GERMAN FEDERAL INSTITUTE FOR RISK ASSESSMENT

20 YEARS

BfR
German Federal Institute for Risk Assessment

Modelling Exposure risk for consumers

differences between bacteria

Carolina Plaza Rodriguez

Risk of consumer exposure to multidrug resistant bacteria

	Prevalence broilers* (Germany)	**Prevalence fresh chicken meat*** (Germany)	**Risk of consumer exposure?** (Barbecue event)
ESBL - *E. coli*	**45.3 %**	**39.6 %**	
MRSA	**2.4 %**	**17.9 %**	

*Data from the National Zoonoses Monitoring

Codex Alimentarius

RISK ANALYSIS

- Hazard identification
- Hazard characterization
- Exposure assessment
- Risk characterization

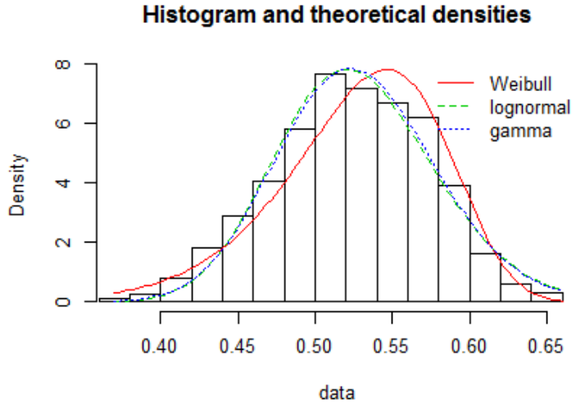
Qualitative Risk Assessment

- More subjective
- Main goal: determine severity of the risk
- Results recorder in a risk assessment matrix

https://www.safran.com/blog/whats-the-difference-between-qualitative-and-quantitative-risk-analysis

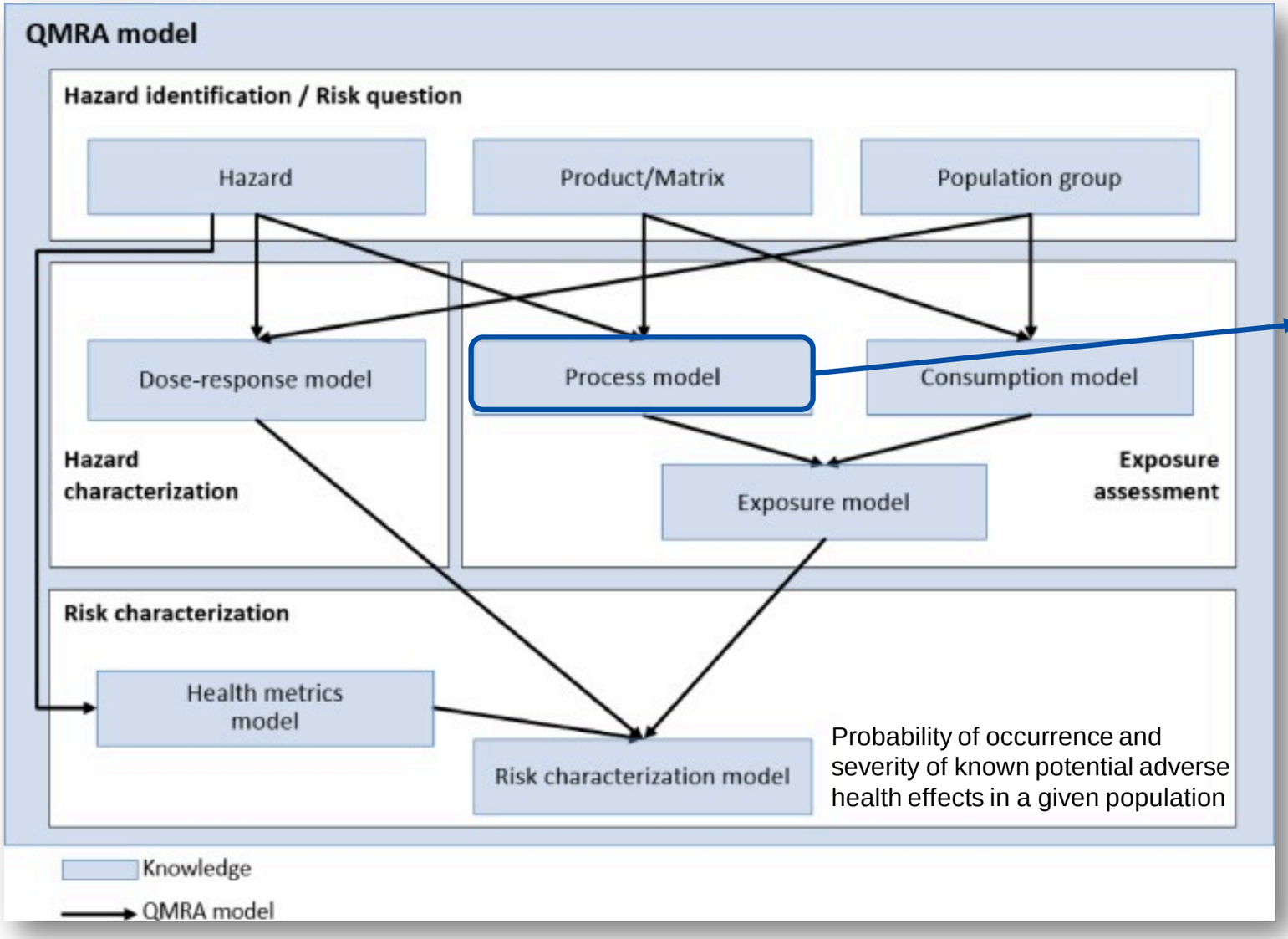
Quantitative Risk Assessment

- Assigns a numerical value to risks
- Dependent upon the quantity and accuracy of data
- Mathematical models
- Variability and uncertainty



Quantitative Microbial Risk Assessment (QMRA) Models

Ungaretti-Haberbeck, *et al*., 2018.



Process model:

- Growth
- Inactivation
- Mixing
- Partitioning
- Removal
- Cross-contamination
- Recontamination

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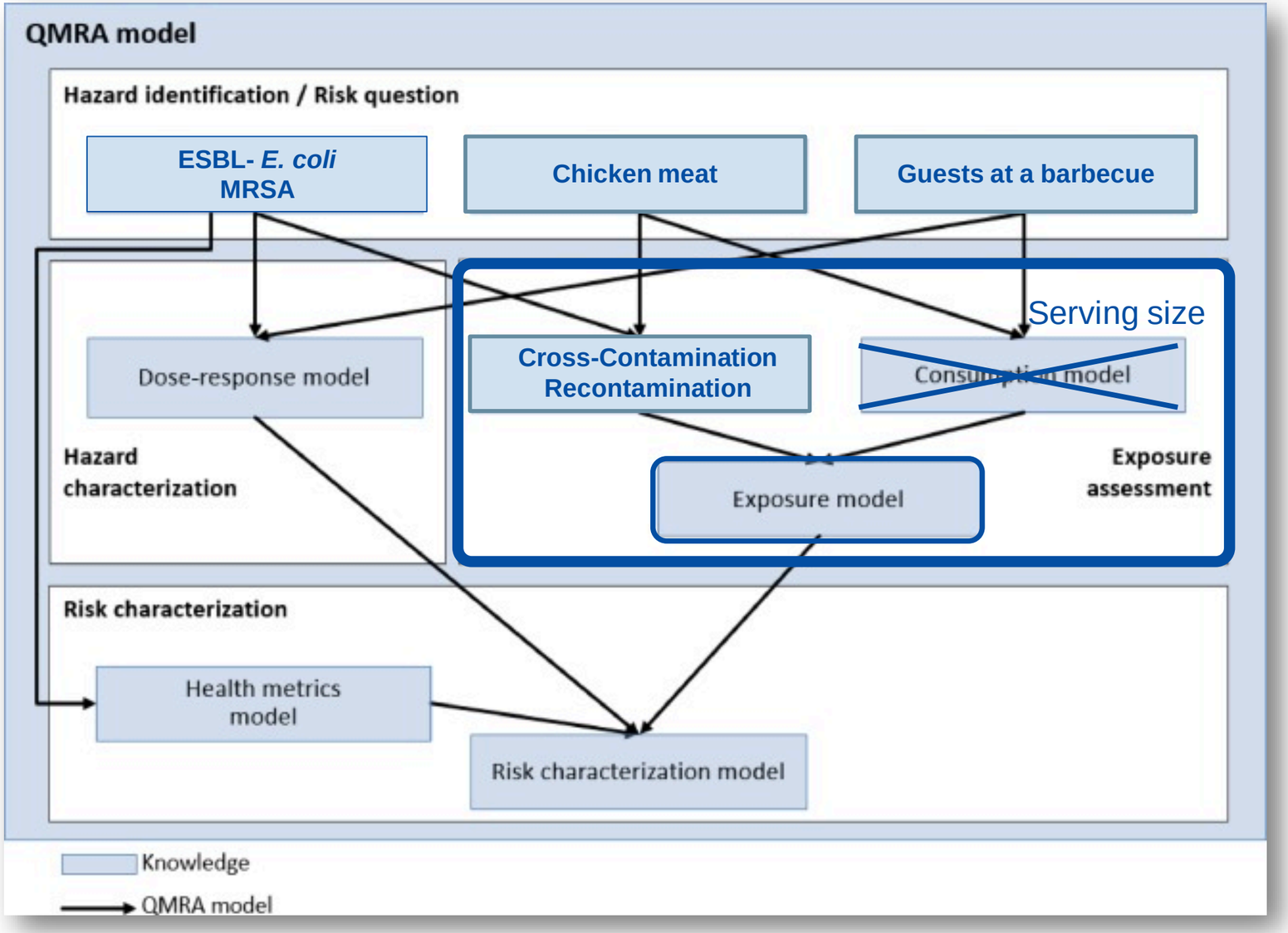
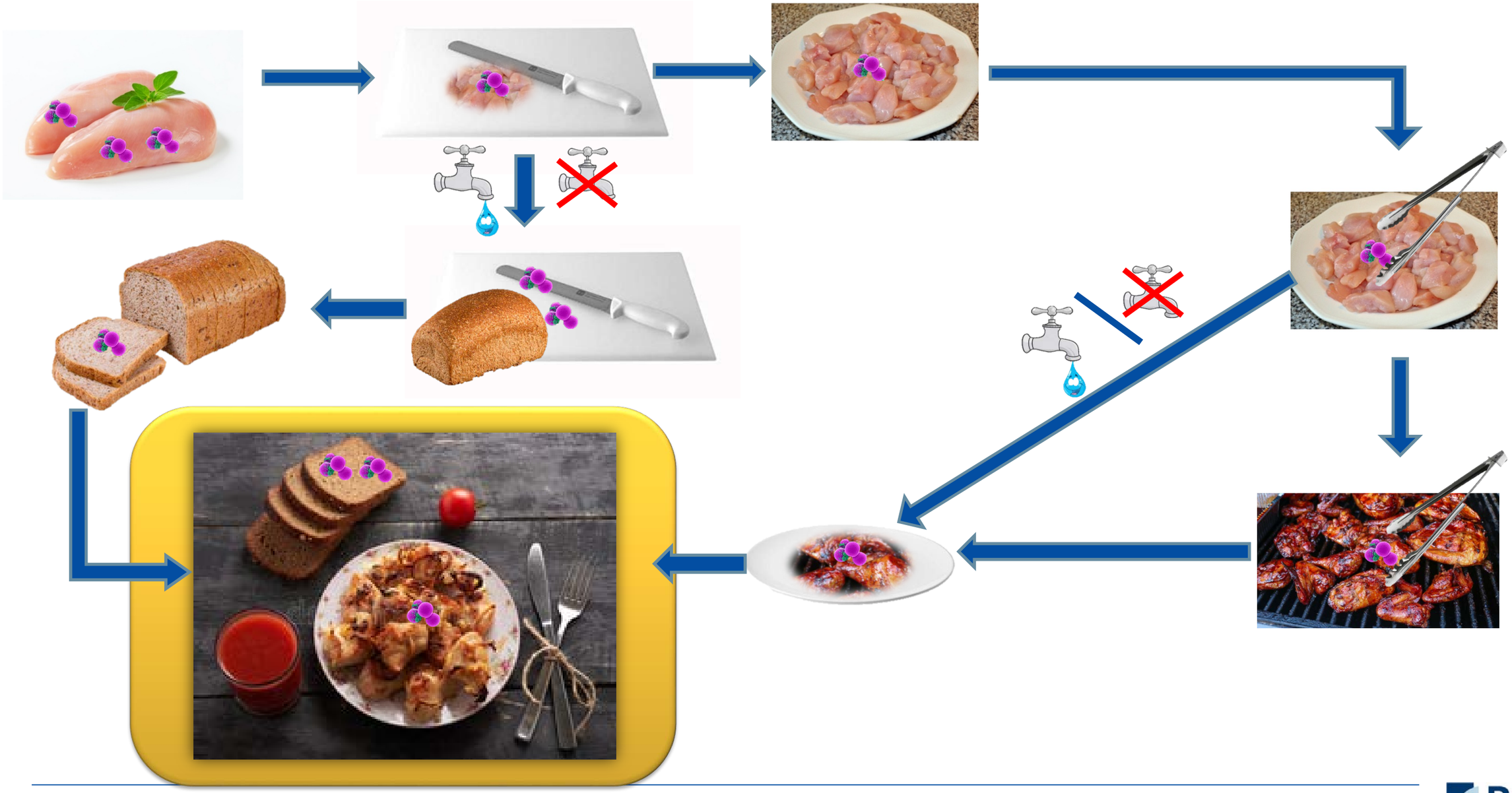
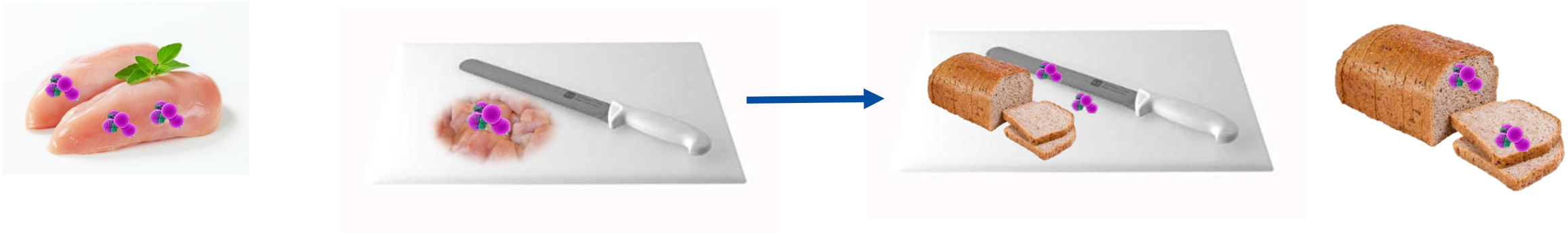


Description of the contemplated scenario



QMRA Models: Process model

Cross-contamination model: transfer from a contaminated product to a non contaminated product via kitchen utensils



Recontamination model: food contamination after the inactivation process

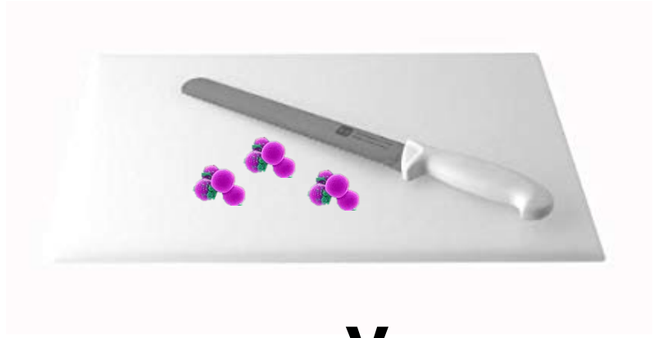
Transfer and persistence coefficients:

Fetsch and Tenhagen (2017)

$$\left(\log \text{CFU/cm}^2 \text{ on destination}\right) / \left(\log \text{CFU/cm}^2 \text{ on source}\right) \times 100\%$$

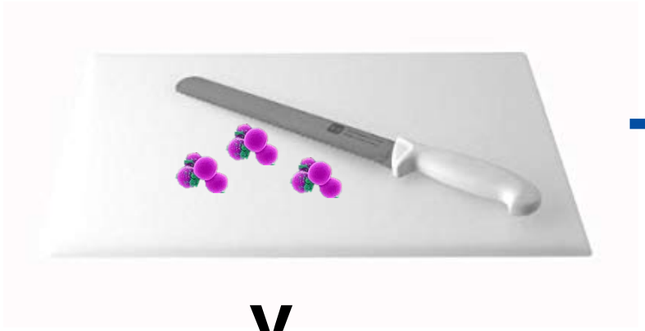
Transfer coefficients: probability for one CFU to be transferred from X to Y during the food preparation.

$t_{x\text{-}y}$

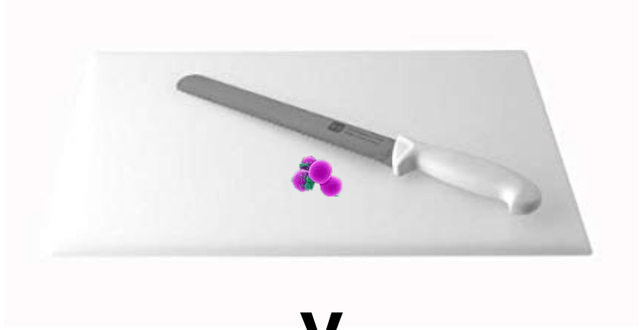


x **y**

Persistence coefficients: probability that a CFU is still present on an object after rinsing it.



$t_{y\text{-}y}$



y **y**

ESBL - *E. coli vs* MRSA

ESBL - *E. coli*

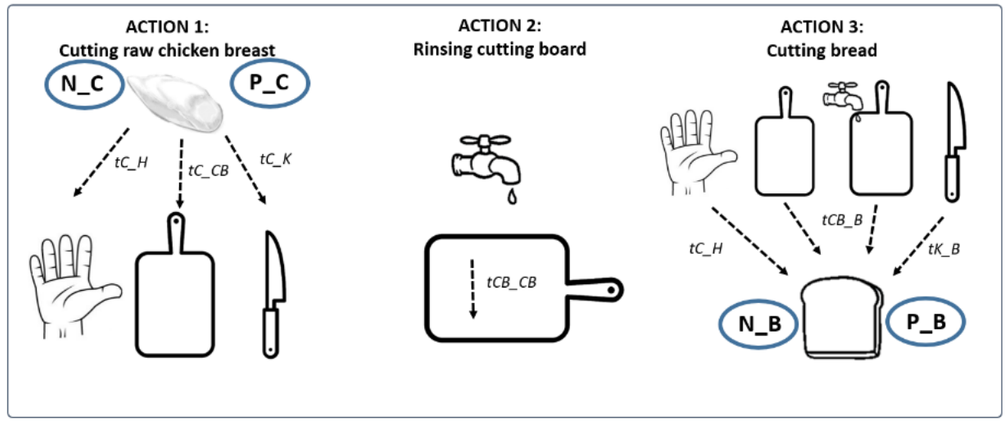
- Higher prevalence and concentration rates in raw chicken meat at retail in Germany

MRSA

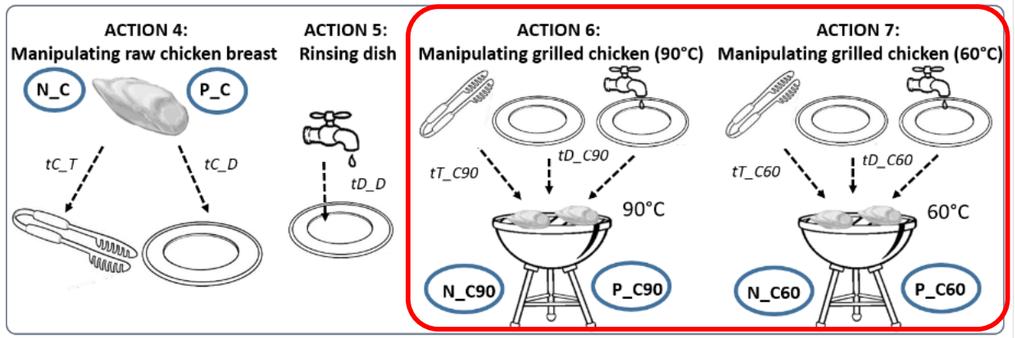
- Spread more easily between surfaces
- Remains detectable in surfaces after rising

Fetsch and Tenhagen (2017)

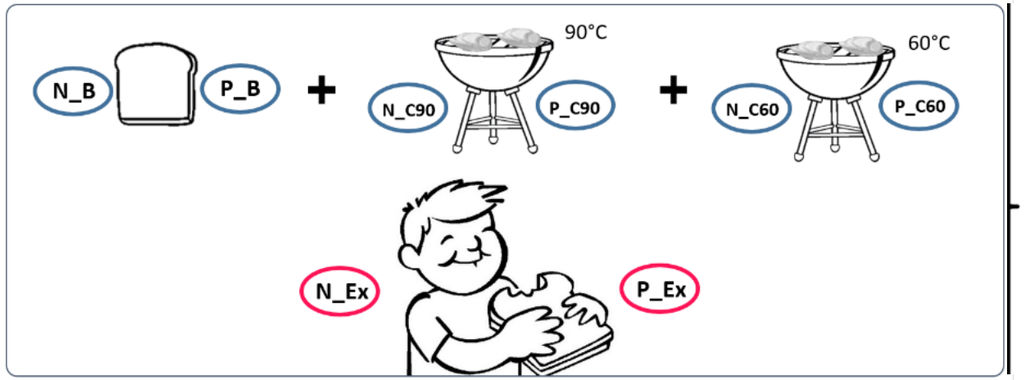
Sub-scenario 1: Cross-contamination of bread

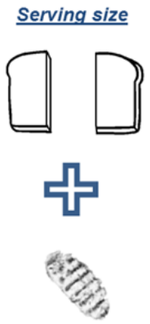


Sub-scenario 2: Recontamination of grilled chicken (90°C/60°C)



Sub-scenario 3: Consumer exposure



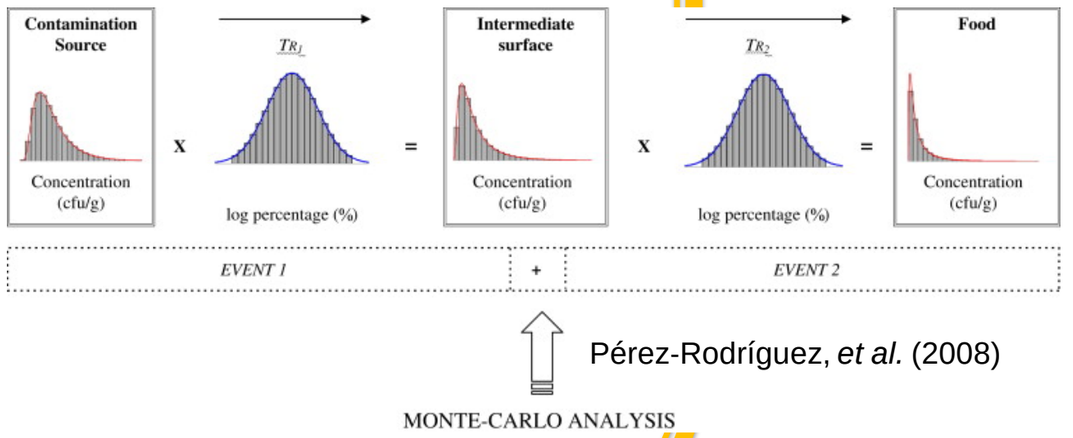


Exposure Model:

- ✓ **Probabilistic approach**
  - ✓ Probability of contamination
  - ✓ Level of contamination
  - ✓ Probability of consumer exposure
- ✓ **Deterministic approach**
  - ✓ Impact of the temperature
  - ✓ Impact of hygiene practices

Exposure model: model design

- Mylius *et al*., 2007 (Cross-contamination model-*Campylobacter spp*.)
- Modular design
- Probability distributions
- R 3.5.0 – package: mc2d
- Monte Carlo simulations: 100.000 iterations
- Shared in standardized format .fskx



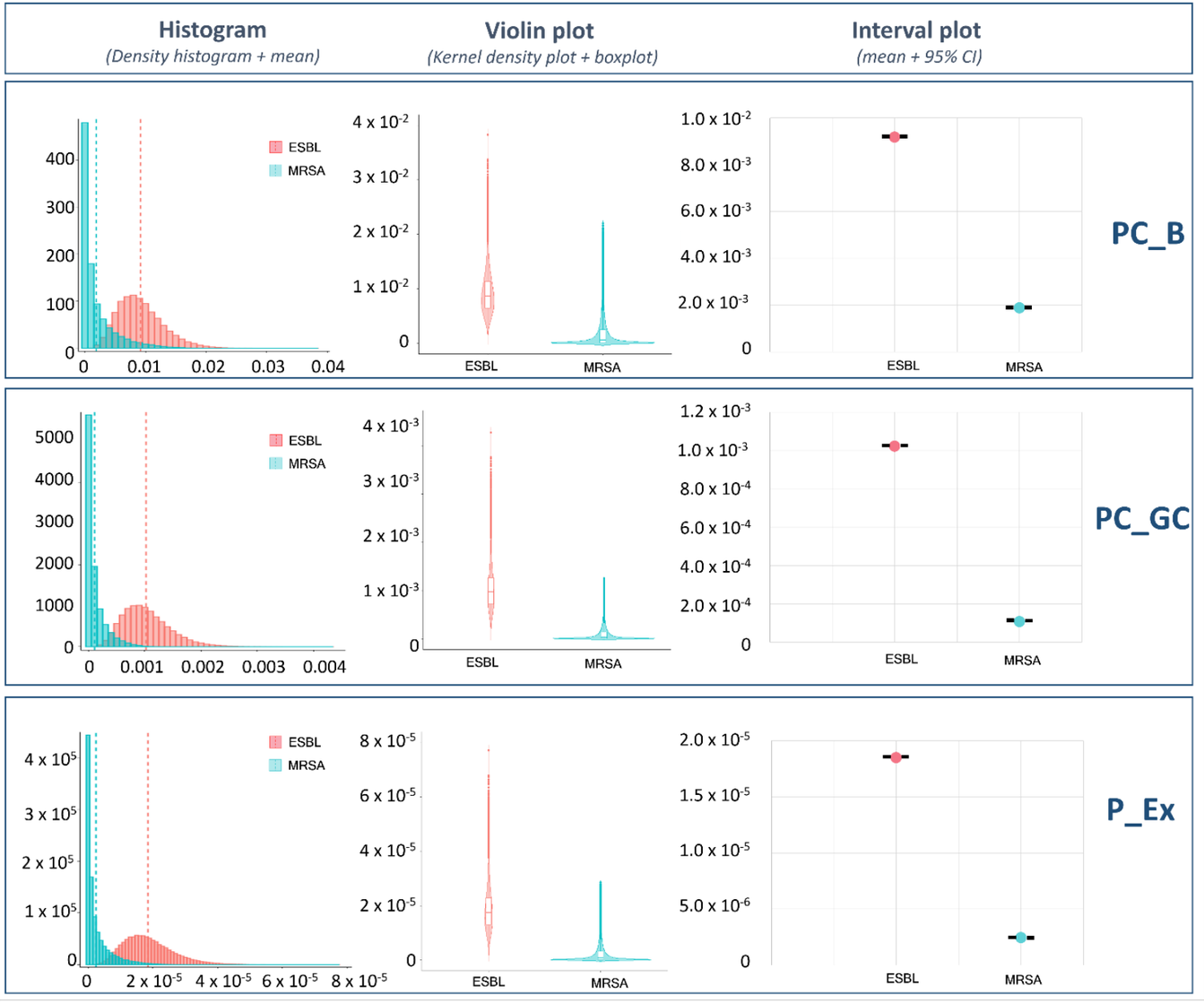
Pérez-Rodríguez, *et al.* (2008)

Technical assumptions

“Models are only a simplified representation of reality”

- Worst-case scenario
- Initially only raw meat is contaminated
- No growth was considered
- Total inactivation of bacteria present on raw meat after grilling
- Surface instead of weight
- Serving always: grilled chicken meat and bread

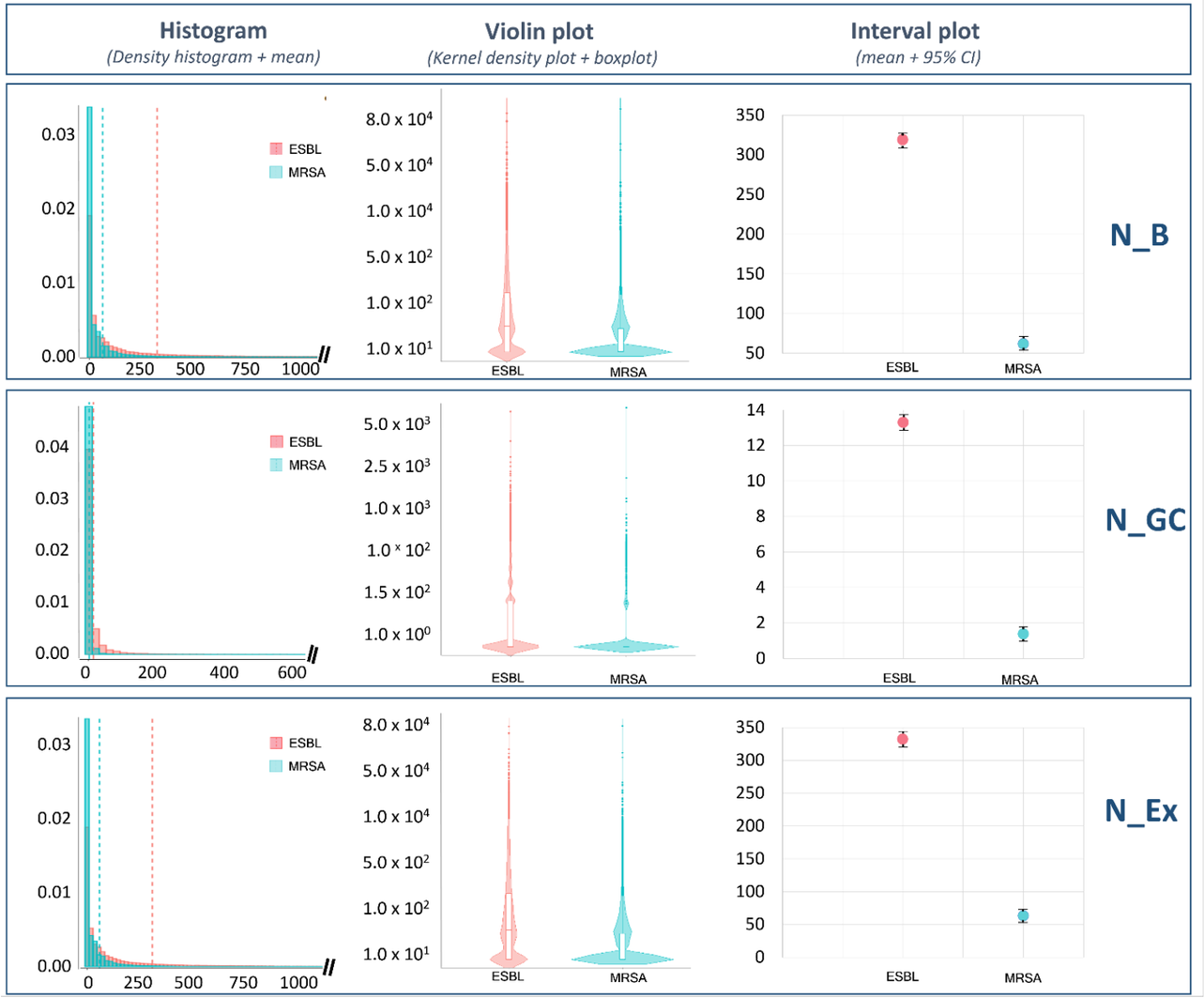
Probability of one cfu to be transferred



Plaza-Rodriguez, *et al.*, 2021

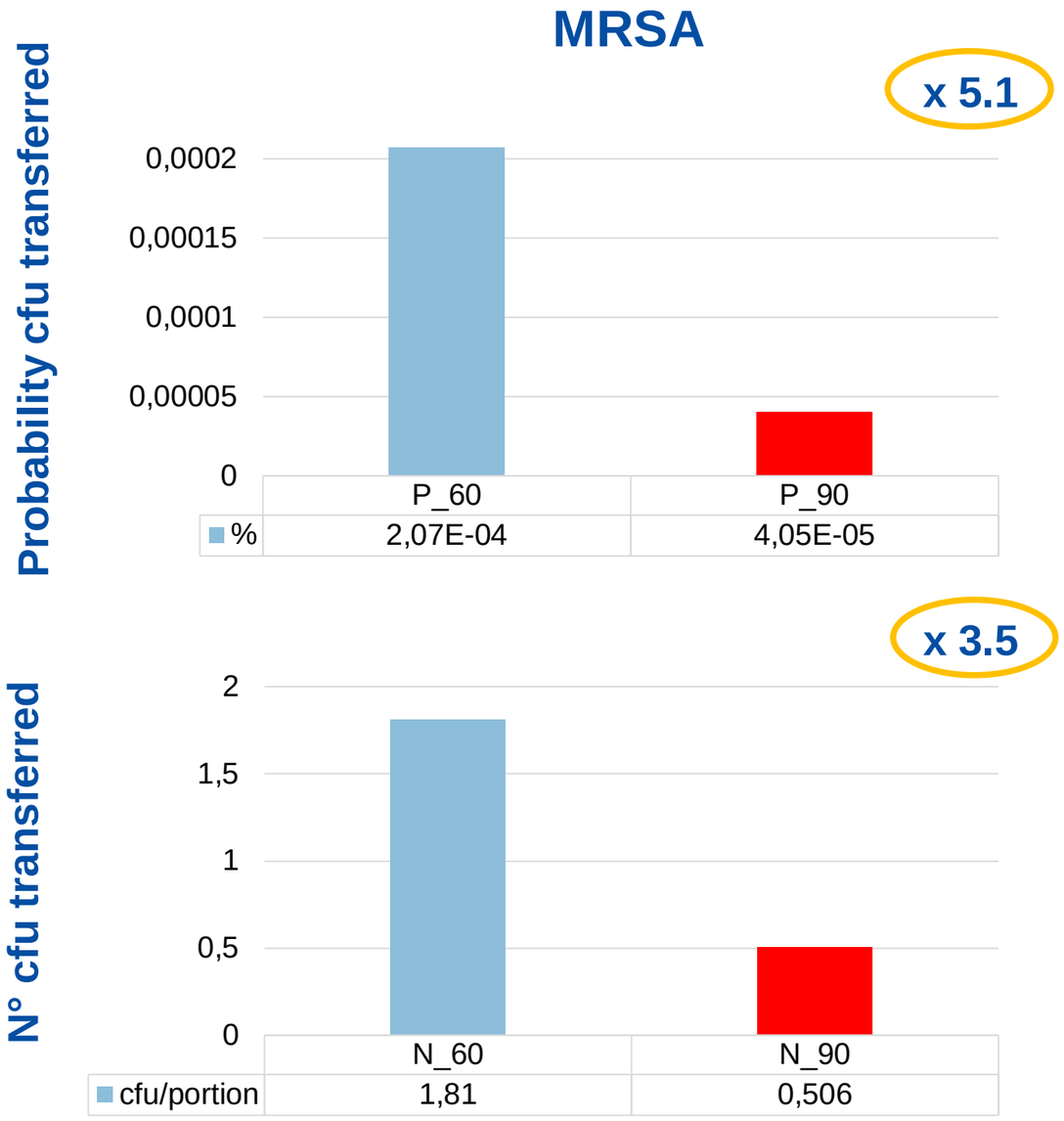
ESBL - *E. coli* > MRSA x 7,6

Number of CFU transferred



ESBL - *E. coli* > MRSA x 5

Impact of the temperature on the recontamination of the grilled chicken (60°C *vs* 90°C)



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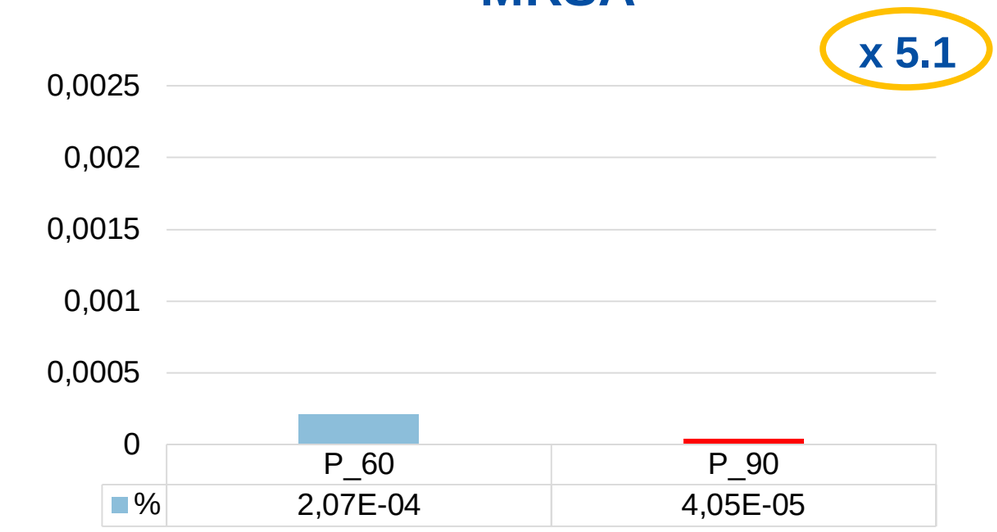
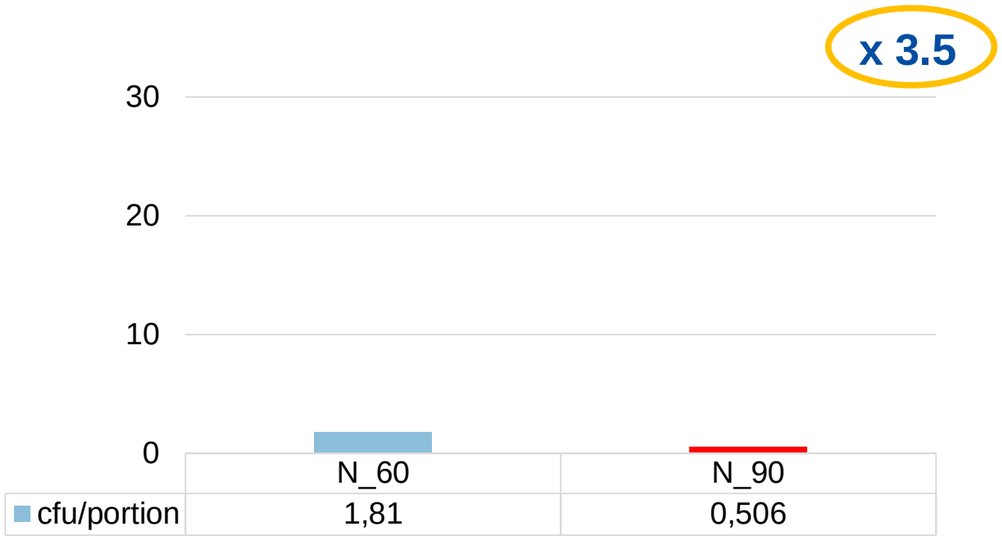
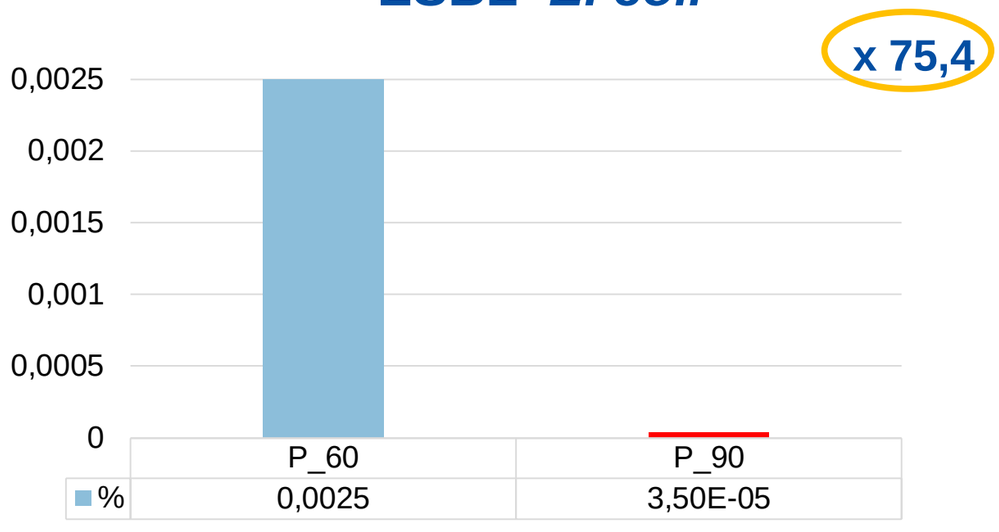
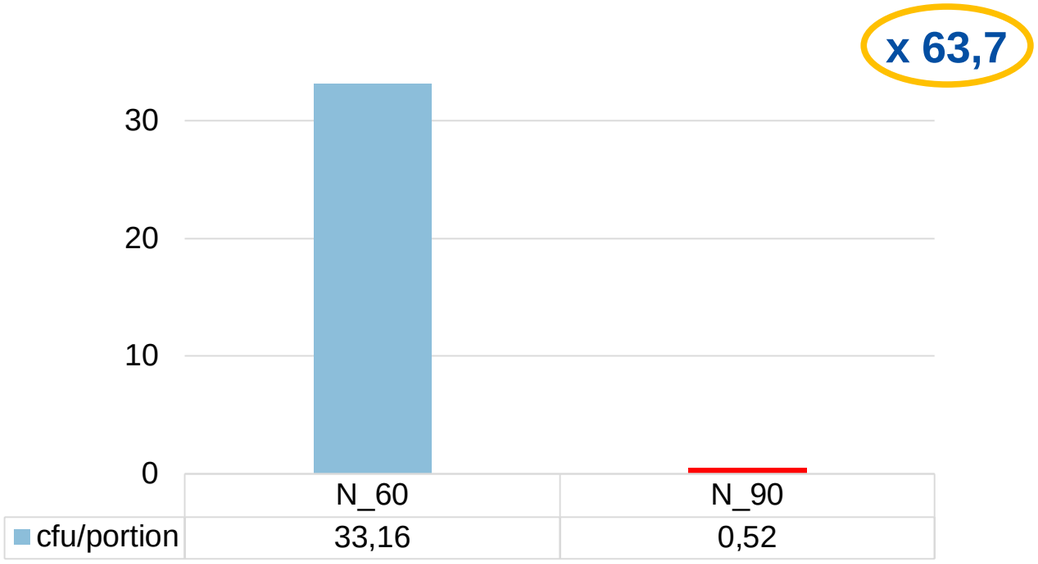
MRSA



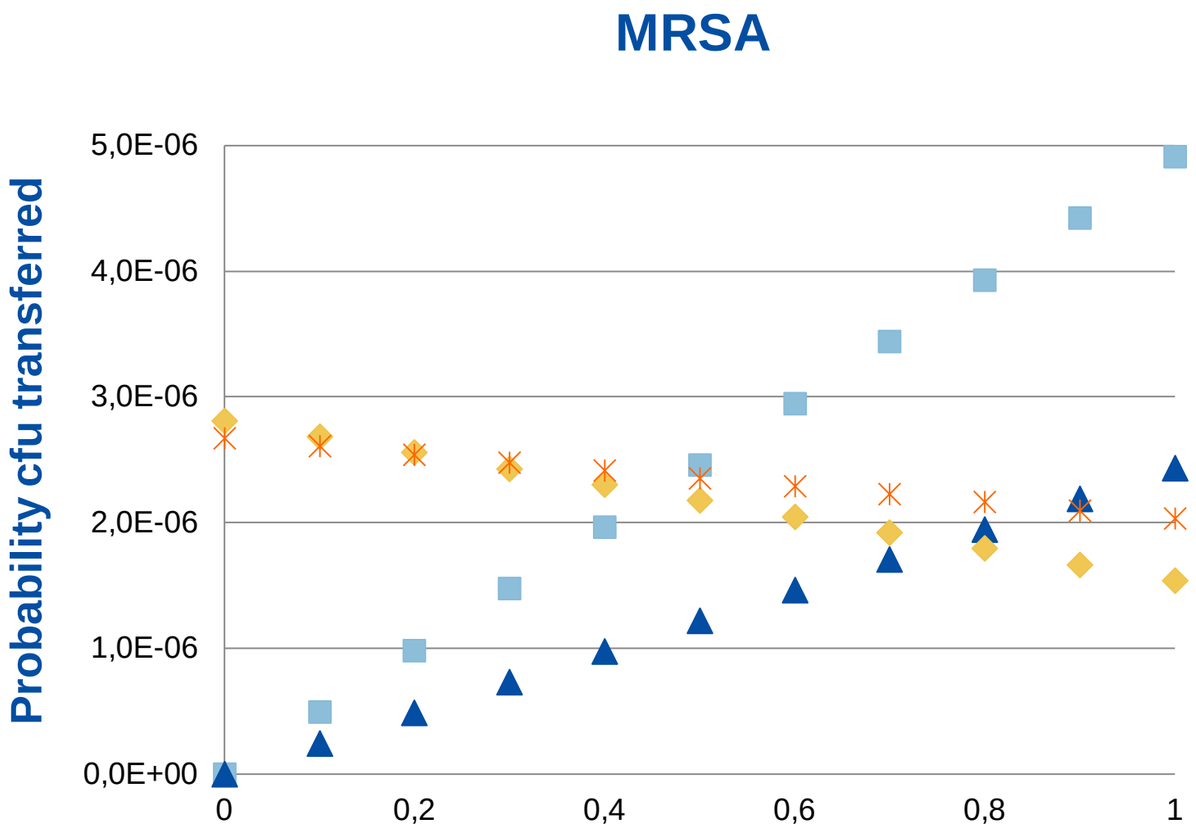


ESBL- *E. coli*





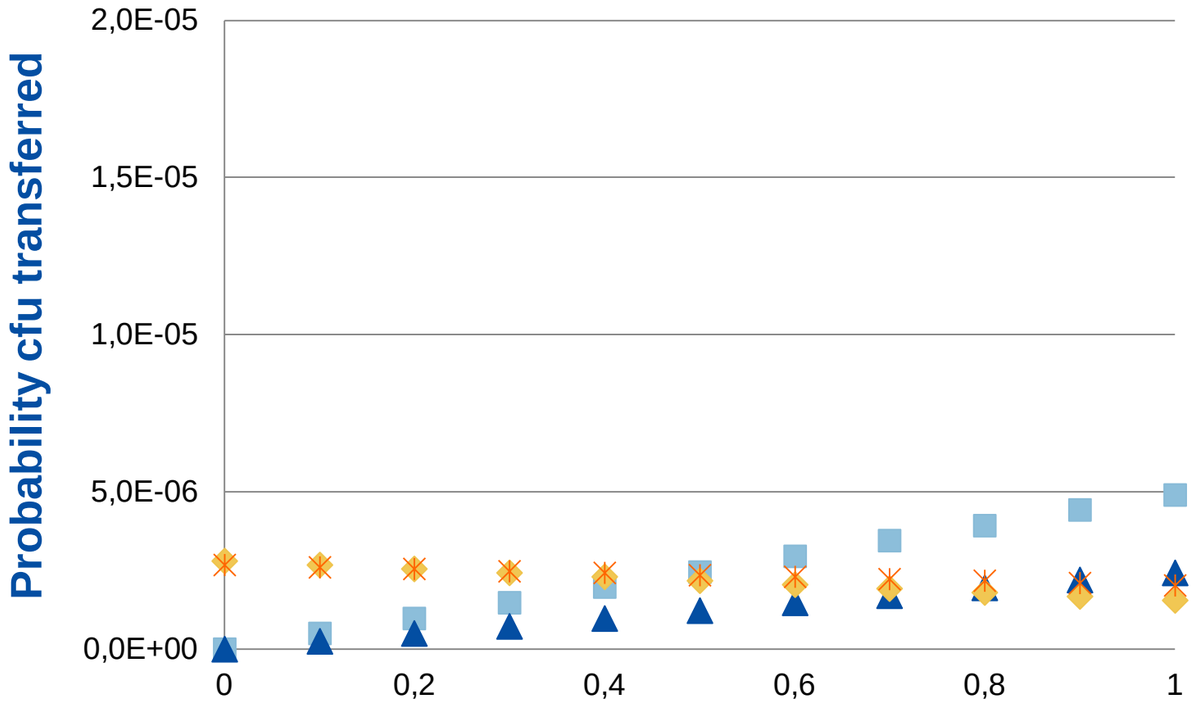
Impact of the hygiene practices “What-if scenario”



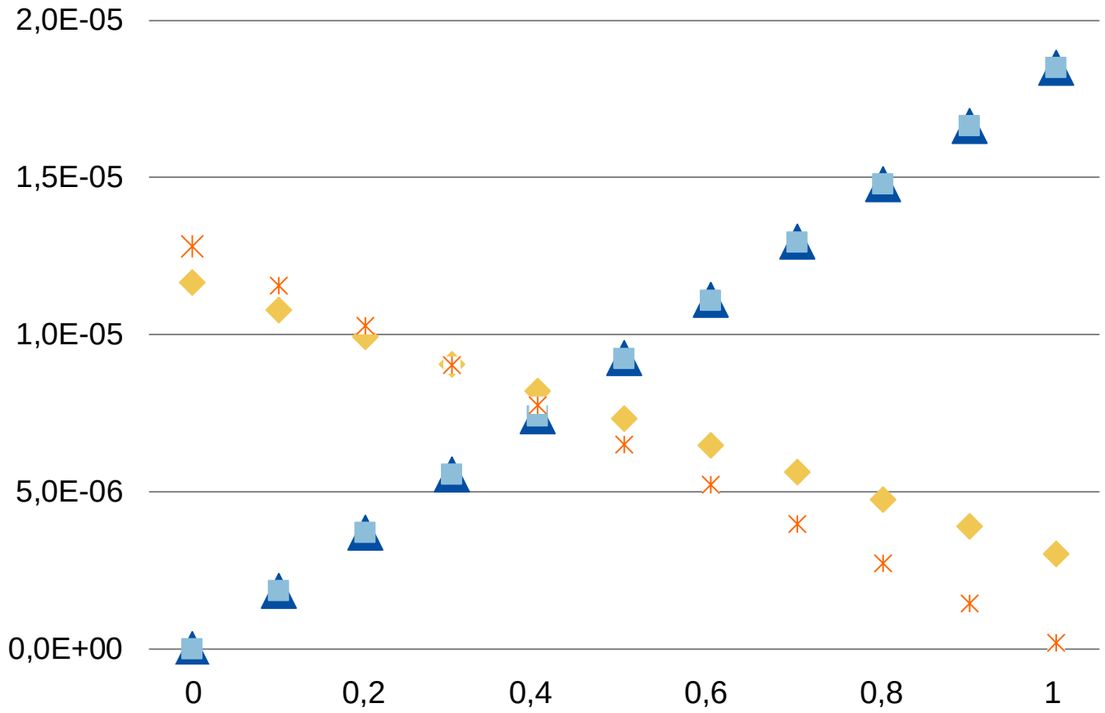
- **pCF**: Probability that the raw chicken meat is cut before cutting the bread
- **pMF:** Probability that the grilled chicken meat is manipulated with the same tong and in the same dish as the raw chicken meat
- **pRCB:** Probability that the cutting board is rinsed after cutting the raw chicken meat and before cutting the bread
- **pRD:** Probability that the dish is rinsed

Impact of the hygiene practices “What-if scenario”

MRSA



ESBL- *E. coli*



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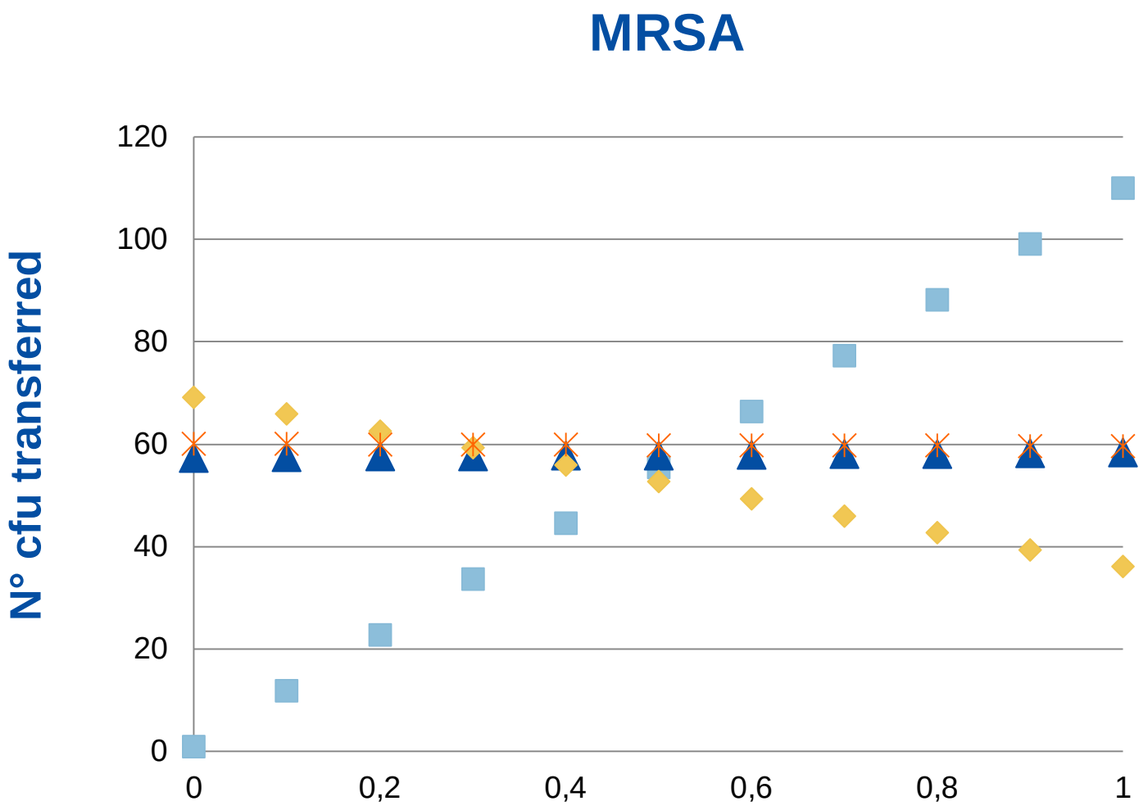

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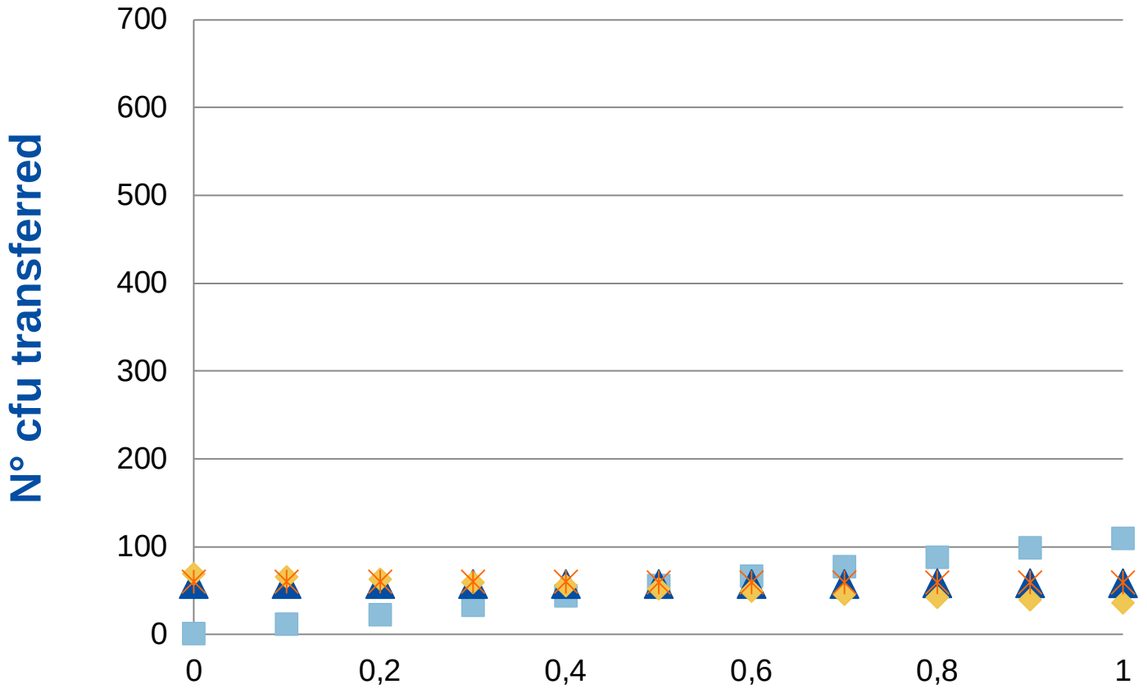

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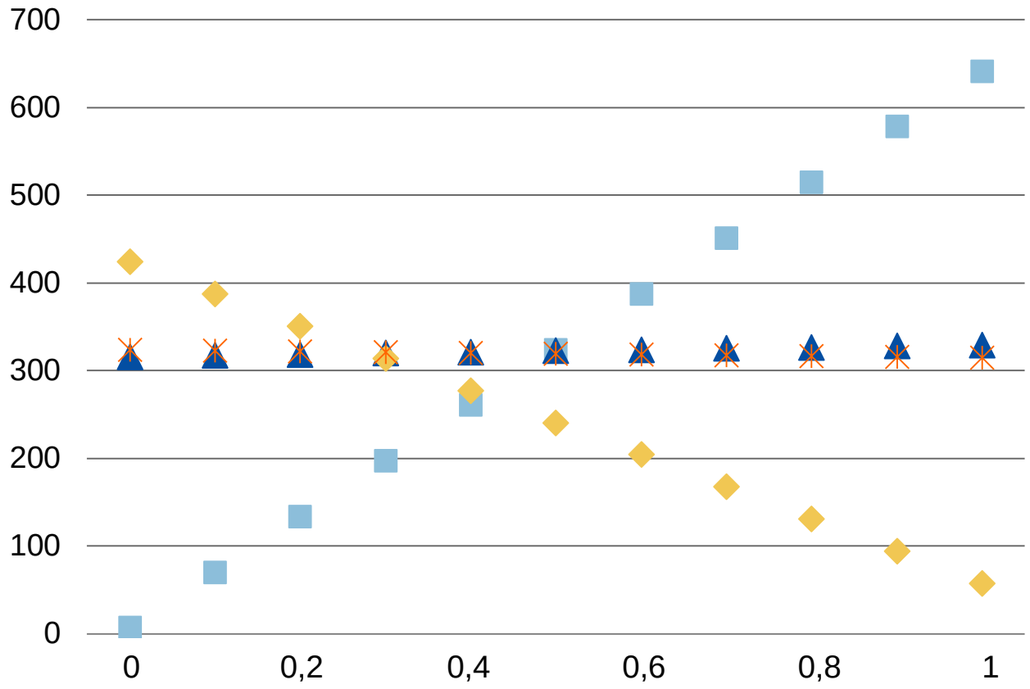

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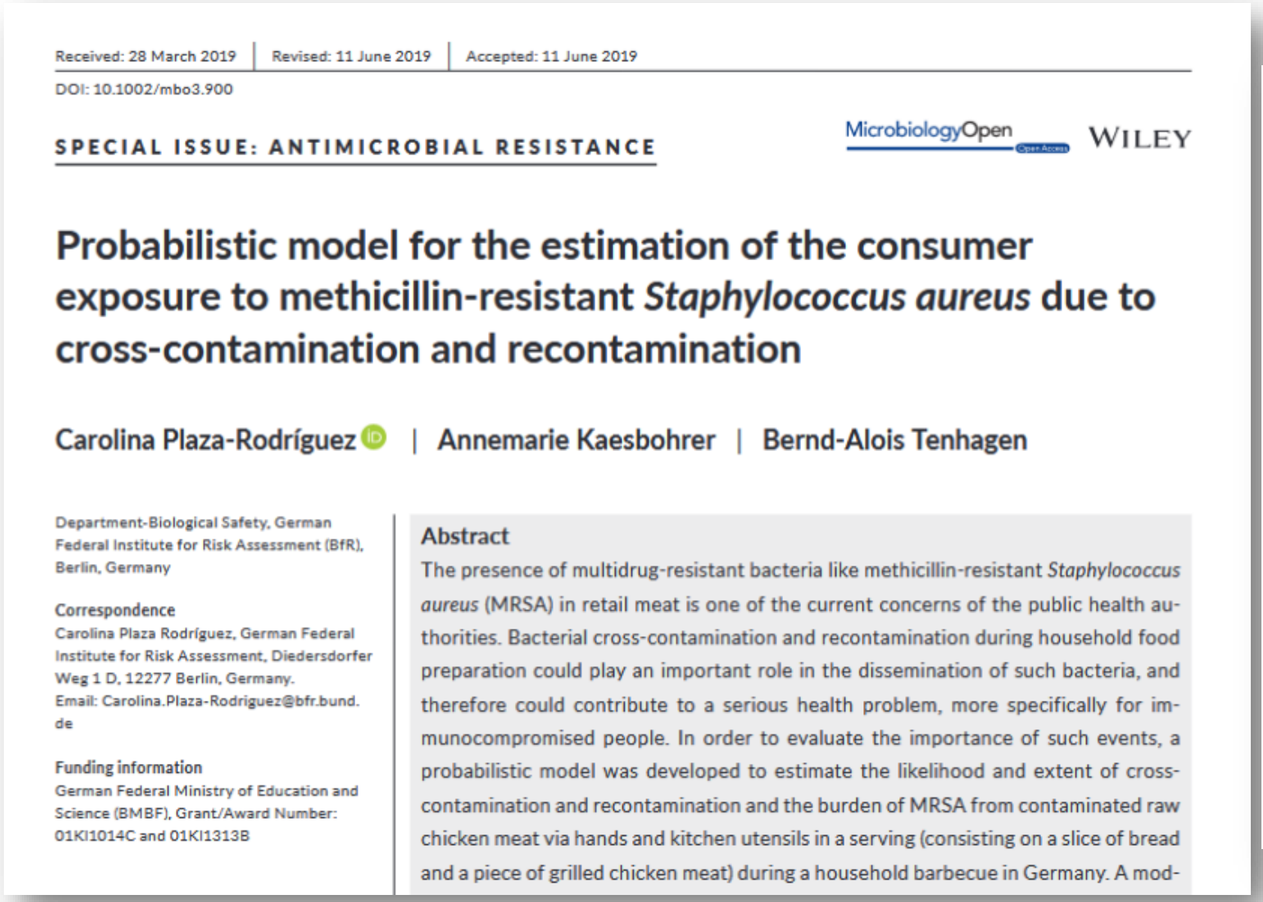
Further information



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SPECIAL ISSUE: ANTIMICROBIAL RESISTANCE

MicrobiologyOpen WILEY

Probabilistic model for the estimation of the consumer exposure to methicillin-resistant *Staphylococcus aureus* due to cross-contamination and recontamination

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Abstract

The presence of multidrug-resistant bacteria like methicillin-resistant *Staphylococcus aureus* (MRSA) in retail meat is one of the current concerns of the public health authorities. Bacterial cross-contamination and recontamination during household food preparation could play an important role in the dissemination of such bacteria, and therefore could contribute to a serious health problem, more specifically for immunocompromised people. In order to evaluate the importance of such events, a probabilistic model was developed to estimate the likelihood and extent of cross-contamination and recontamination and the burden of MRSA from contaminated raw chicken meat via hands and kitchen utensils in a serving (consisting on a slice of bread and a piece of grilled chicken meat) during a household barbecue in Germany. A mod-

DOI: 10.1002/mbo3.900

Model script: https://zenodo.org/record/4713653

microorganisms MDPI

Article

Comparative Analysis of Consumer Exposure to Resistant Bacteria through Chicken Meat Consumption in Germany

Carolina Plaza-Rodríguez [1,*], Octavio Mesa-Varona [1], Katja Alt [1], Mirjam Grobbel [1], Bernd-Alois Tenhagen [1] and Annemarie Kaesbohrer [1,2]

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Abstract: Human exposure to bacteria carrying antimicrobial resistance (AMR) genes through the consumption of food of animal origin is a topic which has gained increasing attention in recent years. Bacterial transmission can be enhanced, particularly in situations in which the consumer pays less attention to hygiene practices, and consumer exposure to foodborne resistant bacteria through ready-to-eat foods could be increased. It has been demonstrated that even methicillin-resistant *Staphylococcus aureus* (MRSA) bacteria, which have low prevalence and concentration in raw chicken

DOI: 10.3390/microorganisms9051045

Model script: https://zenodo.org/record/4748645

Results

- ✓ Findings and conclusions based on specific **scenarios**, **data** and **assumptions**
- ✓ **Probability of consumer exposure to multidrug resistance bacteria** through consumption of grilled chicken meat and bread possibly contaminated from raw chicken meat appears to be **small**
- ✓ **Probability of contamination:** ESBL - *E. coli* > MRSA (x 7.6) (p-value <0.01)
- ✓ **Level of contamination:** ESBL - *E. coli* > MRSA (x 5) (p-value <0.01)
- ✓ **Prevalence** and **concentration** on chicken meat are the most important factors of consumer exposure to resistant bacteria
- ✓ **The higher the prevalence and concentration, the greater the impact of hygiene routines on the probability and extent of consumer exposure**

Consequences

- ✓ **Efforts to reduce the use of antibiotics** by improving animal health must be further intensified in order to achieve a reduction in resistance rates
- ✓ Compliance with **good manufacturing/hygiene practices** in slaughterhouses and processing plants
- ✓ Strict adherence to **hygienic measures during household food manipulation**:
  - ✓ Handling raw meat properly
  - ✓ Using different kitchen utensils for raw and RTE food
  - ✓ Washing hands and surfaces between different steps of food preparation
  - ✓ Heating meat thoroughly
  - ✓ Raw food of animal origin should not be consumed by vulnerable consumer groups
- ✓ Tips on kitchen hygiene: https://www.bfr.bund.de/en/kitchen_hygiene-194171.html

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- Dr. Franziska Schill
- Dr. Michaela Projahn
- Dr. Philine von Tippelskirch
- Prof. Dr. Victoria Plaza
- Dr. Petra Ganas

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Thank you for your attention

Carolina Plaza Rodriguez

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