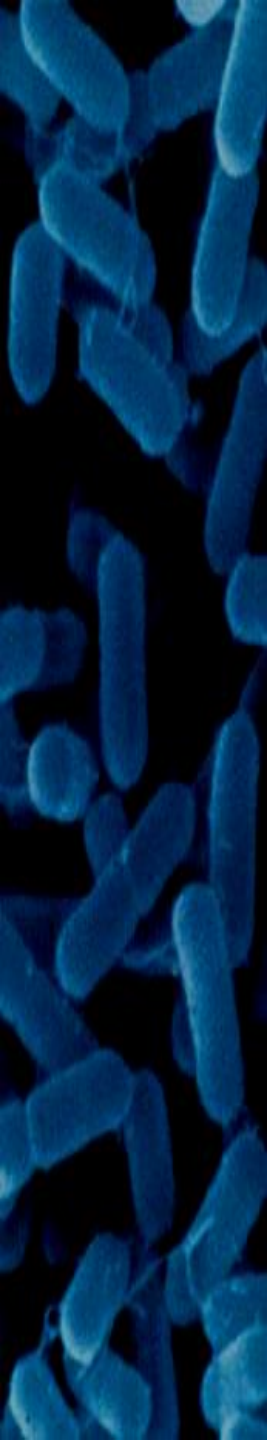


Predictive Microbiology (applications)

Kostas Koutsoumanis

Head of Lab of Food Microbiology and Hygiene Dpt. Of Food Science and Technology
Aristotle University of Thessaloniki

efsa
European Food Safety Authority

Summer School
"In Silico Methods for Food Safety"

Predictive Microbiology

Tertiary models-Software (free access)

Pathogen Modeling Program
http://www.ars.usda.gov/Services/docs.htm?docid=6796

ComBase (database) (http://www.combase.cc)

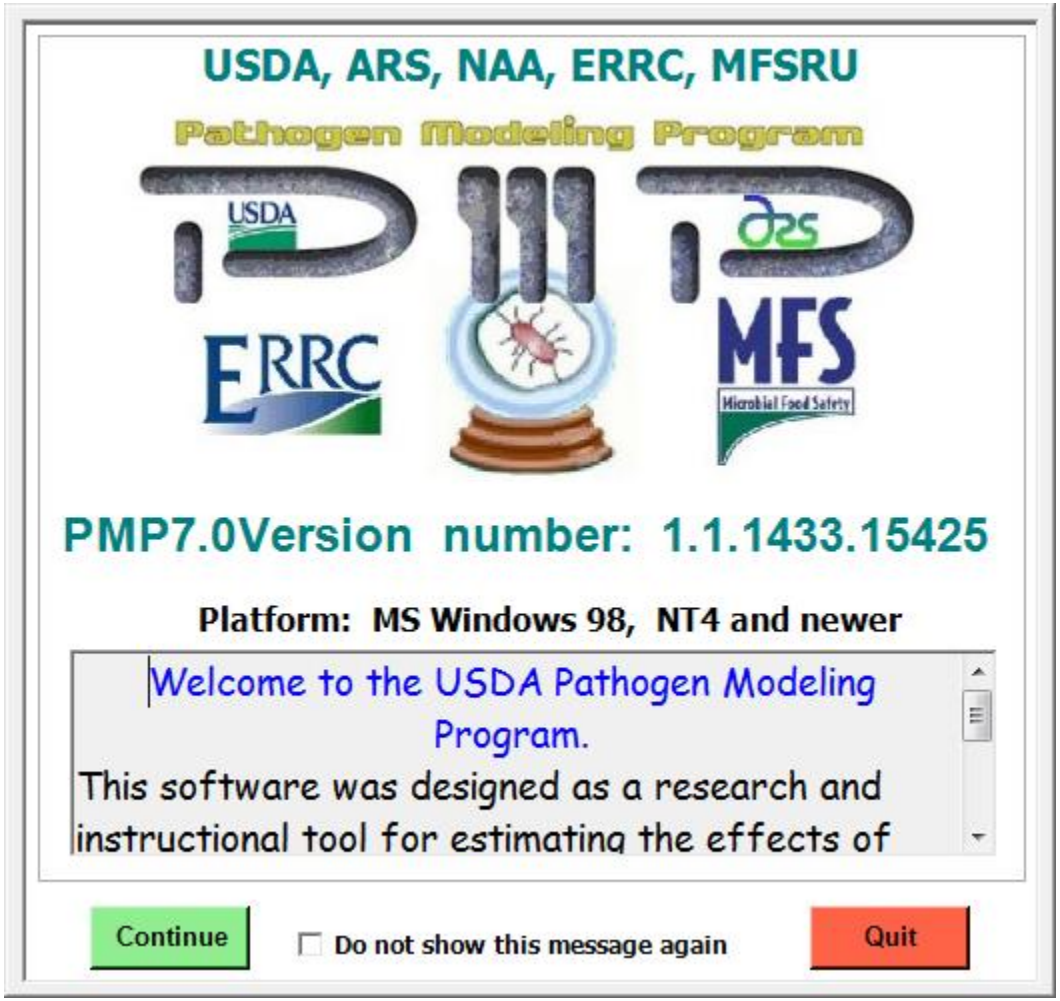
ComBase Predictor (models) (http://www.combase.cc)

Food spoilage and safety predictor-FSSP
(http://www.dfu.min.dk/micro/sssp/Home/Home.aspx)

Refrigeration Index
(ijenson@mla.com.au; http://www.mla.com.au)

Predictive Microbiology

http://www.ars.usda.gov/Services/docs.htm?docid=6796



Predictive Microbiology

Tertiary models-Software

www.combase.cc

- large, searchable, database of microbiological raw data
- still growing, users can add data
- web-based, free access
- integrates “Food Micromodel” and “Pathogen Modeling Program” data, and many more
- includes new models in “ComBase Predictor”

Predictive Microbiology

Tertiary models-Software

www.combase.cc

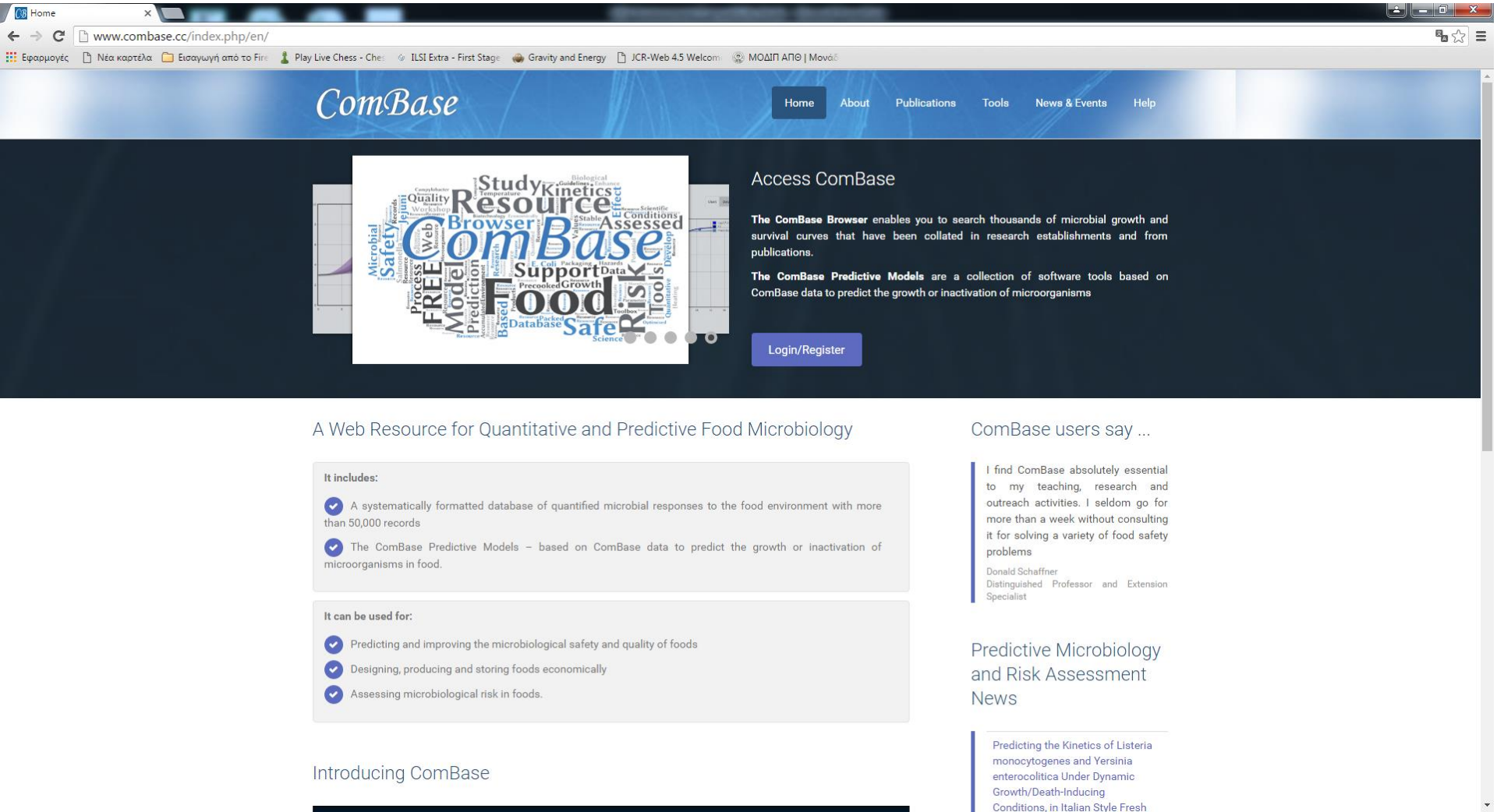
35,000 records on growth and survival of pathogens and spoilage organisms

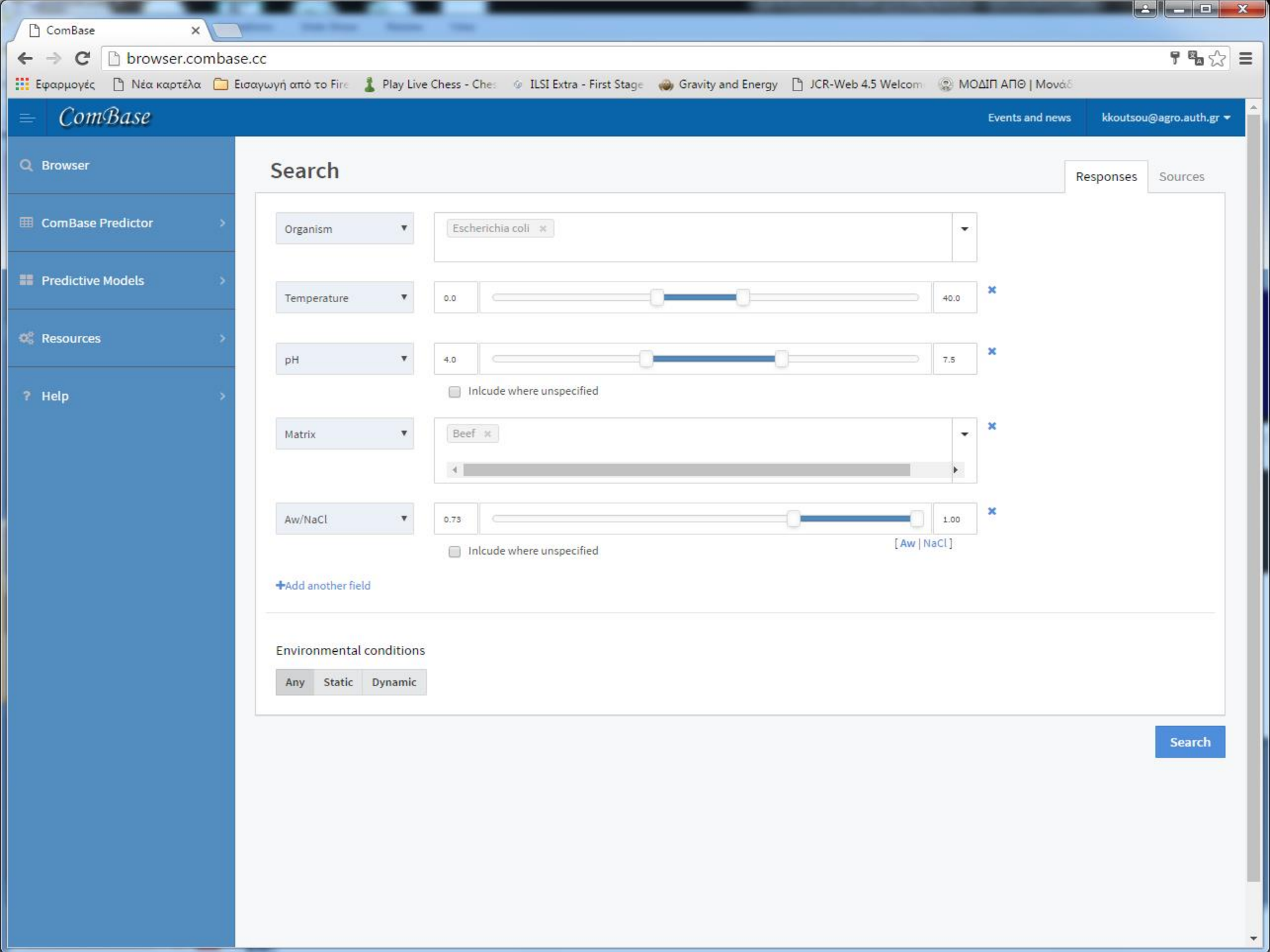
- ~28,000 records on pathogens
- ~4,000 on spoilage organisms, including
- 'total spoilage bacteria' (346)
- '*bacillus* spoilage bacteria' (65)
- *Brocothrix thermosphacta* (741)
- *enterobacteriaceae* (338)
- lactic acid bacteria (701)
- *Shewanella putrefasciens* (57)
- "spoilage yeast" (44)

Predictive Microbiology

Tertiary models-Software

www.combase.cc




ComBase
browser.combase.cc
Εφαρμογές
Νέα καρτέλα
Εισαγωγή από το Fire
Play Live Chess - Che
ILSI Extra - First Stage
Gravity and Energy
JCR-Web 4.5 Welcom
ΜΟΔΙΠ ΑΠΘ | Μονάδ
ComBase
Events and news
kkoutsou@agro.auth.gr
Browser
ComBase Predictor
Predictive Models
Resources
Help
Search
Responses
Sources
Organism
Escherichia coli
Temperature
0.0
40.0
pH
4.0
7.5
Inlcude where unspecified
Matrix
Beef
Aw/NaCl
0.73
1.00
[Aw | NaCl]
Inlcude where unspecified
+Add another field
Environmental conditions
Any
Static
Dynamic
Search

Browser
ComBase Predictor
Predictive Models
Resources
Help

← Back to search

Search results [29 records]

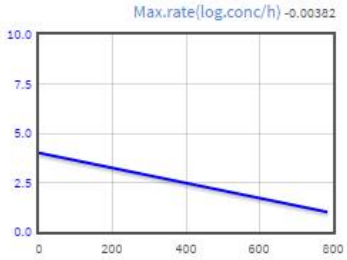
Export ?

Organism (Ascending)

1/3

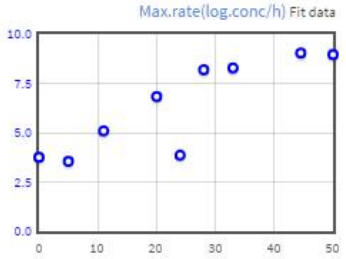
1. *Escherichia coli* in roast beef

Matrix	Beef
Temp (°C)	3
Aw	0.994(assumed)
pH	5.6
Conditions	Cut (minced, chopped, ground, etc), Inoculation in/on previously heated (cooked, baked, pasteurized, etc) but not sterilised food/medium, Sodium chloride in the environment: 1.1 %, Vacuum-packed
Source	*Michel (et al.), 1991: Pathogen survival in precooked beef products and determination of critical control points in processing. Journal of Food Protection 54(10): 767 - 772*



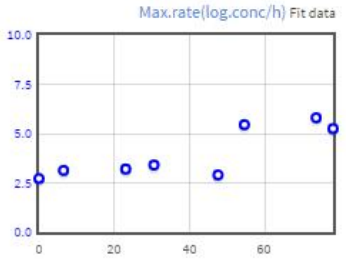
2. *Escherichia coli* in Beef carcass

Matrix	Beef
Temp (°C)	11.1
Aw	0.987
pH	5.76
Conditions	Other species also deliberately inoculated (but only one organism counted here)
Source	*Tasmanian Institute of Agriculture, University of Tasmania, Australia*



3. *Escherichia coli* in Beef carcass

Matrix	Beef
Temp (°C)	11.1
Aw	0.987
pH	5.76
Conditions	Other species also deliberately inoculated (but only one organism counted here)
Source	*Tasmanian Institute of Agriculture, University of Tasmania, Australia*



Browser
ComBase Predictor
Growth
Thermal Inactivation
Non-thermal Survival
Predictive Models
Resources
Help

Growth Model

Prediction | Uncertainty

[Static | Dynamic] [Aw | NaCl]

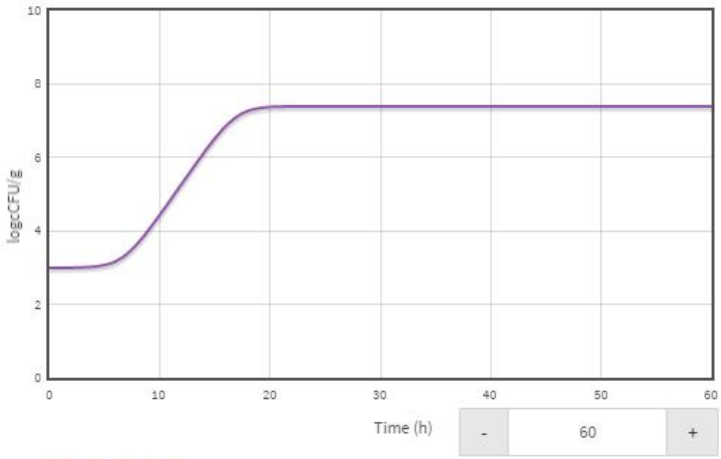
Aeromonas hydrophila

Init. level	3	0	7
Phys.state	1.2e-3	0	1
Temp (°C)	20	2	37
pH	7	4.6	7.5
Aw	0.997	0.974	1

Max.rate (log.conc/h) 0.433 Dbl. time(Hours) 0.696

[Add prediction]

Chart | Data points



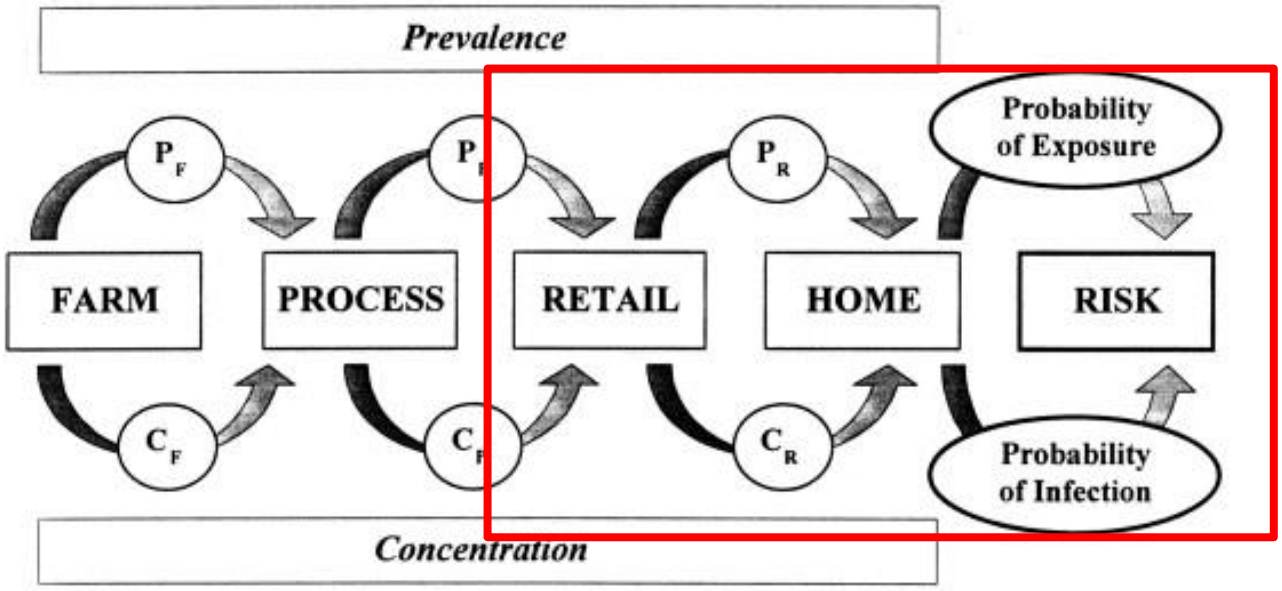
[Plot custom points]

Case Study 1

Deterministic Exposure Assessment of *Listeria monocytogenes* in RTE Foods

For

Evaluating the compliance of RTE foods with the new safety criteria for *Listeria monocytogenes*



Case Study 1

For a vacuum packed, sliced turkey breast product with pH=5.5, aw=0.971 and sodium nitrite concentration of 50 ppm we want to determine a shelf life leading to compliance with the EU reg. 2073/2005 safety criteria for L. monocytogenes.

α) what is the maximum shelf life in days for compliance with the EU reg. 2073/2005

β) How we can increase the shelf life to 25 days

*(assume a mean chill chain temperature of 7 ^{o}C)

The new EC regulation 2073/2005 on microbiological criteria for foodstuffs

Safety Criteria for *L. monocytogenes*

Food category	Samplingplan		Limits		Stage where the criterion applies
	n	c	m	M	
1.2 Ready-to-eat foods able to support the growth of *L. monocytogenes*	5	0	100 cfu/g[4]		Products ready to be placed on the market and during their shelf-life
	5	0	Absence in 25 g[5]		Before the food has left the immediate control of the food business operator, who has produced it
1.3 Ready-to-eat foods unable to support the growth of *L. monocytogenes*	5	0	100 cfu/g		Products ready to be placed on the market and during their shelf-life

Case study 1

Product: cooked ham

(pH=5.49, a_w=0.971, N=50ppm, SL=60 days)

(allows growth of Lm)

Requirement (technical) for the Food Industry for compliance with the new safety criteria for LM in RTE foods

Assure that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

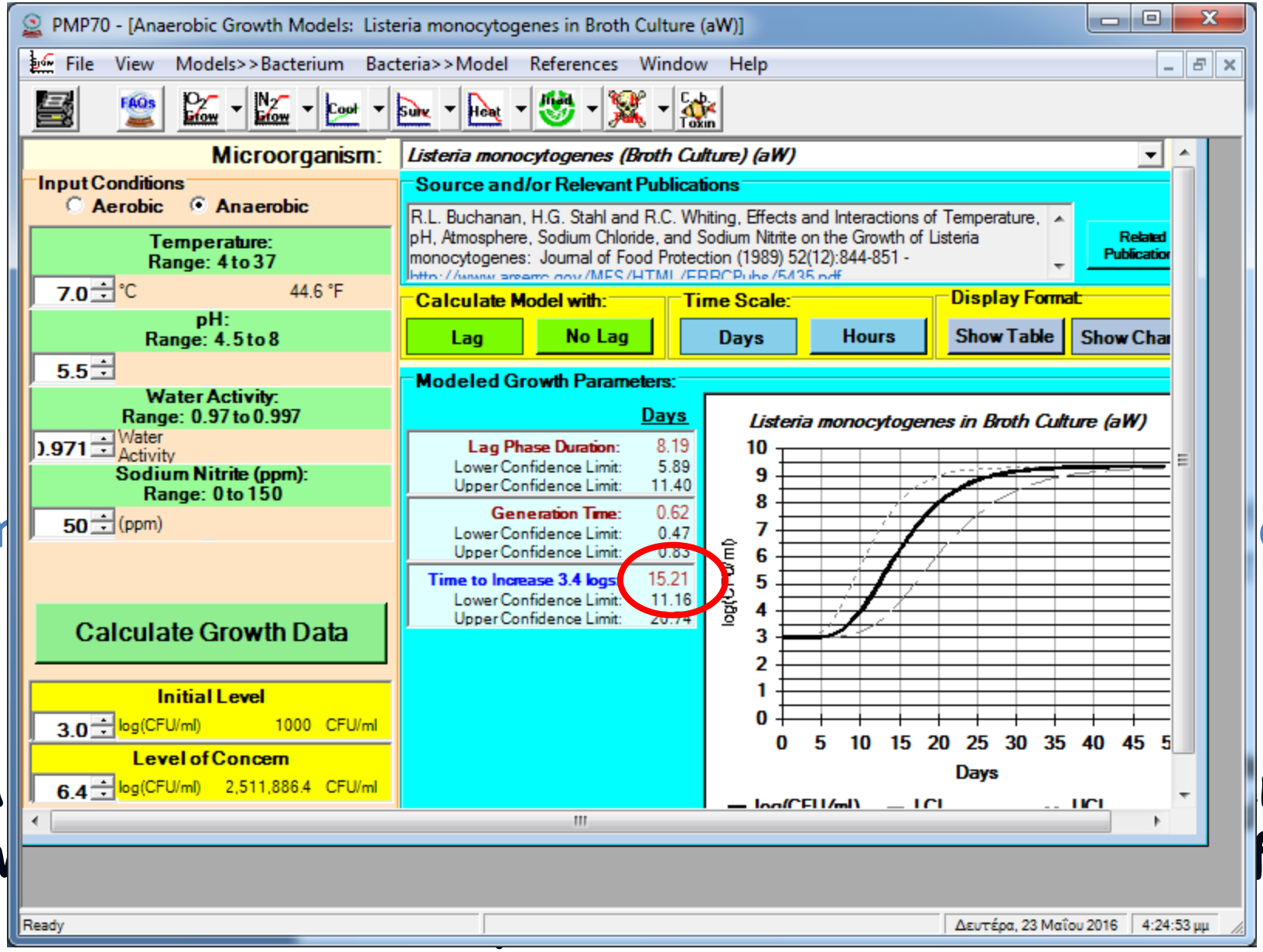
Requirements (technical)

Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

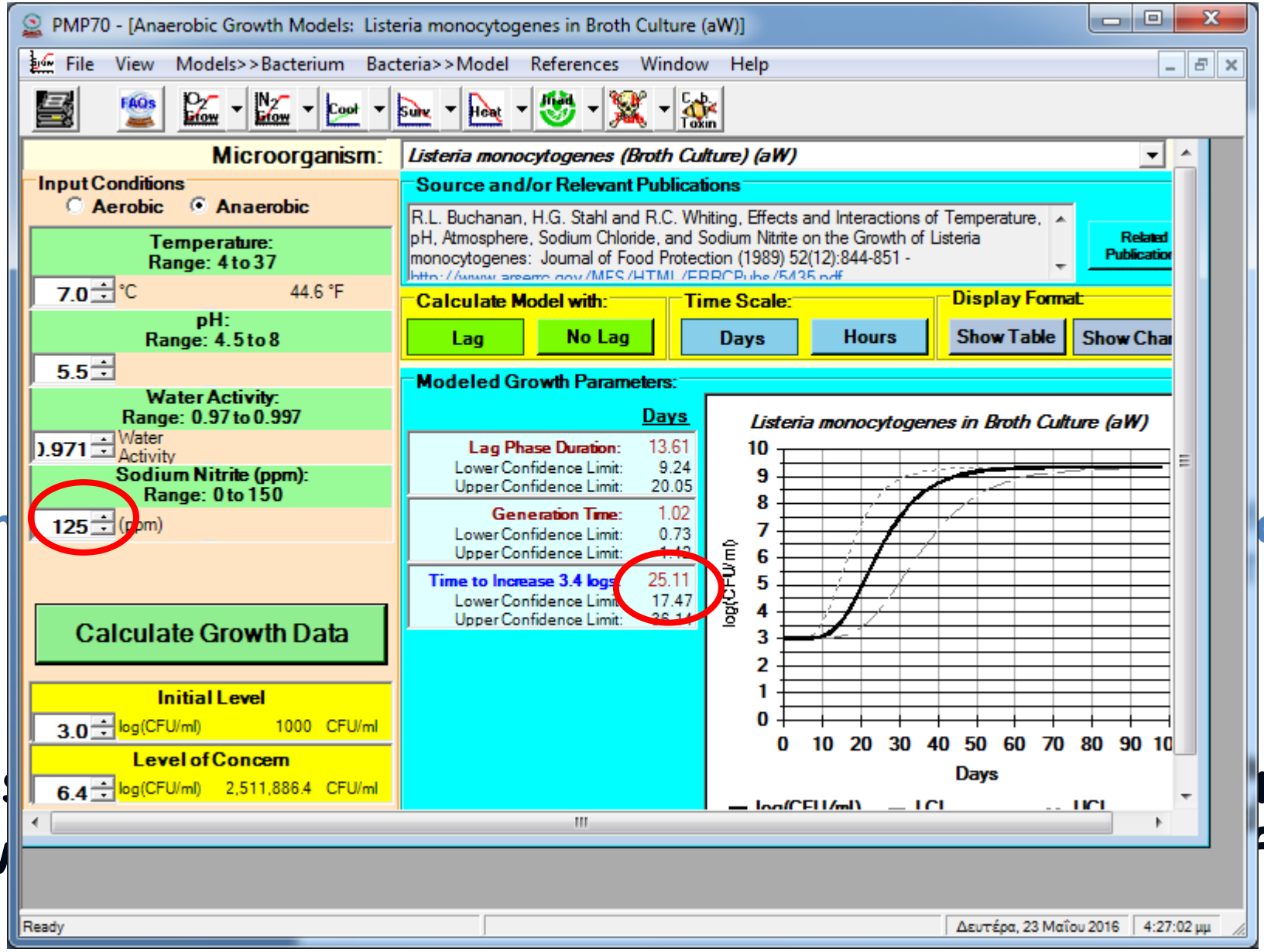
Before the food has left the immediate control of the food business operator, who has produced it	**Absence in 25 g or <-1,4 log cfu/g**
Products ready to be placed on the market and during their shelf-life	**<100 cfu/g or <2 log cfu/g**

Assure that total growth of *L. monocytogenes* will not exceed 3,4 logs cfu/g during the shelf life

Case study 1

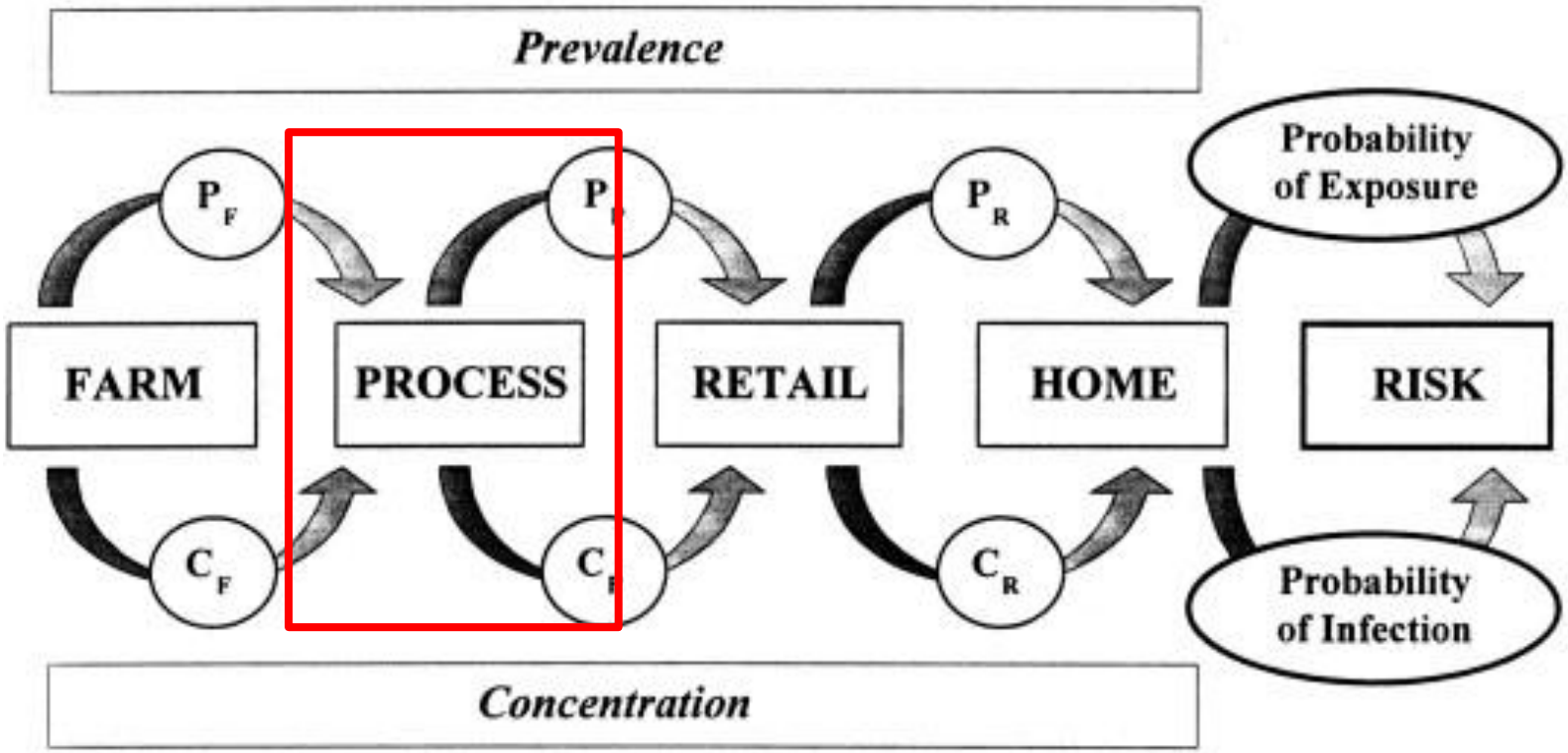

PMP70 - [Anaerobic Growth Models: Listeria monocytogenes in Broth Culture (aW)]
File View Models>>Bacterium Bacteria>>Model References Window Help
Microorganism:
Listeria monocytogenes (Broth Culture) (aW)
Input Conditions
Aerobic
Anaerobic
Temperature:
Range: 4 to 37
7.0 °C 44.6 °F
pH:
Range: 4.5 to 8
5.5
Water Activity:
Range: 0.97 to 0.997
.971 Water Activity
Sodium Nitrite (ppm):
Range: 0 to 150
50 (ppm)
Calculate Growth Data
Initial Level
3.0 log(CFU/ml) 1000 CFU/ml
Level of Concern
6.4 log(CFU/ml) 2,511,886.4 CFU/ml
Source and/or Relevant Publications
R.L. Buchanan, H.G. Stahl and R.C. Whiting, Effects and Interactions of Temperature, pH, Atmosphere, Sodium Chloride, and Sodium Nitrite on the Growth of Listeria monocytogenes: Journal of Food Protection (1989) 52(12):844-851 -
Related Publicatio
Calculate Model with:
Lag
No Lag
Time Scale:
Days
Hours
Display Format:
Show Table
Show Char
Modeled Growth Parameters:
Days
Lag Phase Duration: 8.19
Lower Confidence Limit: 5.89
Upper Confidence Limit: 11.40
Generation Time: 0.62
Lower Confidence Limit: 0.47
Upper Confidence Limit: 0.83
Time to Increase 3.4 logs 15.21
Lower Confidence Limit: 11.16
Upper Confidence Limit: 20.74
Listeria monocytogenes in Broth Culture (aW)
log(CFU/ml)
Days
Ready
Δευτέρα, 23 Μαΐου 2016
4:24:53 μμ

Case study 1


PMP70 - [Anaerobic Growth Models: Listeria monocytogenes in Broth Culture (aW)]
File View Models>>Bacterium Bacteria>>Model References Window Help
Microorganism:
Listeria monocytogenes (Broth Culture) (aW)
Input Conditions
Aerobic
Anaerobic
Temperature:
Range: 4 to 37
7.0 °C 44.6 °F
pH:
Range: 4.5 to 8
5.5
Water Activity:
Range: 0.97 to 0.997
0.971 Water Activity
Sodium Nitrite (ppm):
Range: 0 to 150
125 (ppm)
Calculate Growth Data
Initial Level
3.0 log(CFU/ml) 1000 CFU/ml
Level of Concern
6.4 log(CFU/ml) 2,511,886.4 CFU/ml
Source and/or Relevant Publications
R.L. Buchanan, H.G. Stahl and R.C. Whiting, Effects and Interactions of Temperature, pH, Atmosphere, Sodium Chloride, and Sodium Nitrite on the Growth of Listeria monocytogenes: Journal of Food Protection (1989) 52(12):844-851 -
Related Publication
Calculate Model with:
Lag
No Lag
Time Scale:
Days
Hours
Display Format:
Show Table
Show Char
Modeled Growth Parameters:
Days
Lag Phase Duration: 13.61
Lower Confidence Limit: 9.24
Upper Confidence Limit: 20.05
Generation Time: 1.02
Lower Confidence Limit: 0.73
Upper Confidence Limit:
Time to Increase 3.4 logs 25.11
Lower Confidence Limit: 17.47
Upper Confidence Limit:
Listeria monocytogenes in Broth Culture (aW)
log(CFU/ml)
Days
0 10 20 30 40 50 60 70 80 90
0 1 2 3 4 5 6 7 8 9 10
Ready
Δευτέρα, 23 Μαΐου 2016
4:27:02 μμ

Case Study 2

Microbial Inactivation in Exposure Assessment



Case Study 2

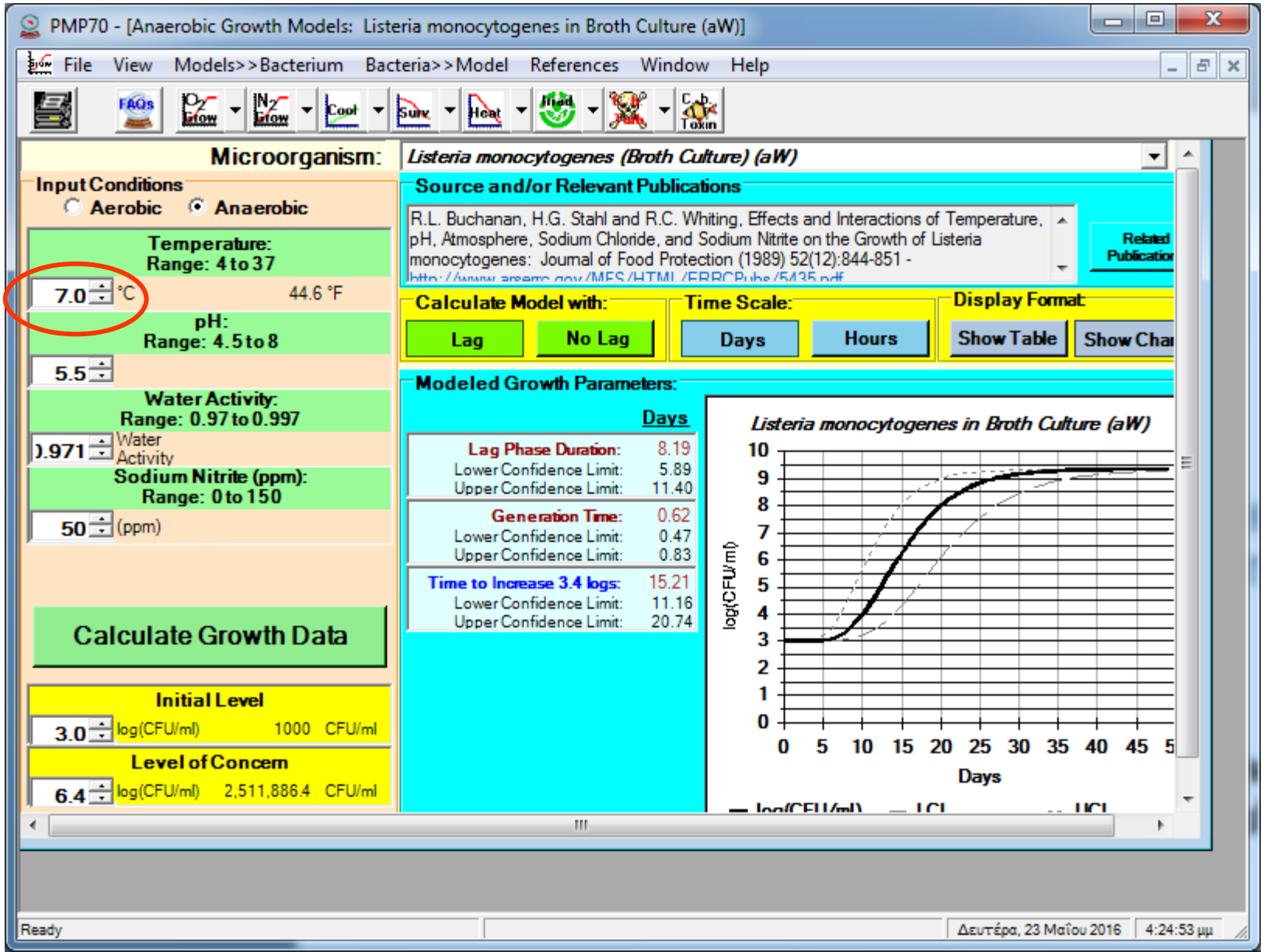
A raw beef with (pH=5.7 and aw=0.989) batch is contaminated with 10.000 cfu/g E. coli O157:H7

What is the concentration of the pathogen after thermal processing at 62 ^{o}C for 3.5 min

Case Study 3

Stochastic Exposure Assessment of *Listeria monocytogenes* in RTE Foods

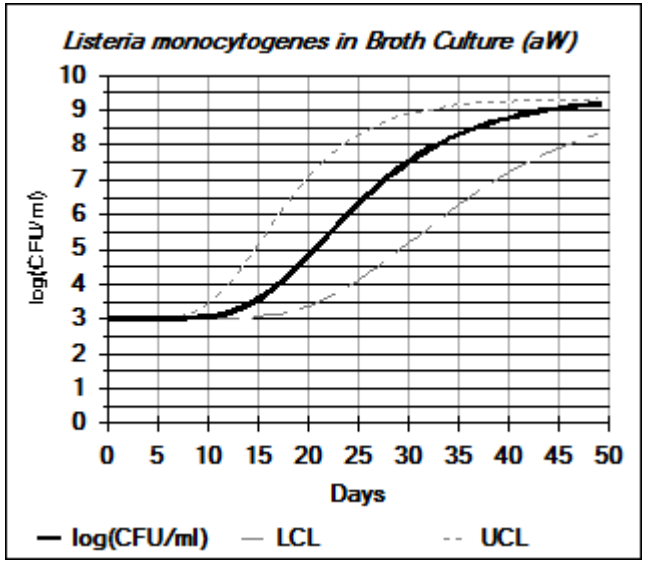
2.Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail



2.Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

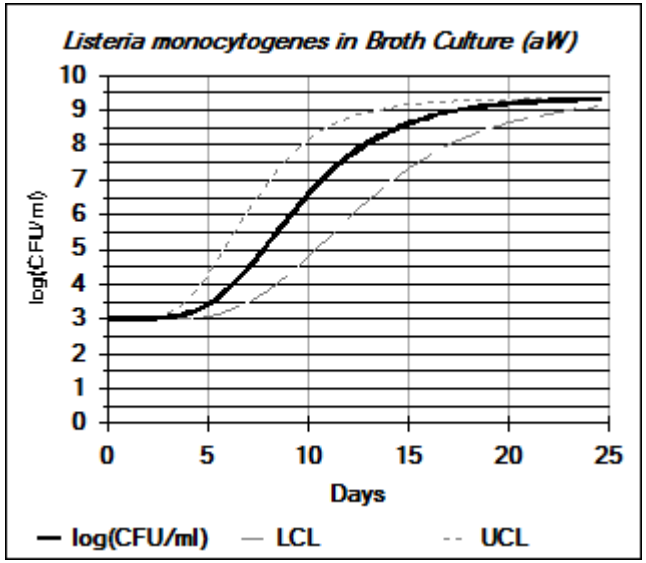
Use of available predictive modeling software (i.e PMP)

4 °C



25 days for 3 logs increase

10 °C



10 days for 3 logs increase

2.Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

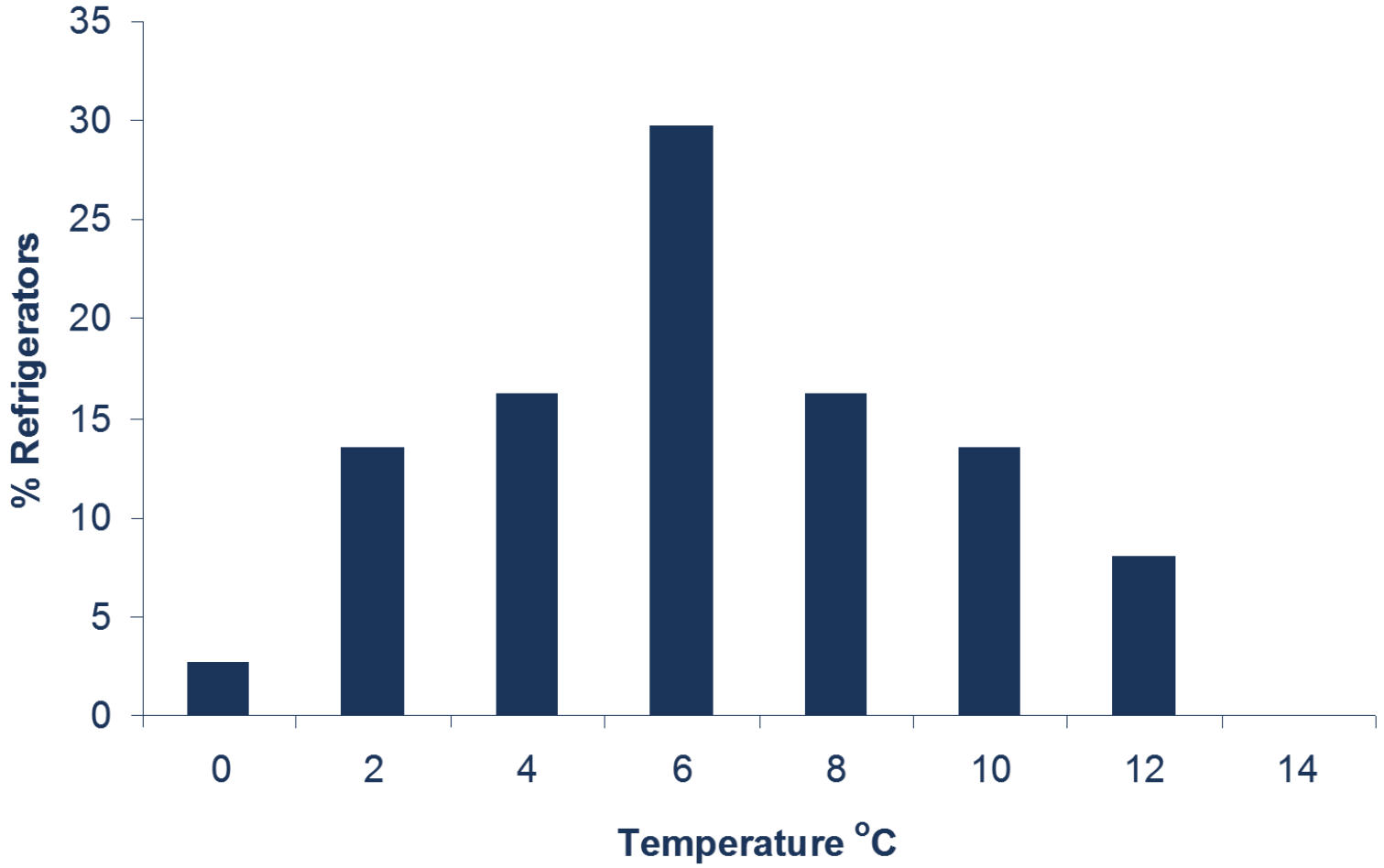
At which temperature ?

General Requirements in Reg. 2073/2005

the food safety criteria applicable throughout the shelf-life of the products can be met under reasonably,foreseeable conditions of distribution, storage and use.

Chill Chain Conditions

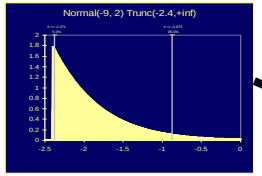
Temperature distribution in retail refrigerators (survey in Greece)



Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

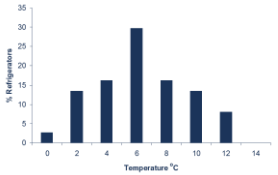
Probabilistic approach

Initial contamination



Product Characteristics (pH, aw, Shelf Life…

Chill chain characteristics

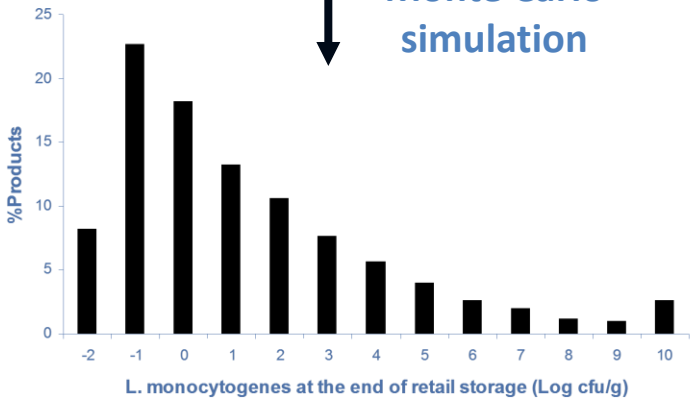


G/NG and Kinetic model*

Biological variability

Monte Carlo simulation

Distribution of *L. monocytogenes* concentration at the end of shelf life

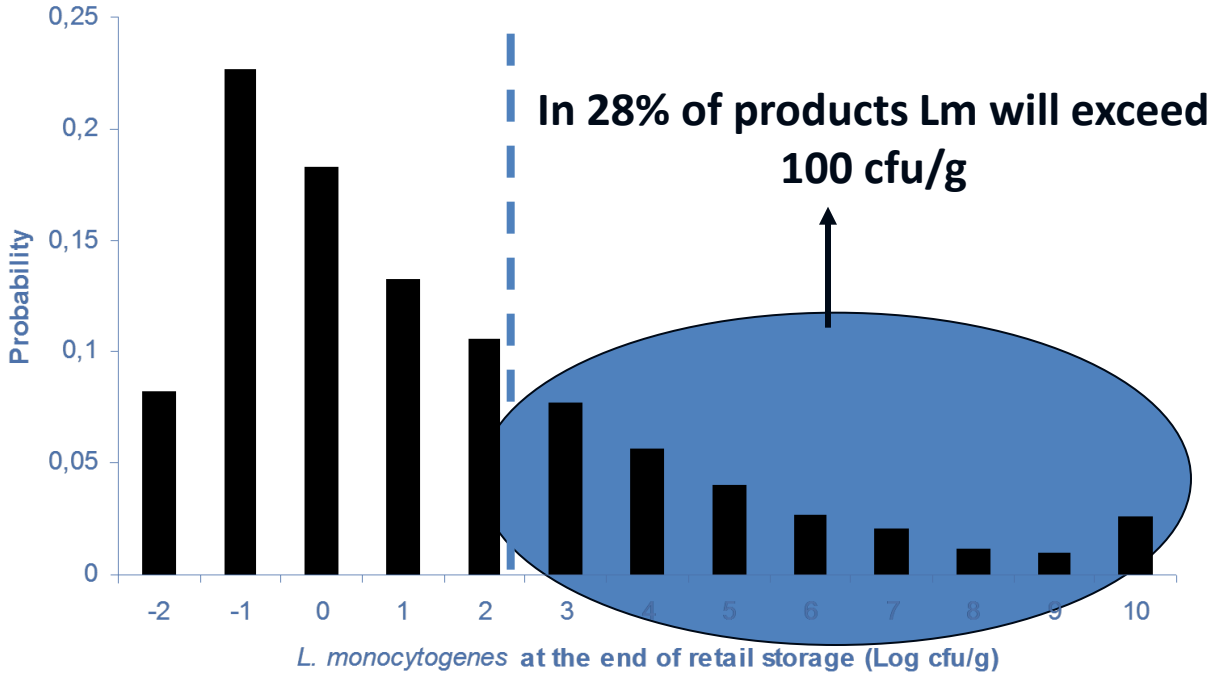


Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

Case study

Product: cooked ham (pH=5.49, a_w=0.971, N=50ppm, SL=60 days)

Distribution of *L. monocytogenes* at the end of shelf life in retail



Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

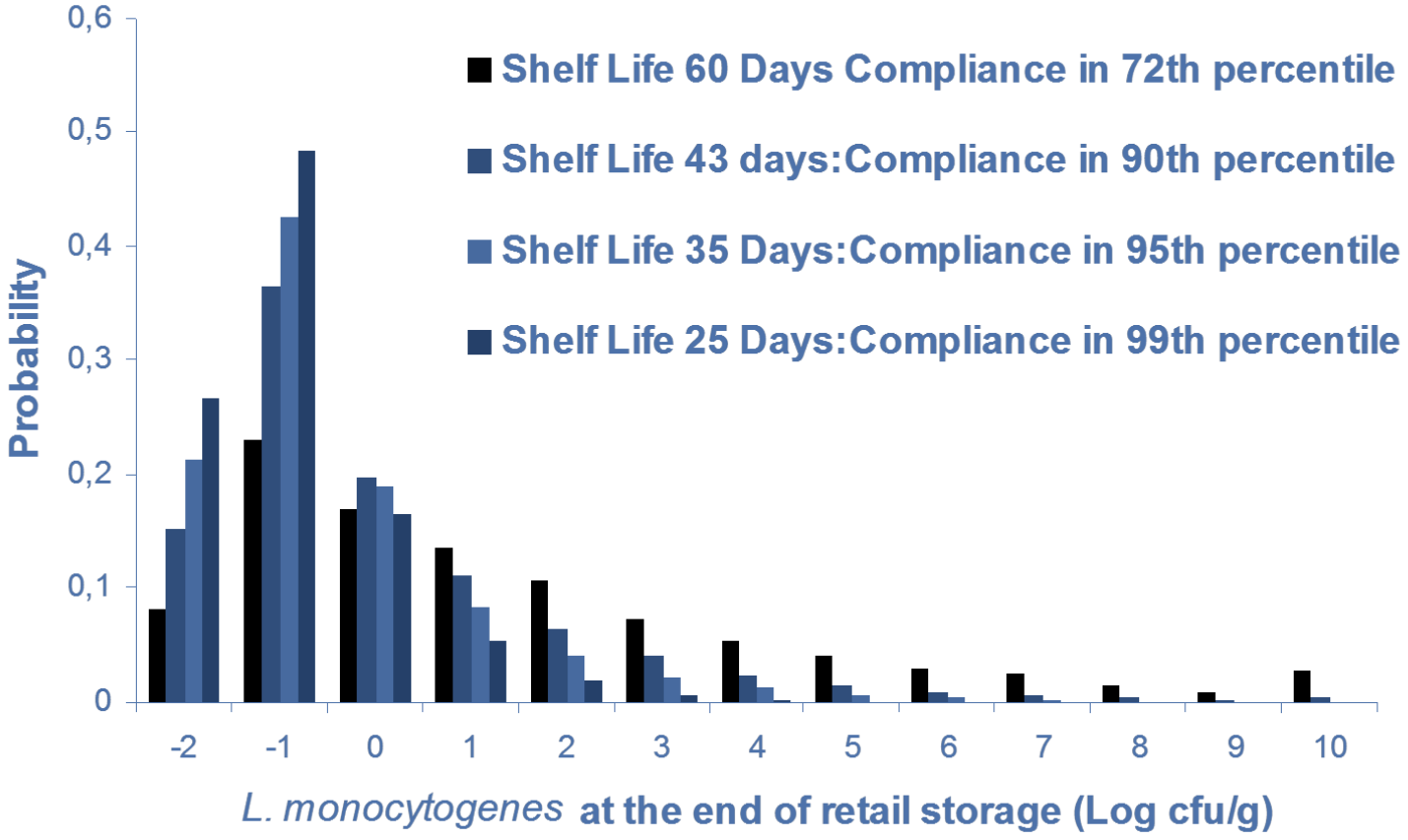
Potential actions for achieving the desired level of compliance to the Safety criteria

- **Adjust the shelf life of the product**
- **Modify the formulation of the product**

Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

Potential actions for meeting the Safety criteria

Adjust the shelf life of the product



Prove that the concentration of the pathogen will not exceed 100 cfu/g at the end of shelf life in retail

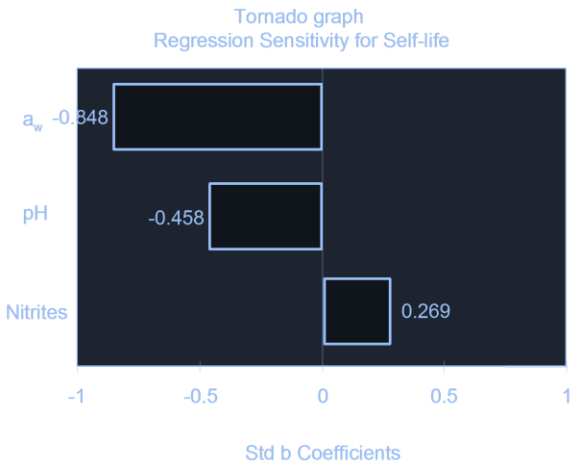
Potential actions for meeting the Safety criteria

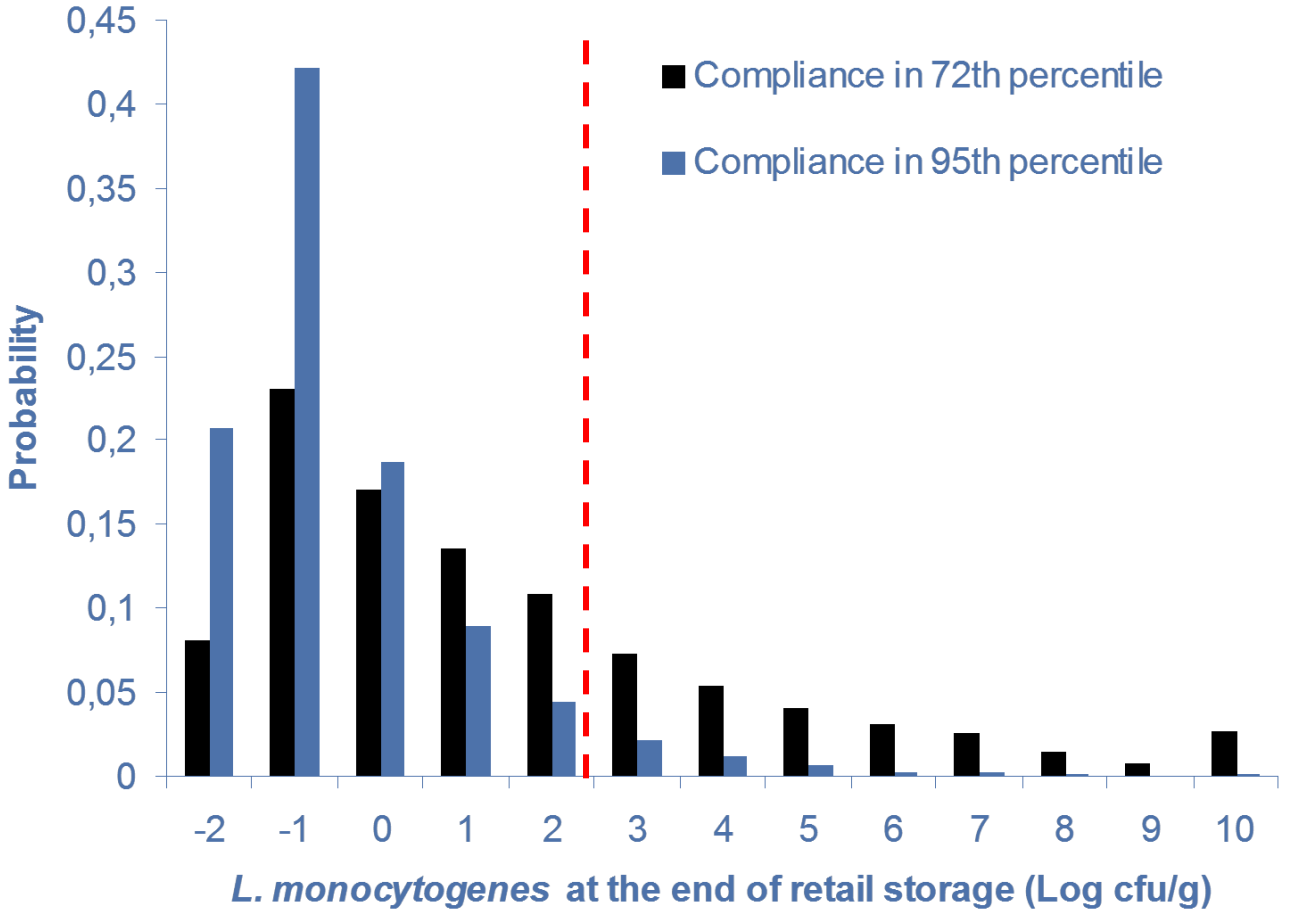
Modify the formulation of the product

Cooked ham

a_w 0.971 → 0.96

N 50ppm → 80ppm

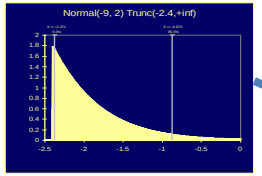




Using the probabilistic approach for both safety and spoilage

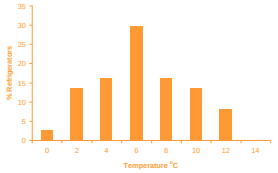
Probabilistic approach

Initial contamination



Product Characteristics (pH, a_w, Shelf Life…

Chill chain characteristics



Kinetic model for Lm

Kinetic model for SSO

SSO Spoilage Level

Distribution of *L. monocytogenes* concentration

Distribution of SSO level

Using the probabilistic approach for both safety and spoilage

Case study

Product: cooked ham

pH=5.49, a_w=0.971, N=50ppm, SL=60 days

SSO: *L. sakei*

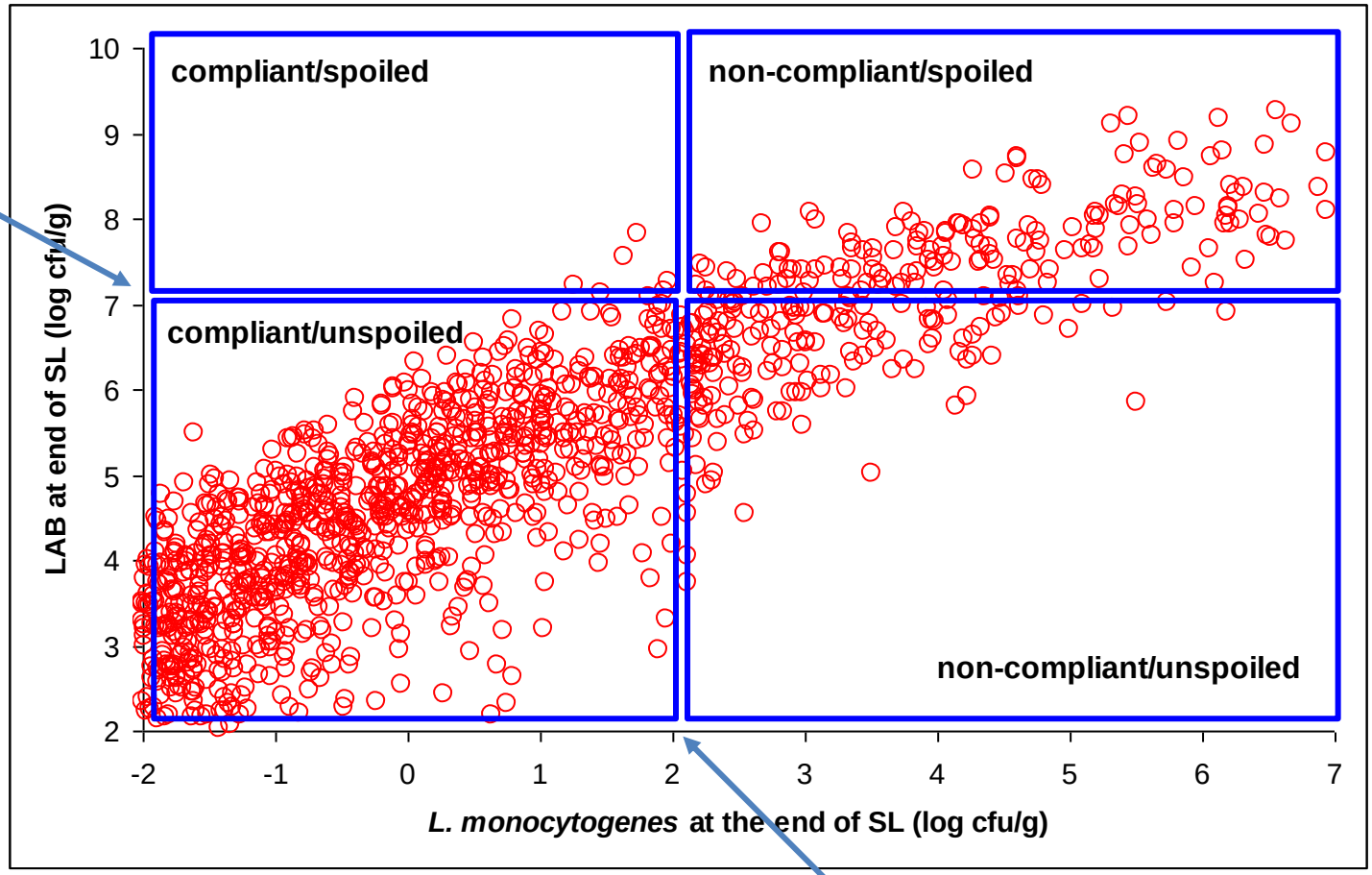
Spoilage level 10^7 cfu/g

Using the probabilistic approach for both safety and spoilage

Case study

Product: cooked ham SL 60 days

Spoilage Level



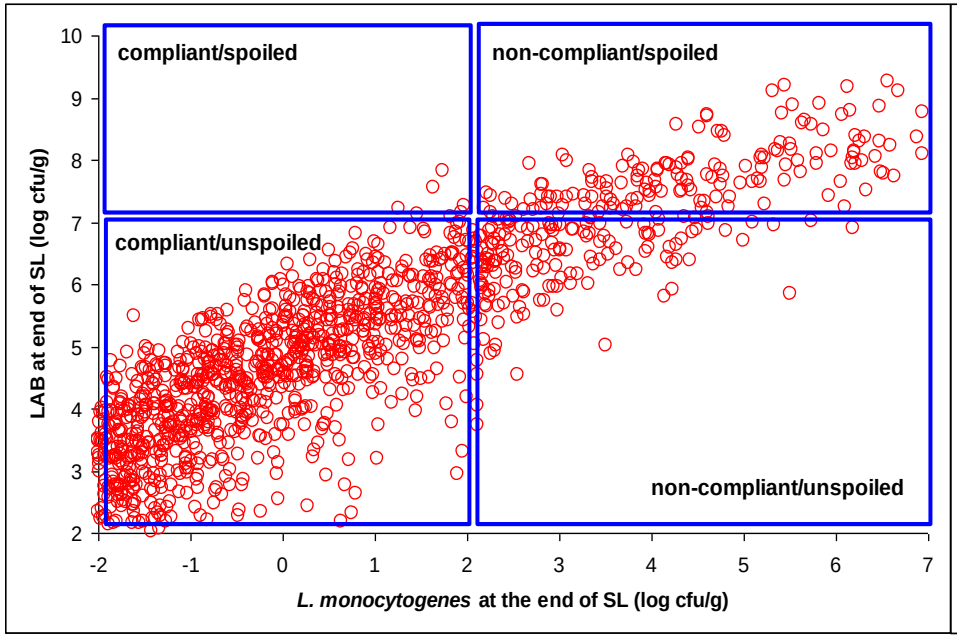
Safety criterion

Using the probabilistic approach for both safety and spoilage

Case study

Product: cooked ham

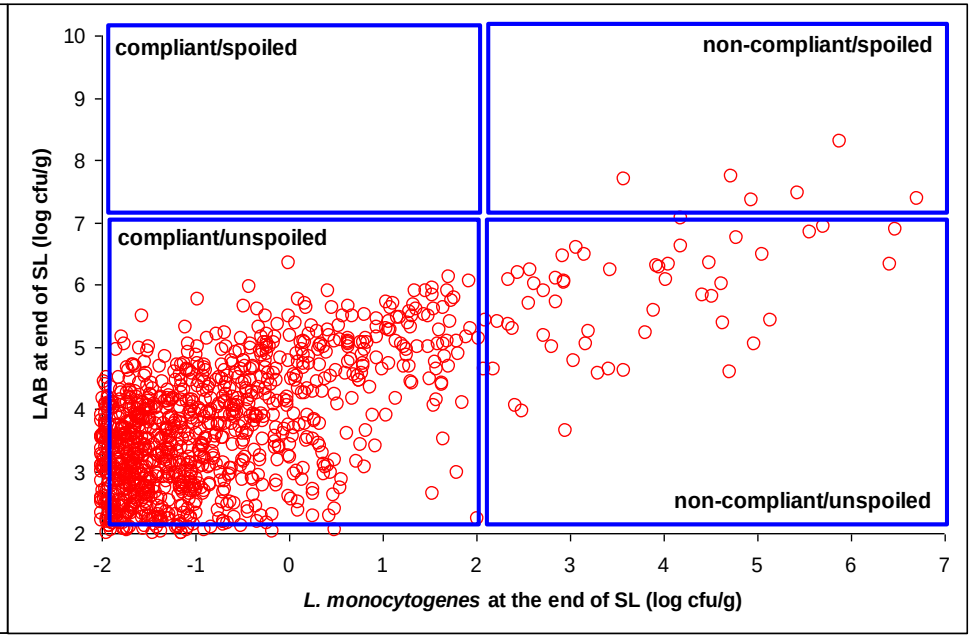
SL 60 days



72% compliance

17% spoiled before end of Shelf life

SL 25 days



99% compliance

0.1% spoiled before end of Shelf life

Predictive Microbiology (applications)

Questions?

For future questions you can contact me
kkoutsou@agro.auth.gr

efsa
European Food Safety Authority

Summer School
"In Silico Methods for Food Safety"