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# The health burden associated with the microbial risk from lentil consumption in France and Hungary

## Insights for policymakers

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SecAliM Food Safety & Microbiology

INRAE la science pour la vie, l'humain, la terre

Oniris École Nationale Vétérinaire, Agroalimentaire et de l'Alimentation

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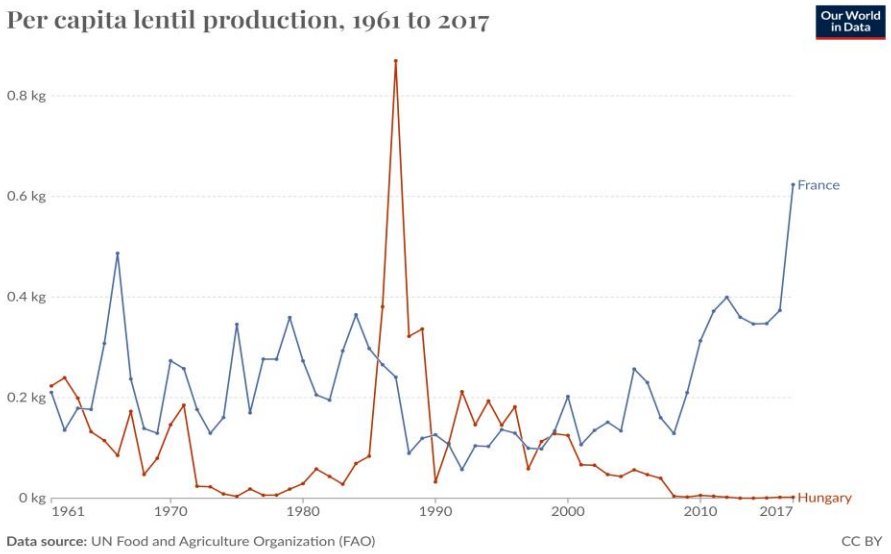
# Lentils: production and home-based consumption

- Lentil is an important crop with **top producers**: Canada, India, Australia
  **top importers**: India, Turkey, European Union
- In <u>EU production (per capita):</u> **France: Fr (high) and Hungary: Hu (low)**
- Most consumed as **canned** and **dried lentils**
- Increased consumption recently



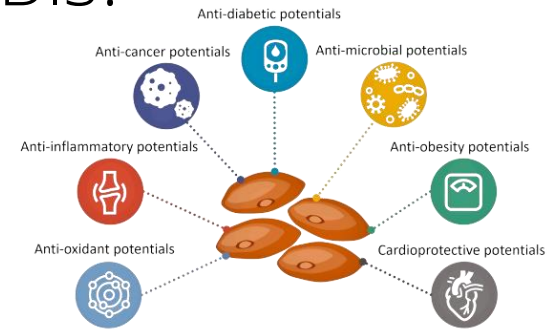


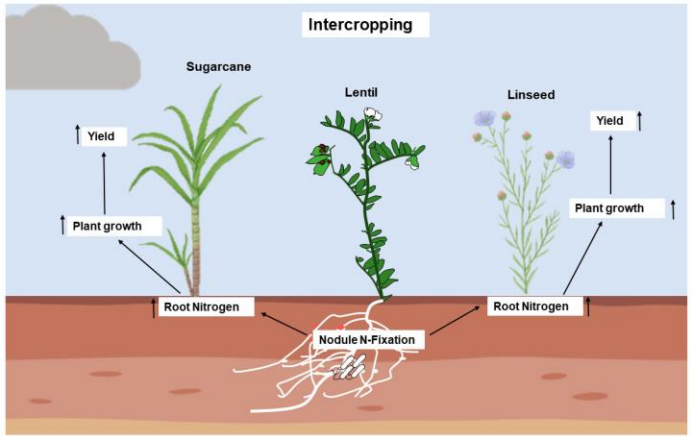
# Lentils: a key crop for sustainable diets

- Alternative crop for **sustainable food systems**
  - **Non-meat protein alternative, biofunctional properties**
  - **Nitrogen fixation** and can be **intercrop**

∴ Governmental/ institutional push for lentil consumption

- BUT, any food safety risks? FBIs?




(Alexander et al., 2024 and Montejano-Ramirez and Valencia and Cantero, 2024)

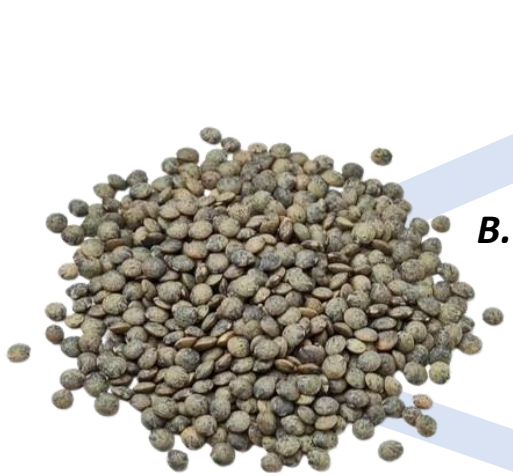
# Lentils: Foodborne outbreaks? hazards?

- Reports/Recalls on lentil-containing products (USFDA/ EURASFF)
  - Crumbles with lentil (Daily harvest) chemical
  - Chocolate bars with lentils (Strauss foods) *Salmonella*
  - RTE red lentil dal (Whole foods) *L. monocytogenes*

- Food safety risks with lentil consumption in Fr and Hu?

# Lentils: Microbial hazards?

- Risks of prolonged storage @ home




*B.cereus / C. botulinum* spores


*B. cereus /C. botulinum* spores
*E. coli* O157:H7 and *Salmonella*
Parasites (oocytes) ?

If eaten immediately/ hot: Safe
(no risk for bacterial growth/
recontamination)

*B. cereus* spores

*B. cereus* +
*L. monocytogenes*

**Hot dish:**
*B. cereus* toxin

**Cold dish:**
*B. cereus* toxin
*L. monocytogenes*

*Domestic settings*

# QMRA as an aid to risk management

- Quantitative Microbial Risk Assessment (QMRA)

*systematic framework integrating science, data analysis and mathematical modelling for the prediction on the likelihood of a probability risk, in either infection, disease, illness or death, during the exposure to pathogenic microorganisms of a specific source via several pathways, including dermal, ingestion and inhalation (Haas et al., 1999).*

- Help assess microbial risks from farm-to-fork
- QMRA can inform policymakers of the possible food safety implications

# Objectives

- This study aims to conduct QMRA with dried lentils in France and Hungary (low and high lentil consuming country).
- Focus on domestic practices (from raw lentil until consumption)
- Aid in managers determining additional health burden
- Possible policy/guidance to minimize these

# Methodology: QMRA Inputs and health burden

***Microbial contamination and growth***

## *Bacillus cereus*

***B. cereus* prevalence and initial concentration**
(Blakey and Priest 1980)

***B. cereus* growth kinetics** (Combase)
lag_after_heat treatment (U: 6-8hrs)
lag_refrigeration (12-72hrs) Daelman et al., 2013

## *Listeria monocytogenes*

**Initial concentration and Prevalence of *L. monocytogenes* in home refrigerators** (Beumer et al.,1996)

**Microbial growth kinetics of *L. monocytogenes*** *(Combase)*


**Raw lentils** → **Home-cooking** *(thermal inactivation)* → **Cooling** → **Refrigeration/ Storage** → **Consumption**

**Cooking time**
**France**: 25-35mins (lentil salad)
**Hungary**: 45-70mins (soup)
**Cooking temperature**: 95°C
**Cooling temperature:** 19°C

**Cooling temperature and duration:**
**France:** 19°C, <24hr **(INCA 3)**
**Hungary: (Koppel,2021)**

**Left-over frequency and storage time**
**France**: Yabre and Membré 2020
**Hungary**: Koppel et al (2016)

**Refrigeration temperature (FR/HU):**
Roccato 2017

**Lenil consumed amount (g/d)**
FR: INCA 3
HU: Nébih/NFCSO
*National surveys

**Lentil salad consumption**
FR/HU: Yabre and Membré, 2020

***Consumer practices***

**Cut-off from dose response (Pouillot,2024: ANSES,2021)**

**Probability of illness**
***L. monocytogenes*** **(cold dish)**
***B. cereus*** **(cold + hot dish)**

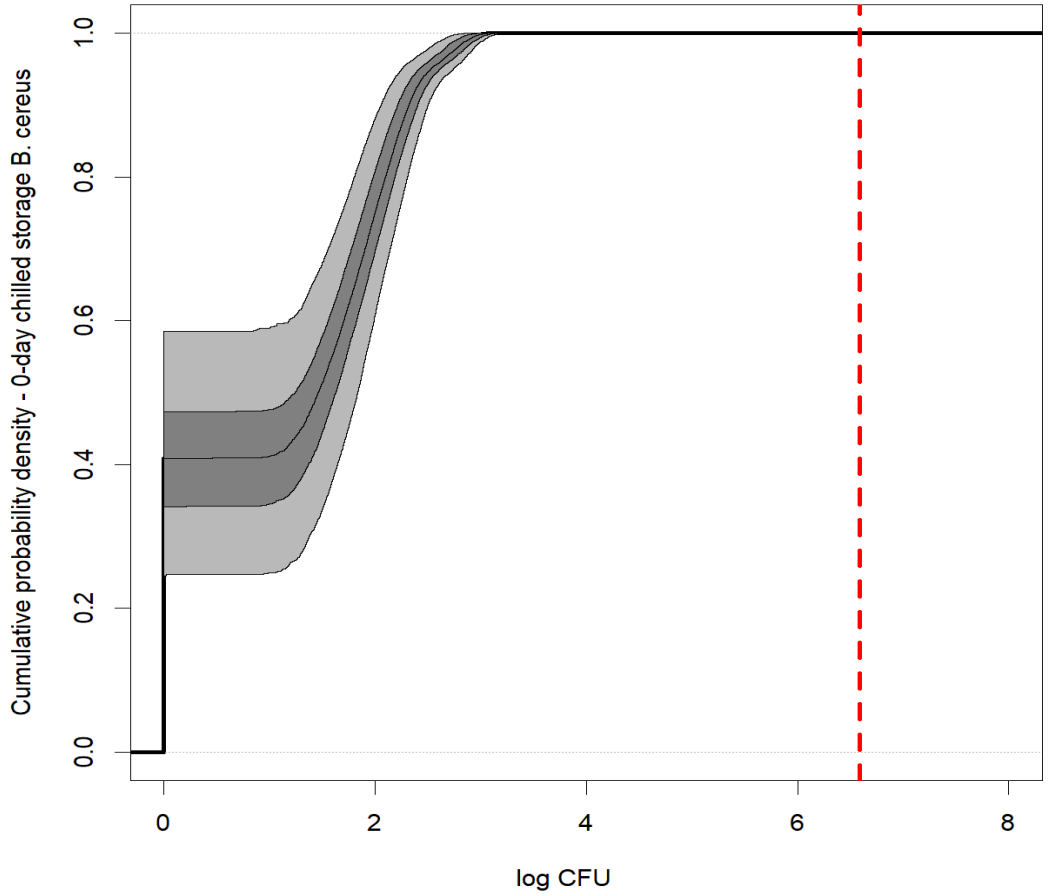
**DALYs**
(Yeak,2024)

***Health burden***

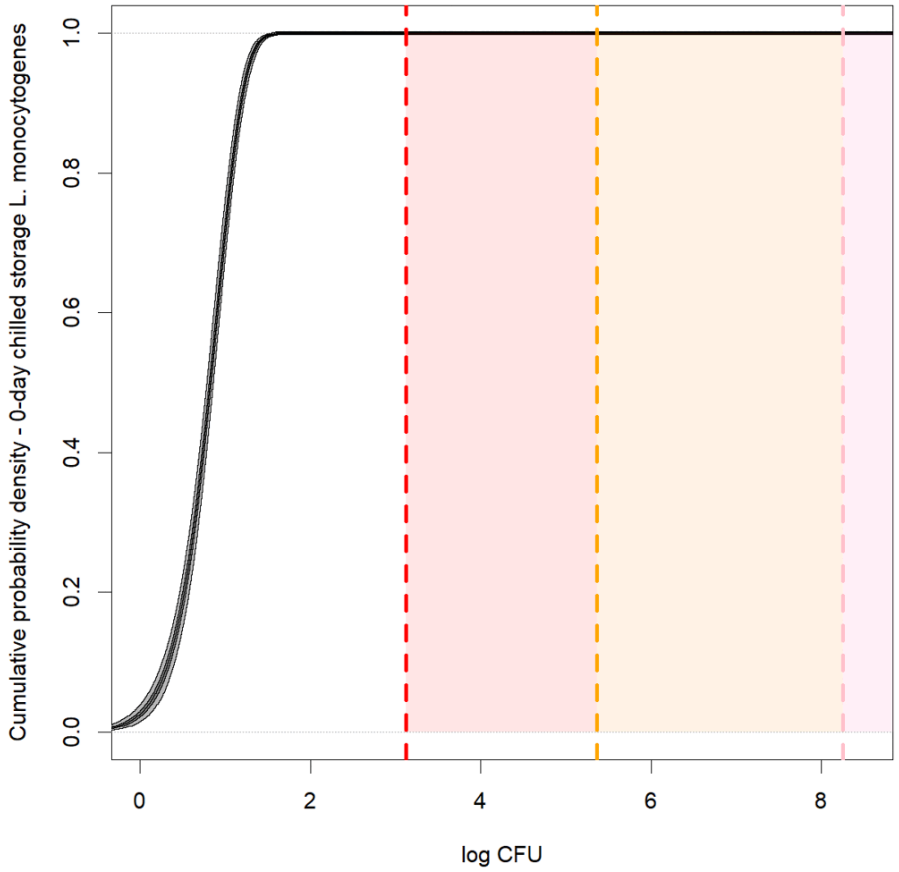
# Methodology:

- Monte Carlo 2nd order (mc2d) **(using variability and uncertainty)**
- R studio/software/packages
- Modular probabilistic modelling approach (Nauta et al., 2001)
- With 2 specific points:
  - *B.cereus* spore recovery lag time was taken into account
  - The risk characterization module harmonized the risk associated between *L.monocytogenes* and *B. cereus*
    - Pr (Dose>cutoff)
    - Dose =bacterial concentration * quantity consumed (French and Hungarian population)
    - Cut-off derived from dose response for *Listeria* (Pouillot, 2024) and from ANSES, 2021 for *B. cereus*.

# Results: Microbial concentration vs time (0-4 d)




***B.cereus***




***L.monocytogenes***

# Results: Risks per portion, Fr vs Hu

| Burden estimates | France | Hungary |
|---|---|---|
| | Median [2.5th, 97.5th] | |
| Risk due to cold portion *(Bacillus cereus)* | **1.79E-06** [1.86E-07, 7.43E-06] | 7.96E-07 [0.00E+00, 5.64E-06] |
| Risk due to cold portion *(Listeria monocytogenes)* | 4.56E-07 [2.80E-08, 3.65E-06] | **2.54E-05** [3.08E-07, 1.51E-05] |
| Risk due to hot portion *(Bacillus cereus)* | **1.28E-05** [1.71E-06, 4.24E-05] | 6.41E-06 [0.00E+00, 2.82E-05] |
| Total risk burden for lentil dishes (hot and cold) | 1.55E-05 [2.19E-06, 4.87E-05] | **7.71E-05** [1.64E-05, 2.78E-04] |

Difference due to

- HT stronger in Hungary → less *B. cereus* post cooking
- %4d vs %3d → *Listeria* growth higher

# Results: Risks and Health burden (DALY)

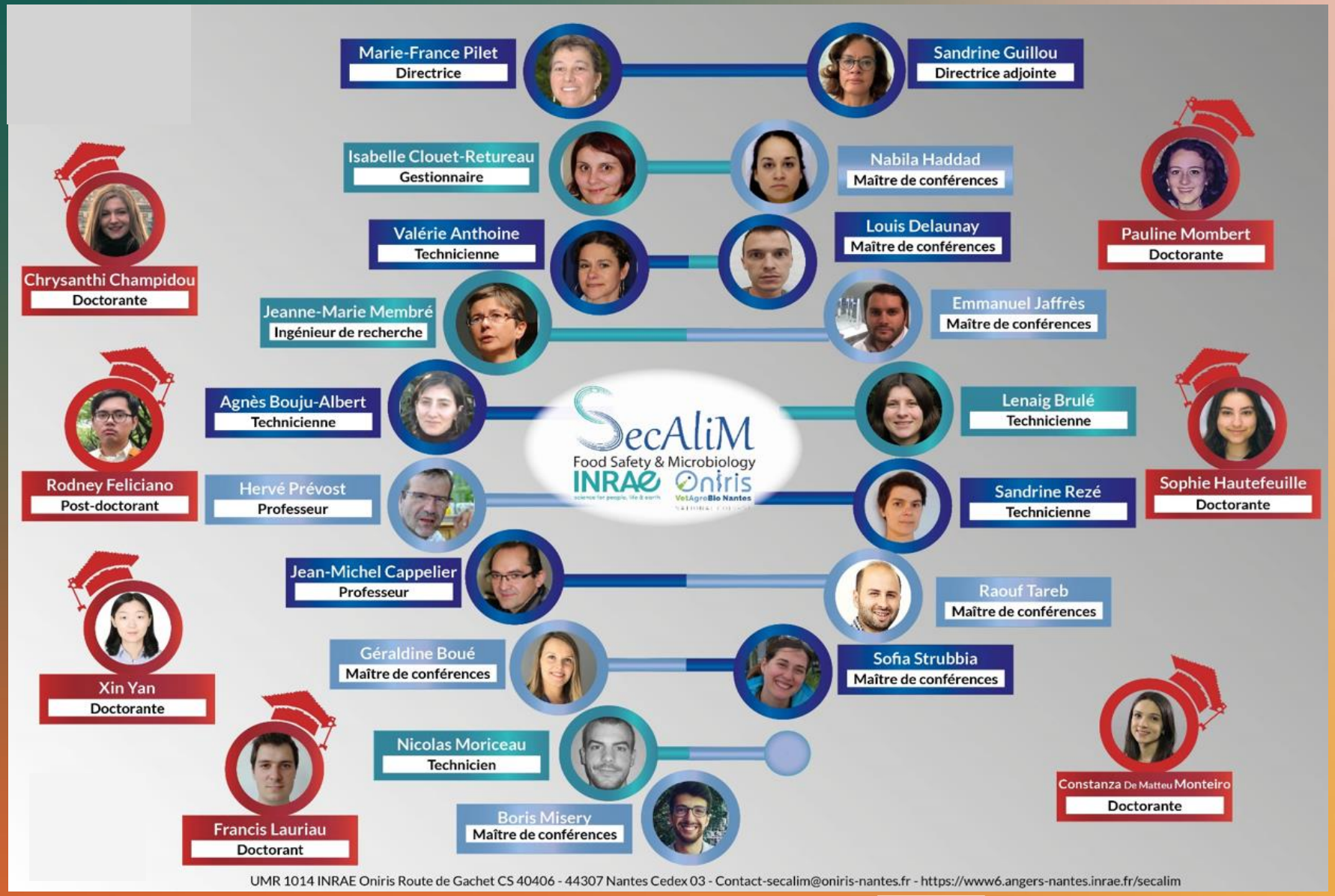
| Burden estimates | France | Hungary |
|---|---|---|
| | Median | |
| ***Health impact per year*** | **Number of Illnesses (DALY)** | |
| No of illnesses due to cold portion *(Bacillus cereus)* | 453 (1.0) | 15 (0.44) |
| No of illness due to cold portion *(Listeria monocytogenes)* | 115 (131) | 49 (56) |
| No of illnesses due to hot portion *(Bacillus cereus)* | 3,236 (7.6) | 123 (0.29) |
| Total number of illness for the whole pop | 3,817 | 360 |
| Total number of illness (per 100,000) | 5.6 | 3.8 |

Main point:

- *B. cereus* leading cause of diseases (Fr/Hu) but *L. monocytogenes* high DALY
- Probable over-estimation is seen due to:
  initial contamination, growth rate kinetics, cut-off values, prevalence of *B.cereus* virulent strains

# Conclusion

- Microbial burden in lentil consumption in domestic level were estimated, but need to **fine-tune the inputs with proper data collected** on lentils.
- ***B. cereus:*** **number of estimated cases** and **DALYs:** ***L. monocytogenes***.
- **Policy decisions** focus on *L. monocytogenes* → recontamination in the kitchen.
  - Cleaning of refrigerators
  - Avoid batch cooking >4d
- Policy decisions,
  - Must support **on the ground data collection** (e.g., research program).
  - Push for dietary shifts must include **food safety education programs**
- Next, pursue holistic risk assessments  to include impacts on economy, environment, nutrition and chemical risks.




# Thank you!

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