Prioritizing Hazards in Infant Foods

Organized by: IAFP's Modelling and Risk Analysis PDG and the International Food Protection Issues PDG

Moderator: Marcel Zwietering, IFPI PDG Chair

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- **It is important to note that all opinions and statements are those of the individual making the presentation and not necessarily the opinion or view of IAFP.**

- **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.**

- **This webinar is being recorded and will be available for access by IAFP members at within one week.**

Today's Panelists

International Association for Food Protection WEBINAR

Moderator

Marcel Zwietering

Presenters

Kah Yen Claire Yeak

Cristina Serra

Jeanne-Marie Membre´

Kah Yen Claire Yeak

Kah Yen Claire Yeak is a postdoctoral researcher in the Food Microbiology group at the University of Wageningen and recently began her role as a Senior Innovation Microbiologist at Solenis. Her research at Wageningen University focuses on developing data-driven decision support systems to identify and rank microbiological hazards in the infant food chain across the EU and China. These systems standardize hazard identification in risk assessment and contribute to informed risk analysis. Her works involve collaboration with leading universities, research institutes, and food companies to ensure high standards of food safety. Previously, she obtained her industrial PhD in Microbiology and Molecular Biology from NIZO food research, where she investigated bacterial stress sensing mechanisms and survival strategies. Additionally, She holds an MSc in Molecular Life Sciences (Microbiology and Biochemistry) and a BSc in Applied Biology (Medical Microbiology and Clinical Biology) and her expertise spans from molecular details of bacteria to applied research. Her research works aim to enhance food safety and address industry needs, bridging the gap between molecular microbiology and practical applications in the food industry.

Cristina Serra

Cristina Serra-Castelló is currently a postdoctoral researcher in the Food Microbiology group of University of Wageningen. Her research focuses on the use of predictive microbiology and quantitative microbial risk assessment approaches to assess the safety of foods, including the emergent plant-based meat alternatives. Prior to her appointment at Wageningen University she developed her PhD in the Food Safety and Functionality Program of IRTA, being involved in research activities dealing with the assessment of the efficacy of processing and/or preservation treatments, such as high-pressure processing or the use of bioprotective cultures, to control pathogens in RTE foods. Her research have been constantly developed in the framework of projects funded through public-private partnerships, making the industry needs and concerns the basics of her research. This prompts her to strengthen her commitment in the development of user-friendly tools (apps) integrating predictive microbiology approaches for food industry.

Jeanne-Marie Membre´

Dr Jeanne-Marie Membré has a degree in food engineering and a PhD in food microbiology. In 1989, she joined the French National Institute for Agriculture, Food and the Environment ("INRAE" since January 2020) where she was responsible for the predictive microbiology research programme. From 2003 to 2009, she worked at Unilever in UK where she developed predictive and exposure assessment models for a wide range of food applications. Since 2010, at INRAE Nantes, she has been working on quantitative microbial risk assessment, health risk-benefit and holistic assessments. She is involved in several national and European research projects and belongs to the scientific advisory board of Journal of Food Protection and International Journal of Food Microbiology. She has published more than 100 papers in international peer-reviewed journals.

We are now in the big data era

How big data-driven structural frameworks safeguard the health of our young populations?

Safe Foods

- What are the hazards?
- Which hazards are at the top risks?


SAFFI
Safe Food for Infants
in the EU and China

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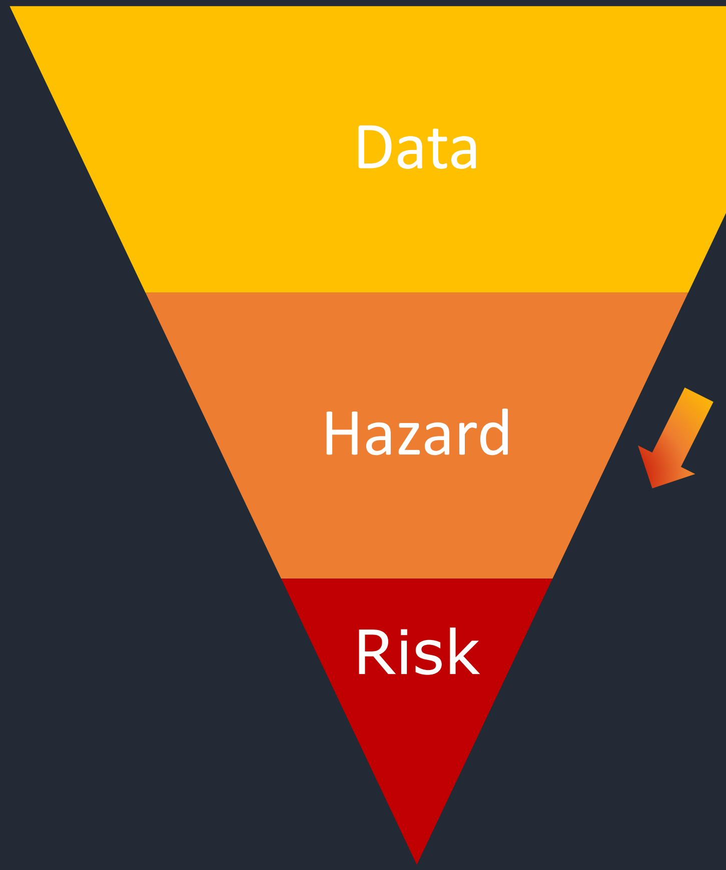
Hazard Identification & Risk Ranking Web-based Tools in Infant Foods

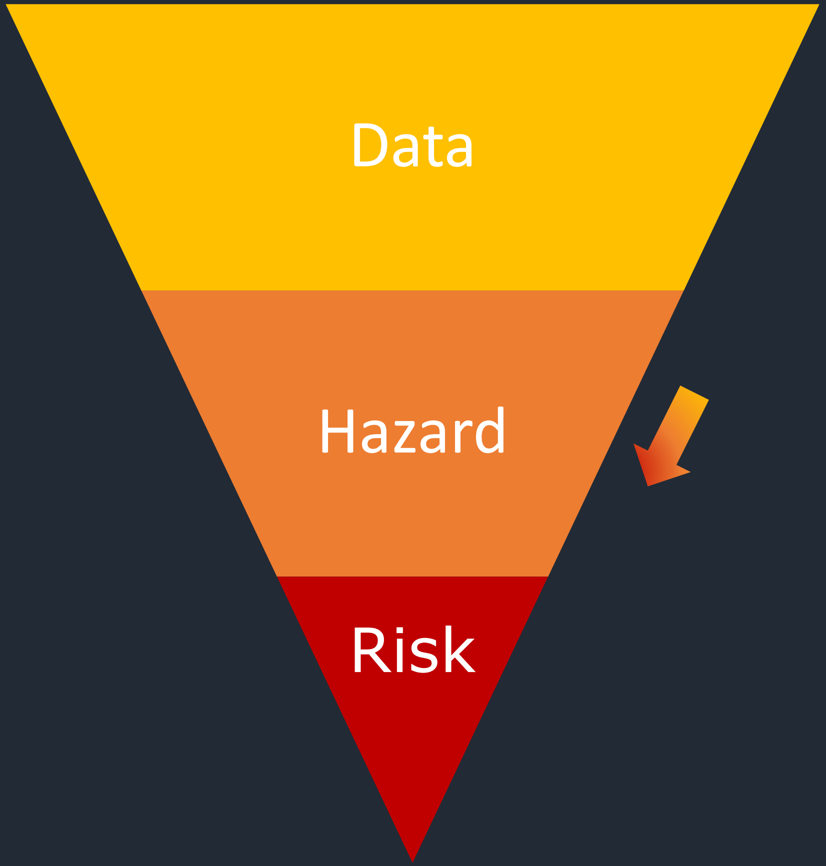
Kah Yen Claire Yeak

23 June 2024



Our goal:

To develop generic procedures for HI & RR in the infant food chain



- Building structural databases
- Hazard Identification Tool
  → MiID DSS
- Risk Ranking Tool
  → Mira DSS

Why?

- **overlook relevant hazards**
- **include too many irrelevant hazards**

Risk Assessment

1. **Hazard Identification**
2. **Hazard Characterization**
3. **Exposure assessment**
4. **Risk characterization**

Why?

1. List of most relevant hazards

Criteria

Legislation

Monitoring

CCPs

QRA

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1. List of most relevant microbial hazards in food chains

Foodborne Outbreak

Recalled Food due to pathogen contamination

Public heath impact

(EU & Global)

Expert knowledge

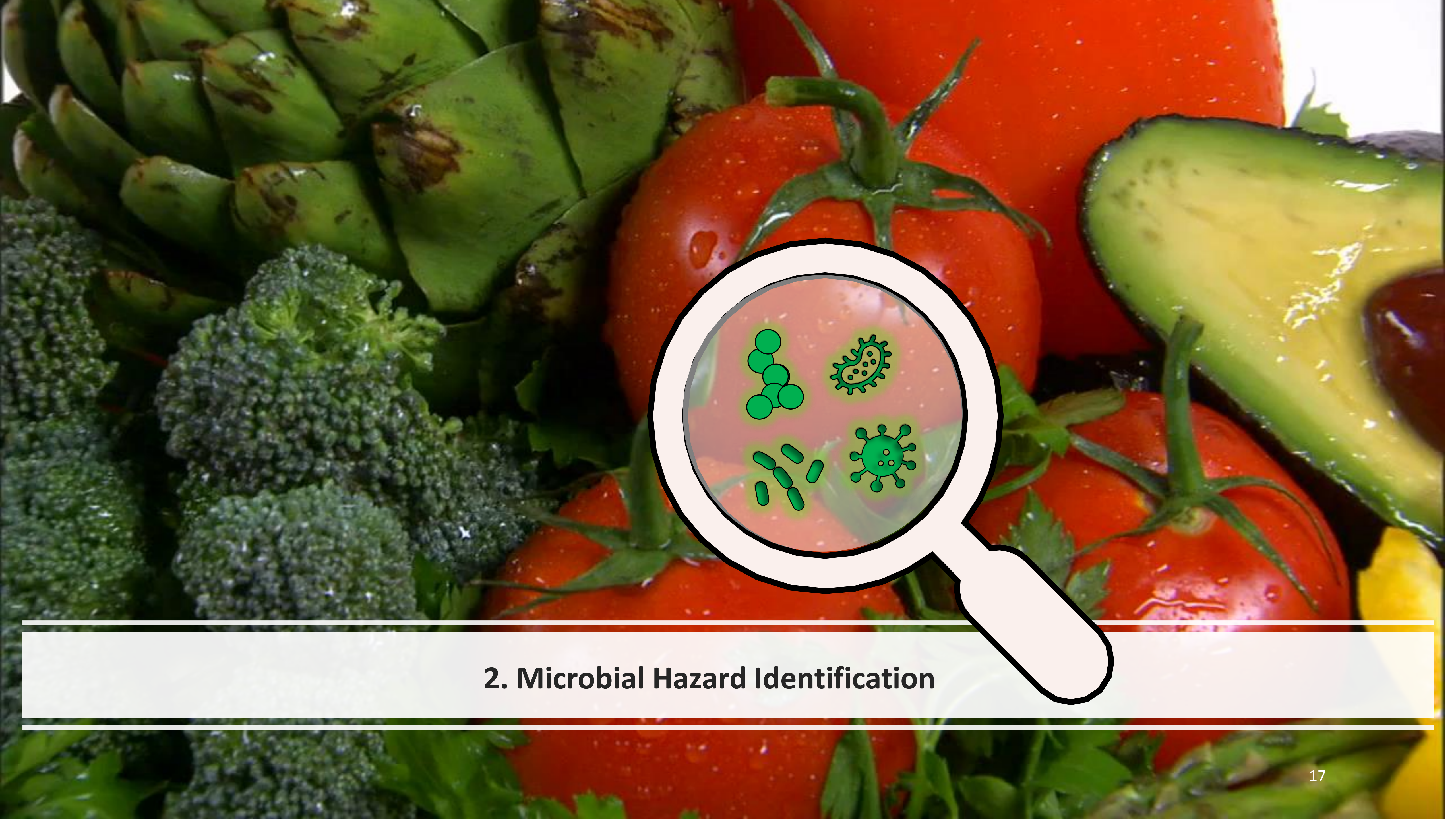
Government reports

17 Bacteria

10 Parasites

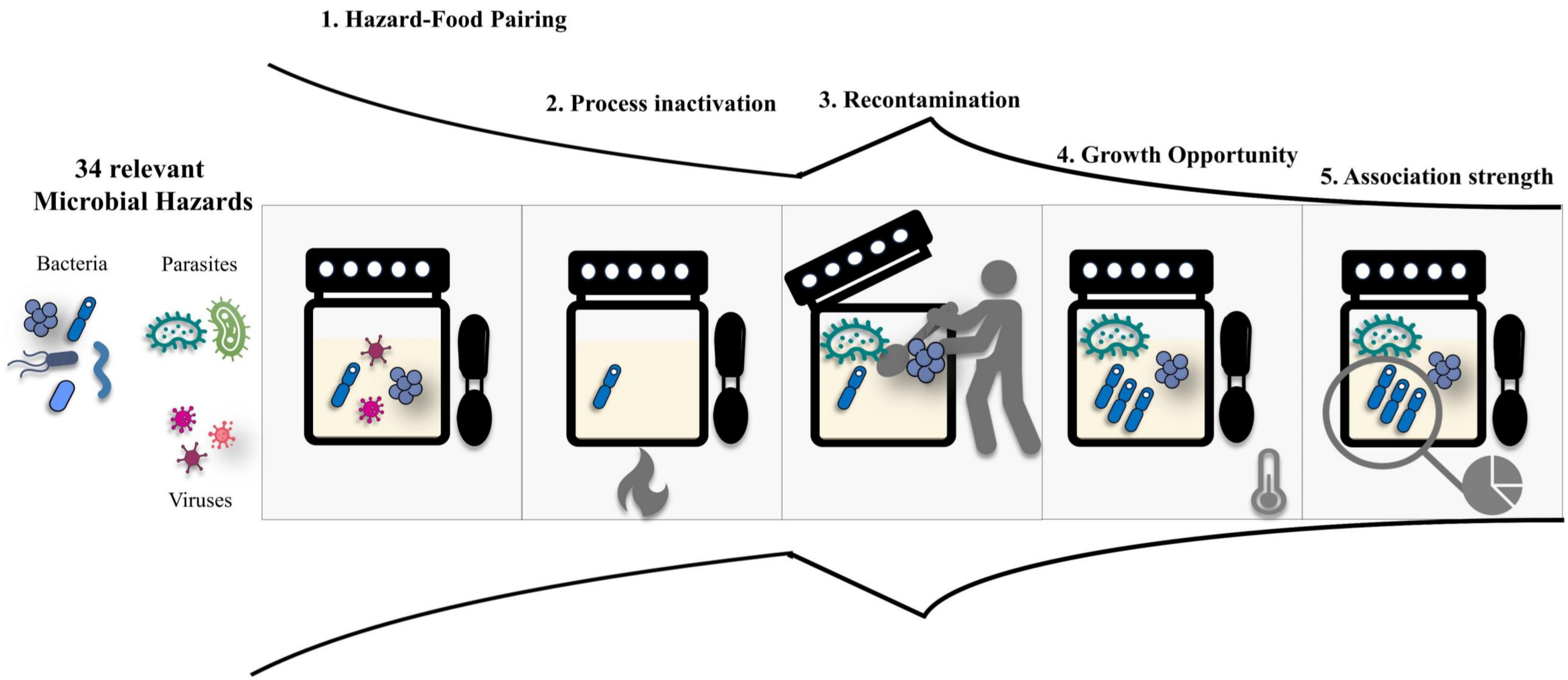
7 Viruses

Yeak et al., 2022, 2024



2. Microbial Hazard Identification

2. Microbial hazards identification tool



Microbial Hazards Identification Decision Support System (MiID DSS)

- Welcome page
- Step 1: Food selection
- Step 2: Processing variables
- Step 3: Recontamination
- Step 4: Product characteristics
- Step 5: Assocciation selection
- Disclaimer Text
- Download
- Continue to Risk Ranking
- User manual
- Github page

Welcome!

MiID Hazards Identification
FOOD MICROBIOLOGY

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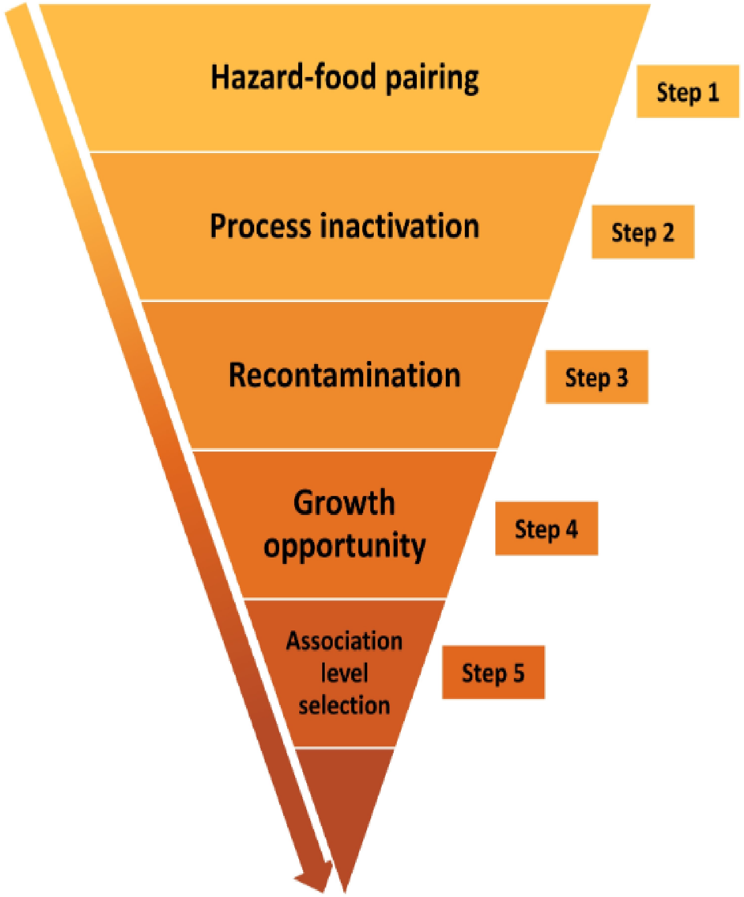
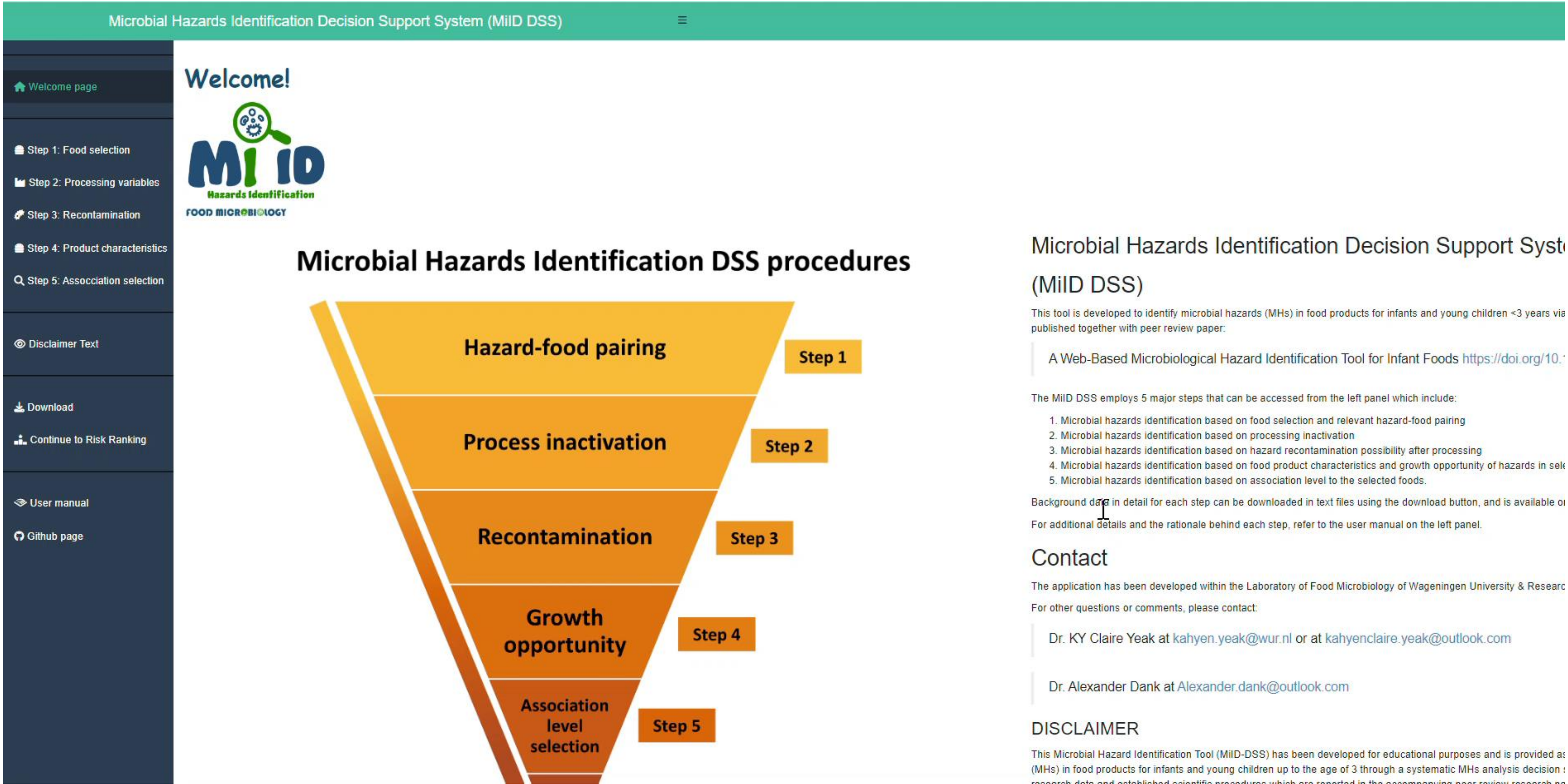
Microbial Hazards Identification DSS procedures



Quick Demo


Microbial Hazards Identification Decision Support System (MiID DSS)
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Welcome!
MI ID
Hazards Identification
FOOD MICROBIOLOGY
Microbial Hazards Identification DSS procedures
Hazard-food pairing
Step 1
Process inactivation
Step 2
Recontamination
Step 3
Growth opportunity
Step 4
Association level selection
Step 5
Microbial Hazards Identification Decision Support Syst
(MiID DSS)
This tool is developed to identify microbial hazards (MHs) in food products for infants and young children <3 years via
published together with peer review paper:
A Web-Based Microbiological Hazard Identification Tool for Infant Foods https://doi.org/10.
The MiID DSS employs 5 major steps that can be accessed from the left panel which include:
1. Microbial hazards identification based on food selection and relevant hazard-food pairing
2. Microbial hazards identification based on processing inactivation
3. Microbial hazards identification based on hazard recontamination possibility after processing
4. Microbial hazards identification based on food product characteristics and growth opportunity of hazards in sele
5. Microbial hazards identification based on association level to the selected foods.
Background data in detail for each step can be downloaded in text files using the download button, and is available o
For additional details and the rationale behind each step, refer to the user manual on the left panel.
Contact
The application has been developed within the Laboratory of Food Microbiology of Wageningen University & Researc
For other questions or comments, please contact:
Dr. KY Claire Yeak at kahyen.yeak@wur.nl or at kahyenclaire.yeak@outlook.com
Dr. Alexander Dank at Alexander.dank@outlook.com
DISCLAIMER
This Microbial Hazard Identification Tool (MiID-DSS) has been developed for educational purposes and is provided as
(MHs) in food products for infants and young children up to the age of 3 through a systematic MHs analysis decision

Case study: Hazards Identification in infant formula

Table 5
Step-wise identification of microbiological hazards in infant formula.

	Step in MiID	Case study 1 Description
1	Hazard-food pairing	milk and dairy products
2	Process inactivation	Thermal pasteurization: 72 °C for 15–30 s
3	Recontamination	processing environment: dry addition of ingredients: dry vitamins
4	Growth opportunity	product pH: 6.5, a_w: 0.2 Transport temperature: RT; temperature abuse: no
5	MH association level selection	remove low-association MHs

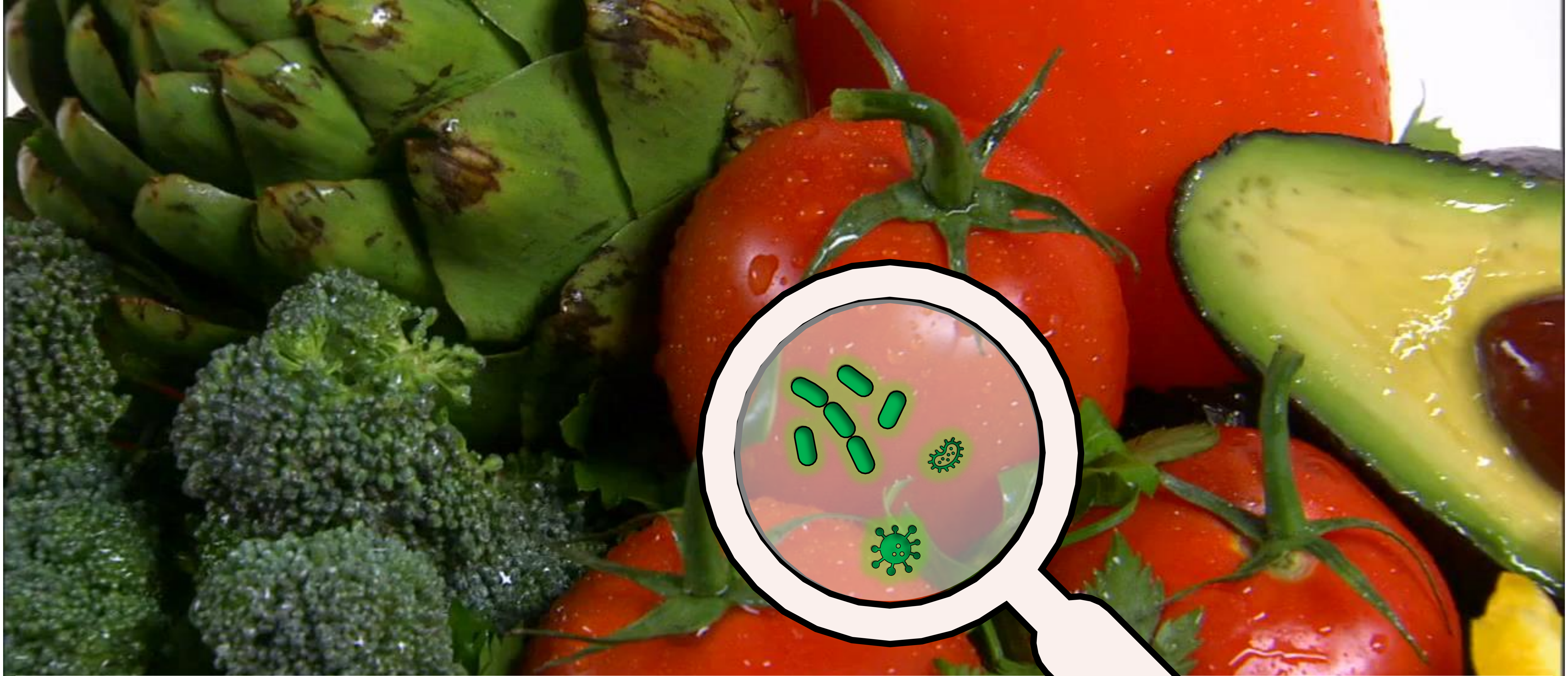
List of identified microbiological hazards [1]

Now what? Which of them is the top risky hazard?

Step 1	Step 2	Step 3	Step 4	Step 5
Aeromonas caviae L				
Bacillus cereus H				
Brucella spp. M				
Campylobacter spp. M				
Clostridium botulinum				
Clostridium botulinum L (proteolytic)	*Clostridium botulinum* L (proteolytic)	*Clostridium botulinum* L (proteolytic)		
Clostridium perfringens L	*Clostridium perfringens* L	*Clostridium perfringens* L		
Cronobacter spp. M		***Cronobacter* spp. M**	***Cronobacter* spp. M**	***Cronobacter* spp. M**
Cryptosporidium spp. M	*Cryptosporidium* spp. M	*Cryptosporidium* spp. M	*Cryptosporidium* spp. M	*Cryptosporidium* spp. M
Escherichia coli M (non-STEC)		***Escherichia coli* M (non-STEC)**	***Escherichia coli* M (non-STEC)**	***Escherichia coli* M (non-STEC)**
Escherichia coli H (STEC)		***Escherichia coli* H (STEC)**	***Escherichia coli* H (STEC)**	***Escherichia coli* H (STEC)**
Flavivirus L				
Listeria monocytogenes H				
Mycobacterium tuberculosis var. bovis L				
Norovirus L	Norovirus L	Norovirus L	Norovirus L	
Salmonella non-Typhi H		***Salmonella* non-Typhi H**	***Salmonella* non-Typhi H**	***Salmonella* non-Typhi H**
Shigella spp. L				
Staphylococcus aureus H	[2]	[2]	[2]	[2]
Yersinia enterolitica L				

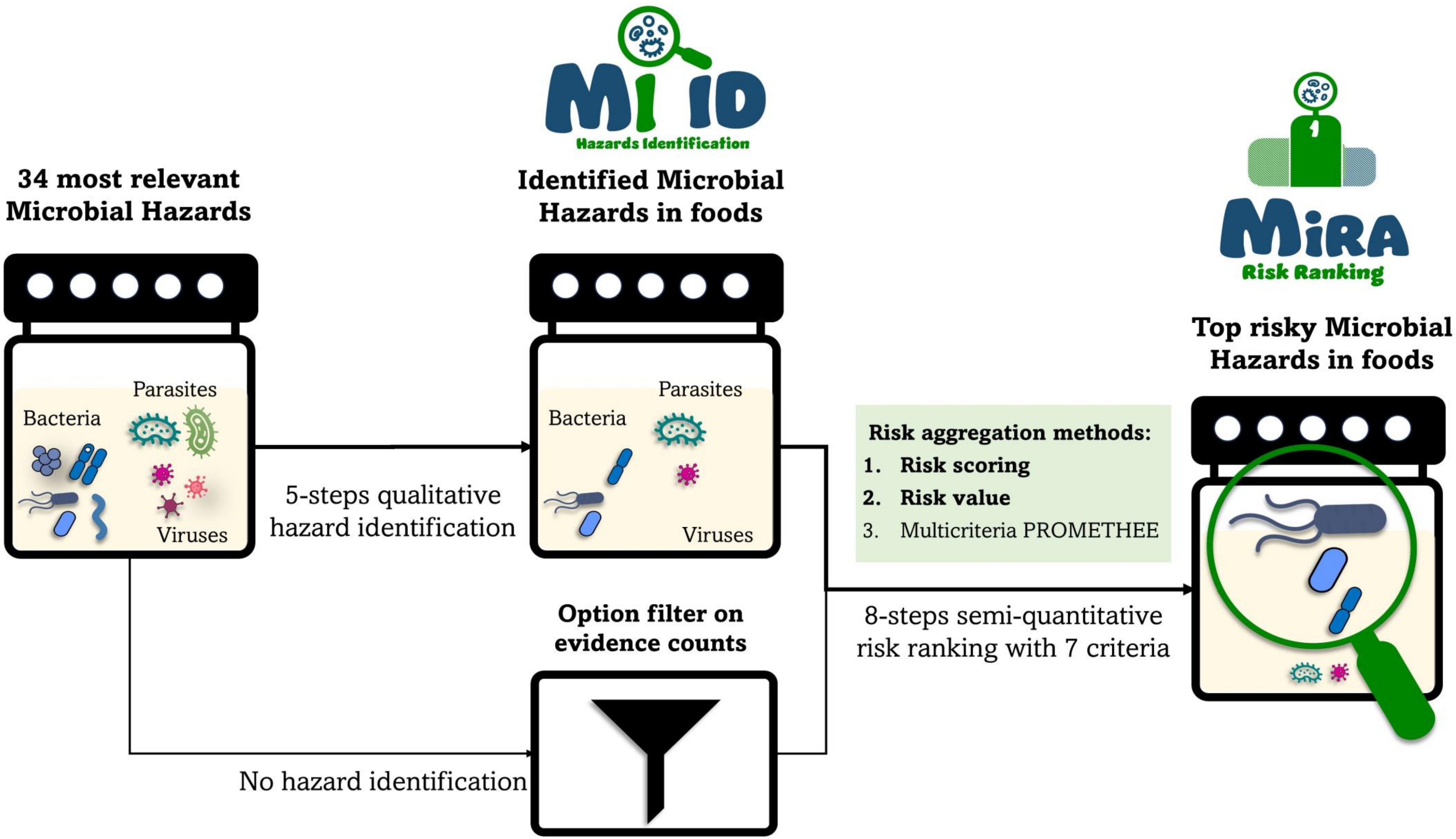
[1] L, M and H stands for low, medium and high association strength. Bold- indicates recontamination
[2] *Staphylococcus aureus* toxin can be included in Step 2 considering that it can be preformed in foods. If this is not the case, *S. aureus* vegetative cells are removed in Step 2, and thus not identified as a MH in this case study

Yeak et al., 2024



3. Hazard Risk Ranking

3. Microbial hazards ranking tool



3. Microbial hazards ranking tool

Microbial Hazards Risk Ranking Criteria

Likelihood

Hazard-Food Characteristics (HFC)

- Processing survival **(C2)**
- Recontamination **(C3)**
- Growth opportunity **(C4)**
- Meal preparation **(C5)**

Hazard-Food Association (HFA)

- Outbreak prevalence in the EU **(C6A)**
- Outbreak prevalence in the USA **(C6B)**
- Food contamination prevalence in the EU **(C6C)**
- Food contamination prevalence in the USA **(C6D)**

Food Consumption (FC) (C7)

Severity

DALY/case (HS)(C8)

Home | Pre-filter | Criteria | Ranking | Sensitivity | About

Microbial Hazards Risk Ranking

MiRA
Risk Ranking

MiRA

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Select ranking all 34 MHs or those identified with MiID

Home | Pre-filter | Criteria | Ranking | Sensitivity | About

? Pre-filter Hazards based on Hazard Identification MiID DSS Output

- [ ] Rank only identified hazards?
- [ ] Exclude none and low associated MHs

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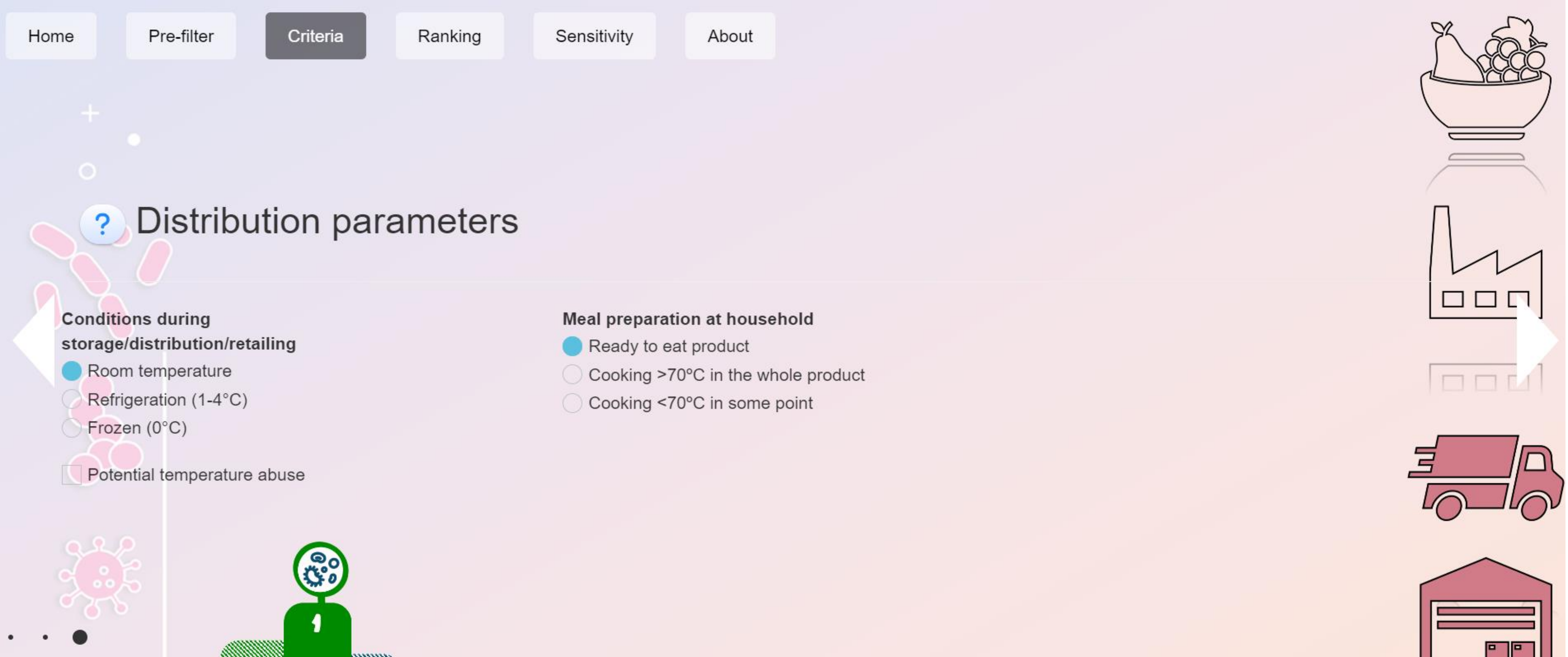
Select relevant criteria

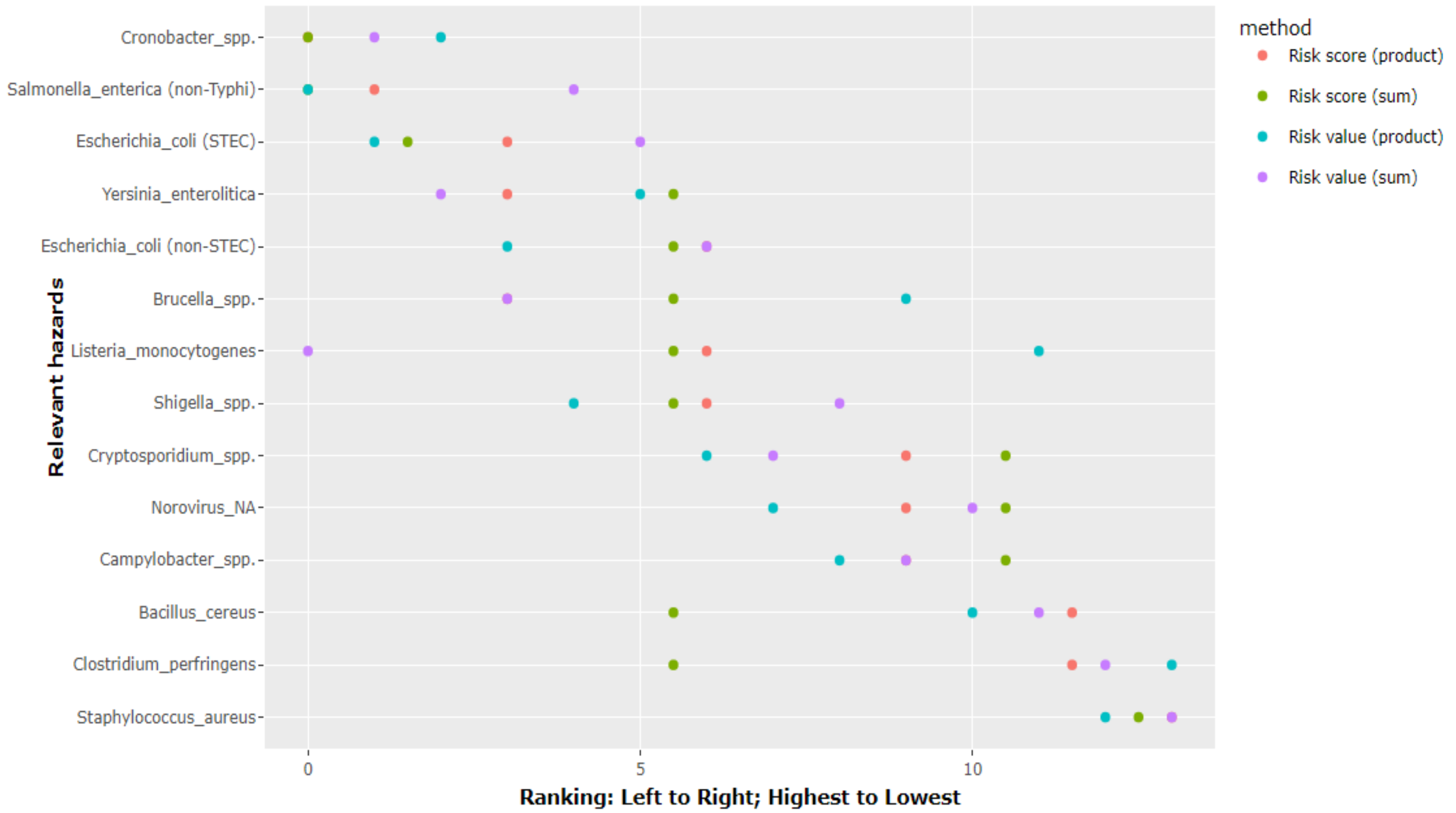


View ranking results

Home Pre-filter Criteria **Ranking** Sensitivity About

Semi-Quantitative Risk Aggregation Method Comparison

Risk value (product) Risk value (sum) Risk scoring (product) Risk scoring (sum)



Download the total risk scores or risk values per hazard in next pages

Case study: infant formula

$$\textbf{Total Risk} = (\mathbf{C2} + \mathbf{C3}^{\mathbf{b}}) * \mathbf{C4} * \mathbf{C5} * (\mathbf{C6A} * \mathbf{C6B} * \mathbf{C6C} * \mathbf{C6D})^{\frac{1}{4}} * \mathbf{C7} * \mathbf{C8}$$

B: Ranking with the hazard identification step									
Rank	**Genus**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**Risk value**
1	***Salmonella* non-Typhi**	10^{-6}	0.005	1	1	0.23	0.074	0.028	2.3×10^{-6}
2	**STEC**	10^{-6}	0.005	1	1	0.056	0.074	0.011	2.2×10^{-7}
3	***Cronobacter* spp.**	10^{-6}	0.005	1	1	1.63×10^{-4}	0.074	2.8	1.7×10^{-7}
4	non-STEC	10^{-6}	0.005	1	1	9.22×10^{-5}	0.074	0.046	1.5×10^{-9}
5	*Cryptosporidium* spp.	10^{-5}	10^{-6}	1	1	1.12×10^{-4}	0.074	0.035	3.2×10^{-12}

C2 survival; C3 recontamination, C4 growth C5 preparation C6 outbreak and contaminant prevalence, C7 consumption, C8 severity

Summary

1. Data acquisition
2. System construction
3. System validation
4. System application

4
data types

2
systems

Infants +
Todlers < 3

2+n
Processing techniques

Take home: governments, academia, companies

1. **Risk Assessment**
2. **HACCP**
3. **Product development**

- **Help defining risk based controls & relevant standard settings**

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Value

Adaptable System Frameworks

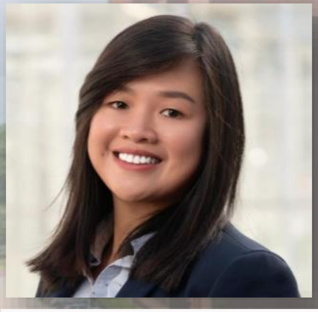
- ➢ **Broader FC**
- ➢ **More Target Groups**
- ➢ **Country/region based**
- ➢ **Cross sectors/industries**

European Commission

Horizon 2020
European Union funding
for Research & Innovation

SAFFI
Safe Food for Infants in the EU and China
中欧婴儿食品安全

Dr. Kah Yen Claire Yeak



Prof. Dr. Marcel Zwietering

Prof. Dr. Heidy Den Besten

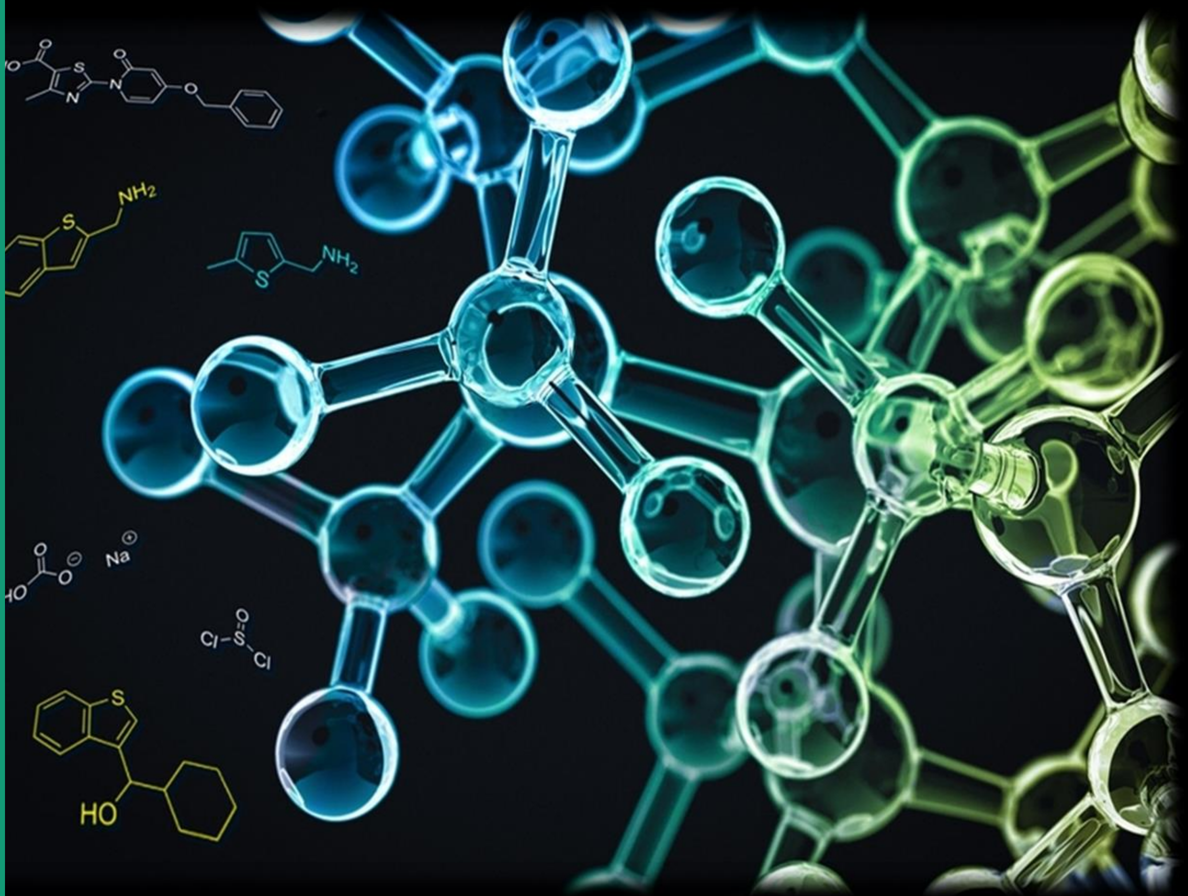
Dr. Alexander Dank

Dr. Alberto Garre

1. List of most relevant chemical hazards in food chains

Persistent Organic pollutants (28)

- Trace elements & Metals (18)
- Pesticides residues (17)
- Mycotoxins (15)
- Substances migrating from food contact materials (11)
- Heat induced compounds (6)
- Food additives (3)
- Ionic compounds (2)
- Phytoestrogen (1)



Decontamination by high hydrostatic pressure: ranking microbial hazards based on resistance

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Safe Food for Infants in the EU and China

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INTRODUCTION

- Microbial safety
- Sensory quality similar to fresh product
- Minimal change on nutrition traits


SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 26 January 2022

doi: 10.2903/j.efsa.2022.7128

The efficacy and safety of high-pressure processing of food

EFSA Panel on Biological Hazards (BIOHAZ Panel),
Konstantinos Koutsoumanis, Avelino Alvarez-Ordóñez, Declan Bolton, Sara Bover-Cid,
Marianne Chemaly, Robert Davies, Alessandra De Cesare, Lieve Herman, Friederike Hilbert,
Roland Lindqvist, Maarten Nauta, Luisa Peixe, Giuseppe Ru, Marion Simmons,
Panagiotis Skandamis, Elisabetta Suffredini, Laurence Castle, Matteo Crotta, Konrad Grob,
Maria Rosaria Milana, Annette Petersen, Artur Xavier Roig Sagués, Filipa Vinagre Silva,
Eric Barthélémy, Anna Christodoulidou, Winy Messens and Ana Allende

Abstract

High-pressure processing (HPP) is a non-thermal treatment in which, for microbial inactivation, foods are subjected to isostatic pressures (P) of 400–600 MPa with common holding times (t) from 1.5 to 6 min. The main factors that influence the efficacy (log_{10} reduction of vegetative microorganisms) of HPP when applied to foodstuffs are intrinsic (e.g. water activity and pH), extrinsic (P and t) and microorganism-related (type, taxonomic unit, strain and physiological state). It was concluded that HPP of food will not present any additional microbial or chemical food safety concerns when compared to other routinely applied treatments (e.g. pasteurisation). Pathogen reductions in milk/colostrum caused by the current HPP conditions applied by the industry are lower than those achieved by the legal requirements for thermal pasteurisation. However, HPP minimum requirements (P/t combinations) could be identified to achieve specific log_{10} reductions of relevant hazards based on performance criteria (PC) proposed by international standard agencies (5–8 log_{10} reductions). The most stringent HPP conditions used industrially (600 MPa, 6 min) would achieve the above-mentioned PC, except for *Staphylococcus aureus*. Alkaline phosphatase (ALP), the endogenous milk enzyme that is widely used to verify adequate thermal pasteurisation of cows' milk, is relatively pressure resistant and its use would be limited to that of an overprocessing indicator. Current data are not robust enough to support the proposal of an appropriate indicator to verify the efficacy of HPP under the current HPP conditions applied by the industry. Minimum HPP requirements to reduce *Listeria monocytogenes* levels by specific log_{10} reductions could be identified when HPP is applied to ready-to-eat (RTE) cooked meat products, but not for other types of RTE foods. These identified minimum requirements would result in the inactivation of other relevant pathogens (*Salmonella* and *Escherichia coli*) in these RTE foods to a similar or higher extent.

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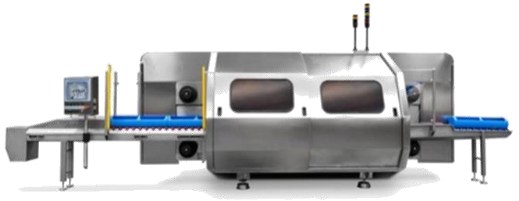
Keywords: High-pressure processing, microbial inactivation, food, milk, ready-to-eat products, safety concern

Requestor: European Commission
Question number: EFSA-Q-2020-00380
Correspondence: biohaz@efsa.europa.eu

Non-thermal preservation technology



L. monocytogenes

S. aureus

STEC

Salmonella

Campylobacter

Mycobacterium bovis

EFSA BIOHAZ (2022)

EFSA Journal 2022;20(3):7128

To collect and meta-analyse available data to evaluate the resistance of microbial hazards towards HPP

- To rank the resistance of microbial hazards towards HPP
- To develop a user friendly tool to estimate what are the HPP requirements to comply with a target performance criterion

APPROACH

Literature review
- Data collection
- Selection criteria

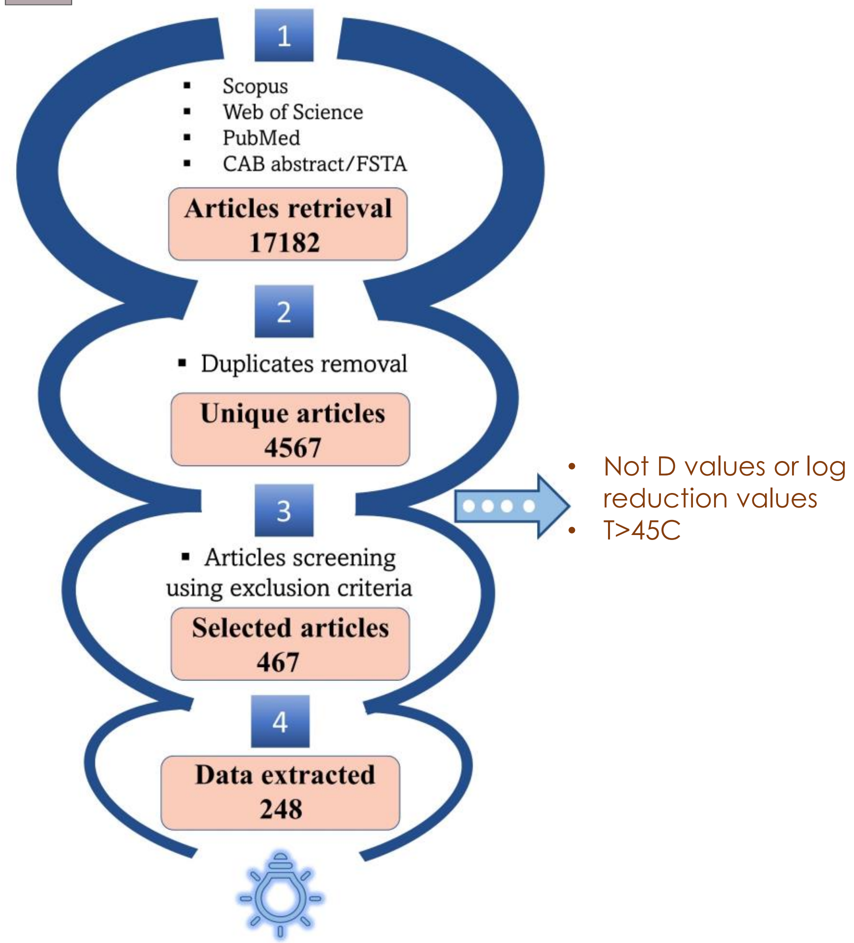
Data cleaning
- Extract & create database
- Impute for unknown

Data Analysis
- General trend analysis
- Exploratory Data Analysis

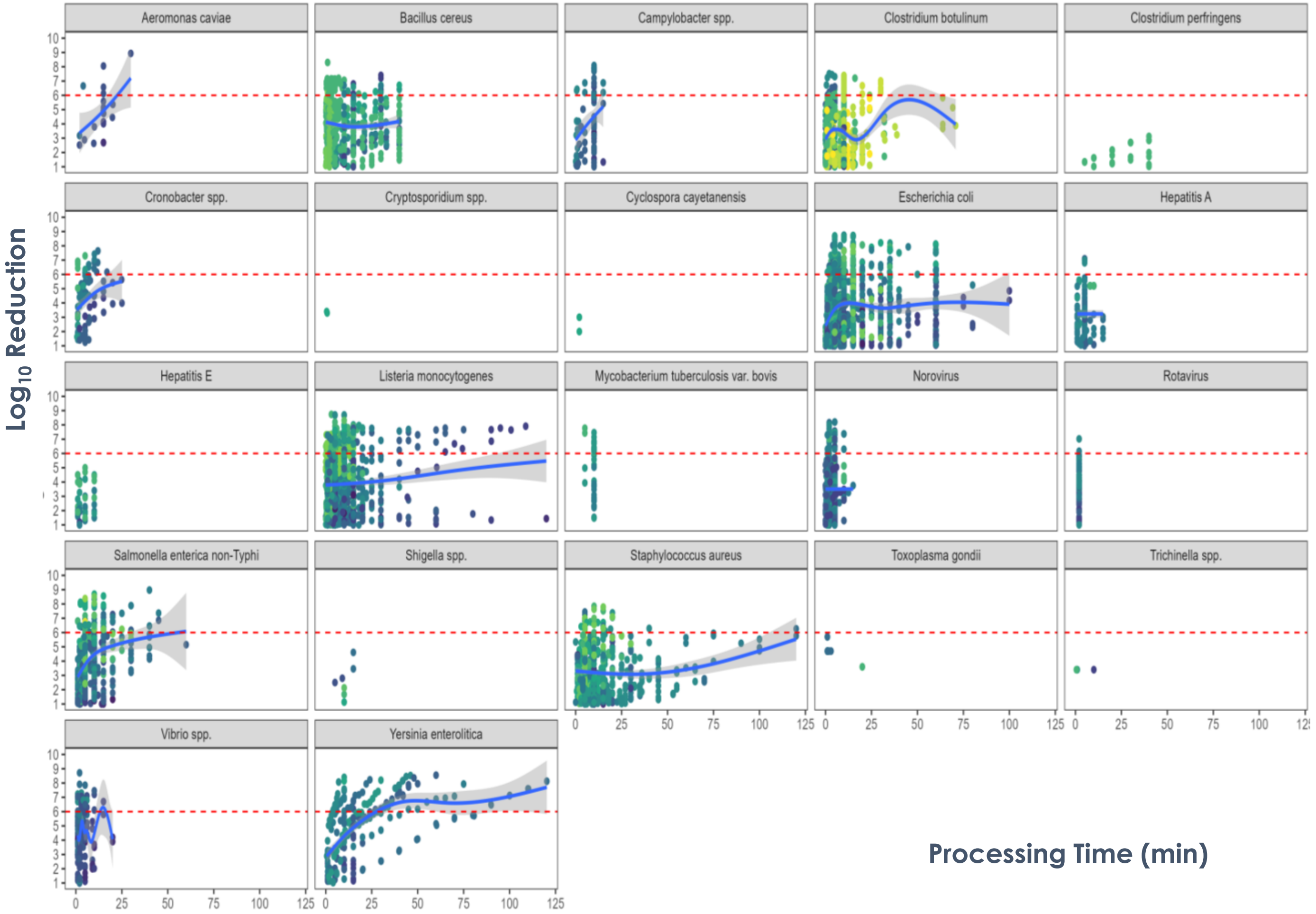
Modelling
- Develop quantitative models for selected MHs

RESULTS

Literature review

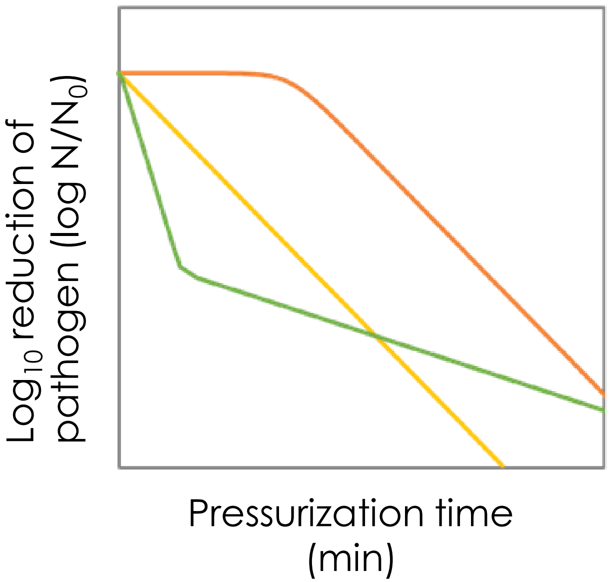


10084 Log reduction values



RESULTS

Inactivation rate→ K_{max}



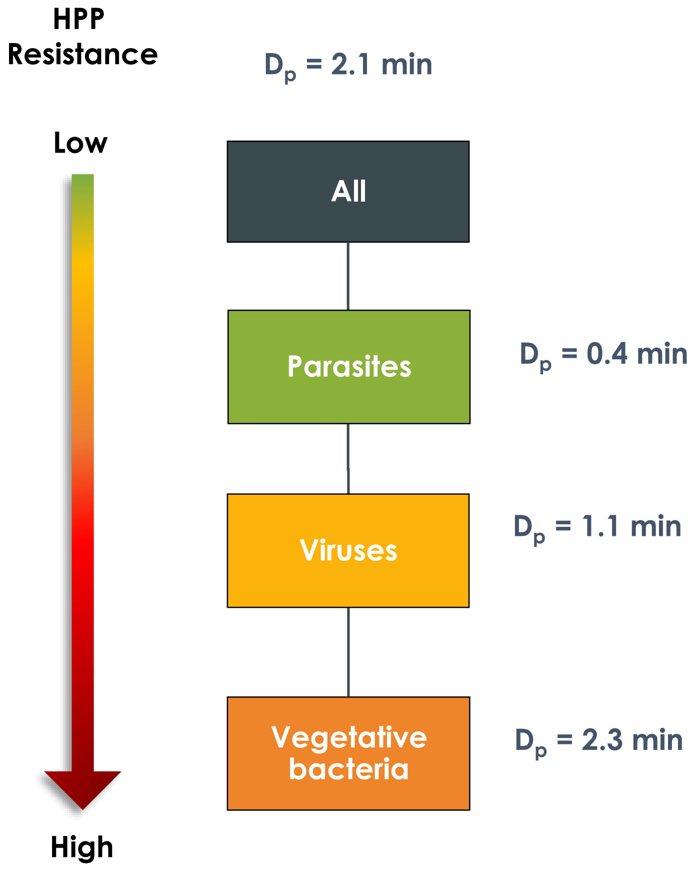
@ Constant Pressure intensity (MPa)

$$D_P = \frac{-Ln(10)}{K_{max}}$$

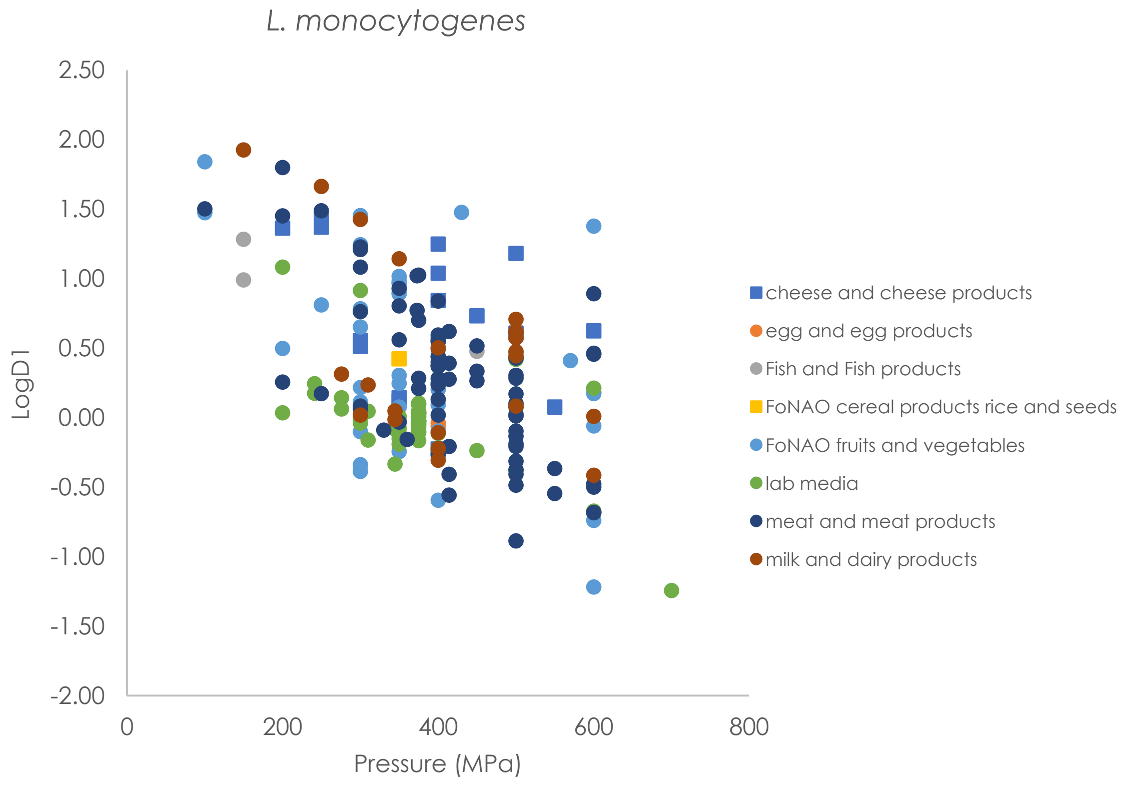
Pressurization time needed to inactivate 1 log of microbial hazard at certain pressure level (MPa)

3450 D values

1 Ranking based on general microbial hazards resistance towards HPP



2 Ranking considering on the impact of pressure level



RESULTS

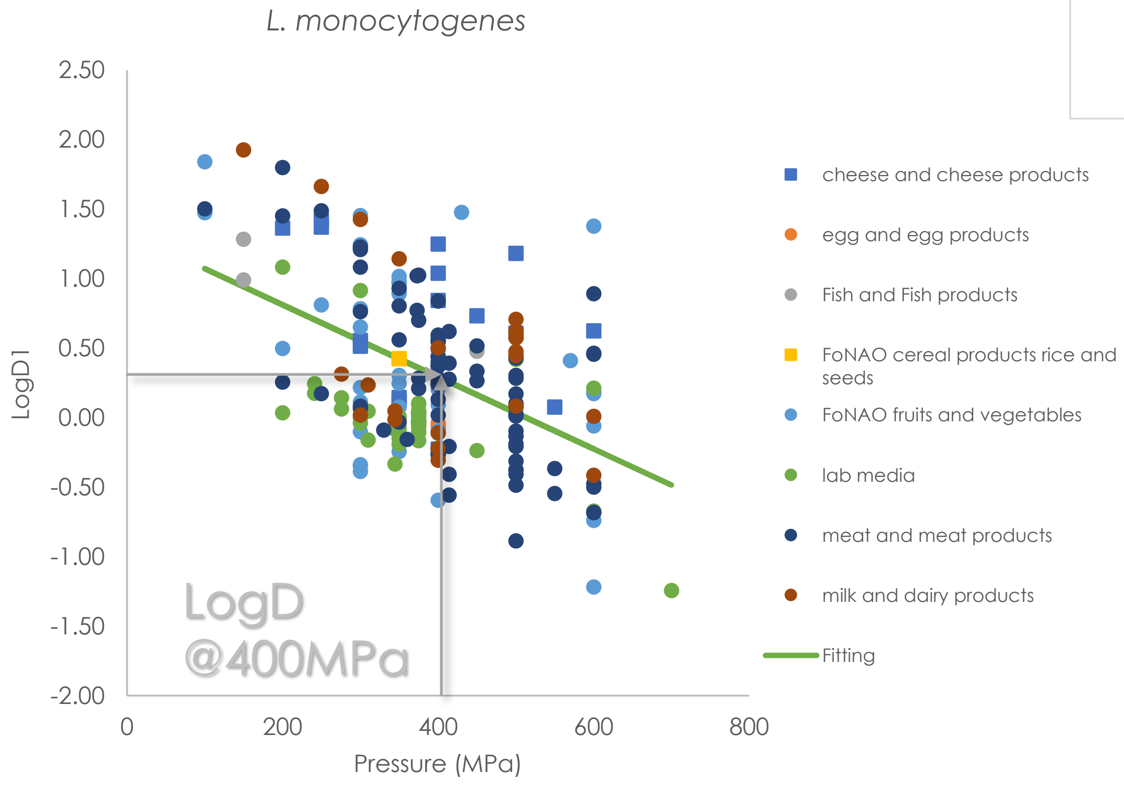
2 Ranking based on the impact of pressure level

$$LogD = LogD_{average} + \frac{P_{average} - P}{Z_P}$$

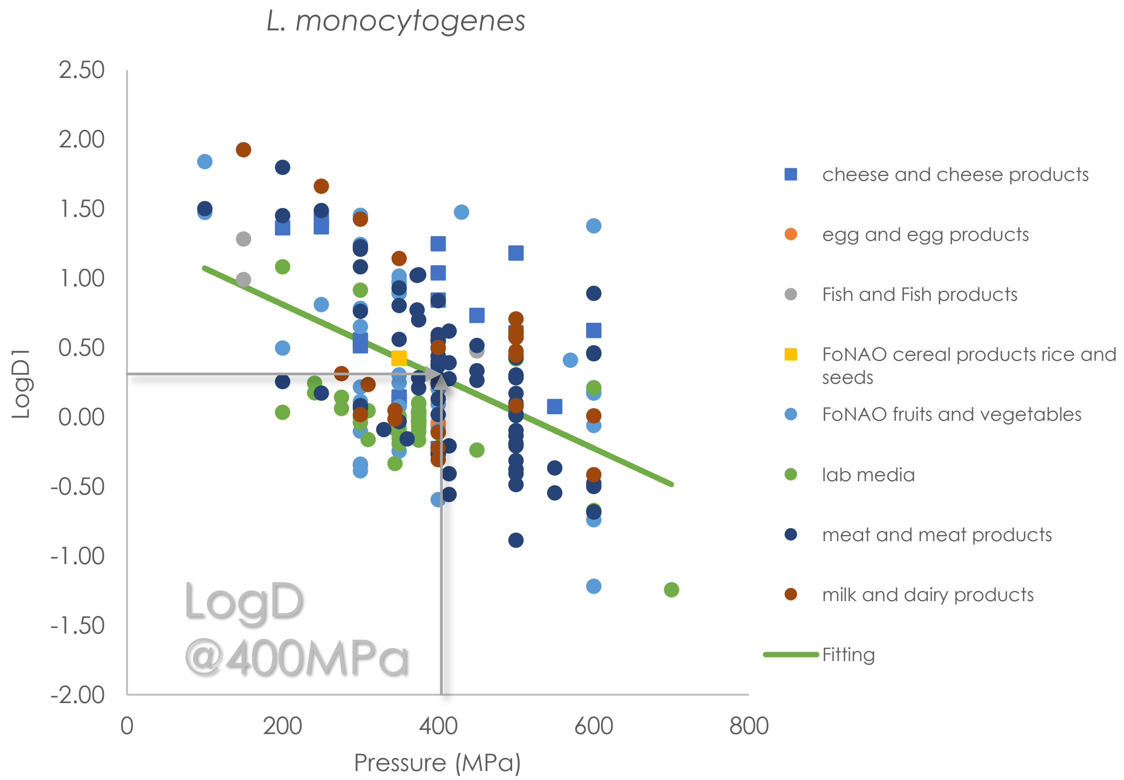
400 MPa

LogD at 400 MPa

Increase in P needed to reduce LogD by a factor of 10

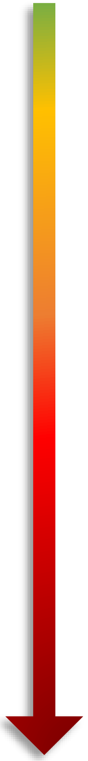


2 Ranking based on the impact of pressure level



HPP Resistance

Low



High

Microbial hazard	$LogD_{average}$ @ 400MPa (min)	$D_{average}$ @ 400 MPa (min)
Toxoplasma gondii	-0.62	0.24
Vibrio spp.	-0.55	0.28
Rotavirus	-0.3	0.50
Aeromonas caviae	-0.25*	0.56
Trichinella spp.	-0.21	0.62
Cronobacter spp.	-0.14	0.72
Campylobacter spp.	-0.089	0.81
Norovirus	0.055	1.14
Hepatitis A	0.17	1.48
Listeria monocytogenes	0.36	2.29
Salmonella enterica non-Typhi	0.36	2.29
Yersinia enterolitica	0.44	2.75
Hepatitis E	0.48	3.02
Bacillus cereus	0.56	3.63
Staphylococcus aureus	0.59	3.89
Escherichia coli	0.59	3.89
Mycobacterium bovis	0.71	5.13
Shigella spp.	0.87	7.41

RESULTS

3 Ranking based on the impact of pressure level and food matrix

SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 26 January 2022

doi: 10.2903/j.efsa.2022.7128

The efficacy and safety of high-pressure processing of food

EFSA Panel on Biological Hazards (BIOHAZ Panel), Konstantinos Koutsoumanis, Avelino Alvarez-Ordóñez, Declan Bolton, Sara Bover-Cid, Marianne Chemaly, Robert Davies, Alessandra De Cesare, Lieve Herman, Friederike Hilbert, Roland Lindqvist, Maarten Nauta, Luisa Peixe, Giuseppe Ru, Marion Simmons, Panagiotis Skandamis, Elisabetta Suffredini, Laurence Castle, Matteo Crotta, Konrad Grob, Maria Rosaria Milana, Annette Petersen, Artur Xavier Roig Sagués, Filipa Vinagre Silva, Eric Barthélemy, Anna Christodoulidou, Winy Messens and Ana Allende

Abstract

High-pressure processing (HPP) is a non-thermal treatment in which, for microbial inactivation, foods are subjected to isostatic pressures (P) of 400–600 MPa with common holding times (t) from 1.5 to 6 min. The main factors that influence the efficacy (log_{10} reduction of vegetative microorganisms) of HPP when applied to foodstuffs are intrinsic (e.g. water activity and pH), extrinsic (P and t) and microorganism-related (type, taxonomic unit, strain and physiological state). It was concluded that HPP of food will not present any additional microbial or chemical food safety concerns when compared to other routinely applied treatments (e.g. pasteurisation). Pathogen reductions in milk/colostrum caused by the current HPP conditions applied by the industry are lower than those achieved by the legal requirements for thermal pasteurisation. However, HPP minimum requirements (P/t combinations) could be identified to achieve specific log_{10} reductions of relevant hazards based on performance criteria (PC) proposed by international standard agencies (5–8 log_{10} reductions). The most stringent HPP conditions used industrially (600 MPa, 6 min) would achieve the above-mentioned PC, except for *Staphylococcus aureus*. Alkaline phosphatase (ALP), the endogenous milk enzyme that is widely used to verify adequate thermal pasteurisation of cows' milk, is relatively pressure resistant and its use would be limited to that of an overprocessing indicator. Current data are not robust enough to support the proposal of an appropriate indicator to verify the efficacy of HPP under the current HPP conditions applied by the industry. Minimum HPP requirements to reduce *Listeria monocytogenes* levels by specific log_{10} reductions could be identified when HPP is applied to ready-to-eat (RTE) cooked meat products, but not for other types of RTE foods. These identified minimum requirements would result in the inactivation of other relevant pathogens (*Salmonella* and *Escherichia coli*) in these RTE foods to a similar or higher extent.

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Keywords: High-pressure processing, microbial inactivation, food, milk, ready-to-eat products, safety concern

Requestor: European Commission

Question number: EFSA-Q-2020-00380

Correspondence: biohaz@efsa.europa.eu

www.efsa.europa.eu/efsajournal

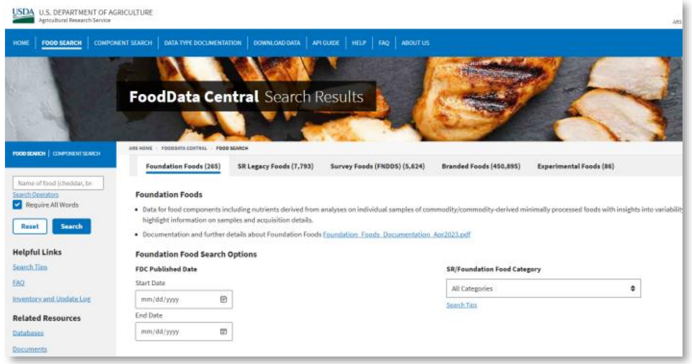
EFSA Journal 2022;20(3):7128

What intrinsic/extrinsic characteristics of food can affect the inactivation of pathogens by HPP?

1. **pH** → **50 %** missing values
2. a_w
3. **NaCl (%)**
4. **Fat, proteins, carbohydrates (%)**
5. Antimicrobials (organic acids, essential oils)
6. Bacteriocins, enzymatic compounds (cheese, raw milk)
7. Frozen products
8. Gases in the package (CO_2)

(items 2–8) → **>80 %** missing values

Imputation with values from:
FoodData Central (USDA)



3 Ranking based on the impact of pressure level and food matrix

What are the parameters that significantly affect LogD values?

Numerical variables
- Pressure
- Processing temperature
- Come-up time
- a_w
- pH
- NaCl
- Fat
- Carbohydrates
- Proteins

Categorical variables
- pH category (strongly acid, acid or low acid)
- a_w category (< or >0.95)
- Food item
- Microbial hazard
- Strain

Spearman's correlation test

Kruskall-Wallis H test

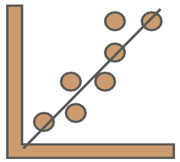
Cramer's V

To identify significant parameters

To find correlations

1. Pressure
2. pH & a_w
3. Microbial hazard

3 Ranking based on the impact of pressure level and food matrix



$$LogD = Intercept + a * (P - Pref) + b * pH + c * a_w + d * pH.aw + \mathrm{MH}$$

(Pref = 400 MPa)

Parameter	Estimate ± SE	P-value
Intercept	-4.39 ± 1.57	0.0055
a (Pressure)	$2.38e^{-3} \pm 1.79e^{-4}$	$<2e^{-16}$
b (pH)	1.67 ± 0.41	$6.25e^{-5}$
c (a_w)	3.10± 1.49	0.038
d (pH.a_w)	-1.55 ± 0.43	0.00032
E. coli	0.81± 0.43	0.06
L. monocytogenes	0.80 ± 0.42	0.06
Norovirus	0.60 ± 0.43	0.16
Salmonella	0.68 ± 0.41	0.10
S. aureus	1.31 ± 0.43	0.0029

Base: aeromonas

$R_{adjusted}^2 = 0.47$
AIC = 338.36

- LogD as a function of the intrinsic characteristics of food
- No data for all microbial hazards (n=350)

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RESULTS

3 Ranking based on the impact of pressure level and food matrix

400 MPa → P; 73 levels → $food_{item}$; 19 levels → MH

$$LogD = Intercept + a * (P - Pref) + b * food_{item} + c * \mathrm{MH} + (1|strain)$$

Parameter	Estimate ± SE	P-value
Intercept	-0.35± 0.30	0.233
a (Pressure)	$2.14e^{-3} \pm 6e^{-5}$	$<2e^{-16}$
b (Food $item_i$)	0.27 ± 0.25	0.277
c (MH_i)	0.43± 0.20	0.031

Marginal $R^2 = 0.492$
Conditional $R^2 = 0.704$
AIC = 2765.21

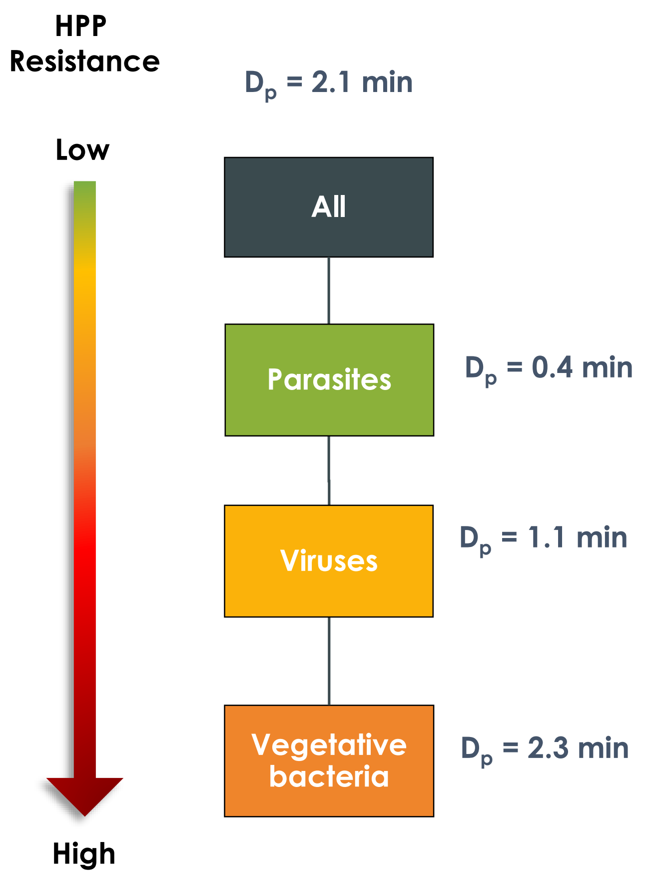
HPP Resistance: Low → High

Microbial hazard	c(log min)	c (min)
Vibrio spp.	-0.74	0.18
Trichinella spp.	-0.54	0.29
Cronobacter spp.	-0.50	0.32
Rotavirus	-0.46	0.35
Campylobacter spp.	-0.26	0.55
Norovirus	-0.24	0.58
Hepatitis A	-0.22	0.60
Bacillus cereus	-0.19	0.64
Aeromonas caviae	-0.18	0.66
Cryptosporidium spp.	-0.09	0.81
Salmonella	-0.04	0.91
Mycobacterium bovis	-0.02	0.96
Yersinia enterolitica	-0.01	0.98
Listeria monocytogenes	0	1
E. coli	0.16	1.45
S. aureus	0.26	1.82
Hepatitis E	0.36	2.28
Shigella spp.	0.39	2.44
Toxoplasma gondii	0.65	4.43

Base L. monocytogenes in neutral buffer

RESULTS

1 Ranking based on general microbial hazards resistance towards HPP



2 Ranking based on the impact of pressure level

Microbial hazard	
Toxoplasma gondii	Sensitive $D_P < 1min$ @400MPa
Vibrio spp.	
Rotavirus	
Aeromonas caviae	
Trichinella spp.	
Cronobacter spp.	
Campylobacter spp.	Moderate $1min \leq D_P < 3min$ @400MPa
Norovirus	
Hepatitis A	
Listeria monocytogenes	
Salmonella	
Yersinia enterolitica	
Hepatitis E	
Bacillus cereus	Resistant $D_P \geq 3min$ @400MPa
Staphylococcus aureus	
Escherichia coli	
Mycobacterium bovis	
Shigella spp.	

3 Ranking based on the impact of pressure level and food matrix

Microbial hazard	
Vibrio spp.	Sensitive
Trichinella spp.	
Cronobacter spp.	
Rotavirus	
Campylobacter spp.	
Norovirus	
Hepatitis A	Moderate
Bacillus cereus	
Aeromonas caviae	
Salmonella	
Mycobacterium bovis	
Yersinia enterolitica	
Listeria monocytogenes	
E. coli	Resistant
S. aureus	
Hepatitis E	
Shigella spp.	
Toxoplasma gondii	

In neutral buffer

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RESULTS

What are the HPP requirements (pressure and time) to comply with a target performance criterion

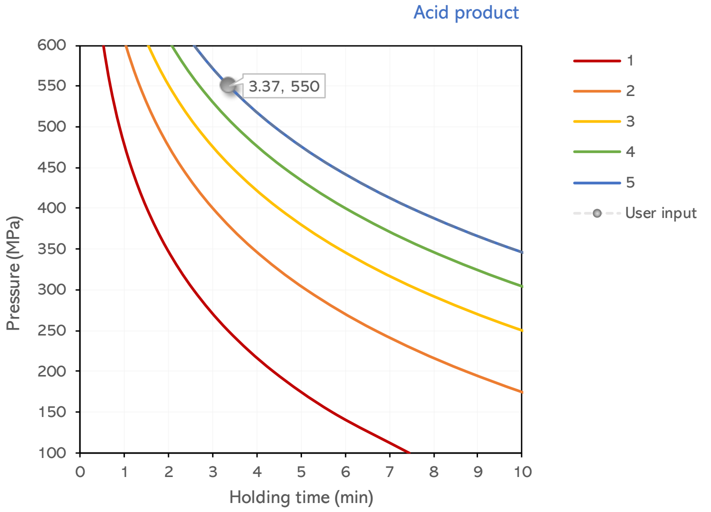
Microbial Hazards Identification DSS procedures

MI ID Hazards Identification

Decision Support System prototype

SET HPP CONDITIONS TO ACHIEVE A TARGET PERFORMANCE CRITERIA

FOR THE INACTIVATION OF VEGETATIVE PATHOGENS IN FRUIT & VEGETABLE PUREE



pH category: 2 — write the number according to the pH of the food matrix

1 Low acid — if pH > 4.5

2 Acid — if 4 ≤ pH ≥ 4.5

3 High acid — if pH < 4

Target performance criteria (Log reduction):

Log (N_0/N): 5.0

Enter the target pressure (input):

Pressure (MPa): 550

Temperature (°C)*: < 29 °C

*Maximum temperature of the pressurisation fluid at the begining of the HPP cycle (assuming a compression heating of 3 °C/100 MPa)

Time (min): 3.4 *output*

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Sara Bover-Cid

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"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°861917"

TRANSIT

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska Curie grant agreement No 955431"

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SAFFI

"Safe Food for Infants in the EU and China"

Ranking risks in food: consumer perception vs quantitative risk assessment

26 June 2024, IAFP Webinar

Jeanne-Marie Membré, jeanne-marie.membre@inrae.fr

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°861917"

Outline

- Introduction
  - Food safety and risk ranking
- Methodology
  - Survey and survey analysis
  - How did we assess consumer perception?
  - How did we assess microbiological and chemical risks?
- Results
  - Consumer perception: general public vs food specialists
  - Consumer perception vs quantitative assessment
- Conclusion

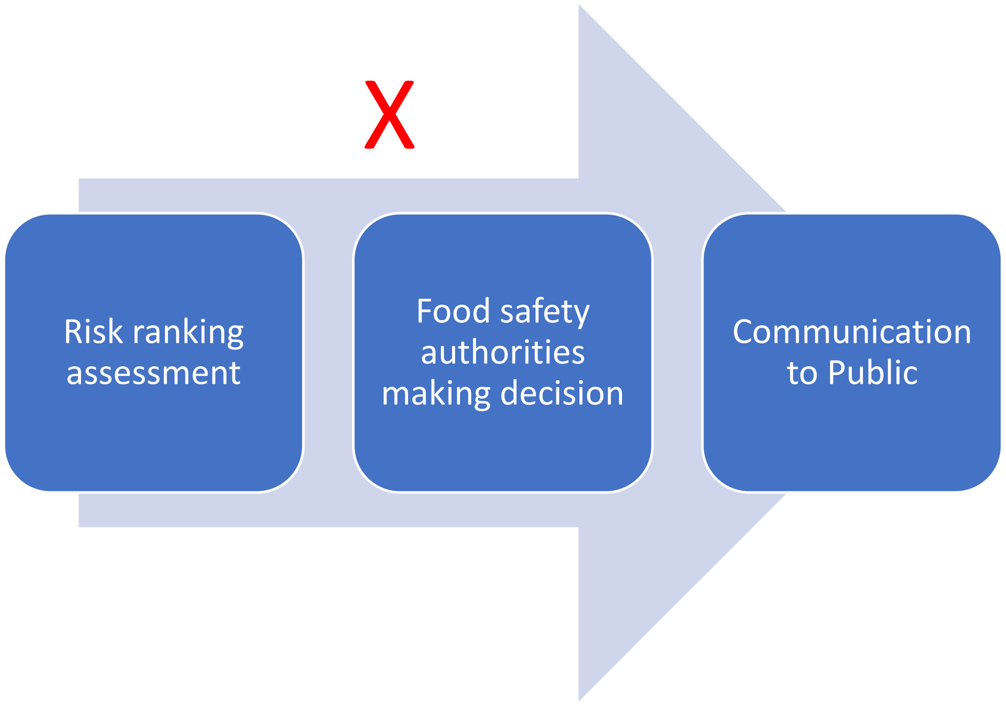
Introduction

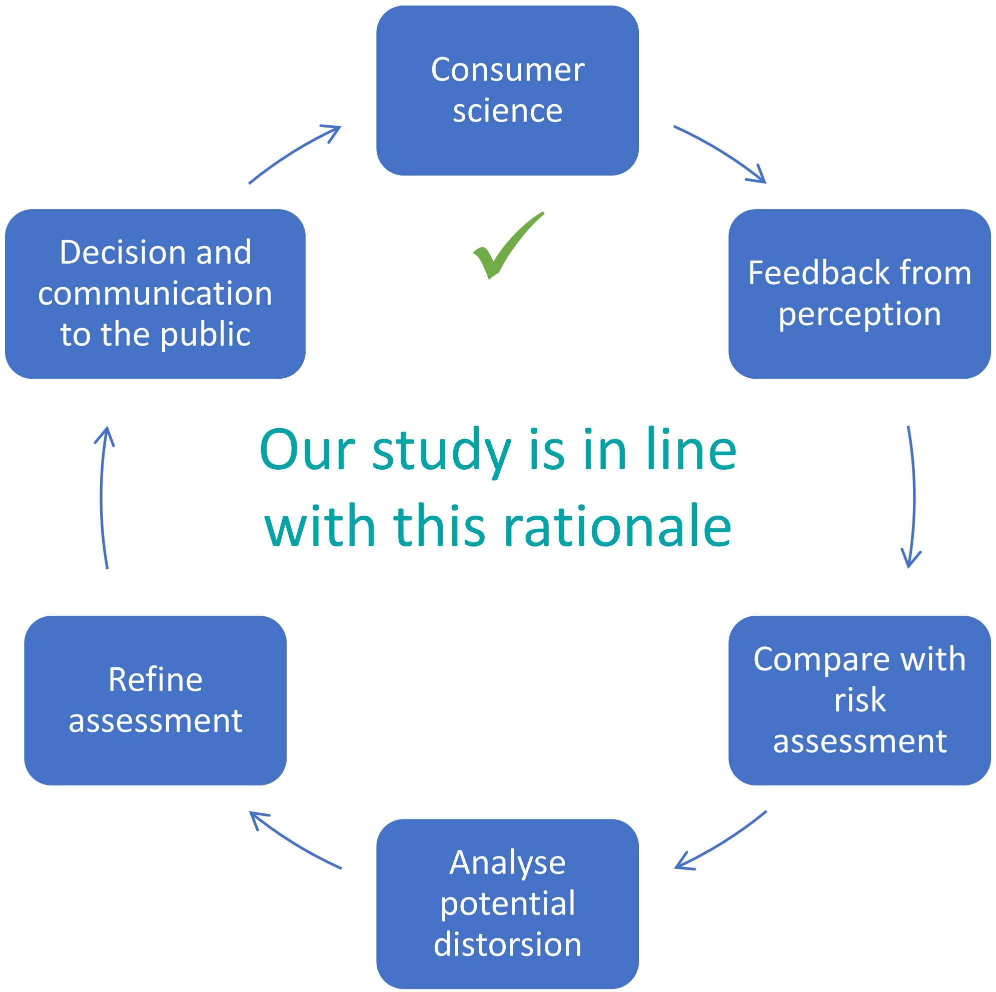
Food safety and risk ranking

- FAO 2020:
  - "Risk analysis is internationally accepted as a key component to support decision-making around food safety.
  - Food safety risk ranking is the systematic analysis and ordering of hazards and/or foods in terms of public health risks, based on the likelihood and severity of adverse impacts on human health in a target population.
  - Risk ranking provides food safety authorities with the scientific basis to make informed regulatory decisions, enhance disease surveillance, determine how food inspections are allocated, …. inform the public of food safety threats"
- What about perception of risk from the public?

Introduction

Food safety and risk ranking





Methodology

Methodology

- Infant formula
  - Food safety is a crucial public health concern, especially for vulnerable groups like infants and toddlers under 3 years

- Population : 2 surveys
  - ca 3000 participants → General Public
  - 38 food professionals → Food professionals

- On-line questionnaire including microbiological and chemical hazards
- Data were analysed and normalized to be compared with risk ranking assessment

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Methodology

How did we assess consumer perception?

- Concern
  - How often do you wonder if the child's meals contain these contaminants when you choose or prepare them?
- Severity
  - According to your best guess, how dangerous would you estimate an industrial produced food for infants and young children to be, when the following are present?
- Likelihood
  - According to your best guess, how frequent would you estimate the presence of the following in an industrial produced food for infants and young children?
- Re-calculated “risk” as severity x likelihood

Methodology

How did we assess consumer perception? – Category of Hazards

- Chemical hazards

Contaminants present in the environment	heavy metals, dioxins , etc
Contaminants from agricultural practices	pesticides, mycotoxins, etc.
Substances generated during industrial processes such as cooking	furan, etc
Contaminants present in packaging that could migrate into food	bisphenol A from contact plastics, etc
Intentionally added substances in food	food additives such as titanium dioxide, etc.
Substances naturally present in foods	phytoestrogens in soy, etc.
Fraudulently introduced contaminants	melamine, etc.

- Microbiological hazards

Bacteria that may cause short-term mild sickness, less than 2-3 days	Bacillus cereus causing diarrhea, etc
Bacteria that may cause long-term sickness, more than 1-2 weeks, or severe symptoms	Listeria monocytogenes causing brain swelling, etc.
Preformed bacterial toxins in foods	botulinum toxins, etc.
Infectious viruses	norovirus causing nausea or stomach pain, etc.
Parasites	roundworms causing loss of appetite, etc.

+ unknown category

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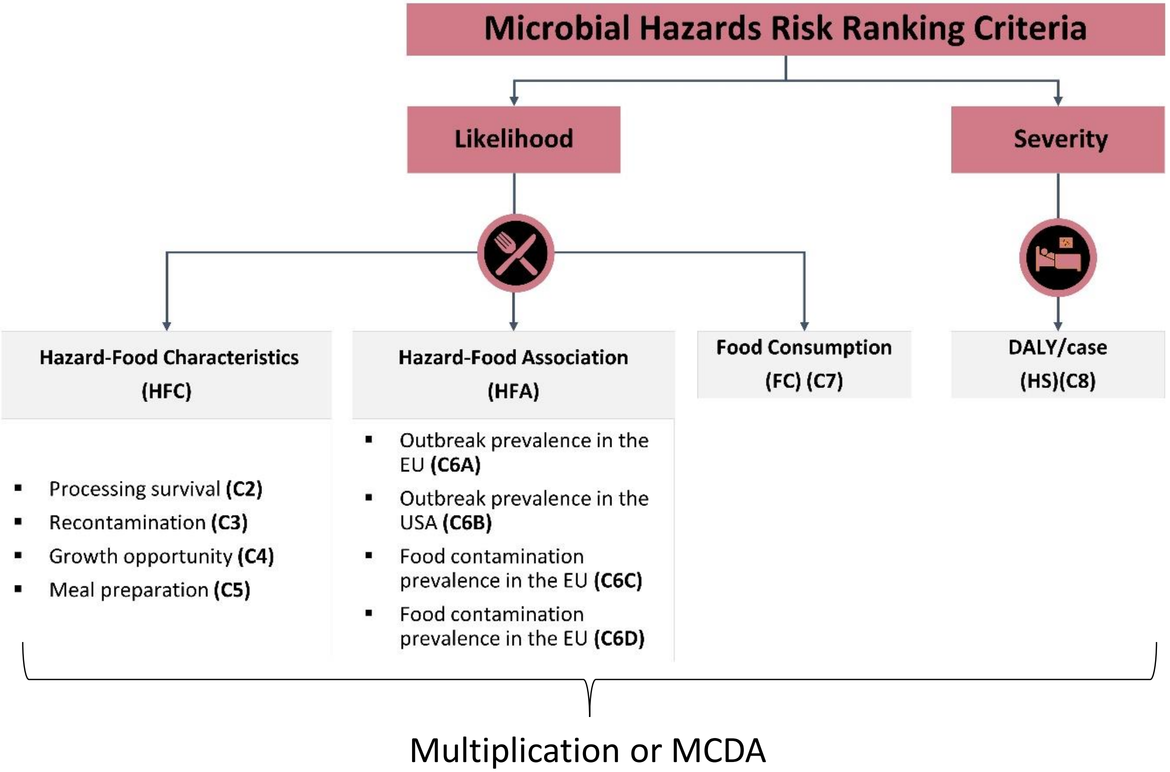
Methodology

How did we assess microbiological and chemical risks?

- Microbiological Risk

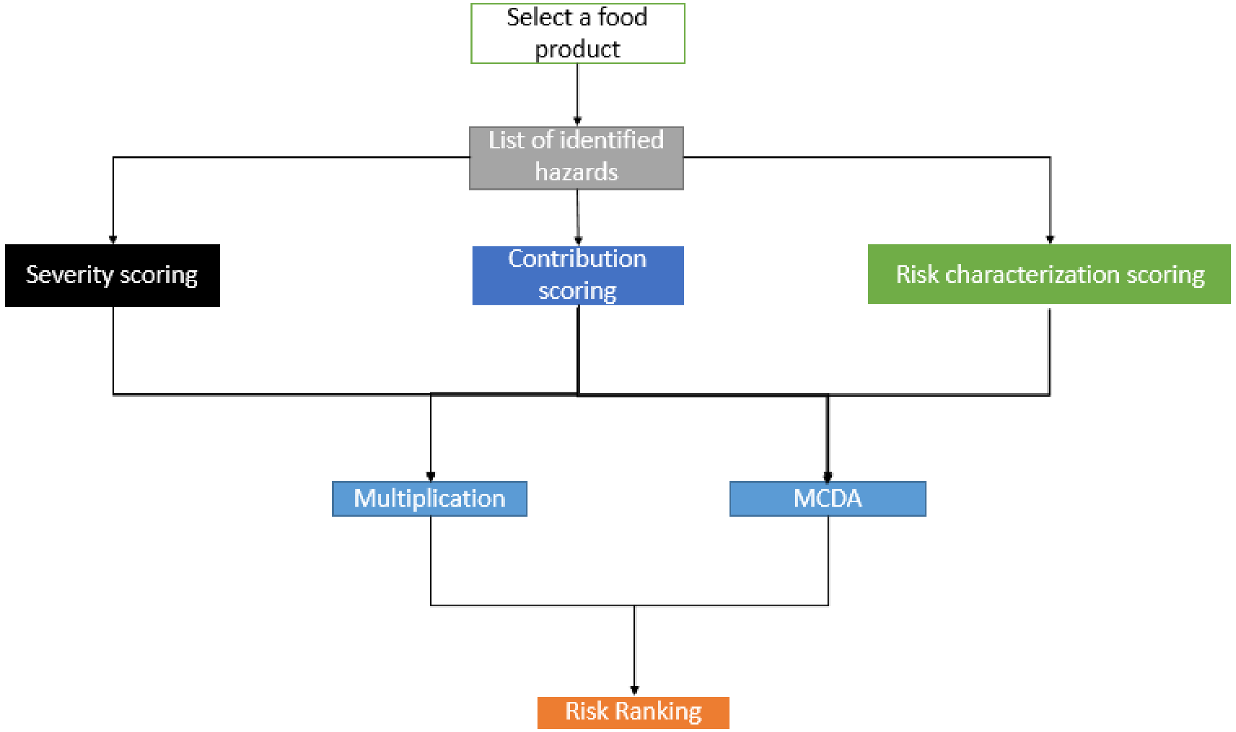


Kah Yen Claire Yeak, Alberto Garre, Jeanne-Marie Membré, Heidy M.W. den Besten, Marcel H. Zwietering.
Systematic Risk Ranking of Microbiological Hazards in Infant Foods.
Food Research International. Submitted.

Methodology

How did we assess microbiological and chemical risks?

- Chemical Risk



P. Palmont, J.-M. Membré, G. Riviere, N. Bemrah. 2023. Risk ranking of chemical hazards in infant foods: Comparison of methods using infant formula as an example.
Food Additives & Contaminants. Part A. 1-9
DOI: 10.1080/19440049.2022.2163302

Results

Perception: general public vs food professionals

Thomopoulos, Rallou; Fuchsbauer, Norbert; Pissaridi, Katerina; Bover, Sara; Besten, Heidy den; Palmont, Philippe; Engel, Erwan, 2024, "End users' perceptions and home practices regarding infant food safety in Europe", https://doi.org/10.57745/8T4VCD, Recherche Data Gouv, V1

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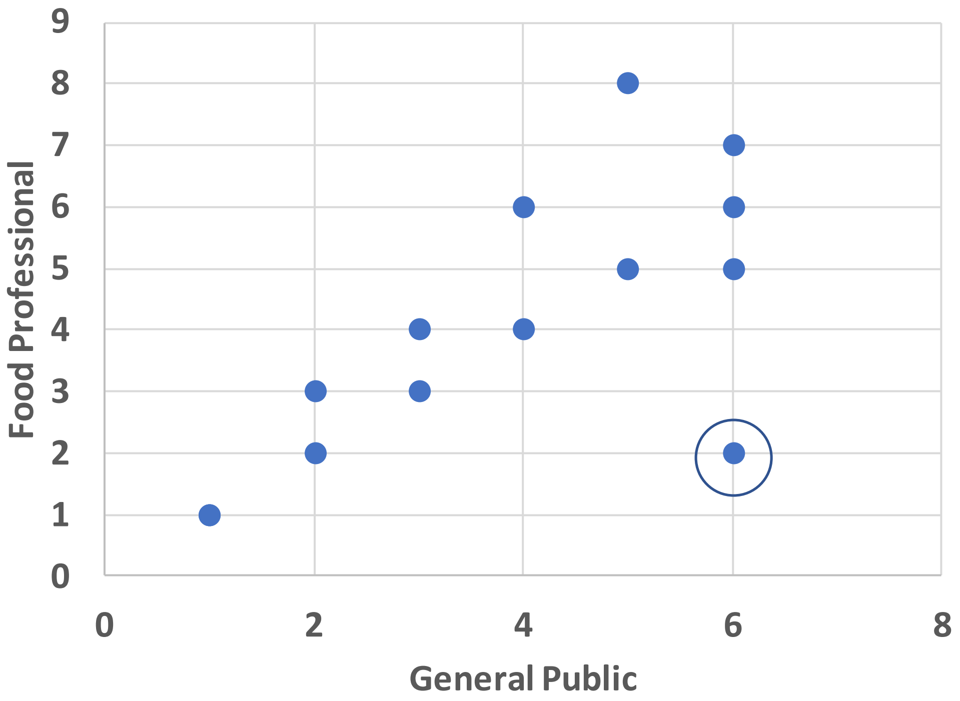
Results

Consumer perception: general public vs food professionals

- Severity / Ranking scores



Microbiological and Chemical Hazards, altogether

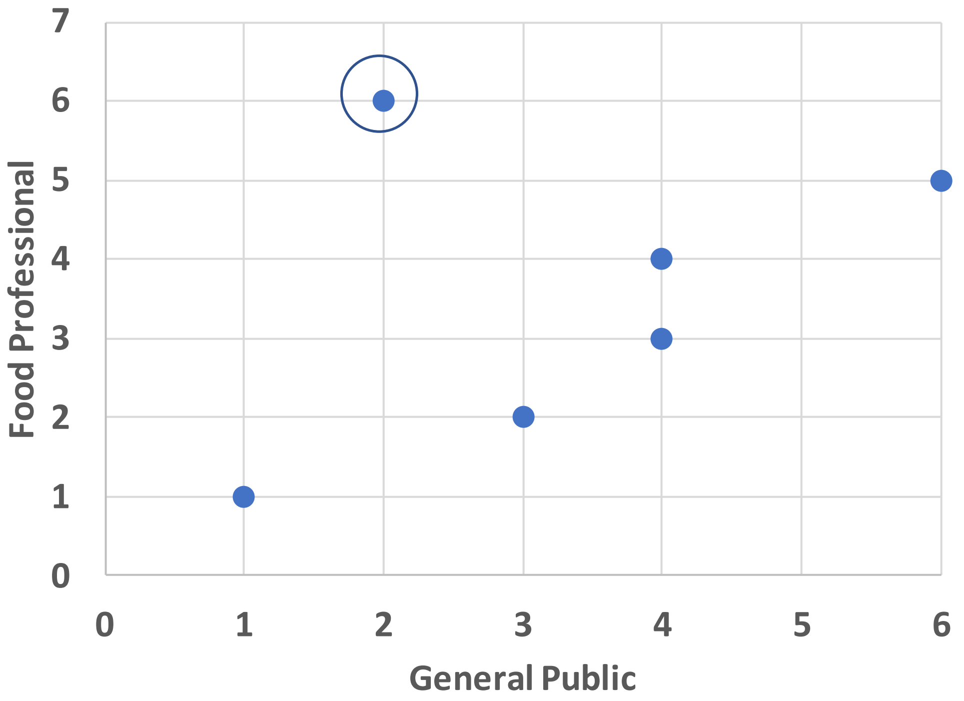
Relative good agreement between perception by the two groups.
Spearman coefficient: 0.89

One exception: “unknown chemical risk”

Results

Consumer perception: general public vs food professionals

- Risk – Microbiological Hazards / Ranking scores



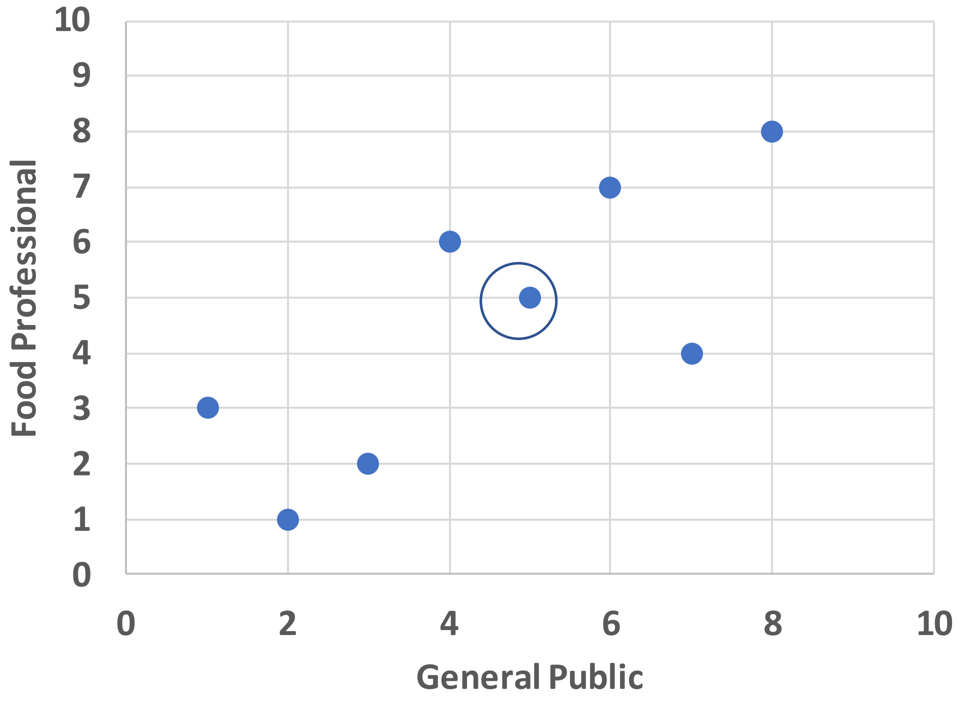
Relative good agreement between perception by the two groups.
Spearman coefficient: 0.97

One exception: “unknown microbiological risk”

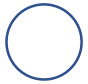
Results

Consumer perception: general public vs food professionals

- Risk – Chemical Hazards / Ranking scores



Relative good agreement between perception by the two groups.
Spearman coefficient: 0.76

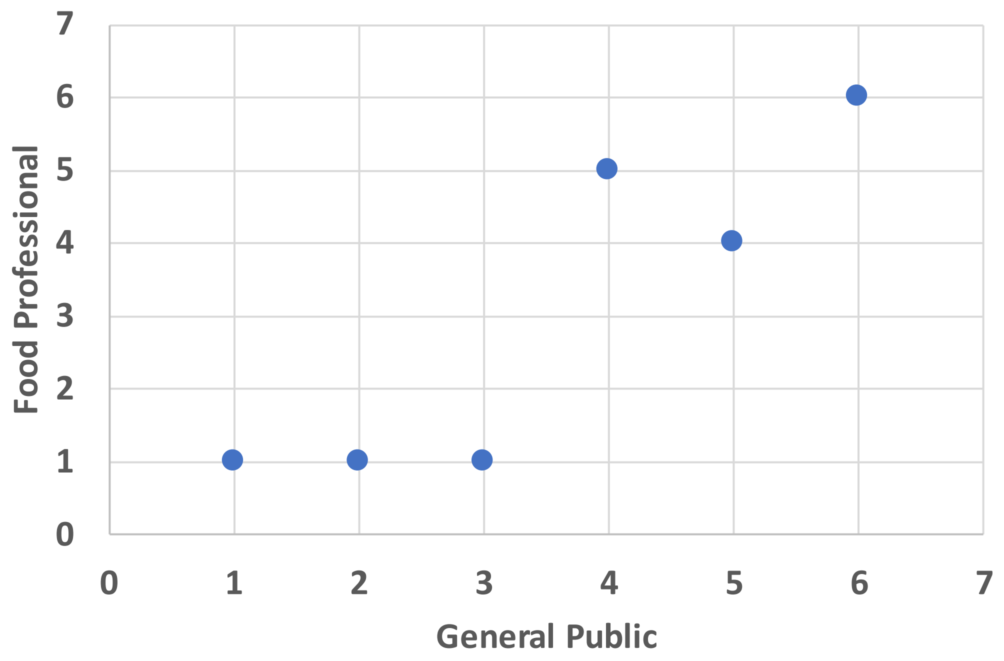


"unknown chemical risk"

Results

Consumer perception: general public vs food professionals

- Concern – Microbiological Hazards / Ranking scores

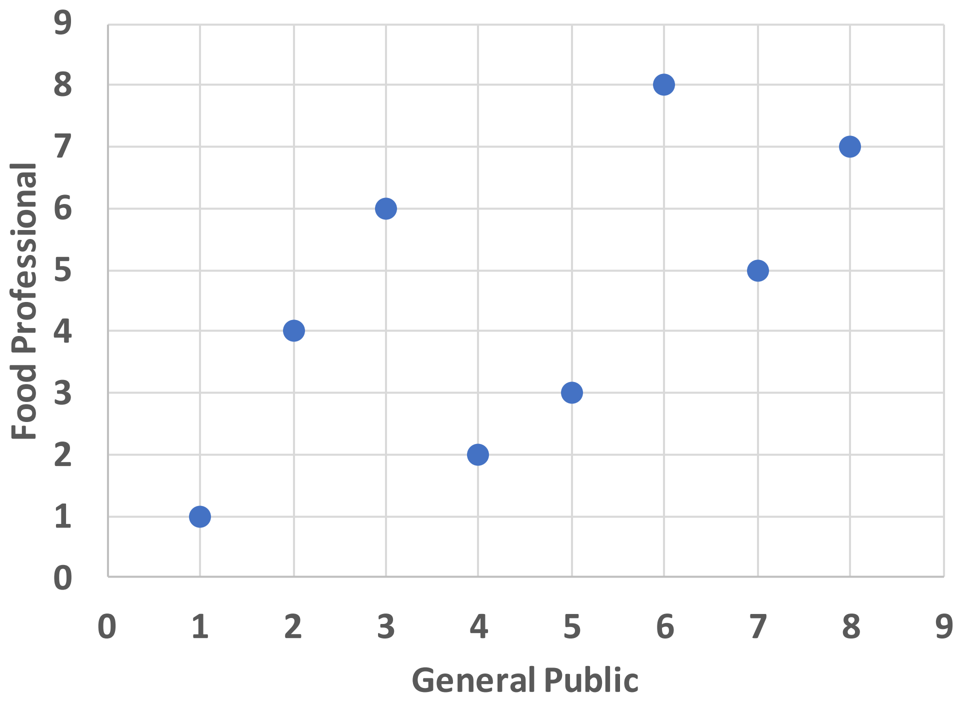


Relative good agreement between perception by the two groups.
Spearman coefficient: 0.88

Results

Consumer perception: general public vs food professionals

- Concern – Chemical Hazards / Ranking scores



Relative good agreement between perception by the two groups.
Spearman coefficient: 0.64

Hereafter: only general public

Results

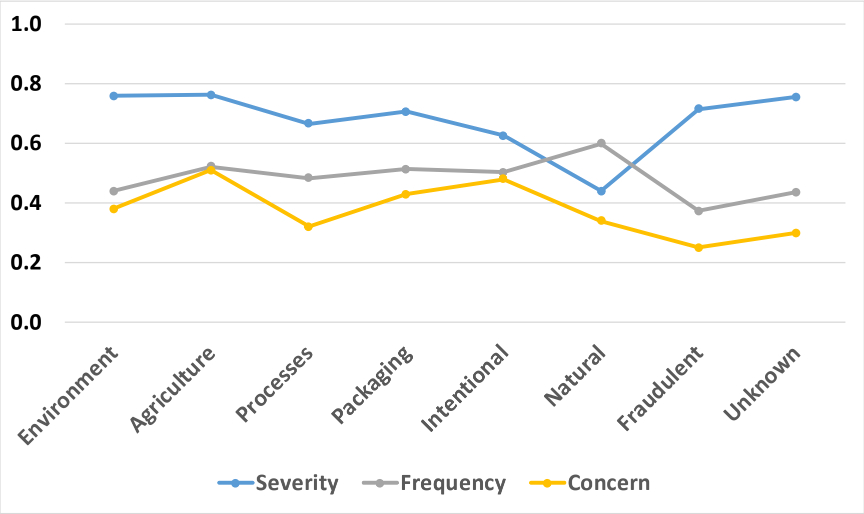
Perception: chemical hazards vs microbiological hazards

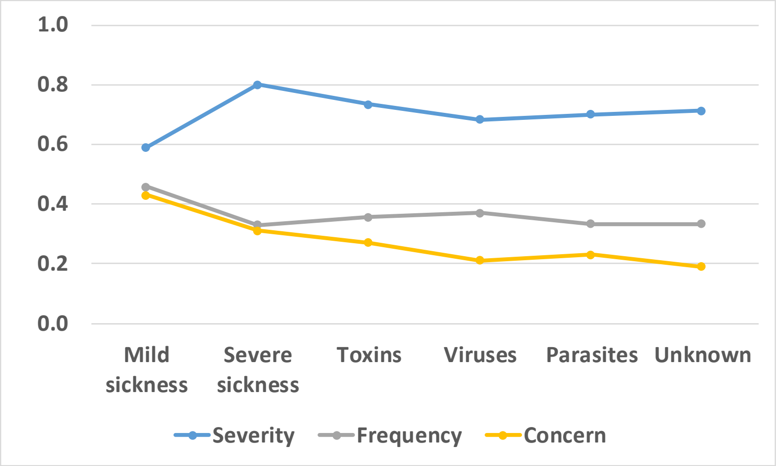
Results

Consumer perception

- Chemical hazards vs Microbiological Hazards

General public





Severity perception of C and M in the same order of magnitude

Overall concern slightly higher for chemical hazards than for microbiological hazards

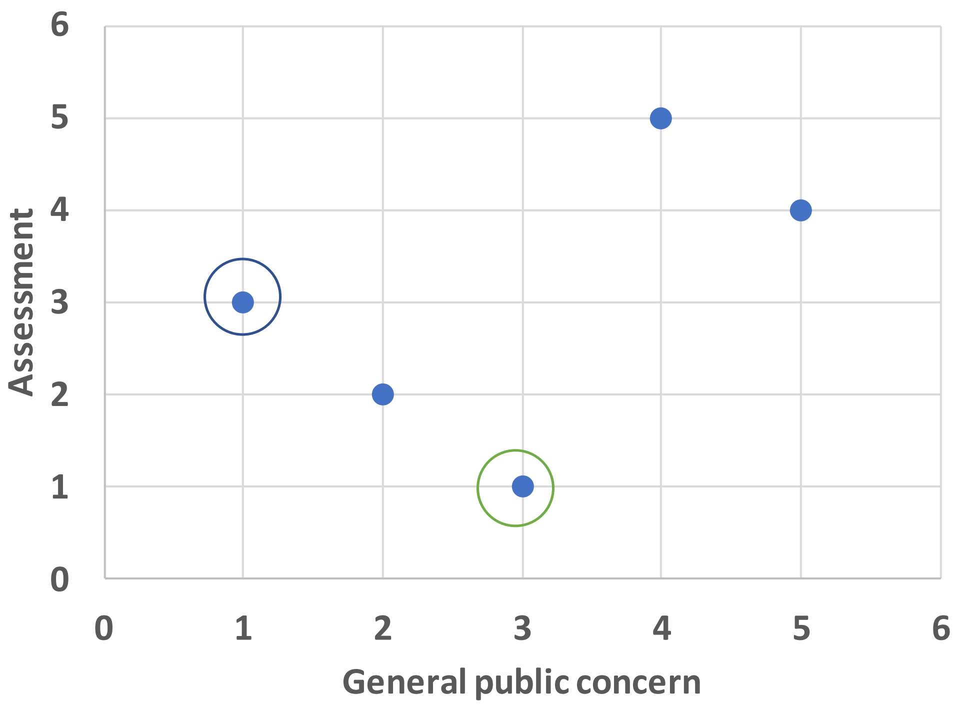
Results

Perception vs Assessment

Results

Consumer perception vs quantitative assessment

- Concern$_{perc}$ vs risk$_{assess}$ / Ranking scores



Microbiological Hazards

Not so good agreement between concern (perception of General public) and risk (assessment).
Spearman coefficient: 0.5

“Viruses”

“Toxins”

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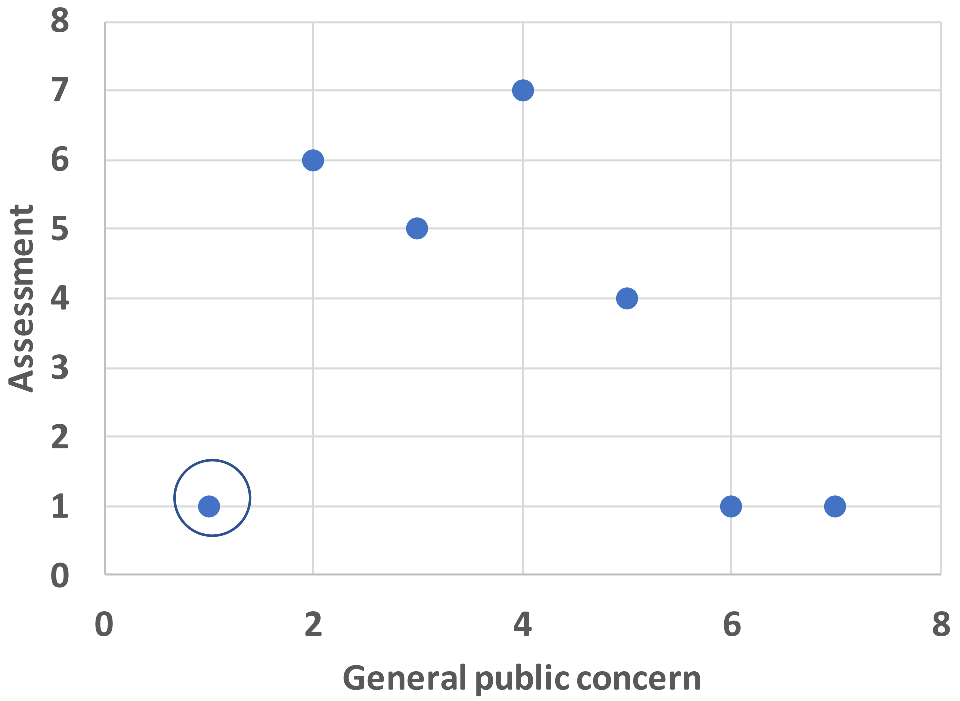
Results

Consumer perception vs quantitative assessment

- Concern$_{perc}$ vs risk$_{assess}$ / Ranking scores



Chemical Hazards

Almost complete disagreement between concern (perception of General public) and risk (assessment). Spearman coefficient: -0.81

One exception: “Fraudulent”

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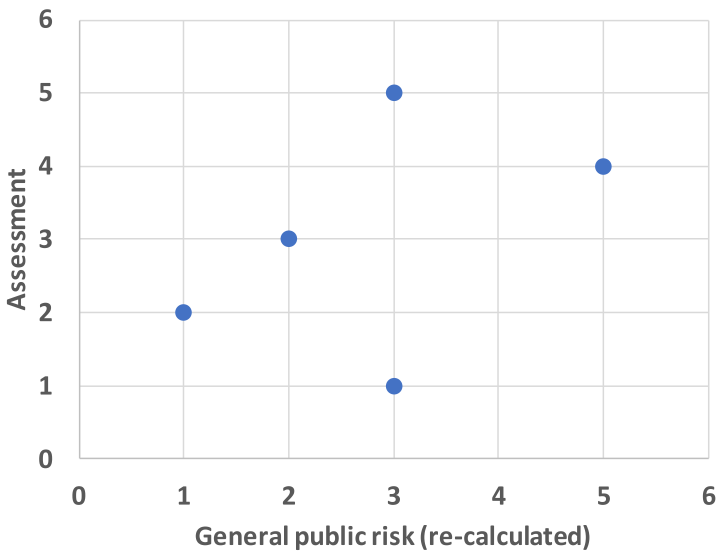
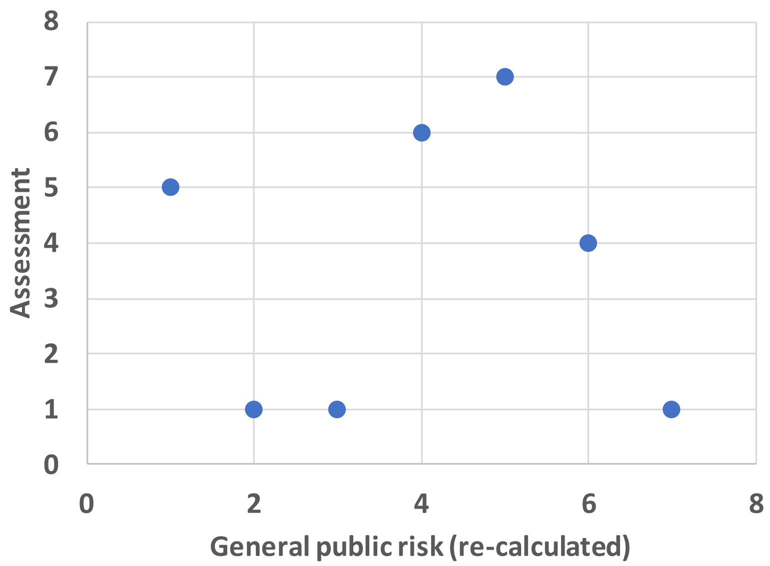
Results

Consumer perception vs quantitative assessment

- « $Risk_{perc}$ » vs $risk_{assess}$ / Ranking scores



Microbiological Hazards



Chemical Hazards

No clear correlation

→ No conclusion from the re-calculated Perception of risk (severity x frequency)

Conclusion

Conclusion

From this study

- Perception: Chemical hazards slightly higher than Microbiological hazards
  - In agreement with Kher et al, 2013: "Consumers expressed higher concerns about chemical, as compared with microbial contaminants. Chemical contaminants were more strongly associated with the potential for severe consequences, long-term effects and lack of personal control"
- No large difference between general populations and food specialists regarding their perception of severity, « risk » and concern
  - Except regarding unknown hazard category
  - Not in-line with van der Vossen-Wijmeng et al, 2022 "Consumers can respond very differently to various food safety issues compared to experts" or Kurtz&Thomopoulos 2021 on Infant food in France
- Ranking based on perception of concern ≠ from a ranking based on assessment
  - In agreement with recent study in France by Haetjens et al. 2023: « Distorsion entre la perception des consommateurs et l'évaluation des risques »

Conclusion

More generally

- This perception-assessment difference has an impact on food safety management and policy development → how decisions will be perceived?
  - These findings may inform the development of more effective food safety standards
  - These findings can also inform consumer education programs
- Understand Consumer's risk perception and behaviour is still an on-going effort
  - EU Project Holifood with a work-package on "Science to Policy"
  - Siegrist and Árvai, 2020:

    "Future research must examine whether risk perceptions causally influence the acceptance of hazards or risk management measures or whether these are only spurious correlations caused by another variable (e.g., affect).

    The situations in which risk perceptions are posited to be an important predictor of judgment, choice, and behavior should be examined using not only survey studies, but also experimental studies that further illuminate causality"

Thank you for your attention

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R Thomopoulos, P Palmont, G Rivière, H den Besten, M Zwietering and K Yeak

Questions?

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