of 10 to 35°C*

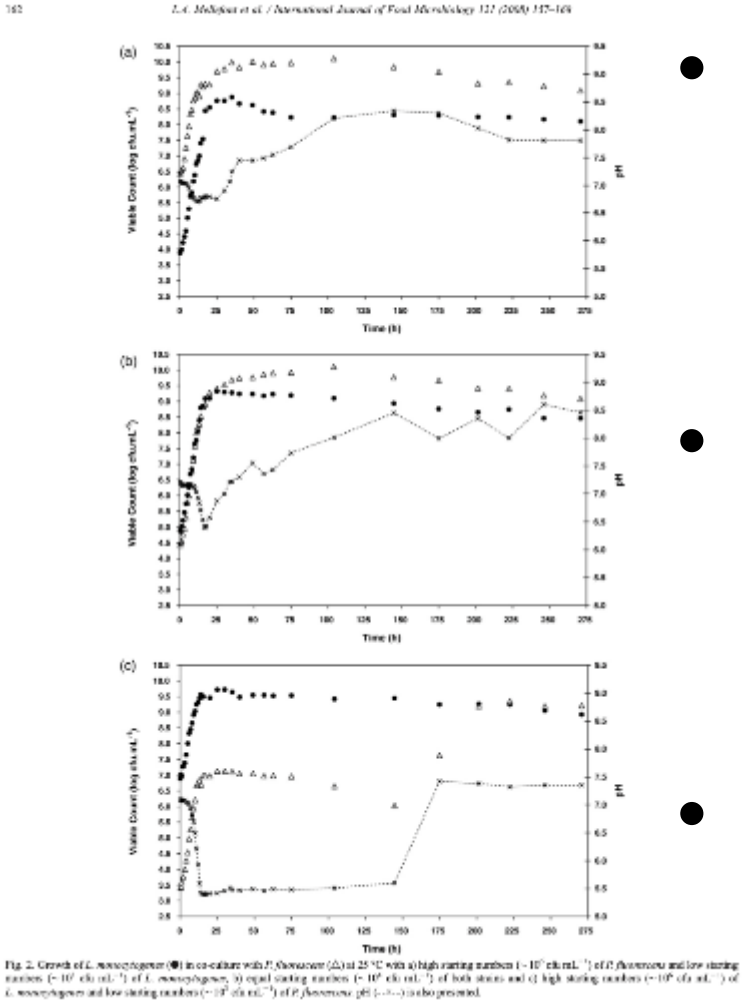
	Salmonella growth rate (Δlog CFU/h)		
		Experimental	
Temp (°C)	Predicted	Antibiotic-resistant	Non–antibiotic-resistant
10	0.0252	0.0147	ND[a]
15	0.0862	0.0457	0.0364
20	0.1837	0.1059	0.1102
25	0.3177	0.1584	0.0957
30	0.4880	0.5955	0.3118
35	0.6949	1.0130	1.4950

[a] ND, not determined. *Salmonella* growth could not be determined at 10°C because of high interference from non-*Salmonella* organisms able to grow on XLT4 media.

Initial conditions matter

- Jameson effect

Mellefont, McMeekin, and Ross (2008) Effect of relative inoculum concentration on *L. monocytogenes* growth in co-culture. IJFM 121: 157–168



- Higher
- Equal
- Lower

Questions?

1. Understanding food loss and how it affects food security/sustainability.

Real-world Solutions to a Global Issue

The world wastes vast amounts of food.

33%

of all food produced globally, goes to waste*.[1]

* In certain regions this figure is as high as 50%.[2]

At a time when **sustainable food systems are a global imperative,** food preservation has a crucial role to play.

Financially, socially and environmentally.

Kerry's Food Protection and Preservation business can help you to:

- Extend shelf life
- Protect margins
- Inspire consumer confidence

Best Before:
DD MM YYYY

[1] FAO, Global Food Losses and Waste
[2] Michigan State University, Americans Waste Almost 50 Percent of Food Produced

Where Protecting Food Can Make an Impact

Shelf-life confidence

68%

of consumers say the use by or best before date is the number one indicator for them of **food safety**.[1]

Unlocking value

Over

52 billion

servings of meat were preserved and protected by Kerry ingredients in 2022. [5]

Less waste

66%

of consumers say they want to cut waste. [3]

Yet up to half of global food waste occurs at consumer level.[2]

Our consumer surveys show that extra shelf-life days and education make a big impact on waste

Low sodium

Low/no/reduced sodium was in the **top 3 positions** across all regions in 2022.[4]

Replacing sodium-based preservatives can help without compromising on shelf life.

More time

A customer saw a

25%

waste reduction by switching from HPP to an ingredient-based clean label solution.

Shelf-life protection after opening is a big weakness in clean label products.[5]

[1] Kerry, Food Safety Fundamentals 2021
[2] FAO, Food loss and waste
[3] FMCG Gurus Sustainability & Clean Label Trends 2021
[4] Innova Market Research, 2022
[5] Kerry Proprietary Information

Food safety: facts, stats, trends & insights

Recalls: the unpalatable price

$10M is the average cost of a product recall. It is this industry's biggest threat to profitability and does not include brand damage and lost sales. [1]

Safety = the date

68% of consumers use shelf-life dates as a key indicator of safe food.[2]

Spoilage alerts

49% of consumers have raised safety worries concerning spoilage issues for the refrigerated plant-based meat industry. Consumers often mistake signs of spoilage (sight, smell, taste) with food safety.[2]

Contaminations: a major issue

45% of USDA recalls in 2022 were due to contamination, which is still a leading cause of recalls globally.[3]

[1] Joint industry study by the Food Marketing Institute and the Grocery Manufacturers Association
[2] Kerry, Food Safety Fundamentals 2021
[3] USDA and Kerry global market analysis

Clean Label Trends & Insights

63%

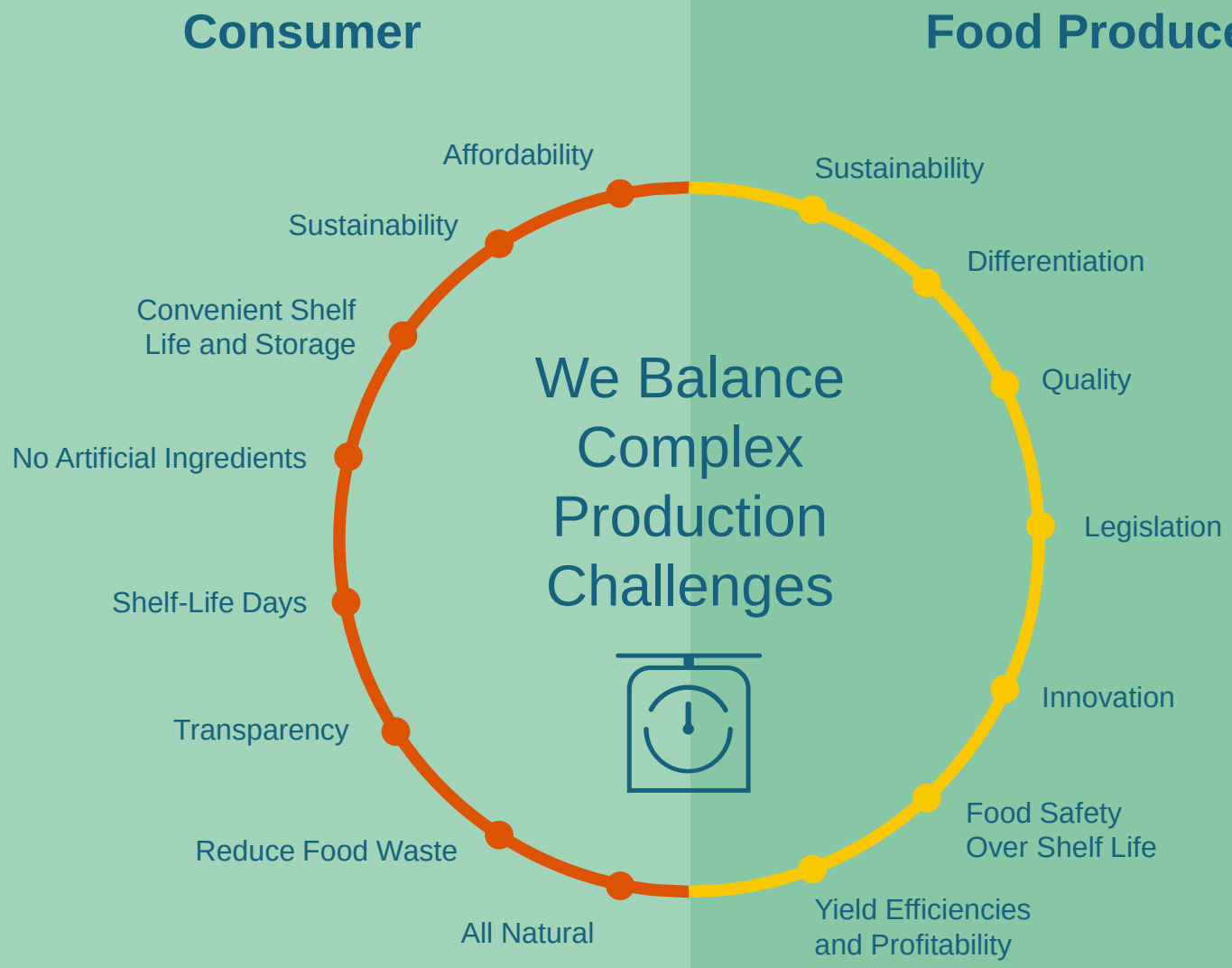
of consumers prefer natural preservatives in their food and beverages (vs. 5% artificial and 25% both).[1]

60%

of consumers say the ingredients list/declarations are their top purchase driver.[2]

[1] Kerry, North America Food Safety Fundamentals, 2021
[2] Kerry, Sustainability in Motion, 2021

Consumer’s Needs.
Producer’s Needs.



2. Microbial ecology and physiology of common spoilage culprits.

Microbial presence in food products

Cleaning reduces initial load

Not completely sterile ➔ products exposed to microbes

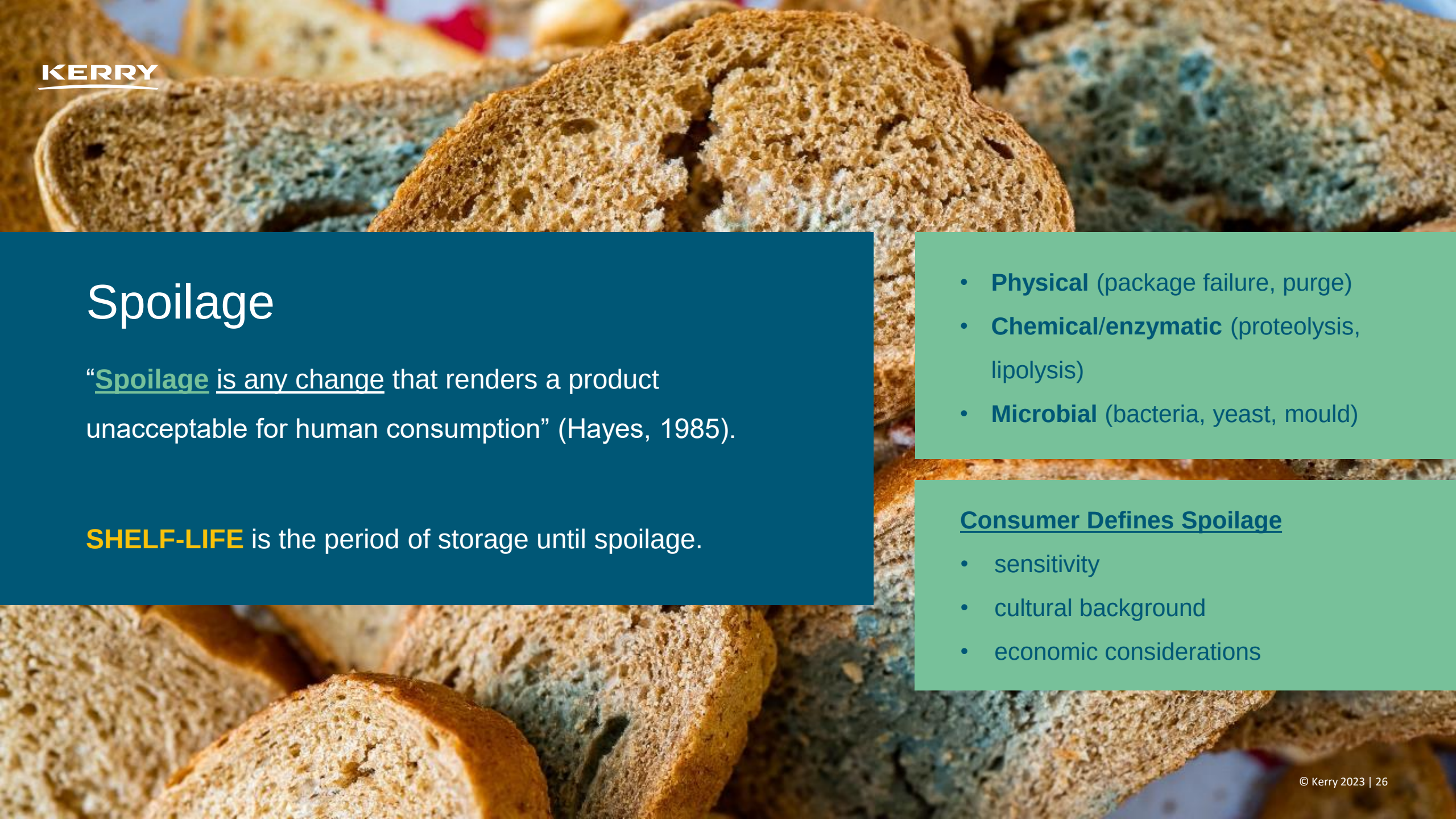
A bacteriostatic component is needed for control !

> “Everything is everywhere and the environment selects”
>
> M.W. Beijerinck 1913

Role of Microorganisms in Food

- The foods we eat, irrespective of how they are prepared, are seldom sterile.

- Most foods are ‘naturally’ contaminated with spoilage microorganisms and occasionally with pathogens.



Spoilage

"**Spoilage** is any change that renders a product unacceptable for human consumption" (Hayes, 1985).

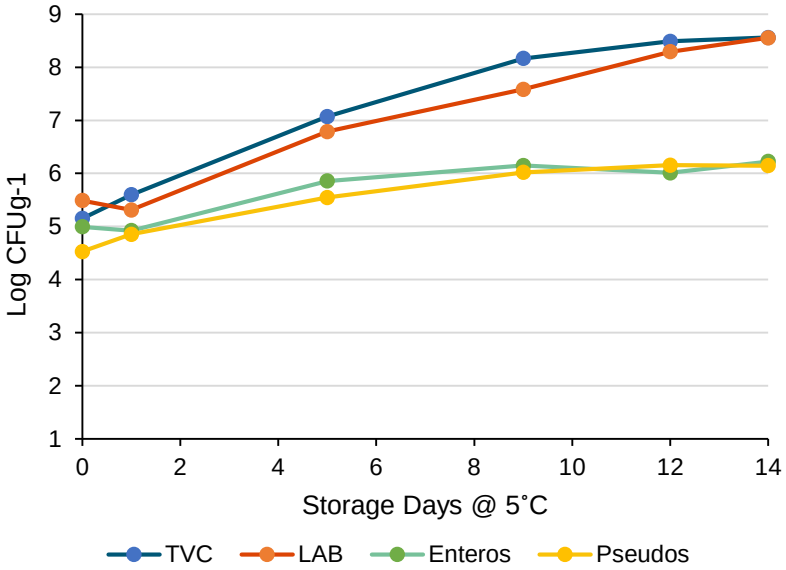
SHELF-LIFE is the period of storage until spoilage.

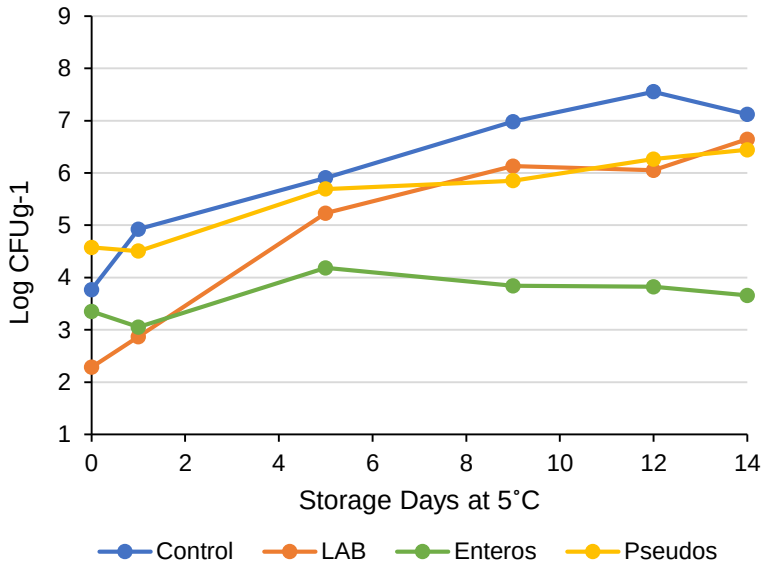
- **Physical** (package failure, purge)
- **Chemical/enzymatic** (proteolysis, lipolysis)
- **Microbial** (bacteria, yeast, mould)

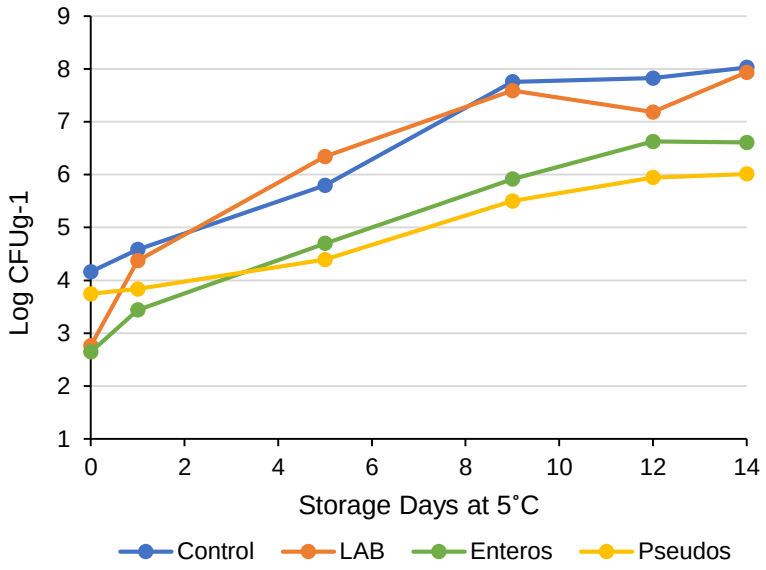
Consumer Defines Spoilage

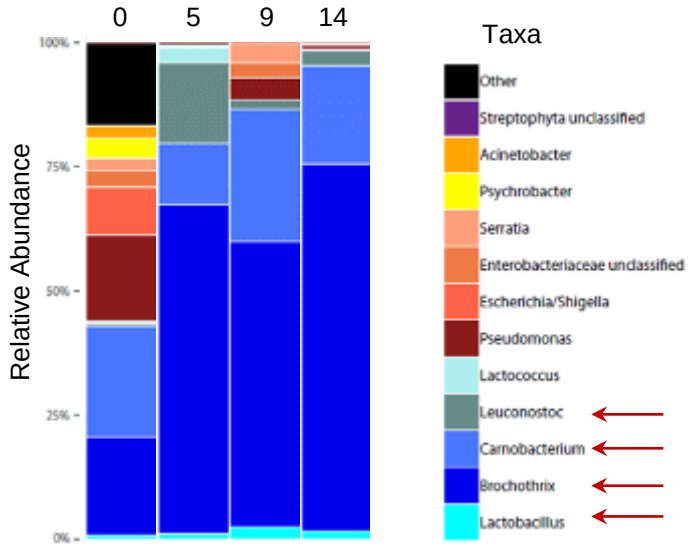
- sensitivity
- cultural background
- economic considerations

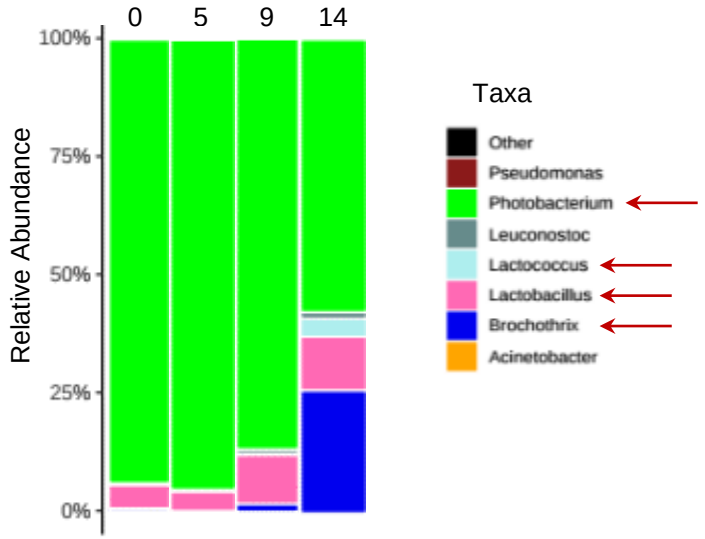
Microflora of Minced Beef, Pork and Chicken

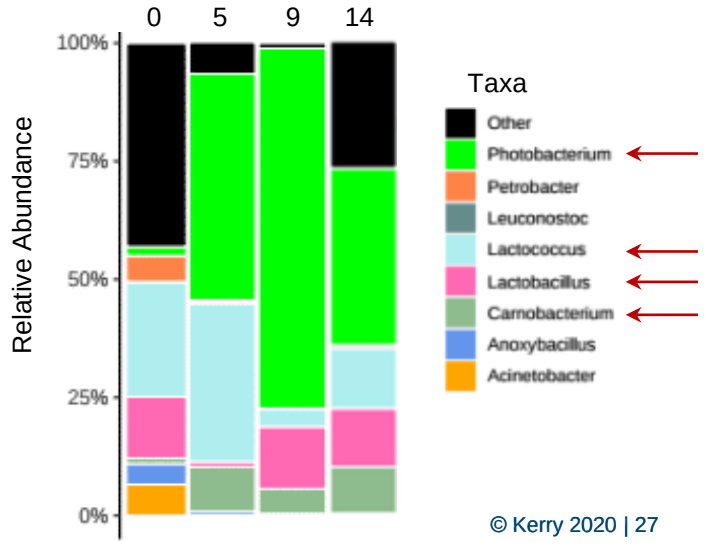












Burden of Foodborne Illness- US

Pathogens causing the most foodborne illnesses, hospitalizations, and deaths each year

Top five pathogens contributing to domestically acquired foodborne illnesses

Pathogen	Estimated number of illness	90% credible interval	%
Norovirus	5,461,731	3,227,078-8,309,480	58
Salmonella, nontyphoidal	1,027,561	644,786-1,679,667	11
Clostridium perfringens	965,958	192,316-2,483,309	10
Campylobacter spp	845,024	337,031-1,611,083	9
Staphylococcus aureus	241,148	72,341-529,417	3
subtotal			91

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Listeria monocytogenes facts

- *Listeria monocytogenes* are widely distributed in nature. They can be found in soil, water, vegetation and the faeces of some animals and can contaminate foods.
- High risk foods include deli meat and ready-to-eat products soft cheeses and cold smoked fishery products.
- Vulnerable group (young, old, pregnant, immuno-compromised) should avoid high risk foods.
- Invasive listeriosis is a serious disease with 20-30% mortality rate

58 recalls for a variety of foods in 2020

Every year, about 1,600 people get listeriosis in the USA

World Health Organization

USDA

FDA

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

3. Potential solutions to the challenge of food spoilage.

Ingredients to Achieve Food Safety and Reduce Waste

Conventional	Fermentation	Vinegar	Plant Extracts	Cultures

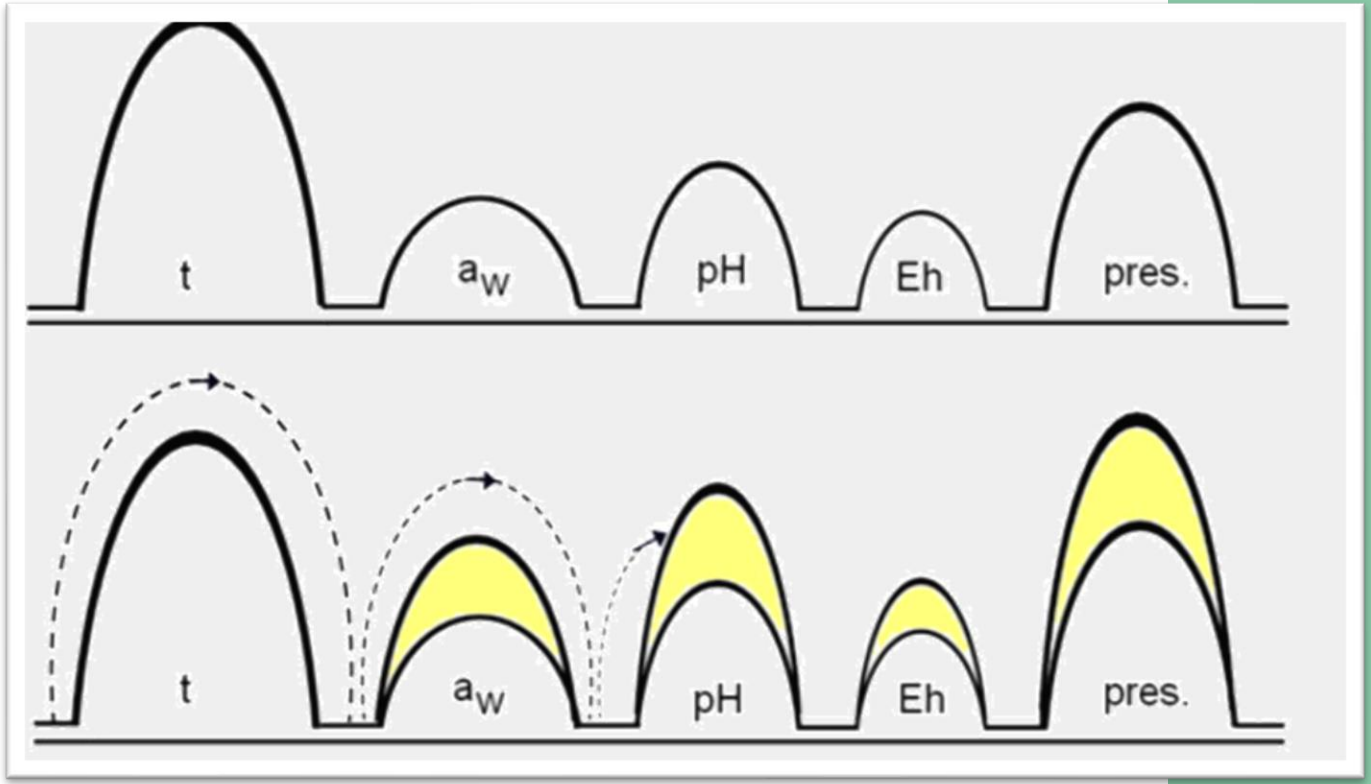
• Organic Acids
  • Sorbates
  • Acetate
  • Lactates
  • Propionate
	• Organic acids
	• Peptides
	• Natural cure
		• Dry buffered vinegar
		• Liquid buffered vinegar
			• Extracts with antimicrobial and antioxidant benefits	• Live cultures for fermented meats and/or bio protection

Multiple pillars come together as:

Multifunctional Systems

Combined technologies / products to meet specific goals. Demonstrated efficacy at low inclusion levels.

Leistner
Hurdle Concept



Hurdle Technology is the combined use of several preservation methods to improve the ***safety*** & ***quality*** of a product.

Microorganism won't be able to ‘adapt’ to all the hurdles.

Leistner 1978

The Market Has Historically Relied on Antimicrobials Derived from Different Supply Chains to Address Conventional & Clean Label Needs

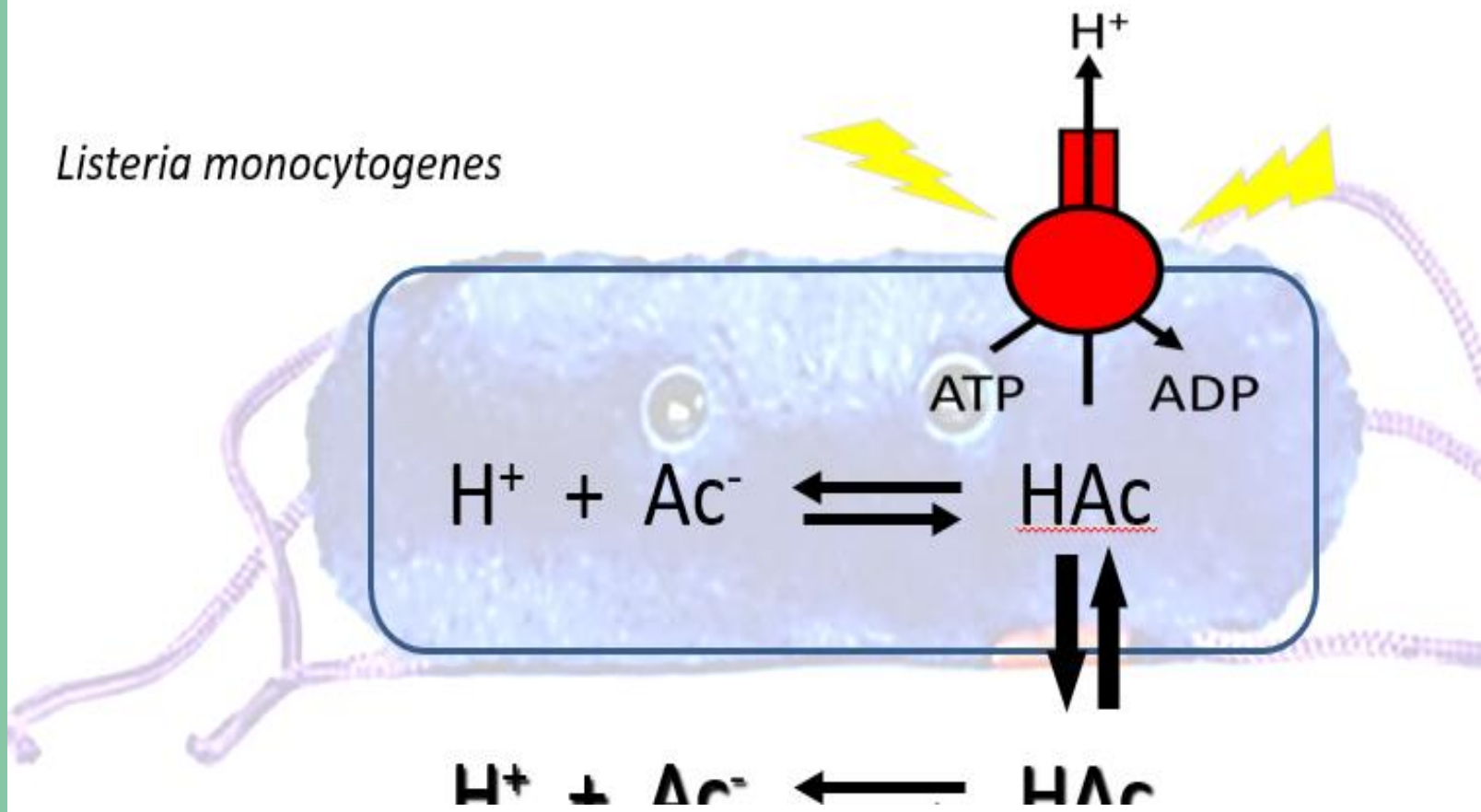
Complexity Impact =
Different formulation considerations, different supply chains, fewer economies of scale, etc.

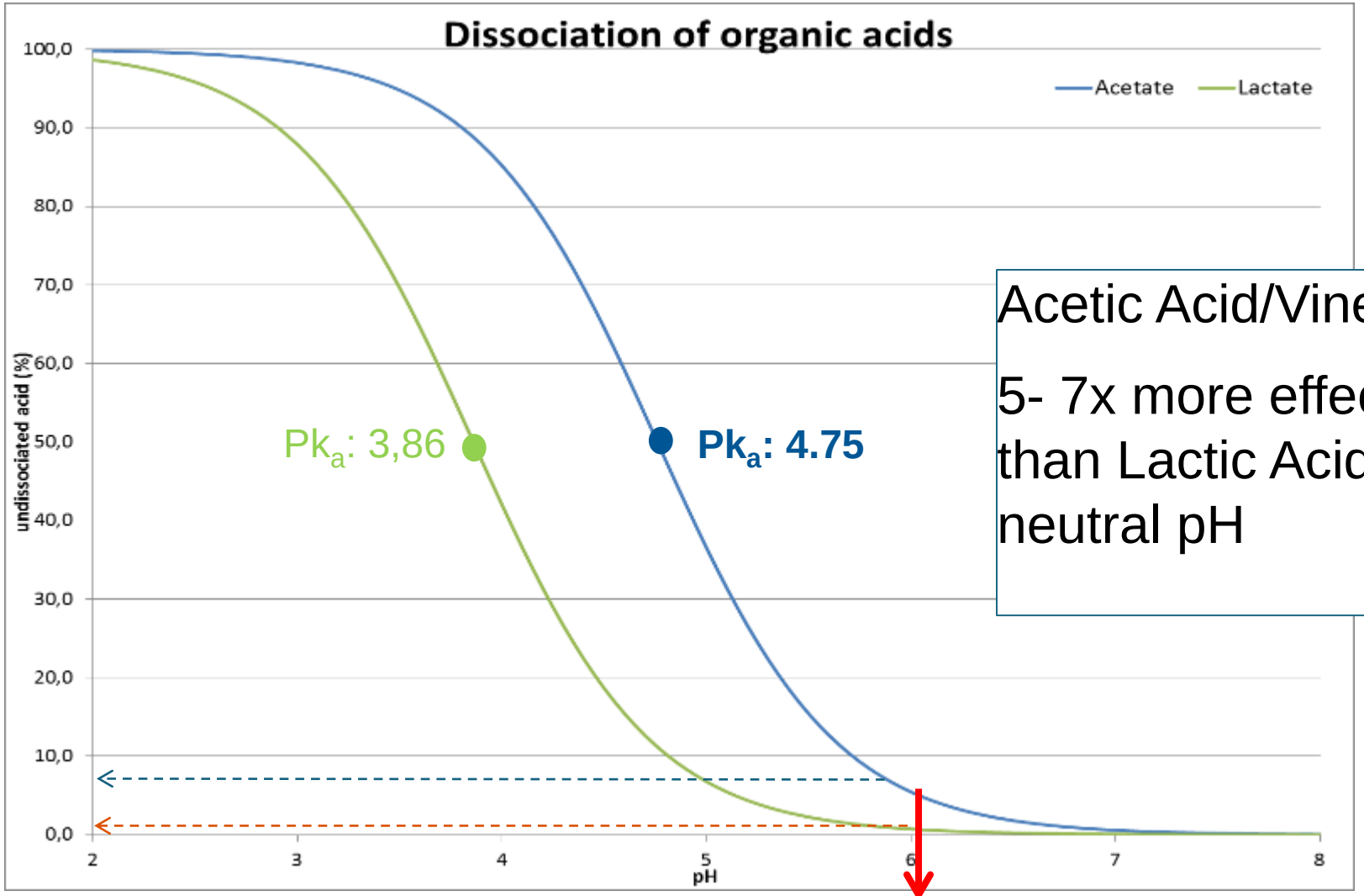
Lactate/Diacetate Based
Conventional Preservation

Vinegar (Acetate)-Based
Clean Label Preservation

AM working mechanism of organic acids

- Undissociated acid is the effective
- Acetic acid has relative high pKA
- Basic chemistry ➔ rel. high amount of undissociated at neutral pH





Acetic Acid/Vinegar is

5- 7x more effective than Lactic Acid at neutral pH

4. The power of Predictive modeling

Food Spoilage and Safety Predictor (FSSP)

The FSSP software is distributed free of charge from:
http://fssp.food.dtu.dk

Predictive modeling

Predict the growth of organisms causing spoilage or food borne illness based on food and storage parameters

- Direct insight on spoilage tresholds
- Direct insight on safety control of food products
- Reduces time and money spend with challenge studies (accepted at food authorities!!)

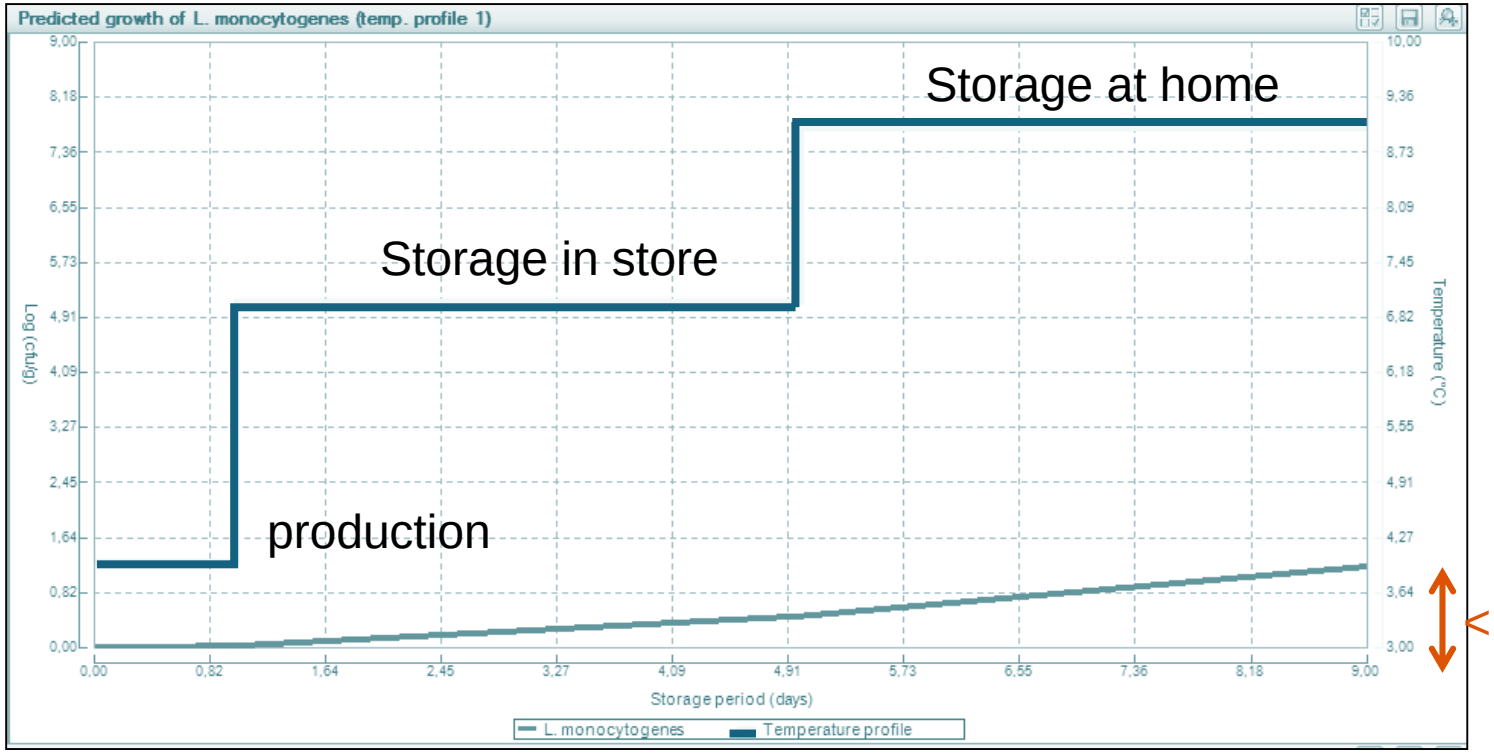
Saves time and money!

Predicted *Listeria* growth

9°C

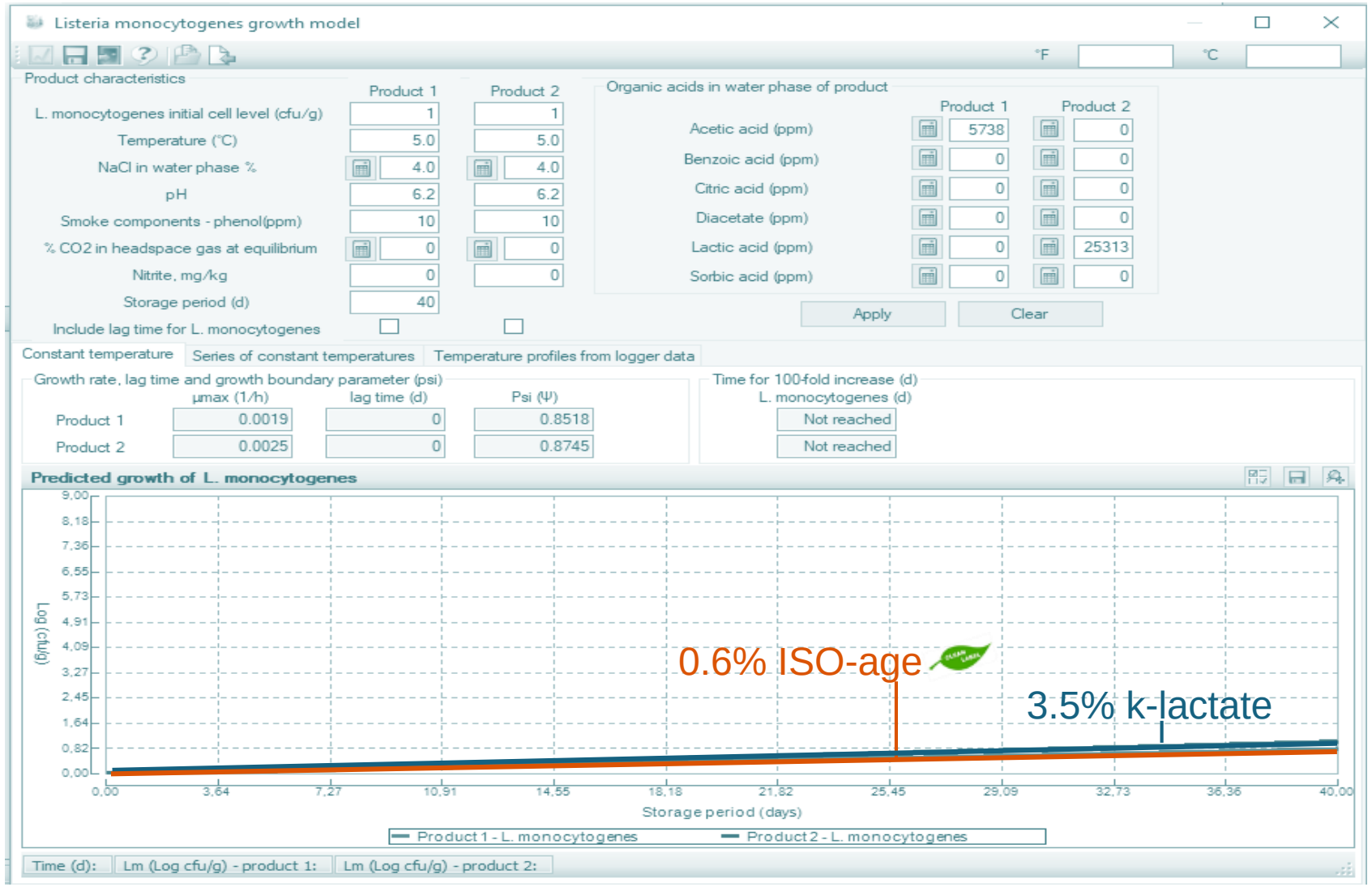
7°C

4°C



< 2log cfu /g

Vinegar (Acetate) vs. Lactate

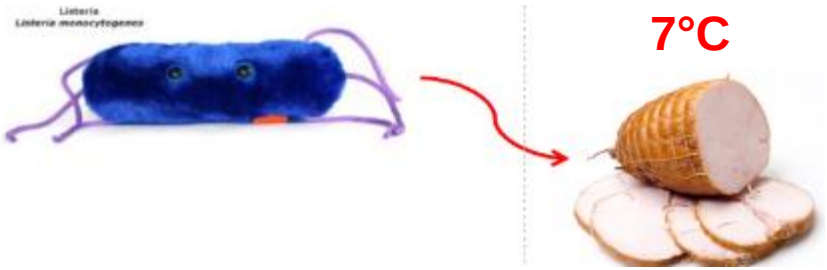


5. Experimental data

Objective:
Chemical vs Natural

Provian® K VS **ISO-Age®**

- Chemical
  - acetate
  - diacetate
- Natural
  - Vinegar



Treatments:

- **Control (no antimicrobials)**
- **0.5% Provian K**
- **0.5% ISO-Age**
- **0.65% ISO-Age**

Microbial Analysis

Triplicate inoculated samples of each treatment were assayed

Rinsed meat in 100ml of Butterfield’s phosphate buffer and hand massaged externally for 3 minutes

Enumerated on Modified Oxford agar (MOX, 35°C, 48h) for populations *L.monocytogenes.*

Background flora measured on PCA and APT + bromocresol purple.

Results

Proximate analysis

All treatments were tested

Moisture: 71.1% - 73.4%

pH: 6.21 - 6.42, constant over time

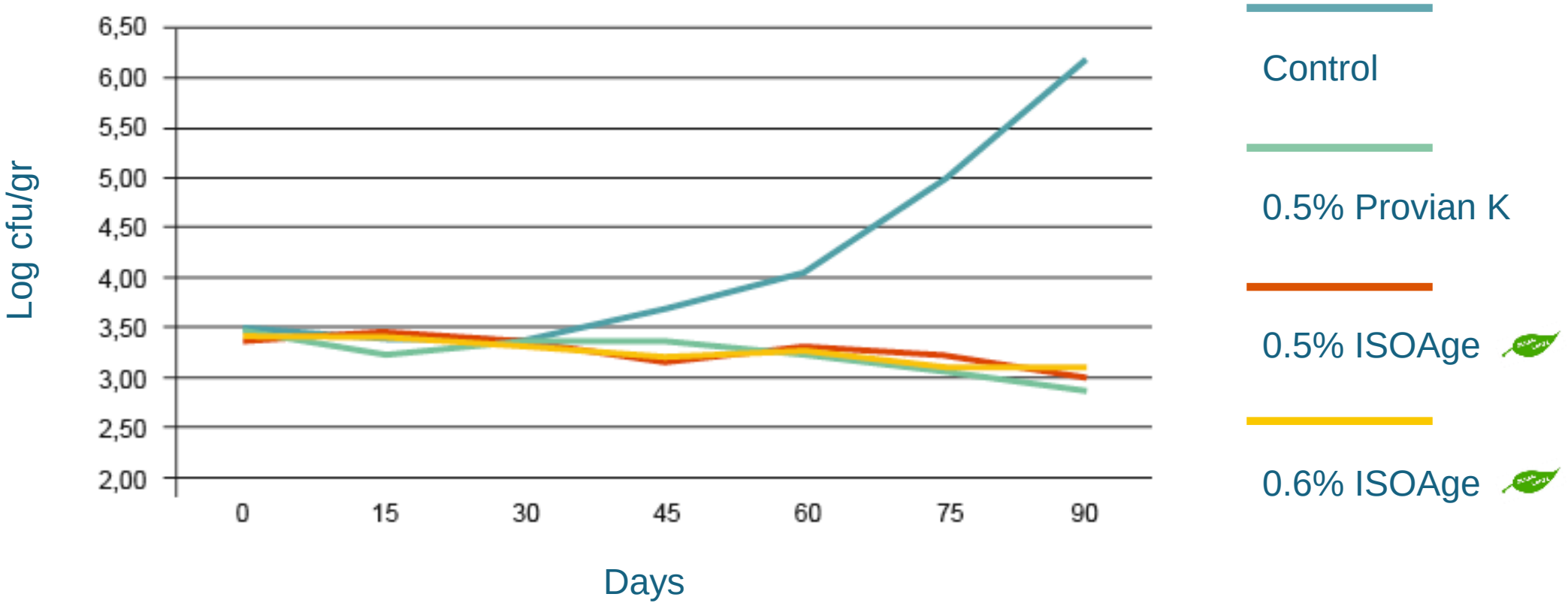
% Nacl: 1.82 - 2.10

Background flora

(PCA & APT+ bromocresol) <1 log cfu/g

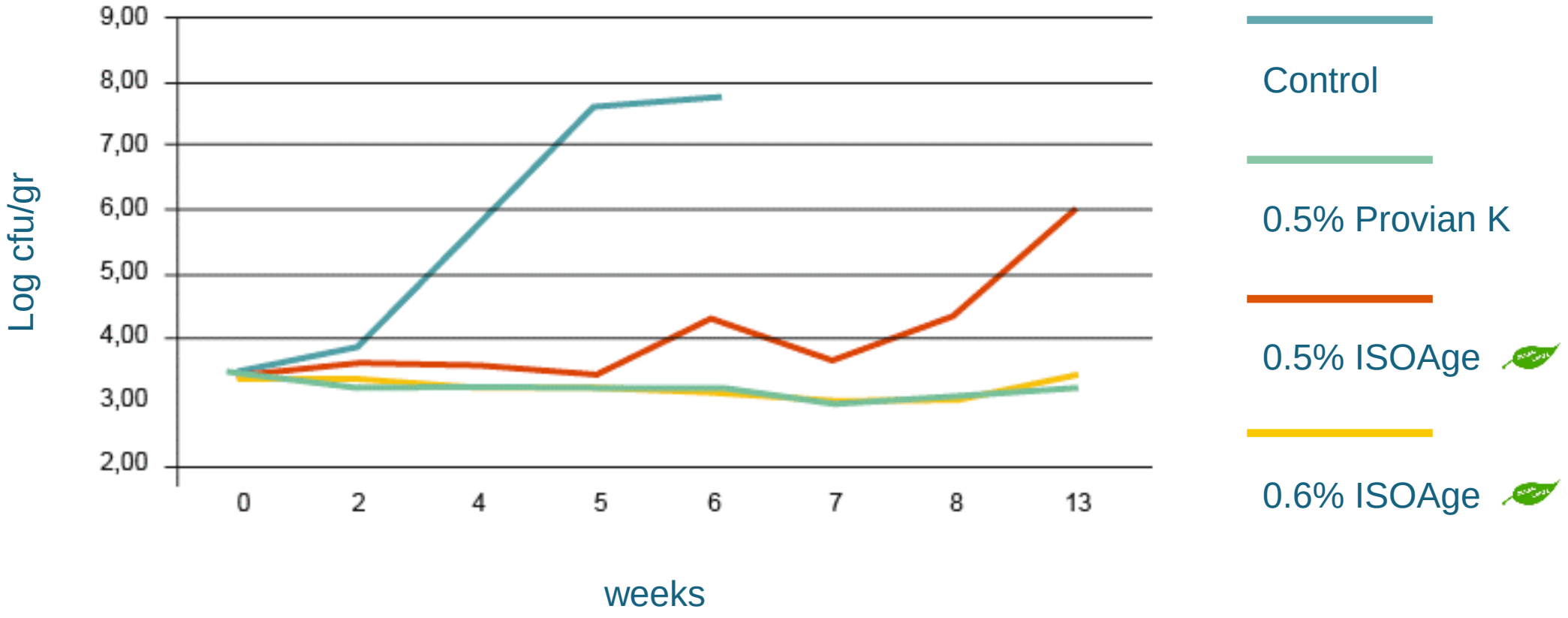
Efficacyin cooked ham at 4°C

Listeria monocytogenes in cooked ham (+4ºC)



Efficacy in cooked ham at 7°C

Listeria monocytogenes in cooked ham (+7ºC)



Conclusions

- Vinegars and acetates are highly effective at meat pH due to high pK value
- comparable antimicrobial efficacy of chemical and natural (vinegar based) Acetates
- Theory and model predictions are confirmed by experimental validation.

What happens when we eliminate sources of food waste?

Go!

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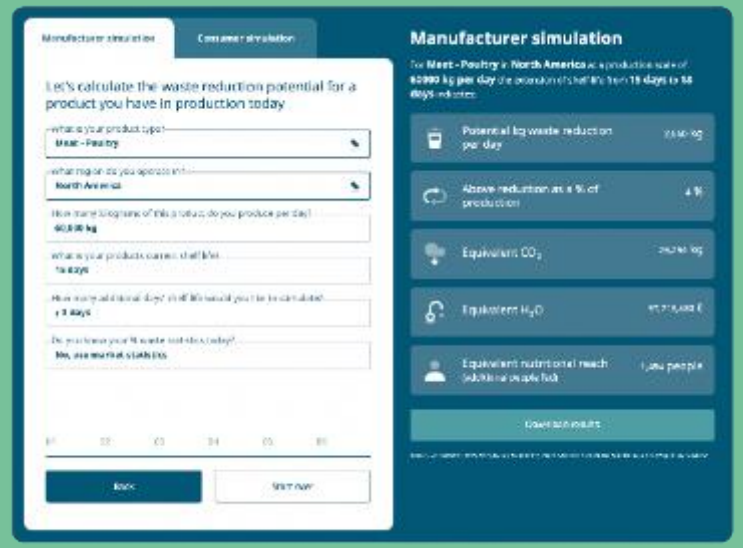
See the impact you could have on the planet's resources **here**

Input some production information, and the Estimator will give an instant guide to the impact that you could achieve.

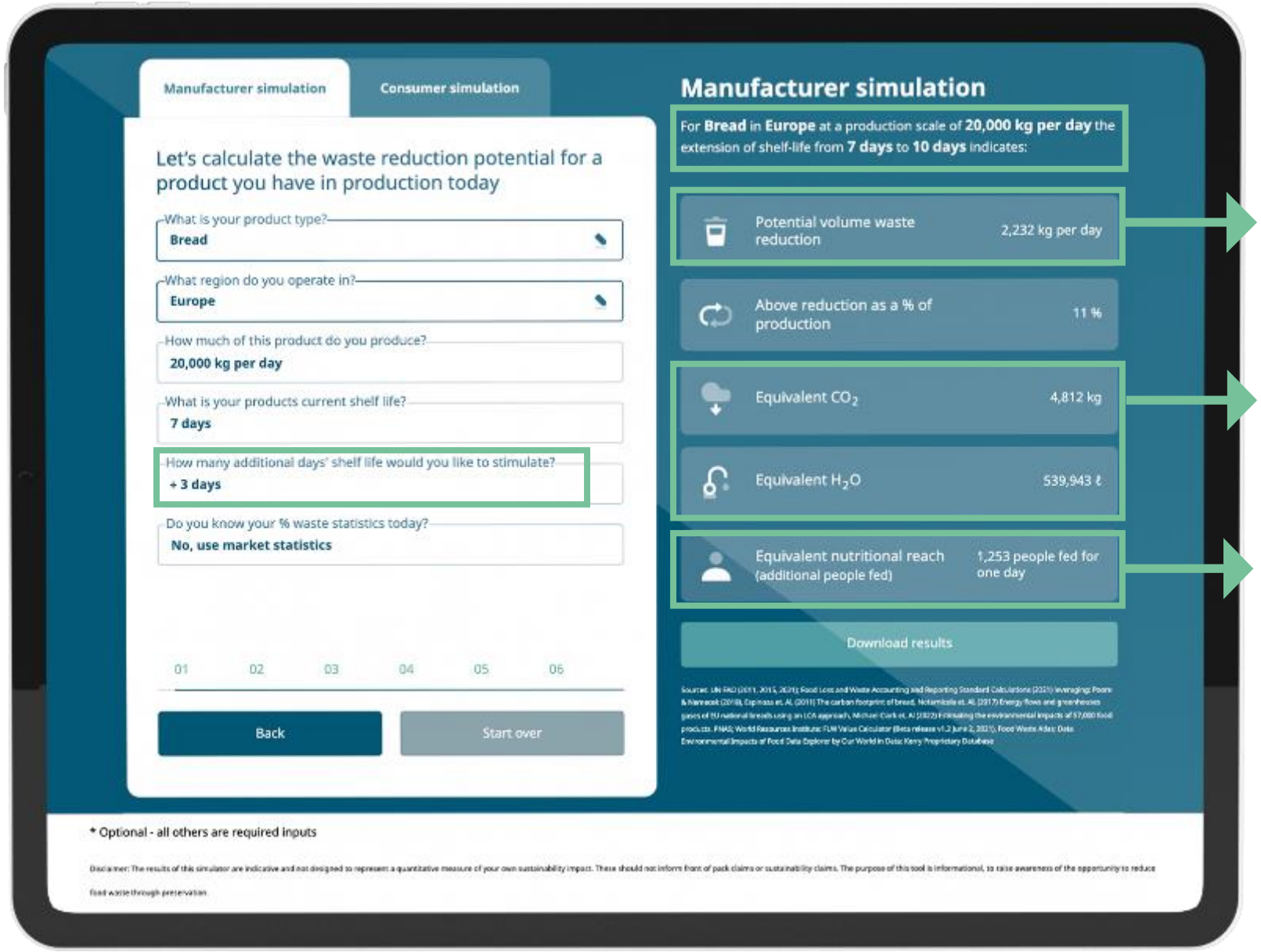
Whether you're a food manufacturer or a concerned citizen – or both – access our Food Waste Estimator.

With food and energy prices at an all-time high, and climate change at critical levels, **now is the time.**



Disclaimer: The results of the food waste estimator are indicative and not designed to represent a quantitative measure of a customer's/consumer's sustainability impact. The outputs should not inform front of pack claims or sustainability claims.

More Shelf Life = Less Waste



Protect your brand, help your retail partner and consumer to **save waste**

Helping your business to achieve its carbon footprint & **sustainability goals**

1,253 **more opportunities** for your brand to **reach new consumers**, every day

Thank You For Attending!
Any Questions??

Reach Out:Joyjit.saha@kerry.com

Upcoming Webinars

June 27, 2023	Don’t be Shellfish! Use Next Generation Sequencing to Improve Seafood Safety and Quality
September 22, 2023	Modeling Salmonella Growth and Inactivation for Small and Very Small Processors with Limited Data
October 24, 2023	Managing Meat Shelf Life and Spoilage to Ensure Food Security

https://www.foodprotection.org/events-meetings/webinars/

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In recognition of this day to increase awareness about food safety, IAFP will provide **open access from June 1–30, 2023,** to all recorded webinars in the IAFP archives for non-Members.

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International Association for Food Protection WEBINAR

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