Development of a quantitative risk assessment model for cheese made from raw goat milk contaminated by *Listeria monocytogenes*

Delhalle L.[a]*, Ellouze M.[b]; Clinquart A.[a], Daube G.[a], Yde M.[c] and Korsak N.[a]

[a] University of Liege, Food Science Department, Sart-Tilman, B43bis, 4000 Liege, Belgium
[b] IFIP, 7, Avenue du Général de Gaulle, 94 704 Maisons Alfort, France.
[c] Scientific Institute of Public Health, Bacteriology section, Rue Juliette Wytsmanstraat 14 - 1050 Brussels, Belgium.

Introduction

A retrospective study was performed to assess the risk of listeriosis following a contamination by *Listeria monocytogenes* in cheeses made from goat raw milk. This incident was reported by the Belgian Federal Agency for the Safety of the Food Chain in 2005. A quantitative risk assessment model was developed covering the production chain from the milking of goats until the storage of end-products.

Figure 1: Description of the cheese process made of raw goat milk

Materials and methods

The principles of the Modular Process Risk Model (MPRM) methodology were used to break down the food production chain into modules and to follow the bacteriological concentration of the pathogen throughout the process (Figure 1). Each module generates an output that is used as an input for the next module. The simulated events are identified for each module: growth, mixing and/or partitioning. Input values are classified as process inputs, microbiological or food characteristics. Predictive microbiology models were used in the exposure assessment step to simulate the growth of *L. monocytogenes* during the cheese manufacturing process taking into account temperature, pH and water activity.

Results and discussion

Table 1 gives the results of the modular exposure assessment model and shows a significant growth of *L. monocytogenes* during chilling and storage of the milk collected the day before the cheese production (increase of 0.6 log cfu / ml) and during adjunction of starter and rennet to milk (increase of 0.8 log cfu / ml). The estimated final result (P50) in the fresh cheese is equal to 3.3 log cfu/g. The model was validated by comparison of the final result issued from the exposure assessment with the number of *L. monocytogenes* analyzed in the fresh cheese (3.6 log cfu / g) reported in the listeriosis episode. The average number of expected cases of listeriosis was 1 for a high-risk sub-population. Scenarios analysis were finally performed to identify the most significant factors and aid in developing priorities for risk mitigation (table 2). The Installation of a heat exchanger could be a good opportunity to reduce the final contamination.

Modules	Item	Percentiles 5th	50th	95th	Unit
Milking	Concentration in a tank before storage over night of the evening milk	-5	0	0.47	log cfu/ml
Storage of the evening milk	Concentration in the tank after storage over night of the evening milk	-3.3	2	2.8	log cfu/ml
Adjunction of ferment and	Concentration before draining off the curdles	-2.1	3.3	4.8	log cfu/ml
Draining off the curds	Number of *L. monocytogenes* per cheese	0.2	5.7	7.4	log cfu/cheese
	Concentration of *L. monocytogenes* in a serving of cheese	-1.8	3.7	5.4	log cfu/g
Cooled storage and wrapping	Number of *L. monocytogenes* per serving of cheese	-0.1	5.4	7.1	log cfu/serving
	Risk of human listeriosis (normal population)	0	0	0	
	Risk of human listeriosis (susceptible population)	0	0	2.10^{-5}	
Human effect	Total number of human listeriosis	0	0	1	people

Table 1: Baseline results of the exposure assessment and the risk characterization modules

Scenarios	Percentiles 5th	50th	95th
Baseline results	-1.8	3.7	5.4
Scenario 1: Installation of a heat exchanger plate to obtain a temperature of 7 °C directly after milking and maintain a constant temperature during the overnight storage.	-3.1	2.2	3.4
Scenario 2: pH reduction of 0.5 units at the start of adjunction of ferment and rennet. This could be achieved, for example, by adjunction of food acid.	-2.2	3.3	4.8
Scenario 3: Increase efforts in the production by combining previous scenarios.	-3.5	1.8	2.9
Scenario 4: 2 shedder goats excreting each 2.6 log *L. monocytogenes* /ml in the right part of the mammary gland.	-0.8	4.2	5.7

Table 2: Results of the scenarios analysis (Concentration of *L. monocytogenes* in a cheese (log cfu/g))

Conclusions

The process does not prevent the contamination by *Listeria monocytogenes* (*L. m.*)

The model seems to correctly estimate the fate of *L. m.*

Surveillance in the primary sector difficult but may be improved

No reported human listeriosis connect to this contamination

Risk analysis can be useful in a HACCP process