Salmonella spp. on the pig meat in the cold chain in Belgium

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Introduction

The cold chain process constitutes a critical stage to prevent the *Salmonella* multiplication. The porcine die actors in Belgium have been careful for several years to respect the good practices and the improvement of the cold chain by decreasing the duration of the stages and by respecting strictly the temperatures. However, there are many different situations in the pig meat die concerning these parameters. Thanks to Monte Carlo simulations, it is possible to integrate these different situations in primary and secondary models of predictive microbiology and determine the most important stages. It is also possible to simulate an accident in the chain and to measure the repercussion.
The pig meat goes trough many stages from the end of the slaughterhouse until the consumer's refrigerator. Each stage was studied by investigations in order to collect data on duration and temperature.
In this context of quality improvement of the porcine production, Belgian Public Health authorities have financed the research project "METZOON". The objective was the development and the validation of a quantitative risk assessment methodology linked to the emerging zoonotic agents transmitted by food in Belgium.

Material and methods

The inputs of the model were the *Salmonella* growth characteristics on the pig meat (parameter of growth of *Salmonella* according to the temperature) and, in addition, the time-temperature data for each stage. Investigations at the level of the slaughterhouses, cutting meat plants, minced meat plants and retails were carried out by investigations in order to collect information necessary to the model. The table 1 gives the time and the temperature distribution for each step of the cold chain The other parameters of growth were provided by the ComBase database (Anonymous, 2007).

Stages	Temperature (°C)	Time (hours)
Tansport to the cuting plant	=RiskPert(-1; 5; 10)	=RiskExpon(1,6; RiskTruncate(0,5;))
Stockage before cutting	=RiskPert(0;2,55; 9)	=RiskPert(0; 8; 72)
Cutting plant	=RiskPert(7;9,54; 12)	=RiskPert(0,08; 0,63; 2,5)
Stockage after cutting	=RiskPert(2; 5;7)	=RiskPert(2; 24; 48)
Transport to the butchery	=RiskPert(4; 5;10)	=RiskExpon(1,6; RiskTruncate(0,5;))
Stockage at the butchery	=RiskPert(0;2; 4)	=RiskPert(0,5; 24;48)
Butchery	=RiskPert(10;12;15)	=RiskPert(0,5; 1; 2)
Stockage at retail	=RiskNormal(5;2,5)	=RiskPert(0,5; 1; 24)
Transport to the house	=RiskPert(10;15;20)	=RiskExpon(1,2; RiskTruncate(0,5;))
Fridge in the house	=RiskNormalAlt(25%; 5; 75%; 9)	=RiskExpon(1,72; RiskTruncate(1;))

Table 1: Time-temperature distribution for each stage of the cold chain

The initial concentrations at the end of the slaughterhouse were estimated from *Salmonella* semi-quantitative data measured during the official monitoring of the zoonotic agents in Belgium (Ghafir et al., 2005). The table 2 shows the data transformed on log CFU scale, base 10 and adjusted in a normal distribution.

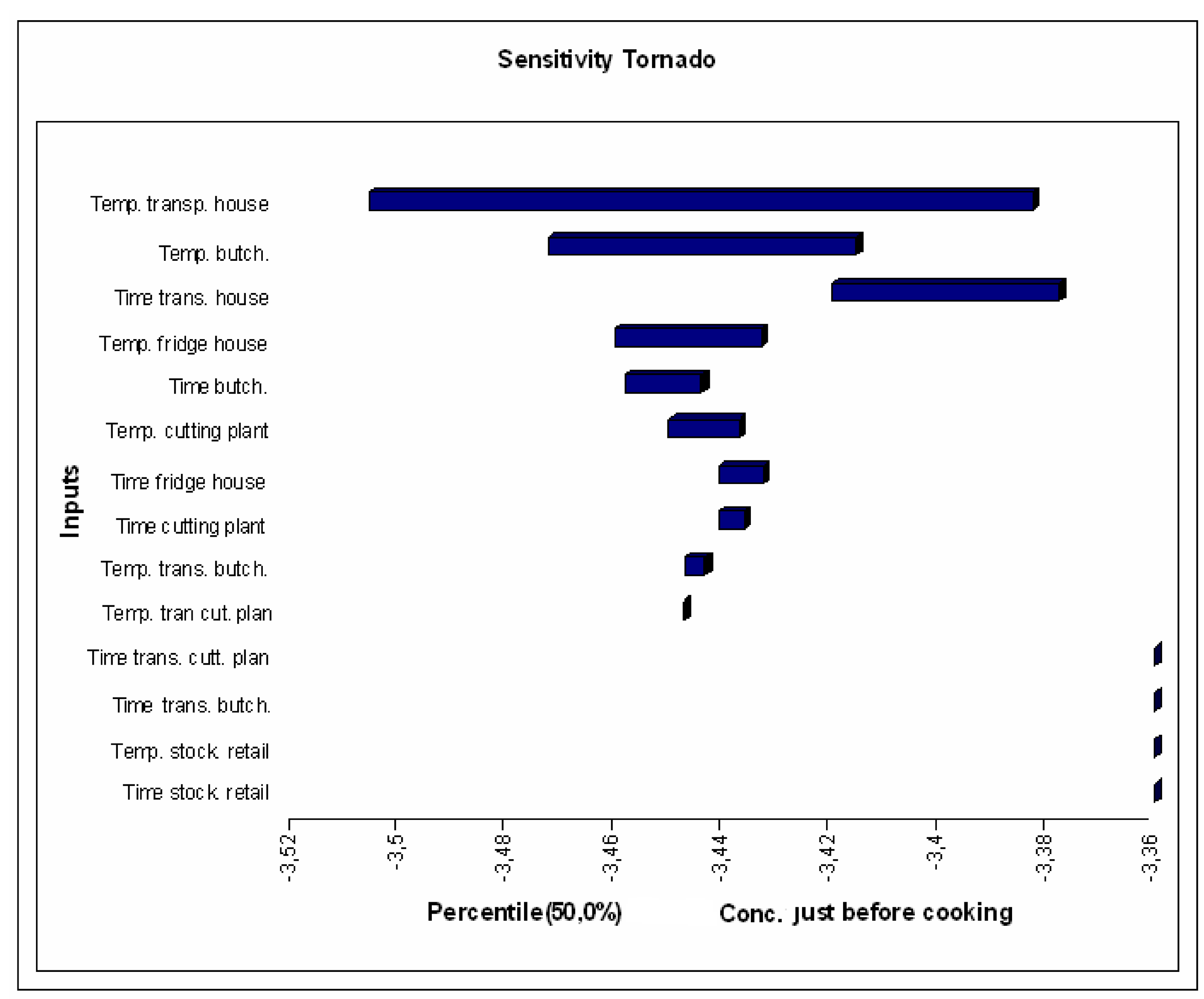
Number of *Salmonella* / 600cm²	Log 10/cm²	Cumulated %
5	-2,08	75
125	-0,68	92,7
1245	0,32	96,8
=RiskNormal(75%; -2.08; 92.7%; -0.68)		

Table 2: Pig carcass concentration at the end of the slaughterhouse

The evolution of the concentration during the various stages of the cold chain was predicted by using the exponential primary model (without lag time) and the square root secondary model (AFSSA, 2006). The model was simulated with Palisade @Risk 4.5 for Micropft Excel. To run the simulations, the Latin Hypercube sampling was used and the number of iterations was fixed at 10^4.

Results and discussion

The initial concentration of the pig carcasses has been estimated at -3.80 ± 1.79 Log 10 *Salmonella* / cm². This indicates that the majority of the carcasses are very few contaminated and that a small percentage has a high contamination.
The cold chain process seems well controlled in Belgium. The data collected by the investigations indicate that producers respect durations and temperatures required at the different stages. However, some stages remain more critical due to higher temperature and time more longer. The graph 1 shows a sensitivity analysis with the time and the temperature inputs for each stage and the final *Salmonella* concentration just before cooking for output.It indicates that the cutting plant, the butchery, the fridge in the house and the transport from the retail to the house have an impact on the final concentration.



Graph 1: Sensitivity tornado with the time and temperature inputs for each stage

But the most important factor to take into account for the final *Salmonella* concentration is *Salmonella* concentration at the end of slaugterhouse. This means that the most important responsibility goes to the slaughterhouses who must provide *Salmonella* free carcasses.

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