References:


Table 1. Distribution of pigs according to bacteriological and serological results at the finishing phase (n=56) and at slaughter (n=26).

<table>
<thead>
<tr>
<th>ELISA Positive</th>
<th>Finishing Isolation Positive</th>
<th>Finishing Isolation Negative</th>
<th>Slaughter Isolation Positive</th>
<th>Slaughter Isolation Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>ELISA Negative</td>
<td>29</td>
<td>11</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Prevalence and number of *Salmonella* in retail pork sausages


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Summary: The aim of this study was to assess the prevalence of Salmonella in Irish pork sausage at retail level. Samples, comprising branded prepacked sausages, loose sausages from supermarket meat counters and butcher shops, were collected from selected retail sites in four cities from October to December 2001 and from June to August 2002. A 3-tube Most Probable Number (MPN) method was used to enumerate Salmonella in a selected number of samples, which were positive by enrichment. Salmonella serotypes were detected in 4.4% and 1.7% of samples at each of the respective sampling periods; a level similar to those reported in other U.S. and U.K. studies. Limited results available on enumeration suggest that contamination rates were low. This study revealed that Salmonella are present in a proportion of Irish sausages and further risk analysis work is necessary in order to quantify...
the risk posed to public health. Keywords: control programme, enumeration, serology, bacteriology, food safety.

Introduction: In Ireland, the crude incidence rate of reported human cases of salmonellosis, over 60% of which were due to Salmonella enterica serotype Typhi murium, rose in the 1990s to peak in 1998. Worldwide, the principal sources of Salmonella infection in humans are poultry, poultry products and eggs. However in Ireland control of Salmonella infection in the poultry industry has been highly effective as evidenced by the decreasing rate of isolation of Salmonella Typhi murium or Salmonella Enteritidis in chickens. Nevertheless, these serotypes represent the predominant serotypes associated with human infection in Ireland (FSAI, 2000). This gives rise to concern that there may be significant sources of Salmonella infection in Ireland other than poultry. A National Salmonella control programme in the pork industry was enacted in Ireland in August 2002. This study was undertaken as part of a larger project investigating the role of pork as a source of human salmonellosis in Ireland. The objectives of this study were 1) to determine the prevalence of Salmonella in pork sausage and 2) to ascertain contamination levels of Salmonella in sausage as part of the assessment of the role of pork as a source of human salmonellosis in Ireland.

Materials and Methods:
Retail Market survey Half-pound (200g) samples of fresh pork sausage were collected at weekly intervals over 8-week periods in 4 cities; Dublin, Cork, Galway and Athlone. Four hundred and fifty five samples were purchased at supermarkets (branded prepacked and loose-type) and butcher shops during the months of October to December 2001, while 466 samples were purchased during the months of June to August 2002. A total of eight supermarkets (different retail chains) and up to forty-eight butcher shops were sampled in each city. Samples were stored in a chilled container during transport and kept at 4∞C prior to examination within twenty-four hours of purchase.

Microbiological analysis Salmonella isolation procedures were performed on 25g of each sausage sample according to BS EN 12824; 1998. Briefly, samples were pre-enriched in 225ml BPW and incubated for 16-24h at 37AC, followed by selective enrichment for 18h-24h in both Rappaport-Vassiliadis broth and selenite-cysteine broth at 41.5∞C and 37∞C respectively. Samples were plated onto mannitol lysine crystal violet brilliant green agar (MLCB) and brilliant green agar (BG) after both 24h and 48h of selective enrichment. Up to 5 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 a selected number of samples was determined using a modified 3-tube MPN method (Dufrenne et al. 2001). These samples had been stored at –20∞C for between 8-20 weeks. Isolation of Salmonella serotypes from 3x50ml, 3x5ml and 3x0.5ml aliquots of homogenised sample in BPW 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).

Statistical Analysis Salmonella prevalence was reported as the percentage of samples that tested positive. Differences in prevalence between product types, cities and time were compared using the chi square option of the frequency procedure of the Statistical Analysis Systems (SAS) and the Fischer’s Exact Test.

Results: A summary of the Salmonella isolation rates is shown in Figure 1. During Part 1 of the survey (Oct-Dec 2001) 20/455 (4.4%) samples were positive for Salmonella. A total of 466 samples were tested in Part 2 of the study (June – Aug 2002) and 7 of these (1.5%) were positive for Salmonella. There was no significant difference in Salmonella prevalence between the four cities, from which samples were collected. However, there was a trend for butcher shop samples to be contaminated more often than the prepacked samples (P <0.07). Significant differences were observed between the two time points in the survey; a higher prevalence of Salmonella was reported in the winter months of the survey (P<0.02).
In total, 27 *Salmonella* isolates were identified. *S. Typhimurium* accounted for 23 of the isolates. *S. Derby* was isolated on two occasions while *S. Livingstone* and *S. Bredeney* were each isolated once. *Salmonella* counts on twelve samples, which were positive for *Salmonella* when first examined, ranged from 1.5 to 37 organisms per 25g of sausage meat examined. In 50% of samples the pathogen was reduced to undetectable levels (< 0.3 MPN per 25g).

**Discussion:** The results of this study indicate that the rate of *Salmonella* contamination in Irish retail pork sausage samples is low (<5%). The detection rate was similar to other studies, which examined pork products, where *Salmonella* contamination was detected at levels ranging from 3.3% to 9.1% (Zhao et al., 2001, Mattick et al., 2002). The difference in prevalence levels could be due in part to the types of samples analysed i.e. comminuted product versus pork chop and also whether samples were fresh or frozen.

Outbreaks and clusters of human salmonellosis in Ireland show a marked seasonality with the highest number of cases occurring during the summer months (June to August). However, in this study the rate of contamination was significantly higher in winter months. No plausible explanation for this result can be offered, however similar findings were reported by Stock & Stolle, (2001) and Zhao et al., (2001).

Eighty five per cent of positive isolates recovered in this study were serotyped as Typhimurium. The predominance of *S. Typhimurium* is consistent with the results of other recent studies, which have examined pork and pork products (Stock et al., 2001). The presence of this serotype in pork is a cause of concern as *S. Typhimurium* is the top cause of human salmonellosis in Ireland.

Quantitative analysis of selected samples revealed that the number of *Salmonella* organisms in contaminated sausages was low (<1.5 to 40 per 25g). In this study pathogen levels were reduced to undetectable levels in 50% of samples. It is possible that initial counts of *Salmonella* in fresh samples were extremely low and therefore less likely to survive freezing. This survey confirms that a percentage of raw pork sausage meat in Ireland is contaminated with *Salmonella* and may lead to foodborne disease due to undercooking and/or cross contamination. The enactment into law of the National *Salmonella* control programme in Ireland (2002) should help to decrease the number of positive carcasses entering the abattoirs and thus reduce the prevalence of *Salmonella* in retail pork products.

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**Figure 1.** Prevalence of *Salmonella* in samples of pork sausage collected in 4 cities on two occasions
Comparison of an excision and a sponge sampling method for measuring salmonella contamination of pig carcasses

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Summary: The aim of this study was to determine if an excision sampling method and a sponge sampling method give comparable results when trying to isolate salmonella from pig carcasses. During ten sampling days in one abattoir in total 312 carcasses were sampled; each carcass was sampled with both sampling methods to get paired observations. The number of salmonella positive excision samples (31 of 312) was significantly higher (P=0.00013) than the number of salmonella positive sponge samples (9 of 312). Sensitivity of the sponge method compared to the excision method was 6.5% and the comparability of both tests was low (kappa value was 0.08). As it seems that salmonella contamination levels of fresh pork are highly underestimated with the actually used sampling methods, the authors recommend that EU-authorities prescribe a destructive salmonella test for monitoring pig carcasses after slaughter in all EU-countries or a swab/sponge method with a comparable sensitivity.