

# TRUEFOOD: A practical procedure for assessing the safety of traditional fermented air dried sausages

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## Objectives

- To develop tools for assessing the microbiological safety risks of traditional fermented, non-heat-treated, ready-to-eat meat products to support industry decisions
  - Combined use of
    - microbiological risk profiling;
    - predictive modelling;
    - challenge testing;
    - probabilistic modelling.
  - Use of the available information for a simplified assessment of the risks associated with *Listeria monocytogenes*, *Staphylococcus aureus* in smoked, naturally fermented, air-dried, RTE meat products and with *Listeria monocytogenes* for "flamed" sausages at the time of the consumption

## Background

- The prevalence of *Listeria monocytogenes* and *Staphylococcus aureus* in traditional smoked sausages can't be excluded.
- There is a need for systematic approach for collecting information for improving the food safety control measures in the industry.
- The knowledge about the behaviour of pathogens in the distribution chain till the consumption is limited
- Slicing, vacuum/MAP packaging is more widely used.

## Method

1. Collection of data on
  - intrinsic properties of the products
  - prevalence and concentration of pathogens
2. Draft Risk Profiling of Industrial Microbiological Risk Assessment (IMRA by CCFRA) for selecting priorities
3. Challenge testing at constant and fluctuating temperatures
4. Predictive modelling and probabilistic modelling
5. Comparison of the results of challenge testing and predictive modelling
6. Conclusions for Improved Risk Profiling

## Product characteristics

Flamed sausage	Smoked, naturally fermented dried sausage
• No heat treatment	• No heat treatment
• Flaming/smoking (drying of the surface)	• Smoking
at < 10°C      3 days	at <10°C      4 days or at < 14°C      3 days
• followed by	• Fermentation and drying
at < 14°C      4 days	at < 18°C      14-28 days
• Shelf-life: 14-21 days	• Shelf-life: 35-56 days
• $a_w$ : 0.94 → 0.86	• $a_w$ : 0.92 → 0.87
• Salt: 3.0 – 4.0%	• Salt: 3.5 – 4.3%
• pH: 4.7 – 5.2	• pH: 4.95 – 5.5
• nitrite (initial) 100 ppm	• nitrite (initial) 100 ppm

## Considerations (1)

- Significant deviations:
  - variation in product composition/brands, batches – but pressure to increase shelf-life as competitors do;
  - temperature fluctuations, abuse in cold chain;
  - consumer practices – mishandling, misuse
  - low consumer awareness of potential growth of pathogens at chilling temperatures – decision about safety is based on visual observation of mould free/discolouration free, smell free status.
- Assessing impact of worst case scenario.

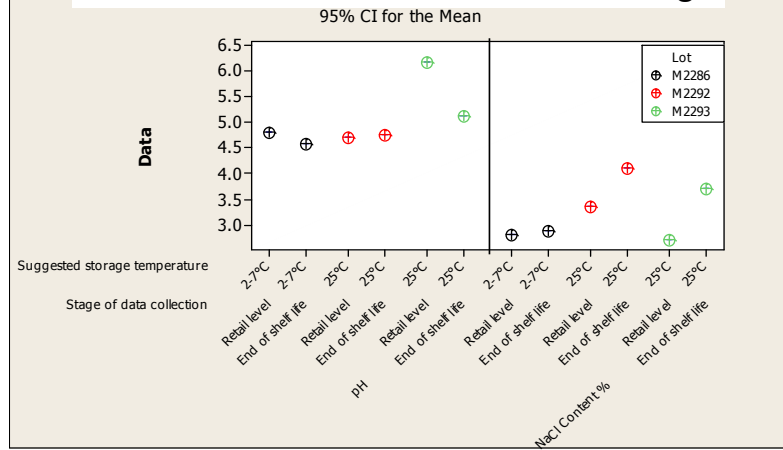
## Considerations (2)

- Majority of the companies find difficult to carry out challenge tests and storage tests at variable temperatures
- Tools, which categorize products by simple methods
  - high likelihood that it is safe,
  - not safe,
  - further tests are necessary.
 can provide help

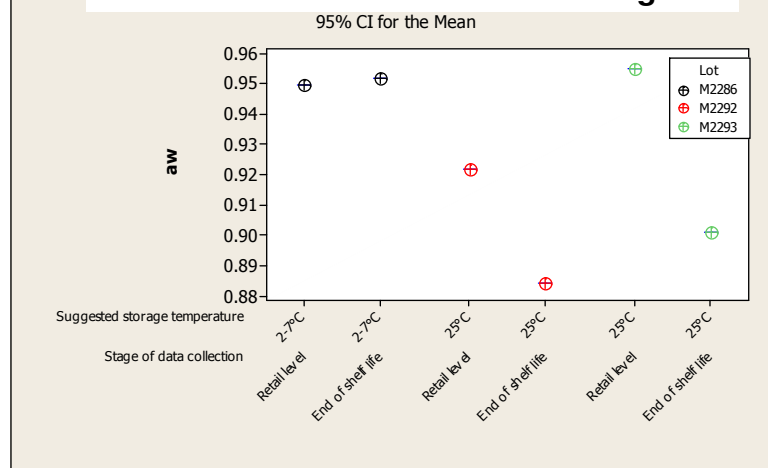
## Prevalence of pathogens salamis, sausages

Food products	Listeria monocytogenes		Staphylococcus aureus	
	No of samples	Presence	No of samples	Presence
Salamis, sausages, whole	2777	0.2%	68	4.47%
Sliced, vacuum packed	339	4.4%		

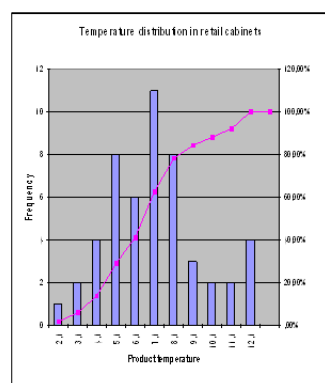
### pH, NaCl content variation at different lots of the same brand of flamed sausage



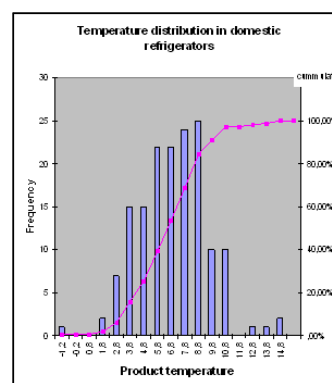
### Water activity variation at different lots of the same brand of flamed sausage



- Questionnaire survey – internet based + traditional hard copies
- Average storage at home:
  - Top shelf (highest temperature!) of the refrigerator is preferred for meat products
  - Neglecting use by date - consumption before the end of use by date 50-60%
  - Storage in larder

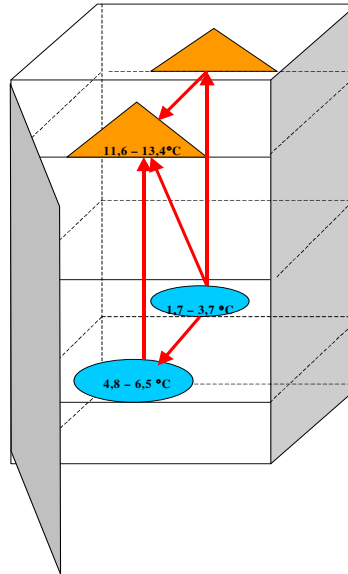


$6.6 \pm 2.4$  °C  
over 5°C:60%  
over 8°C:15%

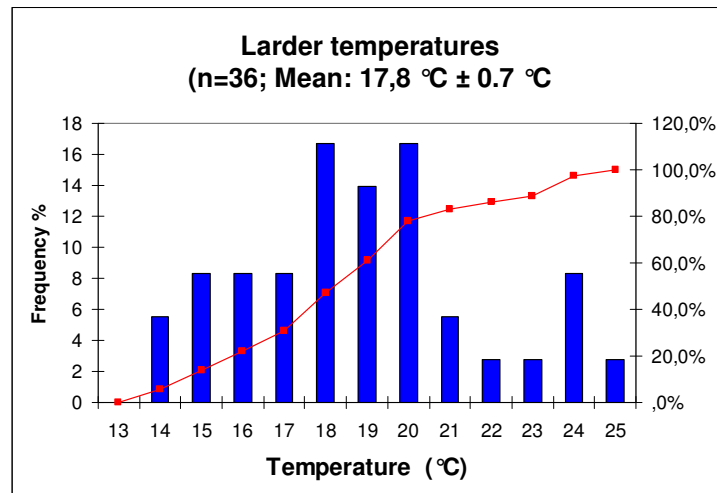


$7.1$  °C  $\pm 2.7$  °C  
over 5°C:80%  
over 8°C:36%

### Temperature gradients in domestic refrigerators



### Larger temperatures (n=36; Mean: 17,8 °C ± 0.7 °C)



## Flamed sausage, whole log Changes of the intrinsic properties (40 days)

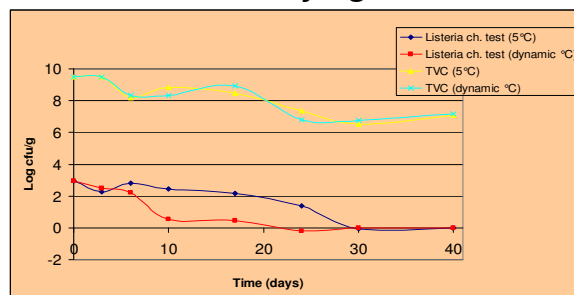
### Salt content

at 5°C	from	2.93%	to	3.94%
at fluctuating temperature	from	2.93%	to	4.05%
(+average 17.18°C, +min. 12.5°C,+max 22.5°C)				

### a<sub>w</sub>

at 5°C	from	0.942	to	0.845
at fluctuating temperature	from	0.942	to	0.816

## Flamed sausage, whole log Challenge test results for *Listeria* monocytogenes

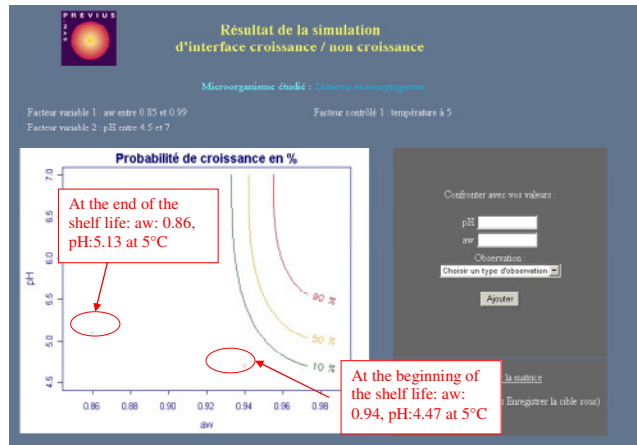


### Prediction of the ComBase Growth Predictor

- growth with the initial parameters
- reduction with the final parameters

Significant changes of the intrinsic properties can't  
be handled

## Flamed sausage, whole log Probabilistic modelling predictions of the Sym'Previus for *Listeria monocytogenes*



- Low probability of growth

## Changes of the intrinsic properties of whole flamed sausage

Storage time: 40 days

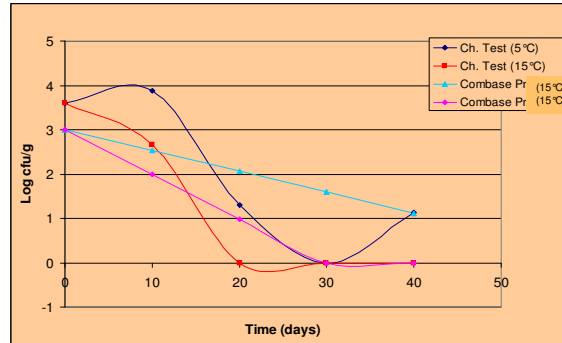
### $a_w$

at 5°C	from	0.91	to	0.86
at 15°C	from	0.91	to	0.85

### Salt

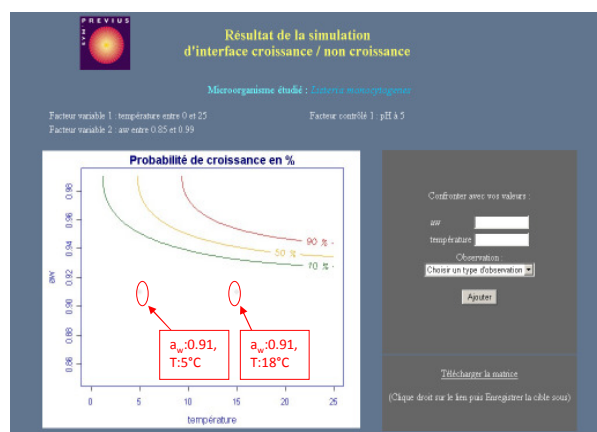
at 5°C	from	3.55%	to	3.92%
at 15°C	from	3.55%	to	3.98%

## Flamed sausages, whole logs Comparison of the challenge test results with the prediction of the ComBase Predictor



- First, small growth followed by reduction of *L. monocytogenes*

## Flamed sausage, whole log Probabilistic modelling prediction of the Sym'Previus "Growth Interface"



- Low probability of growth

### Naturally fermented, air dried sausages, sliced, MAP (50 days)

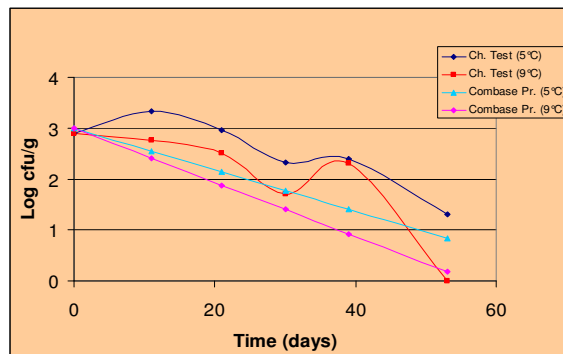
**a<sub>w</sub>**

at 5 °C from 0.8727 to 0.8727  
at 9 °C from 0.8727 to 0.8726

**Salt**

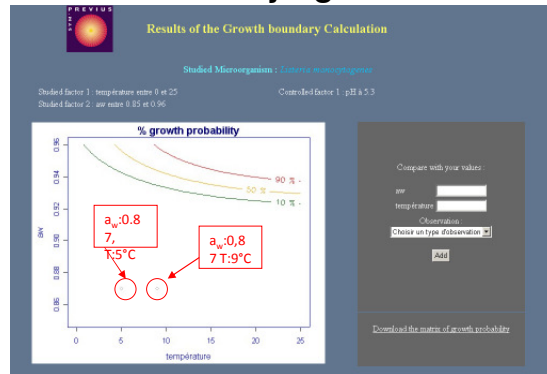
at 5 °C from 4.07% to 4.05%  
at 9 °C from 4.07% to 4.10%

### Naturally fermented, air dried sausages, sliced, MAP Comparison of the challenge test results and the prediction of the ComBase Predictor for *Listeria monocytogenes*



- Small growth followed by reduction at 5 °C

## Naturally fermented, air dried sausages, sliced, vacuum-packed Probabilistic modelling predictions of the Sym'Previous Growth Interface for *Listeria monocytogenes*



- Low probability of growth

## Naturally fermented, air dried, sliced MAP sausages Change of intrinsic properties (30 days)

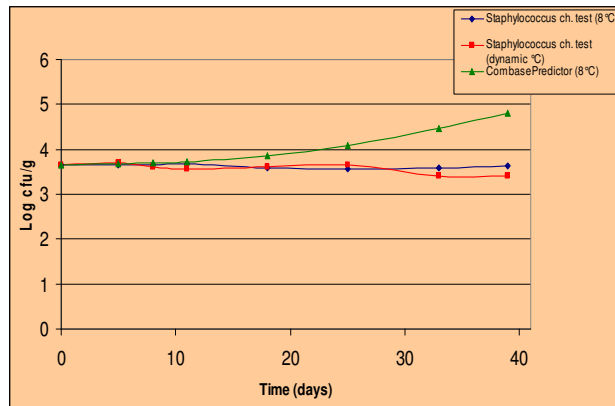
### $a_w$

at 8 °C	from	0.929	to	0.929
at fluctuating temperature	from	0.929	to	0.929

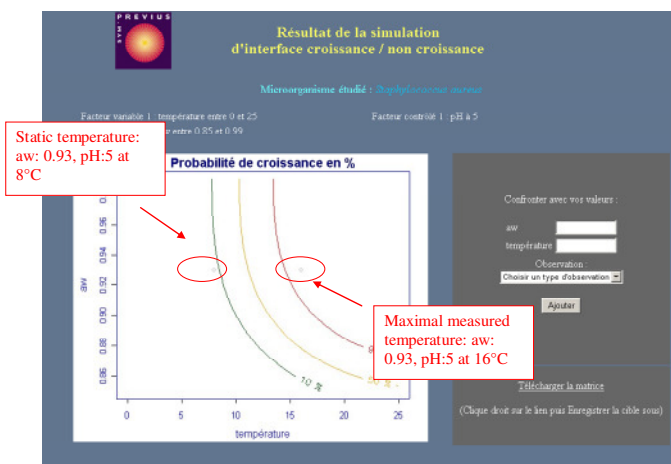
### Salt

at 8 °C	from	3.02%	to	3.02%
at fluctuating temperature	from	3.02%	to	3.05%

Comparison of the challenge test results and the predictions of ComBase Predictor for S. aureus



Probabilistic modelling predictions of the Sym'Previus for S. aureus



- Simple screening method, decision support tool
- Steps following the steps of classic risk assessment: hazard identification, hazard characterisation, exposure assessment, risk characterisation
- Step by step analysis from cold store to consumption
- Risk and quality of information is scored
- Comparative study based on total scores/ scores related to different steps

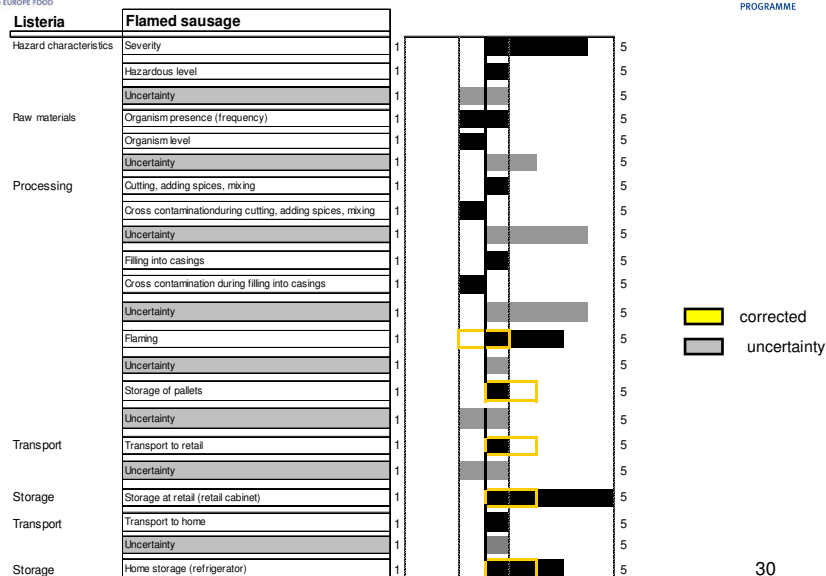
<p>Frequency of contamination</p> <ol style="list-style-type: none"> <li>1. Negligible (0-0.1%)</li> <li>2. Very low frequency (0.1-1%)</li> <li>3. Low frequency (1-10%)</li> <li>4. Mild frequency (10-50%)</li> <li>5. Frequent (&gt;50%)</li> </ol>	<p>Contamination levels</p> <ol style="list-style-type: none"> <li>1. 0-10 cells/g</li> <li>2. 10-100 cells/g</li> <li>3. 100-1,000 cells/g</li> <li>4. 1,000-10,000 cells/g</li> <li>5. &gt; 10,000 cells/g</li> </ol>
<p>Effect of process step:</p> <ol style="list-style-type: none"> <li>1. Complete inactivation</li> <li>2. Partial inactivation</li> <li>3. Survival</li> <li>4. Some Growth</li> <li>5. Growth</li> </ol>	<p>Size of the portion</p> <ol style="list-style-type: none"> <li>1. Very low intake (0-10g)</li> <li>2. Low intake (10-50g)</li> <li>3. Medium intake (50-100g)</li> <li>4. High intake (100-200g)</li> <li>5. Very high intake (&gt;200g)</li> </ol>

## Suggested list of levels for Quality of the Information

### Uncertainty:

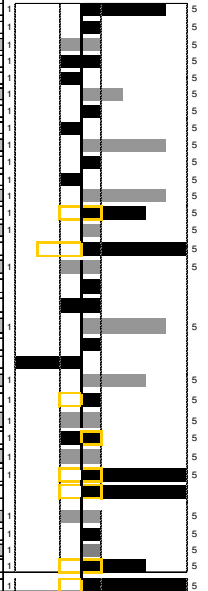
1. Very good confidence in the data/information (same product, same microbe, similar conditions)
2. Good confidence in the data/information but some uncertainty (same product, same microbe, different conditions / similar product, same microbe, similar conditions)
3. Reasonable confidence in the data/information (similar product, same microbe, different conditions)
4. Little confidence in the data/information (different product, similar microbe, different conditions)
5. Opinion/default, no hard data

## Risk profile for flamed sausage *Listeria monocytogenes*



## Risk profile for fermented air dried sausage *Listeria monocytogenes*

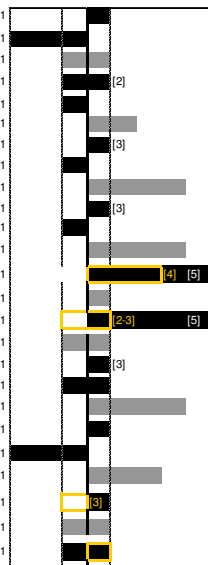
<b>Listeria</b>		<b>Dry, fermented sausage</b>
Hazard characteristics	Severity	
	Hazardous level	
	Uncertainty	
Raw materials	Organism presence (frequency)	
	Organism level	
	Uncertainty	
Processing	Cutting, adding spices, mixing	
	Cross contamination during cutting, adding spices, mixing	
	Uncertainty	
	Filling into casings	
	Cross contamination during filling into casings	
	Uncertainty	
	Smoking	
	Uncertainty	
	Fermentation-drying	
	Uncertainty	
	Slicing	
	Cross-contamination during slicing	
Uncertainty		
Palleting	Palleting	
	Cross-contamination after palleting	
	Uncertainty	
Storage of pallets	Storage of pallets	
	Uncertainty	
	Transport to retail	
Storage	Uncertainty	
	Storage at retail (retail cabinet)	
	Storage at retail (ambient)	
Transport	Uncertainty	
	Transport to home	
	Uncertainty	
Storage	Home storage (refrigerator)	
	Transport to home	



corrected  
 uncertainty

## Risk profile for fermented air dried sausage *S. aureus*

<b>S.aureus</b>		<b>Dry, fermented sausage</b>
Hazard characteristics	Severity	
	Hazardous level	
	Uncertainty	
Raw materials	Organism presence (frequency)	
	Organism level	
	Uncertainty	
Processing	Cutting, adding spices, mixing	
	Cross contamination during cutting, adding spices, mixing	
	Uncertainty	
	Filling into casings	
	Cross contamination during filling into casings	
	Uncertainty	
	Smoking	
	Uncertainty	
	Fermentation-drying	
	Uncertainty	
	Slicing	
	Cross-contamination during slicing	
Uncertainty		
Palleting	Palleting	
	Cross-contamination after palleting	
	Uncertainty	
Storage of pallets	Storage of pallets	
	Uncertainty	
	Transport to retail	



corrected  
 uncertainty

## Summary of the challenge test results for un-cooked, ready-to-eat sausages

	Flamed sausage	Smoked, naturally fermented, air-dried sausage
<b>Whole log</b>		
Listeria monocytogenes		
+5°C	Initial growth less than 0.3 log, followed by reduction; reduction	
+15°C	reduction	
+5°C	reduction	
+17.2°C ± 5°C	reduction	
Staphylococcus aureus		
+8°C ± 5°C		reduction
+17.5°C ± 8°C		reduction
<b>Sliced, MAP/vacuum-packed</b>		
Listeria monocytogenes		
+5°C		Initial growth less than 0.3 log followed by reduction
+9°C	} vacuum	reduction
+5°C		reduction
+7.15°C ± 3°C		reduction
+AFSSA (1/3)+4°C; 2/3 (+8°C)		reduction
Staphylococcus aureus		
+8°C (+8°C), (-1.4°C)		reduction
+7.4 C°+2.5 C° fluctuating		reduction

## Results (1)

1. When predictive models, including probabilistic models show reduction a limited number of challenge tests is need for verification
2. With Sym'Previous relatively good predictions can be prepared if the result of at least one challenge test is used as an input
3. When predictive models show growth additional challenge tests are necessary.

## Results (2)

- Relatively high uncertainty for *Listeria monocytogenes* at cutting, mixing and filling of flamed sausages and fermented dried sausages
- Relatively high uncertainty for *Listeria monocytogenes* at filling and slicing (cross-contamination) of fermented, air dried sausages
- Relatively high uncertainty for *Staphylococcus aureus* at cutting, mixing, filling, slicing of fermented, air dried sausages

## Conclusions

1. Importance of the control of intrinsic properties during production
2. No growth of *L. monocytogenes* and *S. aureus* was observed in the majority of challenge tests for sausages



Results support safety of traditional Hungarian smoked, naturally fermented, air dried and flamed sausages

3. Predictive models, particularly for dynamic conditions and probabilistic facilities can provide a practical help to improve risk profiles and to support decisions.



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