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Listeria monocytogenes - surveillance and interventions

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Annual Report on Zoonoses in Denmark 2024

5. Will new EU regulation on *Listeria monocytogenes* in ready-to-eat foods contribute to the prevention of listeriosis? Hansen and Dalgaard (2025)

Listeria monocytogenes - surveillance and interventions

Outline

- *Listeria monocytogenes* and listeriosis
  - surveillance, challenges and options
- New EU regulation from 1/7-2026
- Interventions – with focus on aquatic food
- Conclusions
- Perspectives 1-3

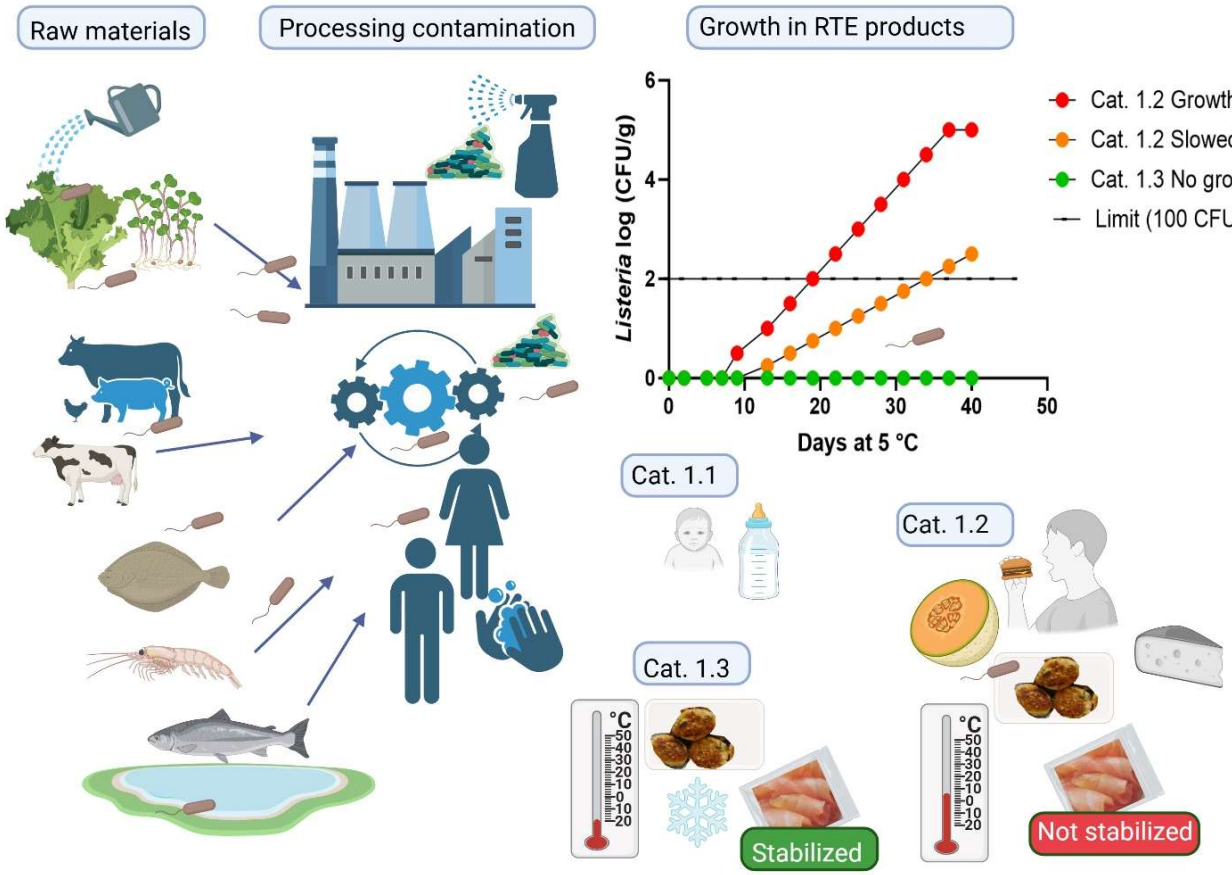
Listeria and listeriosis – surveillance and challenges

Region	Rates of listeriosis (cases per 100,000 population/year)					
	2020-2024	2020	2021	2022	2023	2024
Denmark, Finland, Iceland, Sweden	1.1	1.1	1.2	1.1	1.1	1.2
Norway	0.6	0.7	0.4	0.6	0.7	0.5
EU	0.6	0.4	0.5	0.6	0.7	0.7

- 284 cases of listeriose/year in the Nordic countries
- ~15% mortality
- Aquatic ready-to-eat (RTE) foods are very much involved e.g. smoked and Gravad fish
- The rate of listeriosis is increasing within EU → New regulation from 1/7-2026
- Major changes are needed for Nordic countries to obtain high food safety with respect to *Listeria monocytogenes*

The European Union One Health 2024 Zoonoses Report (EFSA, 2025)

Listeria monocytogenes – challenges and options



- *L. monocytogenes* is present in the environment and low concentrations may occur in some aquatic food raw materials
- *L. monocytogenes* is difficult to remove from processing equipment
- Growth of *L. monocytogenes* in aquatic food, to more than 100 CFU/g (2 log CFU/g), is critical for listeriosis
- EU regulation separate stabilized (Cat. 1.3) and non-stabilized (Cat. 1.2) RTE foods
- *L. monocytogenes* has been extensively studied → We have options to manage survival and growth in aquatic food products

New EU regulation (EU 2895/2024) – changes to category 1.2 from 1/7-2026

EU Regulation	Limits (in 5 samples)[a]	When	Scope of application
OLD: EC 2073/2005			
	100 CFU/g[b]	Products placed on the market during their shelf-life	Apply if FBO[d] **can** demonstrate to the CA[e] that 100 CFU/g will not be reached during the shelf-life of the product
	Not detected in 25 g[c]	When leaving the control of the food business operator, who has produced it	Apply if FBO **cannot** demonstrate to the CA that 100 CFU/g will not be reached during the shelf-life of the product
NEW: EU 2895/2024			
	100 CFU/g[b]	Products placed on the market during their shelf-life	Apply if FBO **can** demonstrate to the CA that 100 CFU/g will not be reached during the shelf-life of the product
	Not detected in 25 g[c]	Products placed on the market during their shelf-life	Apply if FBO **cannot** demonstrate to the CA that 100 CFU/g will not be reached during the shelf-life of the product

Notes: a – n = 5, c = 0, for 100 CFU/g limit m=M=100; b - Analytical method EN/ISO11290-2; c - Analytical method EN/ISO 11290-1; d - FBO is the food business operator (entity responsible for ensuring that food law requirements are met), e - CA is the competent authority.

New EU regulation → increased focus on:

- **Hygiene and inactivation of *L. monocytogenes* in RTE foods**
- **Safe shelf-life (time to 100 CFU/g) and stabilization of RTE foods to prevent growth of *L. monocytogenes***

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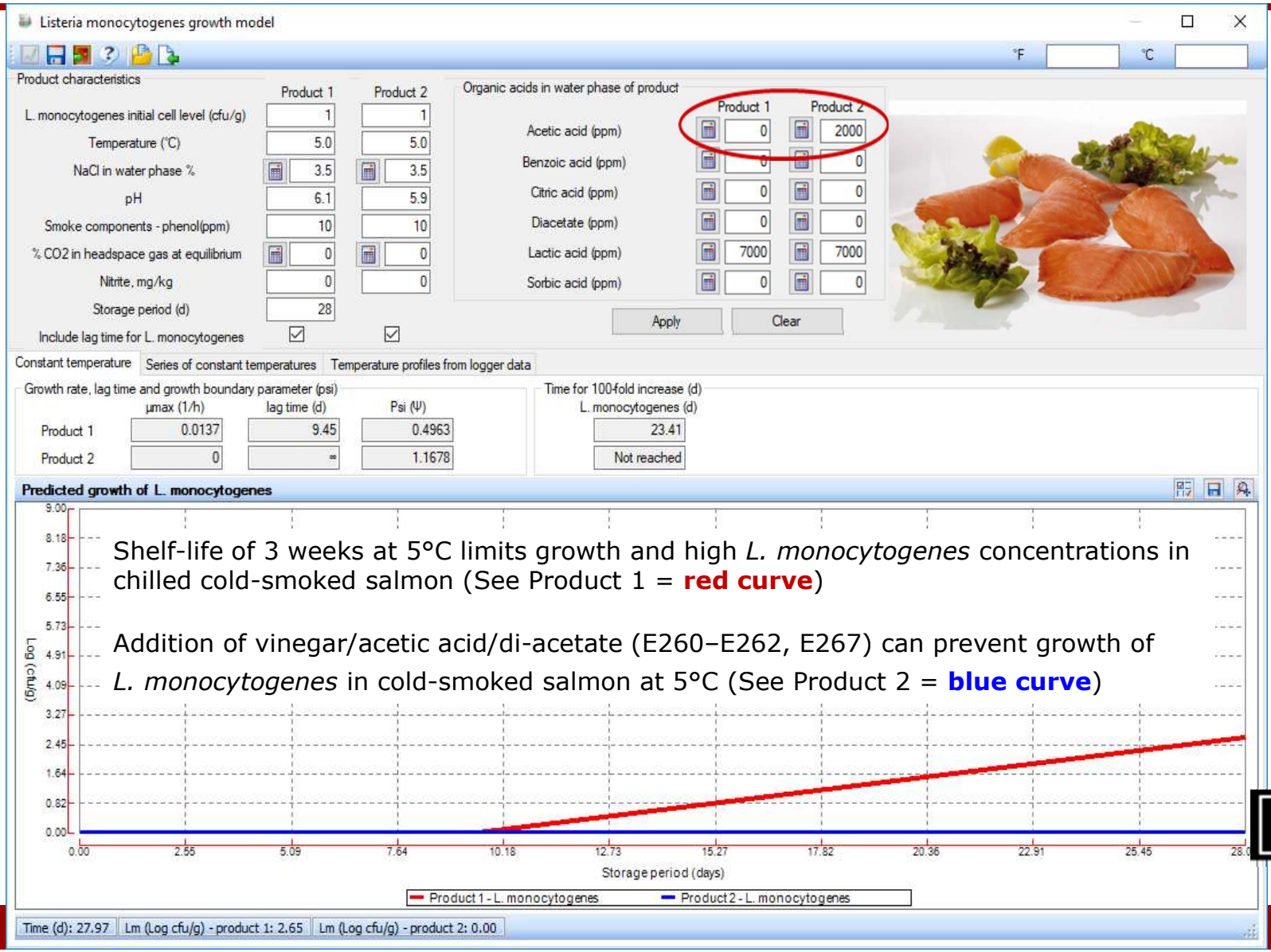
Cold-smoked and Gravad fish

Challenges

- These aquatic foods have for more than 30 years caused numerous outbreaks of listeriosis
- *L. monocytogenes* can be present in fish raw material (low concentration)
- Products can be contaminated during processing - particularly during slicing

Processing and distribution

- Cold-smoking or marination do not inactivate *L. monocytogenes*
- Products are often distributed in vacuum- or modified atmosphere packing (MAP) with storage time of 4 weeks (or more) at 5°C



Shelf-life of 3 weeks at 5°C limits growth and high *L. monocytogenes* concentrations in chilled cold-smoked salmon (See Product 1 = **red curve**)

Addition of vinegar/acetic acid/di-acetate (E260–E262, E267) can prevent growth of *L. monocytogenes* in cold-smoked salmon at 5°C (See Product 2 = **blue curve**)

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Cold-smoked and Gravad fish

Different interventions

- Prevent growth using recipe to stabilize product e.g. with vinegar/acetic acid/di-acetate (E260–E262, E267)
  - Used by Royal Greenland for > 12 years without recalls
- Limit growth using a safe shelf-life of < 3 weeks at 5°C
- Frozen distribution (Cat. 1.3) with short chilled shelf-life (max. 4 days) after thawing
- Protective cultures/lactic acid bacteria (LAB) can limit growth of *L. monocytogenes*
  - Typically to 1-2 log increases in cell concentrations
  - Requires high concentrations of LAB strains – selected not to spoil the product
- Bacteriophages can inactivate *L. monocytogenes*
  - Typically with ~2 log reductions

  → Not an approved treatment within EU

Fish cakes/patties

Challenges

- Fish cakes/patties caused listeriosis outbreaks in 2022 and 2024 in Denmark

Processing and distribution

- Correct pan-frying of fish cakes/patties inactivates *L. monocytogenes*
- Products are distributed in air with storage times of a few days or in MAP with with declared/labelled shelf-life of up to 30-35 days at 5°C

Listeria monocytogenes growth model

Product characteristics

	Product 1	Product 2
Initial cell conc. (cfu/g) and lag time	1	1
Temperature (°C)	5.0	5.0
NaCl in water phase %	1.8	1.8
pH	6.5	6.5
Smoke components - phenol(ppm)	0	0
% CO2 in headspace gas at equilibrium	0	20
Nitrite, mg/kg	0	0
Storage period (d)	28	

Organic acids in water phase of product

	Product 1	Product 2
Acetic acid (ppm)	0	0
Benzoic acid (ppm)	0	0
Citric acid (ppm)	0	0
Diacetate (ppm)	0	0
Lactic acid (ppm)	2000	2000
Sorbic acid (ppm)	0	0

Apply Clear

Constant temperature | Series of constant temperatures | Temperature profiles from logger data

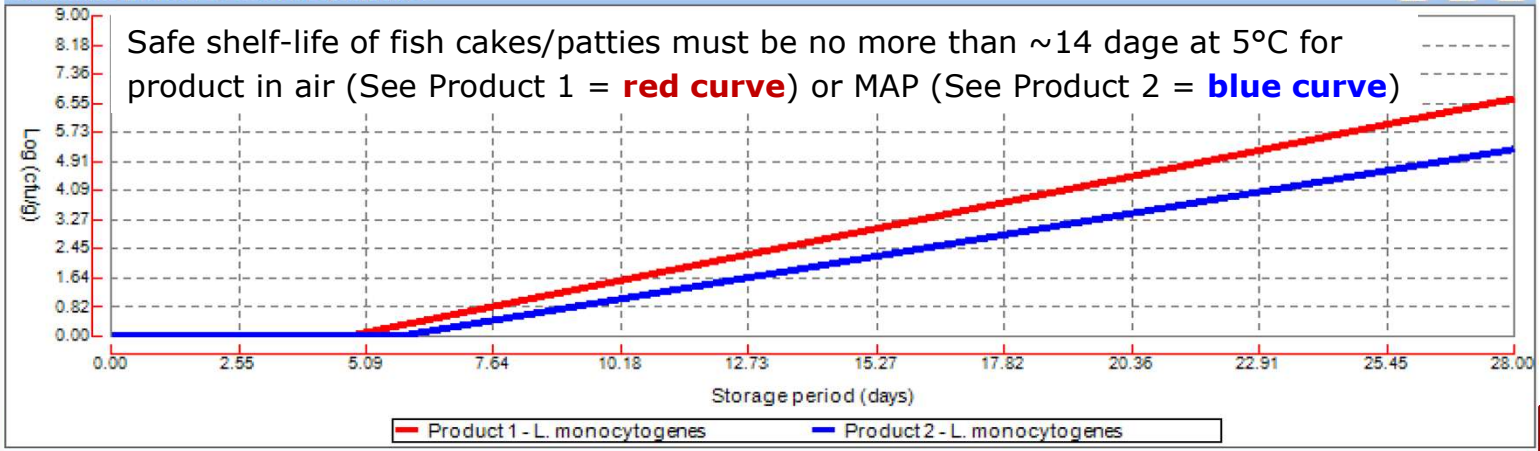
Growth rate, lag time and growth boundary parameter (psi)

	μmax (1/h)	lag time (d)	Psi (Ψ)
Product 1	0.0275	4.72	0.2822
Product 2	0.0226	5.74	0.2938

Time for 100-fold increase (d)

	L. monocytogenes (d)
Product 1	11.69
Product 2	14.22

Predicted growth of L. monocytogenes



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Listeria monocytogenes growth model

°F °C

Product characteristics

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Initial cell conc. (cfu/g) and lag time	1	1
Temperature (°C)	5.0	5.0
NaCl in water phase %	1.8	1.8
pH	6.5	6.0
Smoke components - phenol(ppm)	0	0
% CO2 in headspace gas at equilibrium	20	20
Nitrite, mg/kg	0	0
Storage period (d)	21	

Organic acids in water phase of product

	Product 1	Product 2
Acetic acid (ppm)	0	3000
Benzoic acid (ppm)	0	0
Citric acid (ppm)	0	0
Diacetate (ppm)	0	0
Lactic acid (ppm)	2000	6000
Sorbic acid (ppm)	0	0

Apply Clear

Constant temperature | Series of constant temperatures | Temperature profiles from logger data

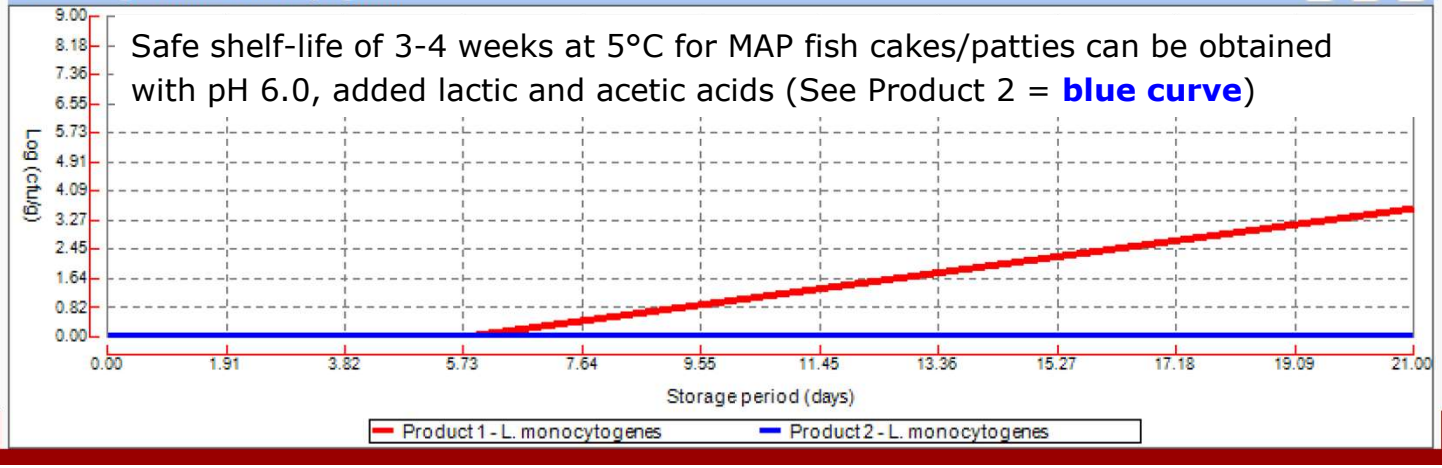
Growth rate, lag time and growth boundary parameter (psi)

	μmax (1/h)	lag time (d)	Psi (Ψ)
Product 1	0.0226	5.74	0.2938
Product 2	0	∞	1.0226

Time for 100-fold increase (d)

	L. monocytogenes (d)
Product 1	14.22
Product 2	Not reached

Predicted growth of L. monocytogenes



Safe shelf-life of 3-4 weeks at 5°C for MAP fish cakes/patties can be obtained with pH 6.0, added lactic and acetic acids (See Product 2 = **blue curve**)

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Fish cakes/patties

Different interventions

- Declared shelf-life of ~14 days at 5°C
- Frozen distribution (Cat. 1.3) with short shelf-life after thawing
- Reduce/prevent growth using recipe with lowered pH, added lactic acid and added vinegar/acetic acid/di-acetate together with shelf-life of 3-4 weeks at 5°C

Labelling

- It is not effective to indicate on the label of pre-fried products that they must be heated prior to consumption

Listeria monocytogenes - surveillance and interventions

Conclusions

- Prevalence of listeriosis in Denmark, Finland, Iceland and Sweden is twice the EU average

  → New interventions are needed to improve this situation

- Hygiene cannot be used alone but must be used in combination with effective interventions to manage occurrence and growth of *L. monocytogenes*
- Very substantial knowledge about *L. monocytogenes* is available and several types of interventions can be used to manage its occurrence and growth
- Processors (FBOs) can choose different interventions for high-risk products

  → It is not an option to avoid interventions for these products

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Listeria monocytogenes - surveillance and interventions

Perspective 1 – Expanded focus for outbreak investivgations

- Whole genome sequencing (WGS) is an important tool for listeriosis investigations and essential to (*i*) identify responsible products and FBOs, (*ii*) enable targeted recalls and (*iii*) limit the extent of an ongoing outbreak

  → This does not prevent future listeriosis outbreaks/cases for the same type of product (e.g. Smoked and Gravad fish, Fish cakes/patties, …)

- Related to listeriosis outbreaks and *Listeria* surveillance, potential growth in products can be predicted based on measured product characteristics and storage conditions

  → Product preservation and/or safe shelf-life can then be changed to avoid unacceptable growth

- In the future both WGS and predictive models/software should be used to understand and prevent outbreaks/cases of listeriosis

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Listeria monocytogenes - surveillance and interventions

Perspective 2 - Labelling

- Current labelling (e.g. 'E260' or 'Protective culture') does not allow consumers (or even experts) to determine if *L. monocytogenes* can grow or not in RTE aquatic products
- To allow e.g. elderly consumers to select stabilized RTE foods we suggest a voluntary label that can be used when an FBO has documented efficient preservation of a product to prevent growth of *L. monocytogenes*

- When shopping, this will allow elderly consumers select RTE aquatic foods and obtain the associated health benefits without an accompanying risk of listeriosis.

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Perspective 3 – Improved predictive models/software

- FSSP v. 5 available from fssp.food.dtu.dk in March 2026
- *L. monocytogenes* models applicable at low pH (pH > 4.6)
- *L. monocytogenes* models for dynamic temp., pH and lactic acid
- *L. monocytogenes* models for seafood, meat and dairy products
- Improved guidance for correct application of models
- One-day workshops for interrested FSSP users in different countries

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