- Processing practices contributing to *Campylobacter* contamination in Belgian chicken meat preparations

- Survival of *Campylobacter* in poultry meat preparations subjected to freezing, refrigeration, increased salt concentration, and heat treatment.

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QRA for *Campylobacter* in poultry based meat preparations: data needs

- (semi-)quantitative data for pathogen in food under consideration  
- data related to consumer habits, concerning food handling procedures/consumption patterns  
- prevalence of undercooking, prevalence of cross-contamination  
- effect of processing practices and storage conditions on survival of *Campylobacter*

**Limited data sets, surrogate data, assumptions, simplifications increase the uncertainty of the outcome of the QRA**
A myth has developed that thermophilic campylobacters are very sensitive to conditions outside the host. (Humphrey et al., 2007)

C. jejuni extremely susceptible to
• a wide variety of antimicrobial treatments
• food processing methods
• environmental stresses
in addition to being difficult to culture and maintain in the laboratory. (Solomon and Hoover, 1999)

↔ challenged in broth culture or inoculated

How is the situation in naturally contaminated chicken samples?
Aim of the Campylobacter project

- To generate prevalence and count data on *Campylobacter* contamination in chicken meat preparations in Belgium (presented by Ihab Habib);

- To evaluate the impact of certain processing-related variables on *Campylobacter* risk profile.

Variability in *Campylobacter* contamination between the 11 Belgian companies.
Composition of minced meat and percentage of frozen chicken meat in the minced meat preparations at the 11 selected companies with time and/or temperature for freezing, thawing, processing and preservation.

<table>
<thead>
<tr>
<th>ID</th>
<th>Composition of minced meat</th>
<th>% pre-frozen</th>
<th>Freezing time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>chicken leg with skin, sometimes skin is added</td>
<td>59%</td>
<td>few days - few weeks</td>
</tr>
<tr>
<td>B</td>
<td>fillet and boned, skinned thigh, skin is added afterwards</td>
<td>59%</td>
<td>max. 1 month</td>
</tr>
<tr>
<td>C</td>
<td>boned thigh with skin, without skin</td>
<td>0%</td>
<td>NA*</td>
</tr>
<tr>
<td>D</td>
<td>fillet and boned, skinned thigh, skin is added afterwards</td>
<td>0%</td>
<td>NA</td>
</tr>
<tr>
<td>E</td>
<td>thigh with skin</td>
<td>0%</td>
<td>NA</td>
</tr>
<tr>
<td>F</td>
<td>pork 30%, chicken 40%, turkey 40%, no skin</td>
<td>30%</td>
<td>thigh max. 3 months</td>
</tr>
<tr>
<td>G</td>
<td>boned thigh with skin (no fat in the meat, more frozen skin is added)</td>
<td>Raw: 0%, Cooking: 45% or 77%</td>
<td>max. 3 weeks; max. 6 months</td>
</tr>
<tr>
<td>H</td>
<td>boned thigh without skin, no pork</td>
<td>100%</td>
<td>max. 1 week</td>
</tr>
<tr>
<td>I</td>
<td>thigh with and without skin</td>
<td>0%</td>
<td>NA</td>
</tr>
<tr>
<td>J</td>
<td>thigh with skin and coating</td>
<td>100%</td>
<td>2-4 weeks</td>
</tr>
<tr>
<td>K</td>
<td>boned thigh without skin and pork, with exception of the product 100% chicken than skin is used</td>
<td>0%</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Not applicable
* Freezing mean after packing (at before) and before cooling

Statistical analysis:

In STATA SE/10.0
Weighting and adjustment for cluster effect of the companies.
Bivariate statistics and multivariable regression models:

- **Variables of interest**: Capacity, Skin, Freezing
- **Survey logistic regression model**: for binary data presence/absence of Campylobacter
- **Survey negative binomial regression model**: for Campylobacter enumeration results (CFU/g)
Campylobacter positive CMP samples in relation to the use of skin, frozen component, and producers' capacity and the logistic regression model of the variables affecting Campylobacter contamination of Belgian chicken meat preparations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Choice</th>
<th>Number Initial</th>
<th>% Campylobacter Positive Status</th>
<th>Description</th>
<th>OR</th>
<th>P-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Without skin</td>
<td>303</td>
<td>67</td>
<td>Skin is present (e.g. damaged; or weight, or added to the product (e.g. hammer and bruise) during processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>With skin</td>
<td>354</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frozen</td>
<td>Not frozen (Fresh)</td>
<td>50</td>
<td>25</td>
<td>Product or produced from frozen meat, or containing a frozen component.</td>
<td>0.044</td>
<td>0.001</td>
<td>1.10-6.97</td>
</tr>
<tr>
<td></td>
<td>Frozen (total or partial)</td>
<td>149</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>Large</td>
<td>348</td>
<td>100</td>
<td>Production capacity with the bigger reference.</td>
<td>0.013</td>
<td>0.001</td>
<td>1.22-5.94</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>143</td>
<td>20</td>
<td></td>
<td>0.127</td>
<td>0.24</td>
<td>0.74-7.82</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>165</td>
<td>20</td>
<td></td>
<td>0.019</td>
<td>0.001</td>
<td>1.31-6.81</td>
</tr>
</tbody>
</table>

**Impact of Skin and Freezing on Campylobacter concentration**

[A] Presence of and/or addition of Skin:

Survey generalized negative binomial regression:
Counts of Campylobacter in samples containing skin, or to which skin was added was significantly higher (P = 0.001) compared to samples in which skin was stripped before processing.

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B) Sample made from frozen (total/partial) meat:

Survey generalized negative binomial regression:
Counts of Campylobacter are significantly less ($P = 0.006$) in products made from frozen meat (totally or partially) compared to those made from fresh meat.

C) Skin & freezing:
Quantitative/qualitative results of the salt experiments

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Quantitative/qualitative results of the freezing experiments for skin and minced meat

Campylobacter could still be found qualitatively on 0.1g after a stay of 84 days, as well as for the upper legs, the minced meat as for the skin.
Conclusion:

Situation of Campylobacter in chicken meat preparations in Belgium:

- High Campylobacter prevalence and “relatively” low count.
- First comprehensive and representative quantitative data, for future update of QMRA model.
- Big producers are more likely to be in a position of supplying big retail chains, supermarkets ..etc. with a consumer-driven demand for products made of fresh meats. That is usually not the case in small producers.
- Presence or adding skin: higher Campylobacter counts, more positives.
- Freezing is a reliable control option, but freezing alone can not add a significant margin of safety, and cannot replace sanitary production and handling.

Message to industry “watch out what are you freezing”

Our study shows that freezing products with skin attached to it, or, freezing the meat and adding skin to it afterward, could limit the positive effect of freezing on Campylobacter reduction.

Conclusion:

Freezing: reduction of ~ -1 log after 1 day of freezing
After 84 days, Campylobacter still detected qualitatively.

NaCl (1.5%): no significant reduction at 4°C
NaCl (1.5%): reduction of ~ -1 log at -22°C;
imputed to the effect of freezing not due the addition of NaCl or the combination

Qualitative detection: positive result mostly for 0.1g, while 1 and 10g gave neg. results.
Competition: Low numbers of Campylobacter vs. high numbers of indigenous flora.

No typical morphology: Experience and confirmation for enumeration and detection obliged!!!
Campylobacter versus E. coli

Even food under HACCP or hygiene codes may be unsafe!

- Chicken meat preparations are high risk products
- Intervention step at the consumer.

Effect of consumer behaviour?
Cooking and prevention of cross-contamination...
Generally infection with *Campylobacter* spp. via contaminated chicken meat happens by means of two ways: cross-contamination and undercooking.

- Some literature indicate that the probability of cross-contamination is higher than the probability of undercooking, because the highest number of *Campylobacter* spp. are found on the surface and internally, where the temperature is lower, the prevalence is also lower (Luber, Brynestad, Topsch, Scherer & Bartelt, 2006).

- This is not generally accepted. For example Bergsma, Fischer, Van Asselt, Zwietering and De Jong (2007) value the risk for infection by means of a not well performed heat treatment higher than commonly adopted.

- Moreover for minced meat preparations the bacteria are uniformly spread throughout the meat by means of meat grinding.

Survival of heating

- Undercooking:
  - No useful data in literature (great variability in D values and no data for chicken meat preparations, most experiments are on inoculated samples)
  - Test in lab
Registration of temperature and internal colour change in function of time.

**CONCLUSION:**

Bacteria are resistant for 2 minutes (internal temperature of 38°C).
No CFU’s after 4 minutes.
Fast killing is observed once temperature above the optimal growth temperature of *Campylobacter* spp. (42 to 45°C).
The criteria “well-cooked” (after 6’ 30’’) and 73,9°C (FSIS=Food Safety and Inspection Service, US) (after approx. 7 minutes) as safety criteria for safe heating are in accordance with the observed results.
CONCLUSION:

Proper food safety practices prevent situations that promote bacterial growth, cross-contamination, and foodborne illness.

**Thorough cooking** destroys bacteria.

Thank you for your attention

Questions?

Comments?