Microbial spoilage of fresh meat

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Introduction

- We are busy developing a model for microbial growth on meat including variance in the growth parameters

- What to expect
  - Introduction TI Food and Nutrition & Project
  - QMRA
  - Preliminary results

TI Food and Nutrition: Who we are

We are a public-private partnership with a strategic portfolio of projects, that are **industry-led**, and designed and executed on basis of an **interdisciplinary scientific** and technological approach

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Theme cluster: Food Chain Sustainability and Dynamics

“The chain approach is the only way for the agrifood industry to fulfill its responsibilities in securing the world’s food supply.”

Toine Timmermans, MSc.

Theme Director Food Chain Sustainability and Dynamics

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Project (RE-002):

Reduction of spoilage of fresh and chilled products

Project Objective (FPP)

"The aim of the project is to develop a decision support system that can be used as a management tool to analyze the supply chain of perishable food products and to evaluate logistical and technological innovations for their contribution to spoilage reduction."

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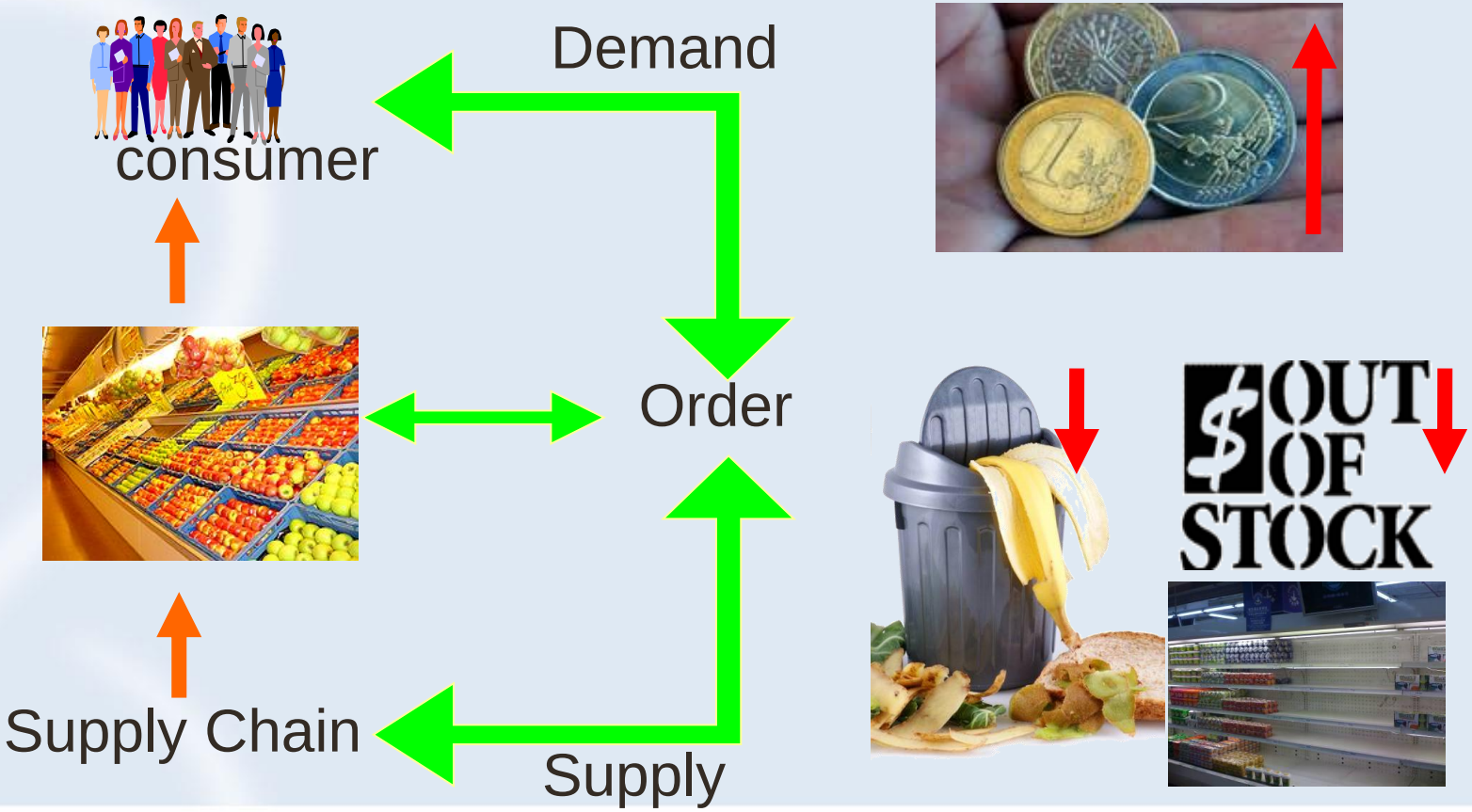
Scope and outline: Decision support

Shrinkage from a retail perspective



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Work package 1:

Microbial spoilage and quality decay of fresh meat

Objective work package (FPP)

"The objective of this work package is to develop accurate shelf life prediction computer models for fresh meat which can be used as building block of the decision support system."

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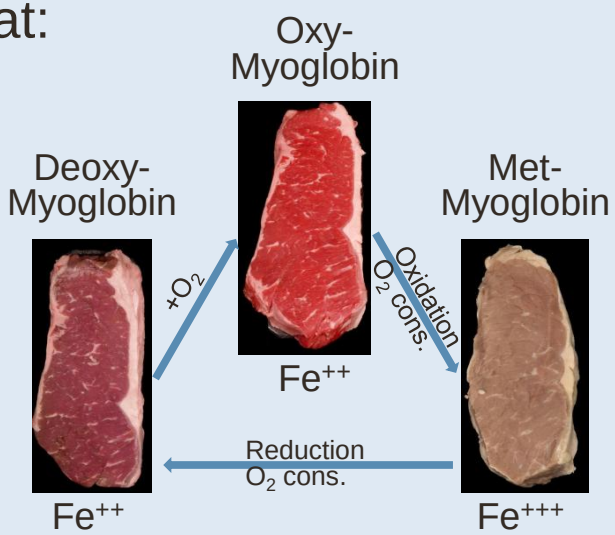
Outline work package

- Develop predictive shelf life models for fresh meat (pork tenderloin and minced beef) for decision support system (DSS)

- Main quality parameters shelf life fresh meat:
  - *Microbial growth*
    - Focus of rest of this presentation
  - *Discoloration*
    - From red to brown color
    - Color is very important buying argument
  - *(Sensorial quality - Lipid oxidation)*
    - Effect on taste, smell of fresh meat
    - Not taken into account in project

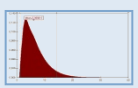


Melvin Hunt (USA) & Chris Raines (USA)

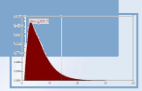
Quantitative Microbial Risk Assessment

- A combination of (relatively simple) microbial kinetics, processing parameter, statistical techniques (Monte Carlo simulation) and mathematical modeling

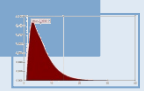
Source of contamination



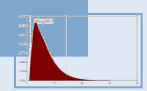
Influential parameters process step 1



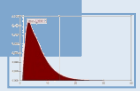
Influential parameters process step 2



Influential parameters process step 3

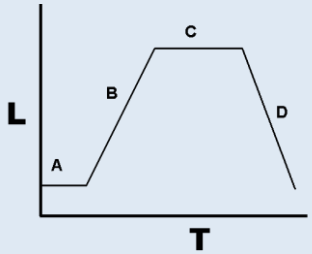


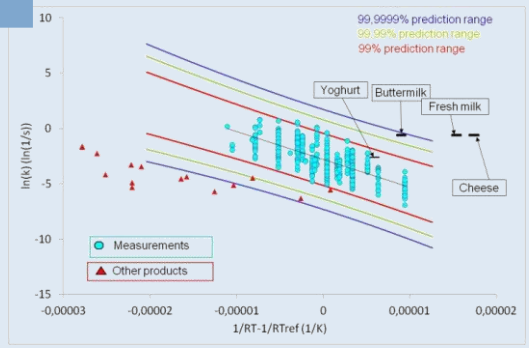
Influential parameters process step 4



Output:

1. Risk of contamination
2. List of most influential parameters





$$\mu_{T,pH,aw} = \gamma_T \gamma_{pH} \gamma_{aw} \mu_{\max}$$

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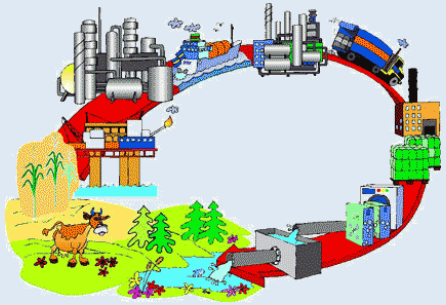
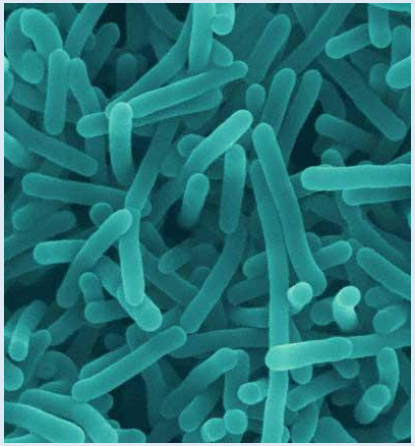
Why QMRA?

- Food producers have an increasing responsibility on food safety
  - Legal responsibility
  - Supply authorities and clients with proof of safety
  - Risks of collateral damage after safety issues
- Challenging risks by new developments
  - Minimal processing
  - Reducing salt and sugar
- Increasingly complex supply chains
  - International sourcing
  - Multiple trading steps
- Predict chances in case of low contamination risks
  - Quantification of risks
- Chain approach
  - Choose a specific part or the whole chain



QMRA approach: Input

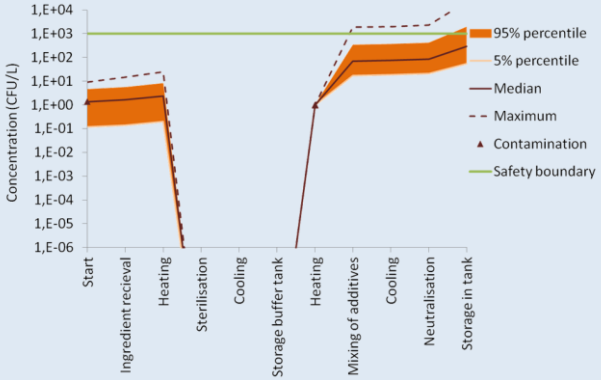
- Process & product
  - Describe the process chain in a stepwise manner
  - Identify process parameters and their variance
  - Identify product properties and their variance



- Micro-organism(s) of interest
  - Identify key micro-organisms
  - Collect growth data under different circumstances (including their variance)

QMRA approach: Model & Output

- Modeling
  - Monte Carlo simulation to quantify risk
  - Sensitivity analysis to identify most influential parameter/process unit/etc.
  - Evaluate “what-if” scenarios



- Output
  - Science-based risk on certain occurrence
  - Knowledge of critical process parameters
  - Calculated effects on changes of process conditions or level of contamination
  - Availability of the model to perform your own calculations

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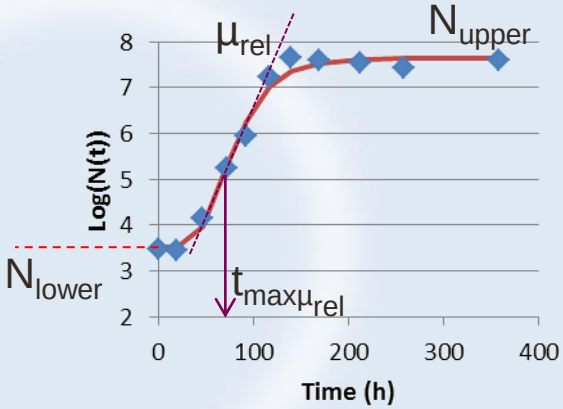
Growth kinetics of meat specific micro-organisms (I)

- Meat specific spoilage micro-organisms:
  - *Brochothrix thermosphacta*
  - *Pseudomonas spp.*
  - Lactic acid bacteria (LAB)

- Growth data from ComBase for different:
  - Temperatures, pH, aw and (gas) conditions
  - Kind of meats: Beef, pork, poultry, unknown type of meat and also for culture medium
  - Use growth data to fit primary model (Gompertz)

Growth kinetics of meat specific micro-organisms (II)

- Primary model:
  - Gompertz function (Gibson et al. (1987))



$$Log(N(t)) = Log(N_{lower}) + Log\left(\frac{N_{upper}}{N_{lower}}\right) e^{-e^{-\mu_{rel}(t - t_{max}\,\mu_{rel})}}$$

Fitted parameters for one data record are:

- N_{lower}
- $Log(N_{upper}/N_{lower})$
- μ_{rel}
- $t_{max\mu_{rel}}$

E.g. for a certain temperature, aw, pH, gas condition etc. combination

- Secondary model:
  - Development in progress
  - Response fitted parameter(s) to change in conditions

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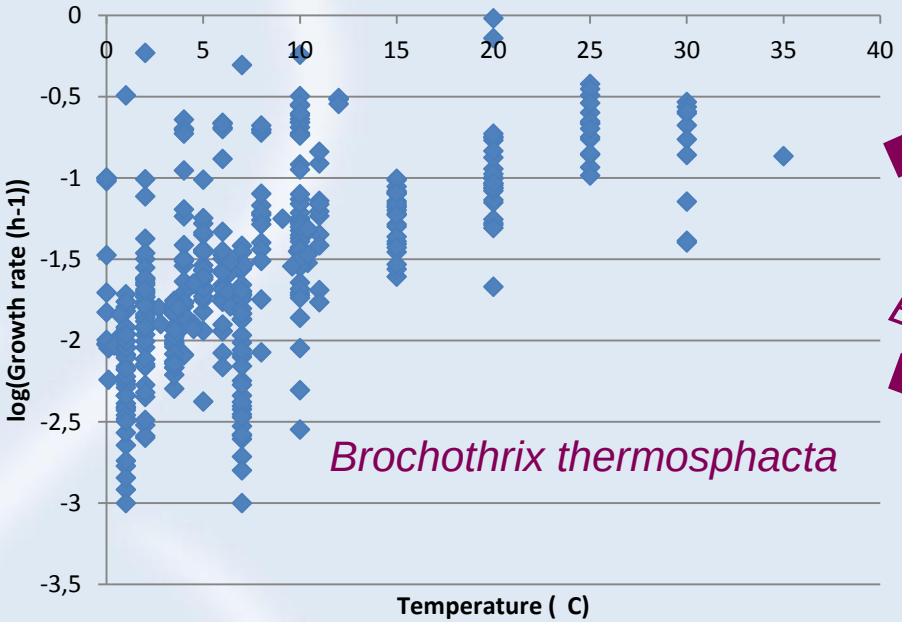
Building block decision support system

- Implement primary and secondary model in DSS
  - Including variance
  - Supply chain of fresh meat (and others) can be analyzed
  - Evaluate logistical and technological innovations for their contribution to spoilage reduction

Preliminary results (I)

- Growth curve data from ComBase fitted with Gompertz function
- Fitted parameters and input parameters like temperature have variances

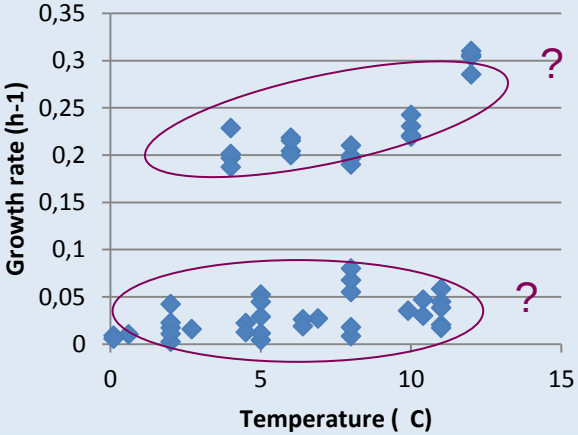


Beef data

Multi effects play a role:

- Type of meat
- Temperature
- pH
- aw
- Packaging
- Etc.

μ_{rel}=f(T,pH,….)



Higher temperature ➡ higher growth rate (logical)

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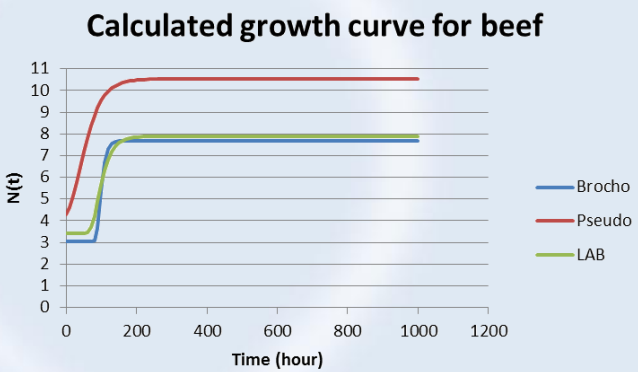
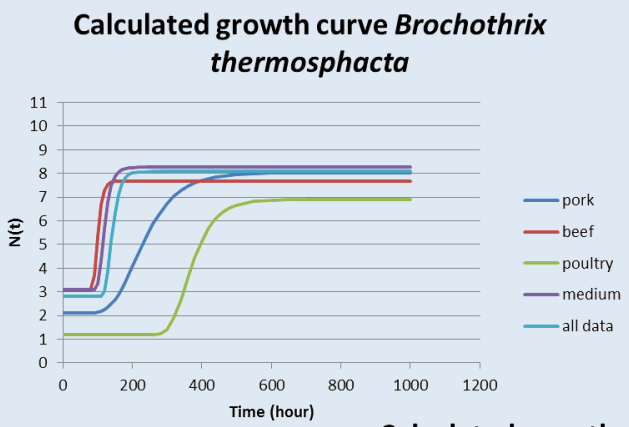
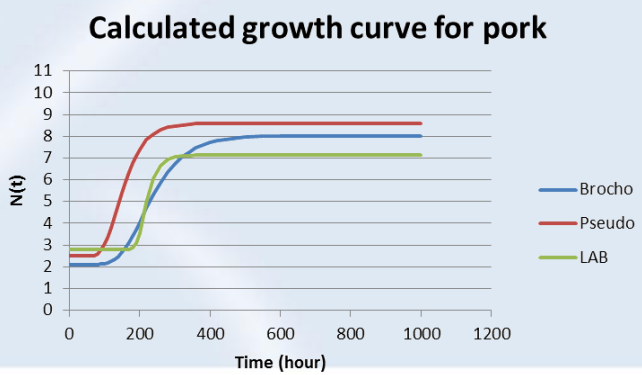
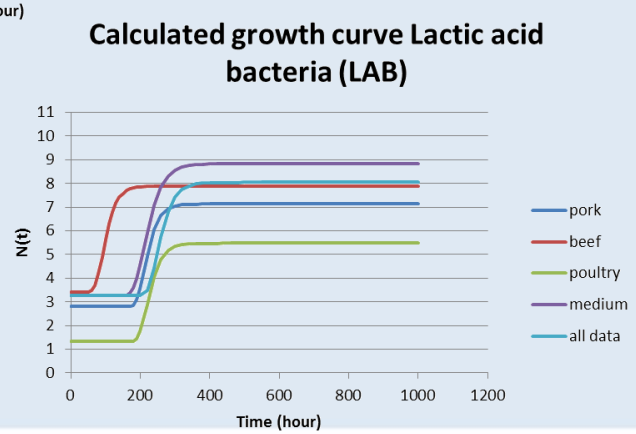
Preliminary results (II)

- Comparison mean values between types of meat, micro-organisms (primary model)









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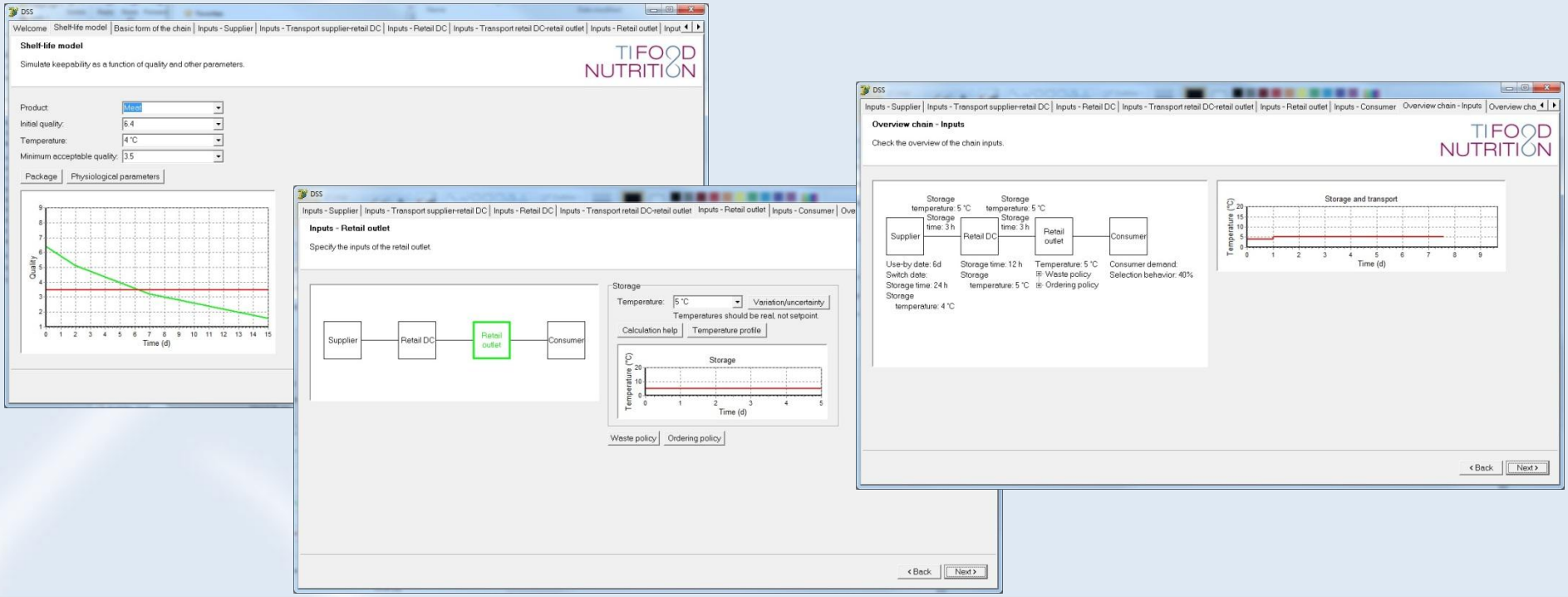
Future research

- Develop and implement secondary model
  - Including variance
- Implement in Decision support system



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Conclusions

- QMRA is a valuable addition to the QA toolbox
  - Make use of probability distributions instead of point estimates
- QMRA enables:
  - A focus on the most influential parameters in a complex chain of events
  - A fact based discussion
- QMRA can be used as a tool for:
  - Convincing the authorities
  - Reducing the number of samples
  - Evaluation of new scenarios
- Monitoring of temperature in food chain is added value for QMRA

Questions and remarks?

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Processing & Safety department

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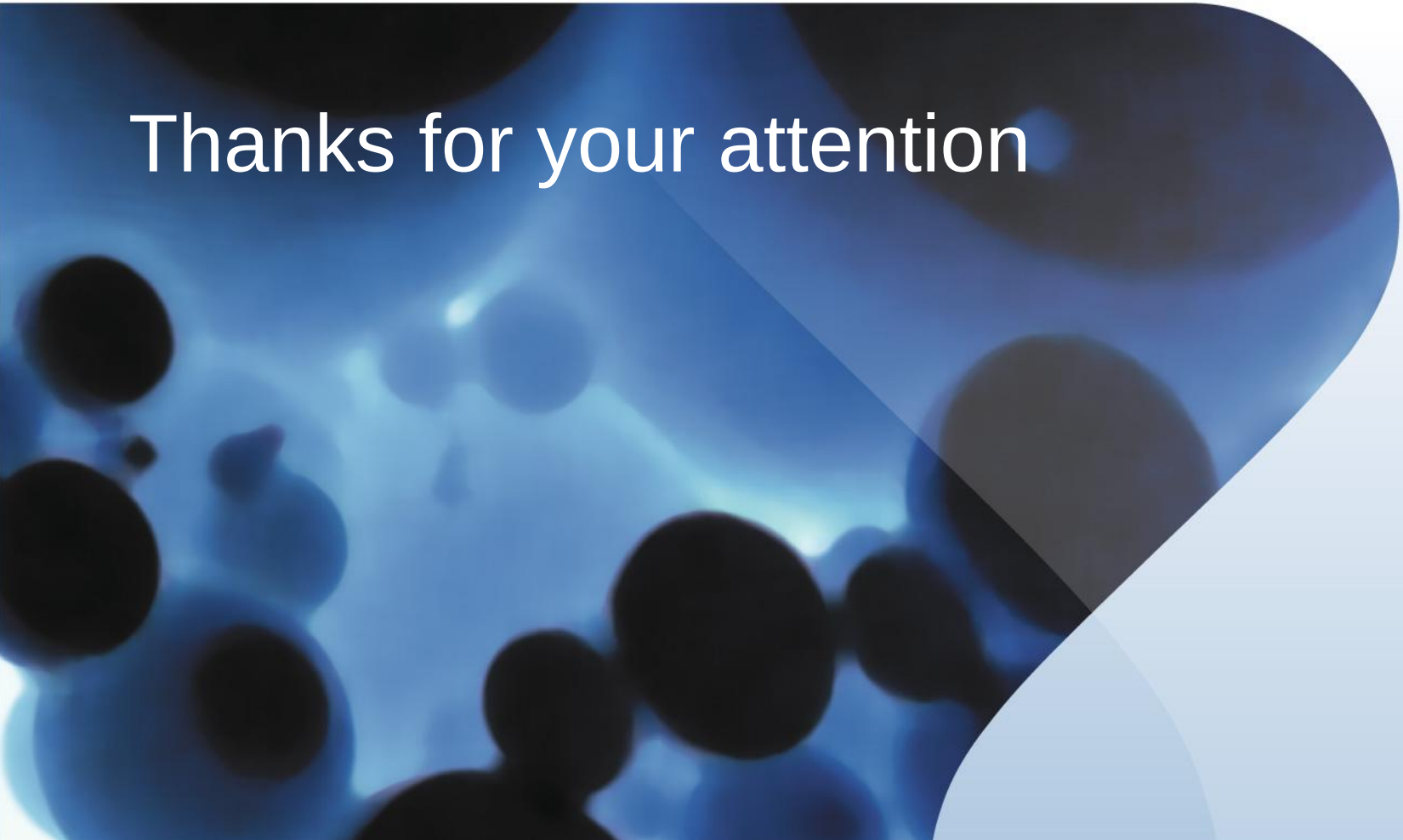

Thanks for your attention