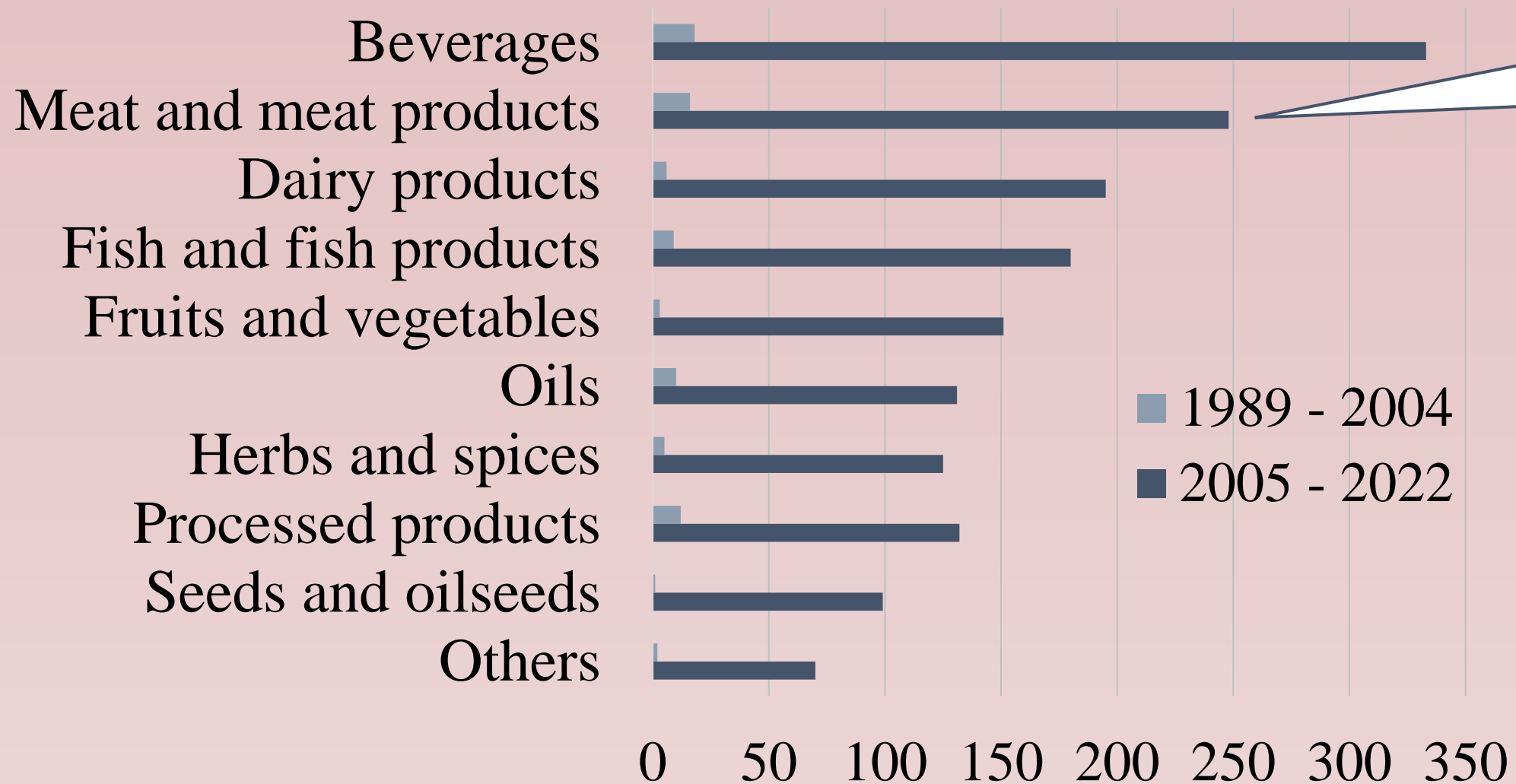


Introduction

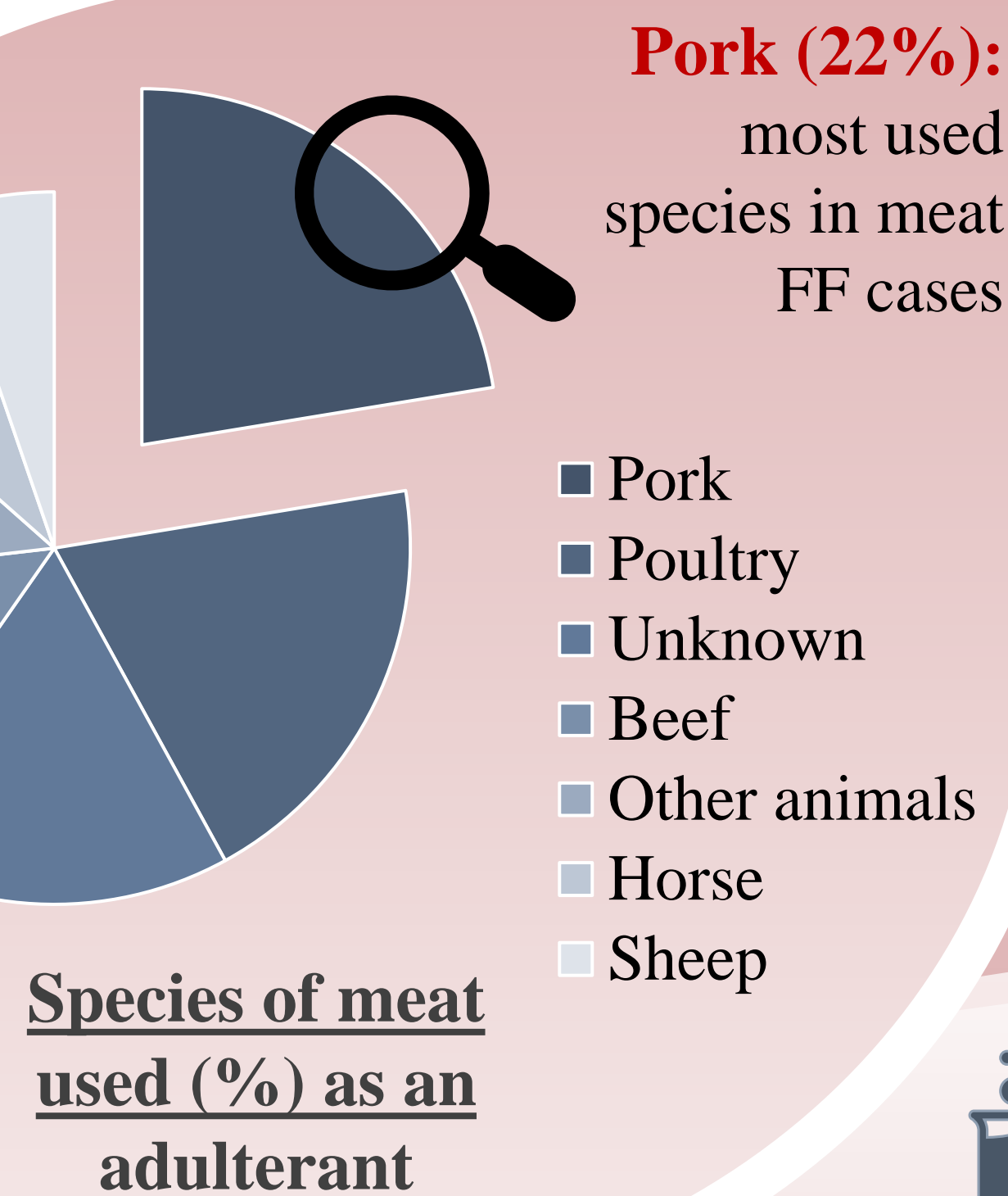
Food fraud (FF) is an intentional act for economic gain (Spink, 2011; Manning, 2016). In recent decades, FF has become widespread, and regulatory authorities have decided to improve food safety regulations with a FF-specific focus. The meat sector is one of the most targeted by FF (Decernis, 2022) and, since the horse meat scandal, the European Commission (EC) has proposed a limit of 1% (2013/99/EU) to distinguish FF from cross-contamination (CC) (EC, 2013).

Number of interferences per food manufacturing sector



Meat products is one of the food manufacturing sectors most affected by fraud, notably by misrepresentation of the origin of the animal species used.

Second most targeted by fraudsters



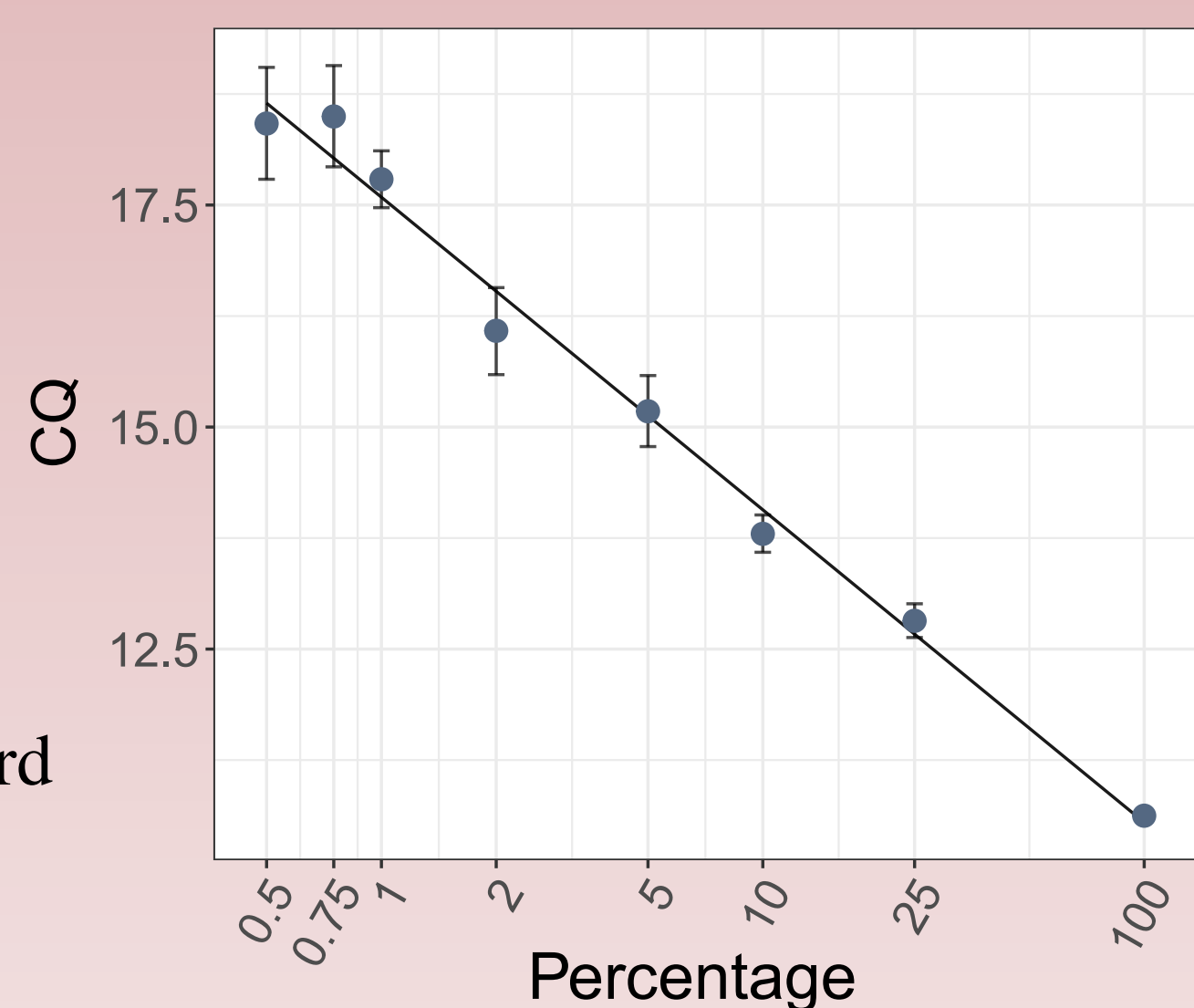
Previous studies investigated the occurrence of pork CC > 1% in ground beef products, after one grinding cycle (Amaral, 2017; Chung, 2020). However, for texture and appearance optimization, raw meat – regardless of the species – is usually ground twice before selling. This process homogenizes the meat and potentially, the pork contamination, if present, making it less likely to be detected analytically.

Objective

The purpose of this study was to assess the EC's 1% limit using exploratory data analysis to determine its applicability.

Results

Example of a standard curve correlating log (% pork) and Cq



Lean pork

“Dirty” scenario
 $R^2 = [0,96 - 0,99]$
Clean scenario
 $R^2 = 0,98$

Fatty pork

“Dirty” scenario
 $R^2 = [0,90 - 0,99]$
Clean scenario
 $R^2 = 0,98$

Validated standard curve protocol

Higher variability because the kit is non-specific for high fat pork

Pork cross-contamination (%) in ground beef

% Lean pork (mean ± SD)

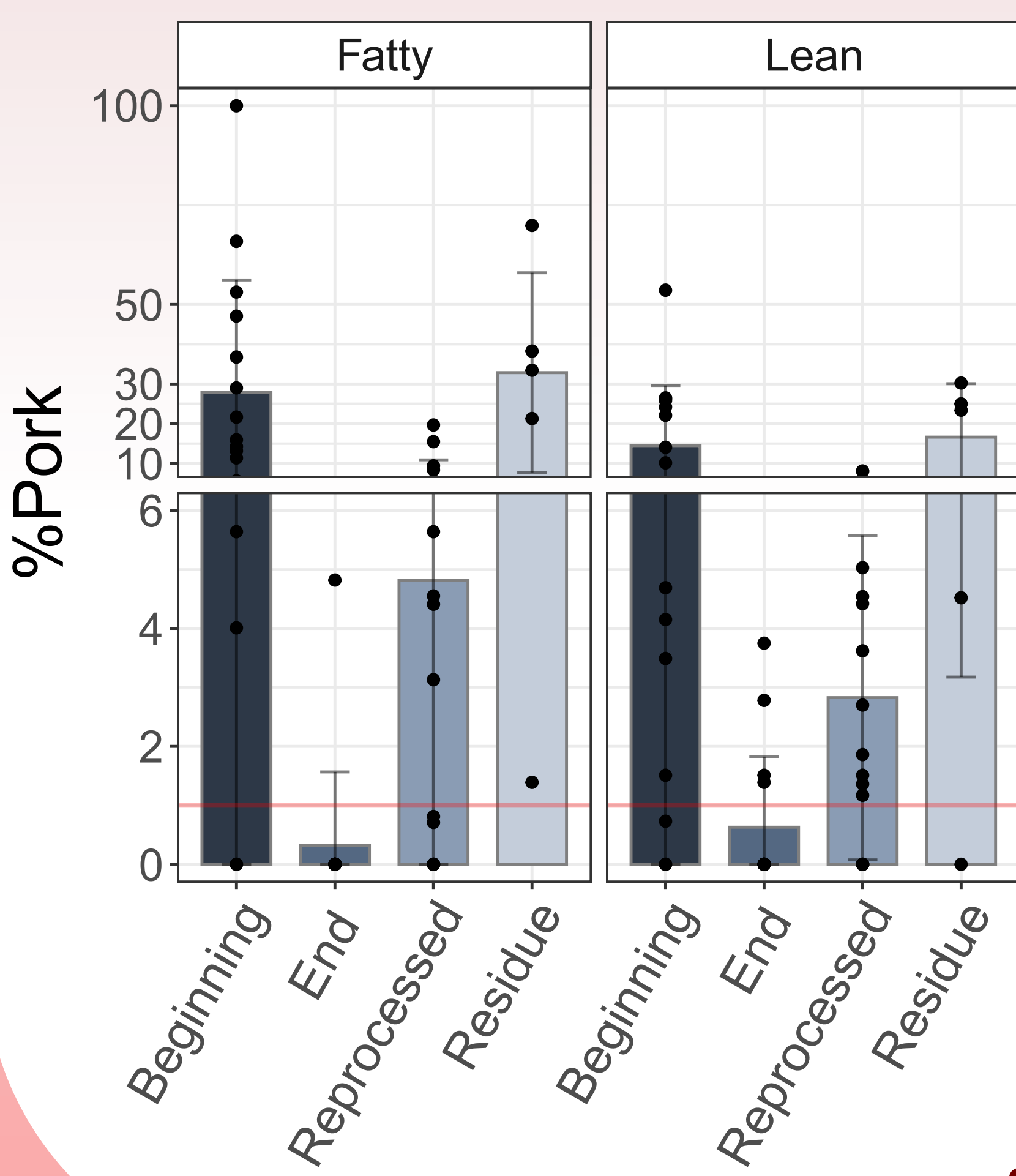
“Dirty” scenario:
• Beginning: $13,70 \pm 15,16$
• End: $0,42 \pm 0,83$
• Reprocessed: $2,61 \pm 2,78$

Clean scenario:
• Not detected

% Fatty pork (mean ± SD)

“Dirty” scenario:
• Beginning: $29,68 \pm 33,61$
• End step: $0,32 \pm 1,24$
• Reprocessed step: $4,86 \pm 6,07$

Clean scenario:
• Not detected



Materials & methods

1st grinding : 2kg Pork

2nd grinding : 2,5kg Beef

3rd grinding : 2,5kg Beef

from the 2nd grinding



OMCAN meat grinder

To determine the level of cross contamination, the pork is ground first, followed by beef. Three samples were realized for each step studied.

1. Semi-industrial samples

Sampling method :

Beginning step: between 0 and the first 500g of beef ground

End step: between 2kg and the end of beef ground

Reprocessed step: randomly in the 2,5 kg of beef reprocessed

Two scenarios were simulated:

- “Dirty” scenario: the grinder was not cleaned between grinding pork and beef, and,
- Clean scenario: the SOP* for cleaning the machine was followed after grinding the pork, right before the beef.



Six repetitions of semi-industrial experiments were conducted with two types of pork : lean and fatty (25% fat).

* Standard Operating Procedure

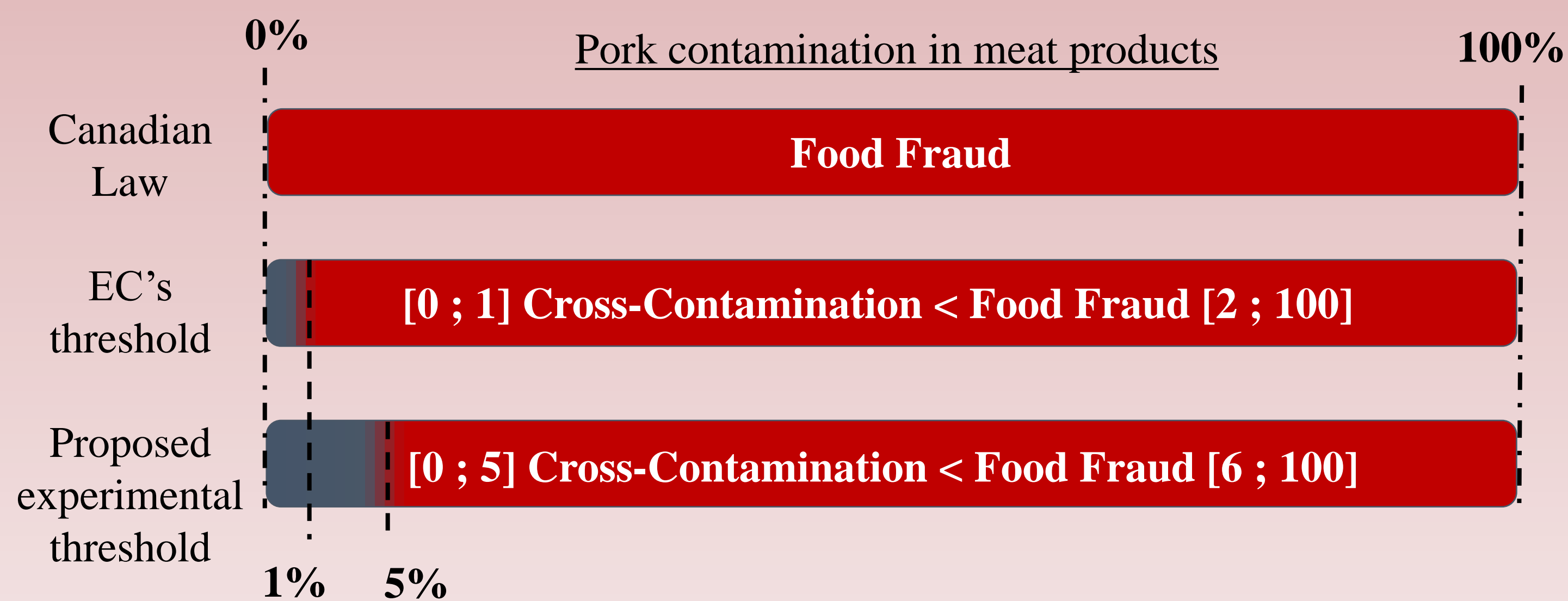
2. Standard Curve

7 matrices with different percentages of pork in beef were prepared: 25%, 10%, 5%, 2%, 1%, 0.75% and 0.5%; and 2 control matrices with 100% pork and 100% beef.

For each of the pork/beef mixtures, three samples were taken to validate the homogeneity of all the matrices. The meat used for each semi-industrial experiment was the same used to build their corresponding standard curve.

Correlation between Cq and log % pork

Discussion & conclusions



- Most ground meat products are homogenized twice – which would also homogenize any potential pork CC. According to Quebec regulations, it is prohibited to add "pork meat to ground beef or veal". Therefore, all positive samples observed in this study (11 /15 samples in the case of lean pork, and 8/15 with fatty pork) would be considered fraud.
- The EC's 1% limit is not suitable because the homogenization of the pork contaminant is a function of the amount of ground beef. The greater the amount of ground beef, the lower the amount of contaminating pork likely to be detected. This is one of the challenges faced by small retailers such as butchers.
- If a limit of 5% pork is applied to differentiate CC from FF, the experimental samples qualifying as FF will decrease to 3/15 for lean pork and 4/15 for fatty pork.
- Even if the experimental occurrence of FF decreases, authorities should not rely solely on a threshold to differentiate CC from FF, but rather use it as guidance when passing judgment against potential fraudsters.

In conclusion, a regulatory limit should not be used alone but rather as an indicator (e.g., during an inspection procedure). Also, if control measures cannot systematically prevent it, the risk of presence of an unintended animal species in the meat purchased should be communicated to consumers.

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