Exploring the risk factors for *Salmonella* in the ten biggest Belgian pig slaughterhouses

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Abstract

The goal of this work is to identify the risk factors related to *Salmonella* in the porcine die at the stage of the slaughterhouse. Thanks to investigations carried out into the ten biggest Belgian slaughterhouses, data concerning the manufacturing process and the working methods were gathered. Moreover, an access to the microbiological results carried out on these companies within the framework of the official plans of monitoring was asked to the Belgian Food Agency. A data base allowing to test the influence of risk factors on the presence of *Salmonella* was established. To quantify a relation between a risk factor and the presence of *Salmonella*, statistical methods such as the mixed logistic regressions were used.

Material and methods

The ten biggest Belgian slaughterhouses were visited for the study.These slaughterhouses represent 60 % of the total volume of pig meat production in Belgian (Source: National Institute of Statistics in Belgium). A detailed questionnaire was created based on the Hazard Analysis Critical Control Point (HACCP) with headings relating to the manufacturing methods, the technical description of the installations, the traceability of the carcasses and the methods of cleaning and disinfection. Measures of temperature were taken during the visits at different places.

An access to the microbiological results concerning the monitoring of the zoonotic agents of the ten biggest slaughterhouses was requested from the Federal Food Agency in Belgium. Carcass swabbing areas were based on those described by Korsak et al. (1998). For one carcass, the area swabbed, including four zones for a total area of 600 cm². The official method SP-VGM002 from the Ministry of Public Health (based on semi-solid enrichment) was used for the detection of *Salmonella.*

The data base was created by gathering the microbiological results of the Federal Food Agency and the results of our investigations into the slaughterhouses. It was structured and organized in order to facilitate the exploitation. Technical description and descriptive statistics on *Salmonella* were carried out for each slaughterhouse. Then logistic regressions were calculated with different variables in order to explain the presence or not of *Salmonella.*

Table 2: Technical data sheet of the slaughterhouses

Steps	Abattoirs	1	2	3	4	5	6	7	8	9	10
Lairage											
	Spraying	x		x	x	x	x	x	x	x	x
Stunning											
	Electric	x			x	x		x	x		
	Carbonic gas		x	x			x			x	x
Sticking											
	Temperature of disinfection for the knives	87	65,8	80	73,5	n.m.	n.m.	79,8	n.m.	52	76
	Trocard			x			x			x	
	Channel used for collecting blood	x	x		x	x		x	x		x
	Lay down	x			x	x		x	x		
Scalding											
	Basin		x	x		x	x	x	x	x	x
	Steam	x			x						
	Temperature (°C)	62	61	64	59	61	60	60	61	59	60
	Time (seconds)	556	435	n.m.	360	345	470	325	480	405	360
	hood	x					x		x		
Dehairing											
	Temperature (°C)	38	13	40	40	48	13	52	13	13	30
Singeing											
	Time (seconds)	7	12	14	6	12	8	5	n.m.	15	16
	Second flaming (after polishing)	x									
Polishing											
	Time (seconds)	90	35	n.m.	45	60	35	97	n.m.	55	75
	Temperature (°C)	17	13	30	13	13	13	13	13	13	13
Evisceration											
	Boring machine	x	x		x	x	x	x	x		x
	Another line system if there is a problem	x	x	x			x	x		x	
	Washing the contaminated meat		x	x		x	x		n.m.	x	x
	Temperature of disinfection for the knives	n.m.	70	81,5	77	66	n.m.	78	n.m.	47	76,8
Splitting											
	Splitting without the head	x									
	Cleaning between two carcases	x	x			x	x	x	x		x
	Disinfection between two carcases	x				x	x				
	Cleaning/Disinfection three times per day	x									
Chilling											
	Automatic	x	x	x	x	x	x	x	x		x
	Time to reach 7°C (hours)	19	n.m.	n.m.	16,5	15	15	n.m.	24	n.m.	n.m.
New hooks		x	x	x	x			x		x	x

n.m. = not measured

Table 1: Prevalence of *Salmonella* in the selected slaughterhouses with data from the Federal Food Agency from 2000 to 2004

Slaughterhouse	n	Prévalence (%)	95% CI
1	76	2,6	(0,3-9,2)
2	46	4,4	(0,5-14,8)
3	39	5,1	(0,6-17,3)
4	47	6,4	(1,3-17,5)
5	54	11,1	(4,2-22,6)
6	66	21,2	(12,1-33,0)
7	55	21,8	(11,8-35,0)
8	60	26,7	(16,1-39,7)
9	74	27,0	(17,4-38,6)
10	67	34,3	(23,2-49,6)
Total	**584**	**16,1**	**(8,8-27,5)**

Results and Discussion

The microbiological results of the ten biggest slaughterhouses in Belgium are presented for *Salmonella* in table 1. A great variability exists between the slaughterhouses with prevalence coming from 2.63% for the best slaughterhouse and with 34.33% for the worst.

The results of prevalence from 2000 to 2004 are observed for each slaughterhouse. The companies with high levels of prevalence remain high along the years and inversely for the companies with weak prevalence.

There is also a great variability with the working methods between the slaughterhouses (see table 2). These methods can protect against *Salmonella* or be a risk factor.

There are important differences in the parametres measured like the temperature of disinfection of knives during sticking and evisceration. Several slaughterhouses had a too low temperature to allow a good disinfection of the knives. This parametre is important to check throughout the working day in order to avoid the cross-contaminations.

Disinfection of the splitting machine between two carcass is carried out only by three slaughterhouses along the day while it is completely cleaned three times per day by only one slaughterhouse.

A factor of protection would be the utilsation of the second flaming at the end of the dirty zone.

The polishing machine is an important source of contamination of the carcass and the second flaming make it possible to strongly reduce a contaminaton.

The companies with a weak prevalence of *Salmonella* use methods in order to achieve their goals while slaughterhouses with a high prevalence have working methods giving them a high risk of contamination. For example, in the best case, the slaughterhouse with the lowest prevalence for *Salmonella* use a double flaming, steam for the scalding, removing the head before the splitting of the carcass, etc. In the worst case, the slaughterhouse with a high prevalence have a temperature of disinfection of the knives not hot enough, wash the carcase if there is a problem of contamination, don't make a desinfection of the splitting between two caracsses, etc.

The first single mixed logistic regressions show that several variables seem significant for risk factors or for protection. But in spite of the great number of microbiological results, they were not enough slaughterhouses to explain many variables.

Conclusions

The originality of this work is to combine in a single data base, not only the microbiological results obtained by the public authorities from 2000 to 2004, but also the data of investigations in the slaughterhouses. A high number of microbiological results have been collected for *Salmonella* for the different slaughterhouses visited (n=584).

The results for *Salmonella* for the different companies have a great variability. These results indicate that it is possible to reach high level of performance in Belgium but also high levels of contamination.

These differences can be explained by the working methods used in the companies. Methods allowing a better control of the cross contamination and avoiding over-infection must be advised to reach a weak prevalence.

An analysis by mixed logistic regression on several variables observed was used in order to establish a relation between with the presence of *Salmonella*. In the state of the researches, the multivariate logistic regressions must be validated.

Acknowledgments

We thank the Federal Food Agency of Belgium for their help and their advices. This study has been carried out with the financial support of the Belgian Federal Public Service of Health, Food Chain Safety, and Environment research programme (R-04/003-Metzoon) 'Development of a methodology for quantitative assessment of zoonotic risks in Belgium applied to the '*Salmonella* in pork' model'.

This research is funded by the Belgian Federal Public Service of Health, Food Chain Safety and Environment