Surveillance of *Salmonella* contamination of pig carcasses through own-check undertaken at the slaughterhouse

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Abstract
Salmonellosis is the major cause of foodborne outbreaks caused by bacteria in Europe. In 2014, the European Commission reinforced the supervision of this contamination in the pig sector. In this context, the General Directorate for Food implemented a new system to centralise regulatory own-check for *Salmonella* in pig carcasses. The results provide an estimate of the level of contamination of carcasses, at national level and for each slaughterhouse. Variability in levels of contamination can be associated with risk factors, which could be the subject of dedicated studies. These results are intended to be transmitted each year to the European Food Safety Authority for comparison among Member States. They could also be used at national level to raise the awareness of stakeholders.

Keywords
Salmonella, Carcasses, Pigs, Slaughterhouses, Own-check

Résumé
Surveillance de la contamination des carcasses de porcs par* Salmonella *via le bilan des autocontrôles réalisés à l'abattoir
Les salmonelloses sont la première cause de toxi-infection alimentaire collective d'origine bactérienne en Europe. La viande de porc est une des sources associée aux cas humains. La Commission européenne a renforcé en 2014 la supervision de la maîtrise de cette contamination en filière porcine. Dans ce cadre, un nouveau système de centralisation des autocontrôles réglementaires vis-à-vis de Salmonella *dans les carcasses de porcs a été mis en place par la direction générale de l'Alimentation dans les abattoirs. Les résultats donnent une estimation du niveau moyen de la contamination par* Salmonella*, au niveau national et dans chaque abattoir. La variabilité des taux de contamination entre les abattoirs peutêtre associée à des facteurs de risque, qui pourraient faire l'objet d'études dédiées. Ces résultats sont destinés à être transmis à l'Autorité européenne de sécurité des aliments chaque année pour une comparaison entre États membres. Ils pourront être également utilisés au niveau national pour sensibiliser les opérateurs.*

Mots-clés
Salmonella*, carcasses, porcs, abattoir, autocontrôles*

The health control of food production systems is regulated by the European texts of the Hygiene package. In this context, operators in the food sector are responsible for the foodstuffs they place on the market and must ensure they are not hazardous . To do so, they must develop a health control plan in order to guarantee the control of identified hazards (including good hygiene practices, procedures founded on the HACCP principles, traceability, and the management of non-compliance) and verify that the defined control measures are effective. This verification relies on own-check, among other things. The competent authorities ensure that operators in the food sector comply with the regulatory requirements.

Although the number of salmonellosis cases has been decreasing since control programmes were implemented in the poultry sector, *Salmonella* remains the major cause of food-borne outbreaks of bacterial origin in Europe (EFSA & ECDC, 2015). Pork is one of the sources associated with human cases. In 2014 in France, 15% of food-borne outbreaks caused by *Salmonella* involved meat and 11% involved delicatessen meat (all species combined) (InVS, 2014). The lack of harmonised control programmes in the pig and pork sector in Europe led the European Commission to reinforce supervision by the competent authorities in this area in 2015. Of the various supervision methods proposed by the European Commission under Regulation (EU) 218/2014, the Directorate General for Food (DGAL) chose to implement a system for the collection and centralisation of the results of own-check undertaken in accordance with Regulation (EC) No 2073/2005 in all pig slaughterhouses. This innovative approach was defined in collaboration with representatives of professionals from slaughterhouses and the pork and pig sector.

Member States send the results collected annually to EFSA in accordance with Directive 2003/99/EC on the monitoring of zoonoses and zoonotic agents.

Materials and methods

Slaughterhouses concerned

Data are collected from all pig slaughterhouses, including both those slaughtering pigs only and those slaughtering several animal species including pigs.

Sample identification

The samples come from own-check for *Salmonella* undertaken in accordance with Regulation (EC) No 2073/2005 (Process hygiene criterion 2.1.4). These own-check are intended to verify control of the slaughter process. Slaughterhouses thus identify these own-check in order to distinguish them from other samples taken in the more specific framework of hygiene control process management or after an isolated loss of control.

Sampling procedure

Own-check are undertaken weekly in every slaughterhouse, randomly, with five carcasses from the same slaughter day, according to technical instruction DGAL/SDSSA/2015-619[1]. The sampling day must change every week. For slaughterhouses that do not operate

1. Technical instruction DGAL/SDSSA/2015-619 of 20 July 2015 on microbiological criteria for own-check of carcasses of slaughter animals.

Table 1. Characteristics of the slaughterhouses for which results are available

	Number of slaughterhouses in France	Annual pig slaughter volume in 2015 (in tonnes)	Main species slaughtered in 2015 (by volume)	Number of slaughter chains	Classification level/ compliance with EU regulations*
Multi-species slaughter-houses (including pigs)	133 (83.1%)	560,523 (28.5%)	Cattle: 63.9% Pigs: 34.5% Sheep: 0.8% Equines: 0.8%	chain: 25.6% chains: 25.6% chains: 47.3% chains: 1.5%	Level I: 6.0% Level II: 84.2% Level III: 9.8%
Pig slaughterhouses	27 (16.9%)	1,404,678 (71.5%)		1 chain: 100%	Level I: 7.4% Level II: 88.9% Level III: 3.7%
Total	**160**	**1,965,201**		**chain: 38.1% chains: 21.25% chains: 39.4% chains: 1.25%**	**Level I: 6.25% Level II: 85.0% Level III: 8.75%**

* The classification level of a slaughterhouse is established by the DDecPP/DAAF during official controls and corresponds to the slaughterhouse's risk control level: Level I = adequate risk control – Level 2 = acceptable risk control – Level III = inadequate risk control. It corresponds to the slaughterhouse's level of compliance.

Table 2. Categorisation of slaughterhouses by number of samples taken in 2015 as part of regulatory own-check

Category	Number of slaughterhouses	Annual number of samples (N)
1	55 (35%)	N < 50 (less than one 5-carcass sample per month)
2	72 (46%)	50 ≤ N < 240 (from one 5-carcass sample per month to one sample every two weeks)
3	29 (19%)	N ≥ 240 (at least one 5-carcass sample per week)

five days a week, samples can be taken every five days of actual slaughter. For plants with several slaughter chains, a own-check plan is established for each chain. This sampling frequency can be reduced to every fortnight (or every 10 days of actual slaughter) if the interpretation of the results is satisfactory for 30 consecutive weeks or for slaughterhouses for which the slaughter volume is less than 1000 heads per year.

Samples are collected using a non-destructive method, with a sponge used for the sampling of four different sites per carcass. The sampling area is at least 100 cm² per site. Samples are commonly taken from the leg, loin, belly and neck[2].

Salmonella testing is performed using reference method NF EN ISO 6579 "Microbiology of foods – Horizontal method for the detection of *Salmonella* spp.", or any equivalent alternative method certified by AFNOR Validation.

Centralisation of results

In 2015, the official control authorities entered, in a Sphinx form created by the DGAL, the results of the regulatory own-check undertaken by each slaughterhouse, specifying the following information : corresponding period, number of samples taken, number of positive results.

These data were centralised and analysed by the DGAL to estimate the average contamination rate for pig carcasses in France and in each slaughterhouse.

It is important to clearly distinguish between this supervision activity and the verification of process control by operators *via* the regulatory process hygiene criterion 2.1.4 of Regulation (EC) No 2073/2005:

- for this supervision undertaken by the competent authority, a positive result corresponds to the presence of *Salmonella* in a carcass; there is no interpretation of compliance for these results,
- for the implementation of the regulatory criterion, own-check results are routinely interpreted by the operator for 10 consecutive sampling times and corrective measures must be taken immediately in the event of non-compliance (more than three contaminated carcasses out of 50 tested for the time period in question).

2. Standard NF EN ISO 17604 recommends thirteen sampling sites.

Results and discussion

Characteristics of pig slaughterhouses

In 2015, 167 pig slaughterhouses were identified in France.

However, own-check results are available for only 160 slaughterhouses; data are missing or incomplete for seven slaughterhouses (three in Brittany, two in Corsica, one in Languedoc-Roussillon-Midi-Pyrénées and one in Auvergne-Rhône-Alpes). These 160 slaughterhouses are spread out across 74 *départements* in mainland France and four overseas *départements* and regions.

Of the 160 slaughterhouses for which results are available, 27 (16.9%) slaughter pigs only and 133 (83.1%) slaughter several animal species including pigs (Table 1).

Pig slaughter volumes range from two to 208,579 tonnes per year depending on the slaughterhouse, with an average volume of 12,362 tonnes per year. The largest slaughter volumes are observed in plants slaughtering pigs only.

Overall own-check results

In France, in 2015, 16,223 samples were collected by pig slaughterhouses as part of their regulatory own-check. In total, 1108 samples showed a positive result, corresponding to an average contamination rate of 6.8% (min. = 0.0%, max. = 28.1%, median = 1.4%).

The annual number of samples taken in the framework of regulatory own-check varies depending on the slaughterhouse. The number of own-check undertaken in the context of the regulations is related to the slaughter volume for most slaughterhouses. In fact, the smaller the volume, the more the number of samples can be reduced, since the number of samples taken can be modulated based on the number of actual slaughter days (for slaughterhouses not operating every day of the week) or in proportion to the tonnage for plants slaughtering several species on the same chain (see above).

For certain slaughterhouses however, it appears that the number of analyses performed was lower than expected; this may have been due to reduced sampling frequencies authorised in some specific cases (see above) or, in other cases, to the misinterpretation of or non-compliance with the regulatory provisions.

Table 3. Characteristics of slaughterhouses that collected between 1 and 50 samples in 2015

	Number of slaughterhouses in France	Annual pig slaughter volume in 2015 (in tonnes)	Main species slaughtered in 2015 (by volume)	Number of slaughter chains	Classification level/ compliance with EU regulations
Multi-species slaughter-houses (including pigs)	53 (96.4%)	25,231 (58.8%)	Cattle: 71.7% Pigs: 24.5% Sheep: 1.9% Equines: 1.9%	1 chain: 34.0% 2 chains: 26.4% 3 chains: 37.7% 4 chains: 1.9%	Level I: 5.7% Level II: 81.1% Level III: 13.2%
Pig slaughterhouses	2 (3.6%)	17,706 (41.2%)		1 chain: 100%	Level II: 100%
Total	**55**	**42,937**		**1 chain: 36.4% 2 chains: 25.4% 3 chains: 36.4% 4 chains: 1.8%**	**Level I: 5.5% Level II: 81.8% Level III: 12.7%**

Table 4. Characteristics of slaughterhouses that collected between 50 and 240 samples in 2015

	Number of slaughterhouses in France	Annual pig slaughter volume in 2015 (in tonnes)	Main species slaughtered in 2015 (by volume)	Number of slaughter chains	Classification level/ compliance with EU regulations
Multi-species slaughterhouses (including pigs)	65 (90.3%)	132,059 (42.3v%)	Cattle: 63.1% Pigs: 36.9%	1 chain: 20.0% 2 chains: 20.0% 3 chains: 58.5% 4 chains: 1.5%	Level I: 4.6% Level II: 86.2% Level III: 9.2%
Pig slaughterhouses	7 (9.7%)	180,380 (57.7%)		1 chain: 100%	Level II: 85.7% Level III: 14.3%
Total	**72**	**312,439**		**1 chain: 27.8% 2 chains: 18.0% 3 chains: 52.8% 4 chains: 1.4%**	**Level I: 4.2% Level II: 86.1% Level III: 9.7%**

Table 5. Characteristics of slaughterhouses that collected more than 240 samples in 2015

	Number of slaughterhouses in France	Annual pig slaughter volume in 2015 (in tonnes)	Main species slaughtered in 2015 (by volume)	Number of slaughter chains	Classification level/ compliance with EU regulations
Multi-species slaughterhouses (including pigs)	11 (37.9%)	403,233 (25.0%)	- Cattle: 18.2% - Pigs: 81.8%	1 chain: 18.2% 2 chains: 45.4% 3 chains: 36.4%	Level I: 18.2% Level II: 81.8%
Pig slaughterhouses	18 (62.1%)	1,206,592 (75.0%)		1 chain: 100%	Level I: 11.1% Level II: 88.9%
Total	**29**	**1,609,825**		**1 chain: 69.0% 2 chains: 17.2% 3 chains: 13.8%**	**Level I: 13.8% Level II: 86.2%**

Four slaughterhouses did not undertake any own-check. These were slaughterhouses for which the pig slaughter volume was extremely low and/or minor.

For the 156 slaughterhouses that conducted analyses in 2015, results are given for three categories of slaughterhouses established based on the number of samples collected (Table 2).

For the overall processing of data, the results for the 156 slaughterhouses that conducted analyses in 2015 (categories 1 to 3) are described below.

Category 1: slaughterhouses that collected between one and 50 samples

For the 55 slaughterhouses that collected between one and 50 samples in 2015, the average contamination rate was 1.8% (min. = 0.0%, max. = 21.4%, median = 0.0%). These were almost exclusively plants slaughtering several animal species (mainly cattle) (Table 3).

Category 2: slaughterhouses that collected between 50 and 240 samples

For the 72 slaughterhouses that collected between 50 and 240 samples in 2015, the average contamination rate was 4.3% (min. = 0.0%, max. = 28.1% and median = 1.6%). These were almost exclusively plants slaughtering several animal species (mainly cattle) and having several slaughter chains (Table 4).

Category 3: slaughterhouses that collected more than 240 samples

For the 29 slaughterhouses that collected more than 240 samples, the average contamination rate was 9.5% (min. = 0.0%, max. = 21.5% and median = 6.8%). These were mainly plants slaughtering pigs only or multi-species plants mainly slaughtering pigs. No slaughterhouses in this category had a Level III classification (Table 5).

Considering all of the results, the average *Salmonella* contamination rate in pig carcasses increased with the number of samples taken in the framework of regulatory own-check (Table 6).

Nonetheless, these results varied considerably between slaughterhouses (Figure 1).

Moreover, contamination rates did not seem related to the classification levels of slaughterhouses (Table 7).

Conclusions and outlook

The implementation of this new system provides an estimate of the

Table 6. Average *Salmonella* contamination rate in pig carcasses by number of samples taken in the framework of regulatory own-check in 2015

Number of samples collected in 2015 per slaughterhouse	Average *Salmonella* contamination rate
Between 1 and 50 (category 1)	1.8% (min. = 0.0%, max. = 21.4%, median = 0.0%)
Between 50 and 240 (category 2)	4.3% (min. = 0.0v%, max. = 28.1%, median = 1.6v%)
More than 240 (category 3)	9.5% (min. = 0.0%, max. = 21.5%, median = 6.8%)

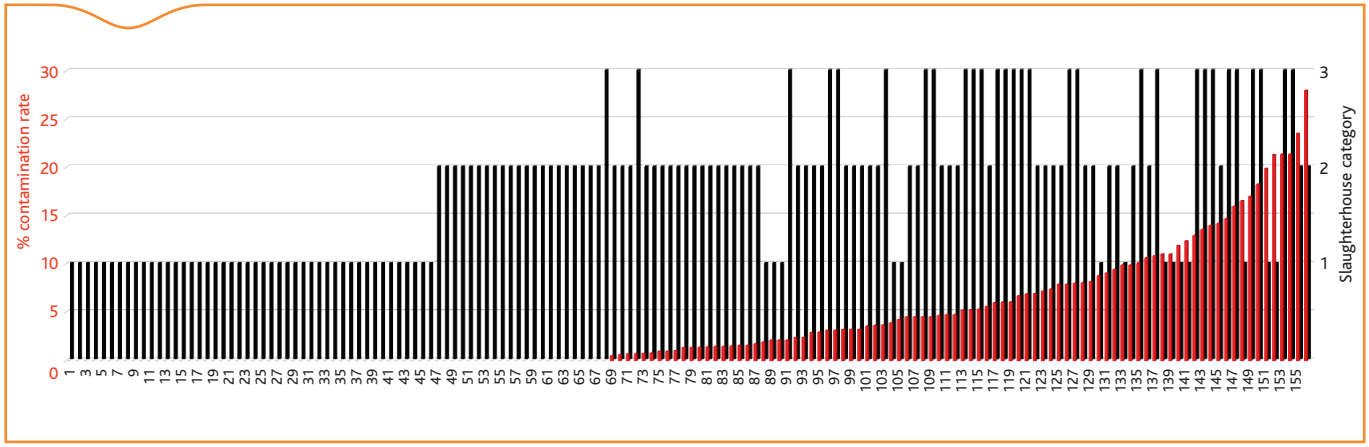

Figure 1. Breakdown of slaughterhouses that conducted analyses in 2015 by category and contamination rate

average level of contamination in pig carcasses from slaughterhouses and supplements national operator awareness-raising campaigns.

The observed results show significant variability in contamination rates between slaughterhouses. This variability may be related to various factors such as the slaughter volume, the characteristics of the slaughtered species, process control, the choice of carcass sampling sites, etc. The impact of these factors on hygiene control could be examined through specific studies. These studies could also include other factors likely to modify contamination rates observed in pig slaughterhouses: animal procurement radius, animal waiting time at the slaughterhouse before slaughter, cleaning/disinfection procedure, process used (singeing/double singeing), slaughter rate, etc. In addition, the individual results of each slaughterhouse should be processed by decentralised services in the context of official controls, especially in the event of deviation from the regulations.

In parallel, since December 2015, the French Pork and Pig Institute (IFIP), with funding from the French Pig and Pork Producers' Association (INAPORC), has developed a Web interface to collect own-check results from pig slaughterhouses, summarise them and interpret them for operators and the industry. So as to not maintain two parallel and redundant collection systems at national level, the DGAL would like to use the data from this database in the coming years. This transition will be gradual, with a stage for comparing the equivalence of the two systems (national coverage, collected results) in 2016.

At European level, vigilance should be maintained as to the interpretation by EFSA of all of the Member States' results, especially since the Commission let the Member States choose between three options for this supervision (organisation of official controls, use of validated control programme results, collection of own-check). The multi-partner group made up of members of the DGAL, the IFIP, French meat companies (Culture-viande), the French Federation of Slaughterhouse Operators (FNEAP), the French Federation of the Wholesale Meat Industry (FNICGV) and the INAPORC association, set up to monitor the French system, will be mobilised as needed to ensure good communication around these data.

References

EFSA & ECDC (European Food Safety Authority and European Centre for Disease Prevention and Control), 2014, The European Union Abstract Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2014. EFSA Journal 2015 ;13(12):4329,191 pp. doi:10.2903/j.efsa.2015.4329.

InVS (Institut de veille sanitaire), 2014, Données relatives aux toxi-infections alimentaires collectives déclarées en France en 2014 (http://invs.santepubliquefrance.fr/Dossiers-thematiques/Maladies-infectieuses/Risques-infectieux-d-origine-alimentaire/Toxi-infections-alimentaires-collectives/Donnees-epidemiologiques).

Table 7. Average *Salmonella* contamination rate in pig carcasses by slaughterhouse classification level

Classification level	Number of slaughterhouses that conducted analyses in 2015	Number of analyses conducted in 2015	Average *Salmonella* contamination rate
I	10 (6.4%)	1,325 (8.2%)	6.7% (min. = 0.0%, max. = 13.0% and median = 1.9%)
II	132 (84.6%)	13,951 (86.0v%)	7.1% (min. = 0.0%, max. = 28.1%, median = 1.4%)
III	14 (9.0%)	947 (5.8%)	3.0% (min. = 0.0%, max. = 8.3%, median = 0.7%)

Box.

Objectives
The objective of this surveillance is to collect and centralise the results of *Salmonella* self-inspections undertaken in pig carcasses at the slaughterhouse, in accordance with Regulation (EC) No 2073/2005. This system was implemented for the first time in France in 2015.

Programming framework
Directive 2003/99/EC on the monitoring of zoonoses and zoonotic agents.

Regulation (EU) No 218/2014 amending Regulation (EC) No 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption.

Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs.

Protocol
- **Nature of the tested contaminants:** *Salmonella*.
- **Affected products ("population"):** carcasses of pigs slaughtered in France.
- **Stage of the food chain:** slaughterhouse.
- **Definition of a "case":** sample contaminated by *Salmonella* spp.
- **Number of samples and sampling method:** the protocol enables the collection of all the results of the *Salmonella* self-inspections identified in the health control plans of operators, in accordance with Regulation (EC) No 2073/2005.
- **Sampling strategy:** random inspection of carcasses at regulatory frequencies for all pig slaughterhouses.
- **Analytical method, nature of sampling:** samples are collected at the end of the chain before the chilling of carcasses, with a sponge rubbed onto an area of at least 400cm^2. *Salmonella* testing is performed for each sample with the ISO/CEN 6579 method or any equivalent alternative method certified by AFNOR Validation.