THE EFFICACY OF CLEANING AND DISINFECTION ON PIG FARMS

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Abstract Little is known about the effectiveness of the cleaning and disinfection methods in use on commercial pig farms either in Ireland or worldwide. A National Salmonella Control Programme was implemented in Ireland in August 2002 to monitor and control infection with Salmonella spp. in pigs. In Ireland, all commercial pig herds must be categorised according to their Salmonella status. Herds in category 1, 2 and 3 have a serological Salmonella prevalence of infection of ≤10%, >10–50% and >50–100%, respectively.

The aim of this study was to assess the efficacy of washing and disinfecting finisher units on category 1 and category 3 farms, in reducing or eliminating levels of Enterobacteriaceae. Enterobacteriaceae counts were used as indicators of the contamination of the environment with enteric bacteria, which could include Salmonella spp. Samples were taken from the pen floors and feeder/drinker units of four category 1, two high category 2 and 1 category 3 farms. Enterobacteriaceae and salmonellae were enumerated in each sample. Limited results available on enumeration suggest that there was a decrease in levels of Enterobacteriaceae on pen floors after cleaning and disinfection, regardless of category. However, significant residual contamination remained on the surfaces of the feeder/drinker units following cleaning and disinfection on all farms.

Introduction A national programme to reduce Salmonella contamination in pork and pork products should include monitoring and intervention from the farm to the factory. In Ireland, the national Salmonella control programme is based on the categorisation of all commercial pig herds according to their Salmonella status. Finishing pigs in herds in category 1, 2 and 3 have a serological Salmonella prevalence of ≤10%, >10–50% and >50–100%, respectively.

The prevalence of Salmonella within a herd from farm to slaughter is governed by many factors, one of the most important being an effective hygiene programme. Cleaning and disinfection have an important part to play in the control of this disease. It has been found that uninfected pigs, which remained in disinfected pens, usually stayed free of Salmonella (Linton et al. 1970). However, achieving a sufficient reduction in Salmonella levels by hygienic and management procedures alone can be quite difficult. In a study aimed at reducing Salmonella at farm level, Dahl et al. (1997) found that problem herds that improved hygiene combined with all in-all out measures did not achieve the same success as those that used organic acids in the water or feed.

The objectives of this study were 1) to determine and compare the efficacy of cleaning and disinfection procedures in finisher units from ten category 1 and ten high category 2/category 3 farms, using Enterobacteriaceae counts as a marker for residual enteric bacteria, and 2) to determine the prevalence of Salmonella spp. both before and after cleaning.

Materials and Methods Farms and sample collection To date five category 1, two high category 2 and one category 3 farm have been identified and sampled. Visits commenced on obtaining agreement for intensive sampling from farmers. Between 40 and 60 samples were taken both before and after the finisher units were cleaned and disinfected according to the farmer’s usual programme. On average a total of twelve pens were sampled per farm with six floor, one feeder and one water sample being collected per pen. Sterile templates of 100cm² were placed randomly on the pen floor and samples were collected by swabbing the area within with a sterile pre-moistened carcass sponge. An approximately similar area was swabbed within the feeders, although it was not possible to use sterile templates due to their rigid design. Drinkers were sampled by collecting approximately 100ml of water in a sterile sample jar. All samples were stored in a chilled contain-
er during transport and kept at 4°C prior to examination within twenty-four hours of collection. **Microbiological Analysis** On arrival at the laboratory each sponge was suspended in 100ml of maximum recovery diluent (0.1% peptone, 0.85% NaCl: MRD; Oxoid, Basingstoke, Hampshire, England). All swab samples were shaken vigorously before analysis.

**Enterobacteriaceae** counts were obtained by preparing violet red bile glucose agar (VRBGA; Oxoid) pour plates using 1ml of swab suspensions, or derived 1:10 dilutions in MRD. 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 1 CFU cm² (McEvoy et al. 2004).

**Salmonella** isolation procedures were performed on 25ml of each water sample and on 20ml of each swab suspension according to BS EN 12824; 1998. Briefly, water samples were pre-enriched in 225ml BPW and incubated for 18-24 h at 37°C. Samples of the swab suspension were also incubated for 18-24 h at 37°C. All samples were then selectively enriched in Rappaport-Vassiliadis broth 41.5°C for 24 h. Samples were plated onto mannitol lysine crystal violet brilliant green agar (MLCB; Lab M, Bury, Lancashire, England) and brilliant green agar (BG; Lab M, Bury, Lancashire, England) after both 24 h and 48 h of selective enrichment. Up to five suspect colonies per plate were identified by subculture onto MacConkey agar and inoculation of triple sugar iron agar slopes followed by serotyping.

**MPN (Most Probable Number) Analysis** An estimation of the number of **Salmonella** spp. in all **Salmonella**-positive samples was determined using a modified 3-tube MPN method (Dufrenne et al. 2001). Isolation of **Salmonella** serotypes from 3x10ml, 3x1ml and 3x0.1ml aliquots of homogenized sample in BPW or MRD was performed as described above. After confirmation, the number of **Salmonella** present in each sample was calculated using the MPN table of de Man (De Man 1983).

**Preliminary Data Analysis** **Salmonella** prevalence was reported as the number of samples that tested positive. **Enterobacteriaceae** counts were transformed to log10 cfu/cm². Because of the wide range and skewed nature of the data, median values were calculated. Statistical analysis of the results is awaiting collection of further data.

**Results** Table 1 shows the results of the samples taken before and after the cleaning procedure from the pen floors in all eight farms. In most cases there was a moderate reduction in **Enterobacteriaceae** levels after cleaning and disinfection procedures. Farm F, which washed only, achieved little/no reduction in **Enterobacteriaceae** levels following washing only. High category 2/category 3 farms possibly achieved a greater reduction in levels of **Enterobacteriaceae** following cleaning.

In most cases there was little **Salmonella** detected before and after cleaning and levels ranged from 0.36-1.1 MPN/cm². However, farm D had a **Salmonella** prevalence of 62% prior to cleaning which dropped to 0.02% following the washing procedure. These results were surprising as although a recent change had occurred in feeding practices it was a category 1 herd at the time of sampling.

Following washing the results for the feeder/drinker units did not improve (Table 2) and residual contamination appeared to be a major problem. A common trend throughout all farms, regardless of category, was a significant increase in **Enterobacteriaceae** levels following washing and disinfection.

**Salmonella** results were highly variable with category 3 farms having higher ranges in washed feeder/drinkers than category 1 farms.

It was not possible to compare the effectiveness of the different disinfectants used by the farms as none of the disinfection programmes were applied in a standardised way.

**Discussion** Although preliminary, and with little published data to compare with, the results of this study of cleaning and disinfection on commercial pig farms indicate that there are particular problems with the cleaning of the feeder/dinker units. This may be due to operator negligence or difficulties accessing all crevices in the feeder units. Whatever the reason, large volumes of contaminated faecal matter are remaining in these units following cleaning of the pen. In contrast, previous studies of disinfection on commercial poultry laying units (Davies et al, 2003) found that
equipment was less contaminated than the main house structures even though there was a smaller reduction after cleaning and disinfection.

Healthy pigs can carry _Salmonella_ serotypes in their intestine and may shed this pathogen when stressed. Pigs are subjected to many stress factors during production, which in turn may induce these carriers to shed the bacterium at a higher rate and increase the likelihood of _Salmonella_-free pigs to acquiring infection. Fedorka-Cray _et al._ (1994) showed that pigs that were _Salmonella_-free prior to exposure were likely to acquire infection once exposed to a contaminated environment. Thus, thorough cleaning and disinfection of pens between batches of pigs is an important tool in _Salmonella_ reduction at herd level and if neglected, residual infection may initiate infection in clean stock (Thomas, 1982).

Van der Wolf _et al._ (2001) reported that a lower _Salmonella_ seroprevalence was associated with herds that never disinfected a compartment after pressure washing as part of an all-in/all-out procedure than herds that sometimes or always used disinfectants. It was suggested that farmers that use disinfectants clean less adequately in the hope that any remaining microbes will be dealt with by the disinfectant. In contrast, the preliminary results from this current study have shown a lower _Salmonella_ and _Enterobacteriaceae_ prevalence in herds that always washed and disinfected than herds that washed only. It has always been accepted that hygiene is important for optimal production results and reduction of infection in the pig industry.

Fedorka-Cray _et al._ (1997) showed that pigs weaned at 14-21 days and removed to clean accommodation remained free of _Salmonella_. In a study by Funk _et al._ (2001) a sizeable reduction in _Salmonella_-shedding in sows was detected shortly after relocation to the farrowing unit. It was suggested that due to more frequent and thorough cleaning of the farrowing rooms there was decreased environmental contamination. Similarly, Rajkowski _et al._ (1998) showed a considerable reduction in _Salmonella_ levels in trucks following washing and disinfecting. 41.5% of pens yielded confirmed _Salmonella_ isolates before washing and this dropped to 2.7% after washing and disinfecting.

In summary, although this work is still in progress, we have shown so far that washing and disinfecting pen floors is apparently effective in greatly reducing levels of _Enterobacteriaceae_. However, contamination of the feeder/drinker units following cleaning is a far greater problem and one that needs to be better addressed. Further work and intervention in this area could be expected to reduce the potential for spreading of infection and cross-contamination of other animals. This in turn should help to reduce the number of positive carcasses entering the abattoirs.

**Acknowledgements** This work is supported by the Irish Government under the National Development Plan 2000-2006. C. Mannion is being supported by a Stimulus Research Grant awarded by the Department of Agriculture and Food.

<table>
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<th>Pen Floors</th>
<th>Enterobacteriaceae&lt;sup&gt;a&lt;/sup&gt;</th>
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<th>Salmonella&lt;sup&gt;a&lt;/sup&gt;</th>
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<tr>
<td></td>
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<td>Range</td>
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<tr>
<td>3</td>
<td>A</td>
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</table>
| High 2    | B    | 64 | 3.5-6.1 | 4.6 | 0-1.6 | 0 | _<sup>c</sup> | _ | _<sup>c</sup> | _ | _
| High 2    | C    | 72 | 0-5.1 | 1.2 | 0-1.6 | 0 | 1 | 1.1 | _<sup>c</sup> | _ | _
| 1         | D    | 84 | 2.6-6.1 | 4.6 | 0-3.6 | 0.8 | 26 | 36->106 | 1 | 7.2 |
| 1         | E    | 84 | 0-3.6 | 1.6 | 0-3.2 | 0 | _<sup>c</sup> | _ | _<sup>c</sup> | _ | _
| 1         | F    | 60 | 1.2-5.1 | 3.3 | 0.7-4.2 | 2.9 | _<sup>c</sup> | _ | _<sup>c</sup> | _ | _
| 1         | G    | 72 | 0-6.0 | 2.0 | 0-3.6 | 0 | _<sup>c</sup> | _ | 1 | 0.36 |
| 1         | H    | 48 | 0.8-4.2 | 3.7 | 0.7-4.1 | 2 | _<sup>c</sup> | _ | _<sup>c</sup> | _ | _

Table 1. Effect of cleaning procedure on levels of _Salmonella_ and _Enterobacteriaceae_ on the pen floors. <sup>a</sup>Log<sub>10</sub> cfu/cm<sup>2</sup>. <sup>b</sup>MPN/cm<sup>2</sup>; detection limit, 0.36 MPN/cm<sup>2</sup>. <sup>c</sup>Negative for _Salmonella_ (detection limit, <0.36 MPN/cm<sup>2</sup>).
Table 2. Effect of cleaning procedure on levels of *Salmonella* and *Enterobacteriaceae* in feeder/drinker units

<table>
<thead>
<tr>
<th>Category</th>
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<th>Samples Tested (n)</th>
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<th>Salmonella*</th>
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Table 2. Effect of cleaning procedure on levels of *Salmonella* and *Enterobacteriaceae* in feeder/drinker units

*Log10 cfu/cm²*. bMPN/cm²; detection limit, 0.36 MPN/cm². cNegative for *Salmonella* (detection limit, <0.36 MPN/cm²).

References


