An investigation into the efficacy of washing trucks following the transportation of pigs - a *Salmonella* perspective

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Abstract

A National *Salmonella* Control Programme is in place in the Republic of Ireland, which requires the categorisation of all pigs according to their *Salmonella* status. Herds in Categories 1, 2 and 3 have a serological prevalence of infection with *Salmonella* serotypes of ≤10%, >10-≤50% and >50-≤100%, respectively. Transport of animals constitutes a stress which may induce shedding of salmonellae by carrier pigs. Although washing of trucks before leaving the abattoir is mandatory in the Republic of Ireland, little is known about the efficacy of the cleaning methods in use on trucks following the transportation of live pigs.

The main objective of this study was to determine the efficacy of washing trucks transporting live pigs from Category 1 and Category 3 herds. In total, six Category 3 and three Category 1 herds supplying three separate abattoirs were investigated. *Salmonella* organisms in samples collected from farm pens and from trucks preload, postload and after washing were quantified and compared using serotyping and phage typing. *Enterobacteriaceae* counts were also evaluated to indicate the level of contamination of the pigs' environment with enteric bacteria.

Preliminary results suggest that washing of trucks is not effective at reducing levels of *Enterobacteriaceae* regardless of category. Of the 108 samples taken from trucks transporting Category 3 herds, 6% were positive for *Salmonella* preload, 17% postload and 18% after washing. In contrast, of the 54 samples taken from trucks transporting the three Category 1 herds, 11% were positive for Salmonella preload, 11% postload and 6% after washing. These results demonstrate the need for better cleaning of trucks after each load, particularly when transporting pigs from high-risk herds.

Introduction

A National Salmonella Control Programme for pork is in place in the Republic of Ireland, which requires the categorisation of all pig herds according to their *Salmonella* status. Herds in Categories 1, 2 and 3 have a serological prevalence of infection with *Salmonella* serotypes of ≤10%, >10-≤50% and >50-≤100%, respectively.

Pigs are subjected to many stress factors during transportation and these stresses may induce *Salmonella*-carrier pigs to shed the bacterium at a higher rate and increase the susceptibility of *Salmonella*-free pigs to infection. *Salmonella*-contaminated trucks may infect farms, abattoirs and animals if the trucks are not cleaned and the bedding material is not removed and replaced between trips. Previous research has shown that pigs can acquire this pathogen as soon as 2 hours after exposure to such a contaminated environment (Hurd *et al.*, 2001) and Rajkowski *et al.* (1998) confirmed the contamination of truck floors and bedding material with *Salmonella* spp. after the transportation of pigs.

This study formed part of a major project examining *Salmonella* levels in pigs and pork on the island of Ireland. The main objectives of the study were 1) to investigate the role of transport and the efficacy of truck washing as potential factors in the dissemination of *Salmonella* spp. and 2) to compare *Salmonella* isolates identified from the farm and truck environment.

Materials and methods

Herd and animal selection.

Farms that participated in the study were selected on the basis of their *Salmonella* categorisation. A total of three Category 1 and six Category 3 production units were selected, from

each of which sixteen to twenty finishing pigs were followed from the farm, through transport, to the lairage. Herd sizes averaged 400 sows and on all farms, finishing pigs were reared under similar husbandry and feed conditions.

Sample collection.

One week before the scheduled depopulation environmental swabs of the dunging area in the relevant pens were taken by vigorous swabbing of 1.0 m^2 surface area using a large gauze surgical swab (Robinson Healthcare, Chesterfield, UK: No.5345), which had been autoclaved and premoistened with 10 ml of buffered peptone water (BPW, Lab M). On the Category 3 units sixteen to twenty pigs from the pen with the greatest number of positive samples were randomly selected and followed to the abattoir the following week. In contrast to this, pigs from Category 1 units were selected from a pen that tested negative for *Salmonella* spp.

Swabs from the trucks were collected at three stages: on the farm before the pigs were loaded (preload), at the processing plant immediately after the transported pigs had been moved into the lairage (postload) and after the trucks had been cleaned at the processing plant (post-washing). At each of these three stages six environmental samples were taken using a large gauze surgical swab, with each swab covering a surface area of 0.5-1m^2, thus ensuring the entire surface of the compartment transporting the relevant pigs was sampled. All trucks were immediately cleaned following unloading and a cold power-wash was used on site in all incidences. In order to prevent external contamination of samples, aseptic measures were taken at all times.

Microbiological analysis.

Each swab was suspended in 90 ml of BPW. All samples were shaken vigorously in a stomacher before analysis.

Salmonella isolation and enumeration procedures were performed on the basis of BS EN 12824; 1998 as described previously (Boughton *et al.*, 2004) with a slight modification of the volumes used in the enumeration method. All *Salmonella* Typhimurium strains were phage typed by the Health Protection Agency (Centre for Infections, Colindale, London, U.K.).

Enterobacteriaceae counts were obtained by preparing violet red bile glucose agar (VRBGA; Oxoid) pour plates using 1 ml of the BPW containing the swabs or derived 1:10 dilutions in BPW. Plates were over-poured with VRBGA to create a semi-anaerobic environment, incubated at 37°C for 24 h and examined. The *Enterobacteriaceae* enumeration method had a minimum detection limit of -2.0 $\log_{10}$ CFU cm^{-2}.

Statistical analysis

Salmonella prevalence was reported as the number of samples that tested positive. Differences in prevalence at each sampling stage were compared by Fischer's exact test. Due to the wide range and skewed nature of the data, the effect of washing the trucks and the transportation of pigs on *Enterobacteriaceae* and *Salmonella* levels was investigated by calculating the median count, preload, postload and after washing on each truck followed by analyses using the Wilcoxon signed rank test. All statistically significant differences are reported at the $P < 0.05$ level.

Results

Table 1 shows the recovery of *Salmonella* spp. on farms and on trucks, preload, postload and after washing. There was a significant increase in the number of samples positive for *Salmonella* spp. on the trucks transporting Category 3 pigs, from 19% (7/36) preload to 50% (18/36) postload ($p<0.05$). Following washing of the trucks there was no significant change with the number of samples positive for *Salmonella* spp. increasing to 53% (19/36). On the trucks transporting the Category 1 farms, the *Salmonella* isolation rates preload, postload and after washing were 33% (6/18), 33% (6/18) and 17%, (3/18) respectively and did not differ significantly ($p<0.05$).

Although the trucks transporting the Category 1 farms had a significantly higher isolation rate of *Salmonella* than those transporting the Category 3 farms preload ($p<0.05$), this could be attributed to a single Category 1 unit. There was no significant difference between the categories postload, however, the number of samples positive for *Salmonella* spp. after washing was significantly higher on the trucks transporting the Category 3 herds ($p<0.05$). Numbers of *Salmonella* organisms did not differ significantly between categories preload, postload or after washing. Overall levels of contamination with *Enterobacteriaceae* did not differ significantly preload

and postload ($p>0.05$). Similarly the results postload and after washing did not differ significantly ($p>0.05$).

Table 1. The recovery of *Salmonella* spp. from trucks before (preload) and after (postload) transporting pigs to slaughter and after washing (post-washing)

Farm[a]	Journey (hr)	Location[b]	Positive Samples / Samples Tested (n)	Min - Max Count[c]	Serovars and Phage Types (n)
A	3	F_2	3/3	>110	Typhimurium DT104 (3)
		Preload	6/6	0.94 - >110	**Typhimurium PTU288 (5)**, Derby (1)
		Postload	6/6	1.1 - >110	Typhimurium DT104 (6)
		Post-washing	6/6	9.3 - >110	Typhimurium DT104 (6)
B	2.5	F2	6/6	0.92 - >110	Derby (6)
		Preload	0/6	-	-
		Postload	6/6	0.3 - 2.3	Derby (1), **Goldcoast (5)**
		Post-washing	5/6	0.36 - 46	Derby (5)
C	2	F2	1/3	<0.3	Typhimurium DT104b (1)
		Preload	0/6	-	-
		Postload	1/6	<0.3	Typhimurium DT104b (1)
		Post-washing	0/6	-	-
[d]D	3.5	F2	0/3	-	-
		Preload	0/6	-	-
		Postload	2/6	0.3 - 0.92	Typhimurium DT193 (2)
		Post-washing	6/6	<0.3 - >110	Typhimurium DT193 (6)
E	3.5	F2	1/6	<0.3	Typhimurium DT104b (1)
		Preload	0/6	-	-
		Postload	3/6	3.8 - 16	Typhimurium DT104b (3)
		Post-washing	2/6	21 - >110	Typhimurium DT104b (2)
F	1	F2	1/3	0.92	Typhimurium PTU302 (1)
		Preload	1/6	2	Typhimurium PTU302 (1)
		Postload	0/6	-	-
		Post-washing	0/6	-	-
G	4.5	F2	0/6	-	-
		Preload	0/6	-	-
		Postload	0/6	-	-
		Post-washing	0/6	-	-
H	0.5	F2	0/6	-	-
		Preload	6/6	<0.3 - >110	Kimuenza (6)
		Postload	6/6	<0.3 - 21	Kimuenza (6)
		Post-washing	3/6	<0.3 - 0.74	Kimuenza (3)
I	2.5	F2	0/7	-	-
		Preload	0/6	-	-
		Postload	0/6	-	-
		Post-washing	0/6	-	-

[a]Category 3 (A-F) and Category 1 (G-I) farms.
[b]F_2, farm samples day of transport; Preload, truck before pigs; Postload, truck after pigs; Post-washing, truck after washing. Bold type indicates most frequently isolated serovars for each set of samples.
[c]cfu/1000cm^2; detection limit, 0.3cfu/1000cm^2.
[d]1 of 4 samples collected a week before transport was positive

Discussion

Although preliminary, the results of this study indicate that there are particular problems with the washing of trucks following the transport of pigs especially from high-risk herds in the Republic of Ireland. Both the results for *Salmonella* serotypes and for levels of *Enterobacteriaceae* suggest that washing of trucks as carried out in Irish abattoirs is ineffective in reducing contamination with these organisms. These findings support those of previous research, which has shown that 80% of trucks transporting pigs were contaminated with *Salmonella* spp. before transportation, despite drivers being asked to clean and disinfect their trucks thoroughly before loading the pigs (Swanenburg *et al.*, 2001). Dorr *et al.* (2005) showed a reduction in contamination levels from pre to post wash, however, trucks still remained a potential source of *Salmonella* spp. Despite this, correct cleaning procedures after animal unloading have been shown to significantly reduce the incidence of *Salmonella* spp. and *E. coli* found in trucks (Rajkowski *et al.*, 1998).

It is believed that the stress of transport alters the excretion pattern of *Salmonella* spp. Williams *et al.* (1970) found that a greater percentage of pigs were shedding *Salmonella* spp. after a 'joyride' of over 3 hours than those transported for only 20 minutes. In addition to this Isaacson *et al.* (1999) showed that the stress of transport increased the proportion of carrier pigs positive for *Salmonella* spp. only when feed was not withheld. In the study reported here transport lasted on average 2.6 hours and we know this to be sufficient for pigs to acquire infection (Hurd *et al.*, 2001)

In summary, this study showed that transport increases the *Salmonella* isolation rate regardless of category and that better cleaning of trucks is necessary especially when transporting pigs from high-risk herds so as to reduce the potential for contamination during the slaughter process.

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References

BOUGHTON, C., LEONARD, F.C., EGAN, J., KELLY, G., O'MAHONY, P., MARKEY, B.K., GRIFFIN, M., 2004. Prevalence and number of Salmonella in Irish retail pork sausages. *Journal of Food Protection* 67, 1834-9.

DORR, P. M., LOWMAN, H. and GEBREYES, W., 2005. The role of truck wash practices in dissemination of *Salmonella* and Campylobacter in commercial swine production. In: Proceedings of the 6th International Symposium on the Epidemiology and Control of Salmonella in Pork, California 161-163.

HURD, H. S., GAILEY, J. K., McKEAN, J. D. and ROSTAGNO, M. H., 2001. Rapid infection in market-weight swine following exposure to a *Salmonella* Typhimurium-contaminated environment. *American Journal of Veterinary Research* 62, 1194-1197.

ISAACSON, R. E., FIRKINS, L. D., WEIGEL, R. M., ZUCKERMANN, F. A. and DIPIETRO, J. A., 1999. Effect of transportation and feed withdrawal on shedding of *Salmonella* Typhimurium among experimentally infected pigs. *American Journal of Veterinary Research* 60, 1155-1158.

RAJKOWSKI, K. T., EBLEN, S. and LAUBACH, C., 1998. Efficacy of washing and sanitizing trailers used for swine transport in reduction of *Salmonella* and *Escherichia coli*. *Journal of Food Protection* 61, 31-35.

SWANENBURG, M., VAN DER WOLF, P. J., URLINGS, H. A. P., SNIJDERS, J. M. A. and VAN KNAPEN, F., 2001. *Salmonella* in slaughter pigs: the effect of logistic slaughter procedures of pigs on the prevalence of *Salmonella* in pork. *International Journal of Food Microbiology* 70, 231-242.

WILLIAMS, L. P. and NEWELL, K. W., 1970. Salmonella excretion in joy-riding pigs. *American Journal of Public Health* 60, 926-929.