A Research Note

Occurrence of *Salmonella* in Porcine Liver in Northern Ireland

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ABSTRACT

Pork livers from four pork processing plants in Northern Ireland were studied to assess their contamination by salmonellae. Additionally, aerobic plate counts (APC) and counts of *Enterobacteriaceae* were made. One hundred twenty livers were sampled immediately after evisceration and 110 sampled after being chilled overnight in the commercial premises. No salmonellae were detected. Geometric mean values for the APC were 1.6 × 10^4 and 3.1 × 10^5 CFU/g for fresh and chilled livers, respectively. Homologous geometric mean values for *Enterobacteriaceae* were 7.9 × 10^2 and 6.0 × 10^2 CFU/g, respectively.

A survey of the microbial quality of edible offals in the Central Wholesale Meat Market in Berlin (West) by Sinell et al. (8) revealed high levels of contamination by *Salmonella*. Over 60% of porcine offal (251 samples) was positive and fresh pork liver was one of the most heavily contaminated offals; 72% of the 50 samples were positive. Sinell et al. (8) concluded that the level of contamination “represents a considerable health hazard for the consumer.”

The purpose of the present study was to assess the hazard associated with fresh and refrigerated pork liver produced in Northern Ireland and the importance of chilling in the cross-contamination of finished products. Livers were sampled immediately after evisceration to determine the level of contamination before opportunities for cross-contamination arose. Livers were then sampled after chilling overnight in the commercial premises. This allowed cross-contamination to take place and also, because such livers were ready for wholesale sale, the results obtained could be compared with those of Sinell et al. (8).

Opportunities for cross-contamination are dependent on the procedures used in individual factories. Normally the viscera are carried on a hook to an operator where washing removes excess blood and the livers are separated from other organs. The livers are then placed in trucks and removed to the chill room where they are laid out on trays overnight. After chilling, the livers are bagged, usually 6 to 8 livers per bag, for sale to wholesalers. Hence, many opportunities exist for cross-contamination after evisceration.

MATERIALS AND METHODS

Livers were sampled immediately after evisceration (warm) and after chilling overnight (chilled). About 30 g (4 or 5 pieces) was cut from each liver using sterile scissors and the individual samples were placed in sterile plastic jars (Sterilin), on ice, for transport to the laboratory. Analysis took place less than 4 h after sampling. Ten samples were taken at random on each plant visit, constituting one batch, and sampling took place over a period of 4 wk. Each plant was visited on at least two occasions. In the laboratory, samples were finely chopped and each liver was used to provide duplicate samples each of 13.5 g. The composited samples of 135 g were then thoroughly mixed. Ten g was withdrawn to prepare a decimal dilution series in peptone saline (Oxoid CM9) for plating on nutrient agar (Oxoid CM3) and the *Enterobacteriaceae* medium described by Mossel et al. (6). Nutrient agar plates were incubated for 3 d at 22°C and Mossel medium at 37°C for 18 h.

The remaining 125 g of liver was incubated overnight (37°C) with 1125 ml of buffered peptone water (BPW) (Oxoid CM509). Ten ml was then withdrawn, added to 100 ml of Muller-Kauffmann tetraphionate broth (Oxoid CM343) and incubated at 43°C. After 24 and 48 h of incubation, samples were streaked onto brilliant green agar (Oxoid CM329) to determine if *Salmonella* spp. were present.

Trials revealed a problem with *Proteus* spp. on the liver samples, therefore, Oxoid sulphamandelate supplement was added to the brilliant green agar (BGA) to control them.

Because the above methodology was a simplified version of that used by Sinell et al. (8), its sensitivity was assessed using a stock culture of *Salmonella typhimurium* previously isolated in our laboratory. A batch of ten fresh livers was used to prepare 24 flasks for preenrichment as noted above. Six uninoculated 125-g composites (controls) and three sets each consisting...
of six composites were inoculated with 1 ml of a 10⁶ to 10⁸-fold dilution of an overnight (37°C) nutrient broth culture of *S. typhimurium* containing 6.4 × 10⁸ CFU/ml. Enrichments of all flasks were assayed as described above and serological testing was done on suspect colonies to confirm recovery of the original serotype.

**RESULTS**

No *Salmonella* was isolated from livers during the study. Results of the assays performed are shown in Table 1.

| TABLE 1. Aerobic plate counts and Enterobacteriaceae counts of livers. |
|-----------------------|-----------------------|
| **Samples**           | **APC (log₁₀ CFU/g)** | **Enterobacteriaceae (log₁₀ CFU/g)** |
| Warm livers (120)     | 4.21 ± 0.44           | 2.90 ± 0.65                         |
| Chilled livers (110)  | 5.49 ± 0.85           | 2.78 ± 0.55                         |

**DISCUSSION**

The results indicate that contamination of porcine livers by *Salmonella* in Northern Ireland is much lower than that reported by Sinell et al. (8) in West Berlin, with no *Salmonella* found in 230 livers despite the fact that 110 had been exposed to the possibility of cross-contamination. However, the methodology used was a simplified version of the procedures used by Sinell et al. (8) because of the limited resources available for this study. While Sinell et al. (8) used two enrichment media, i.e., Muller-Kaufmann (MK) and dulcitol-selenite-enrichment (DSE), this study used only MK because D’Aoust (3) showed that MK medium is superior to selenite-based media for the recovery of *Salmonella* from high moisture foods. Hence, the use of MK only should not adversely affect recoveries.

Also, the procedure used was based on British Standard 5763: Part 4: 1982 (ISO - 6579 - 1981) (1); however, only one selective liquid medium (MK) and one solid plating medium (BGA) were used to allow a larger number of samples to be processed. Another modification was at the preenrichment stage where 12.5-g samples were tested in duplicate batches of ten, whereas Sinell et al. (8) used MK only because D’Aoust (3) showed that MK medium is superior to selenite-based media for the recovery of *Salmonella* from high moisture foods. Hence, the use of MK only should not adversely affect recoveries.

An overnight culture of *S. typhimurium* containing 6.4 × 10⁸ CFU/ml was used to determine the sensitivity of the isolation procedure. *S. typhimurium* was recovered from all of the 18 enrichment cultures in which the organism was inoculated, indicating a high efficiency of recovery, whereas all six control enrichment cultures gave negative results. It should be noted that the recoveries were obtained in the presence of high numbers of competing organisms (Table 1).

Beckers et al. (2) observed that adding food to *Salmonella* isolation methods depressed recoveries. Therefore, our system was tested under adverse conditions and still gave 100% recovery when a mean of 6.4 *Salmonella* cells were added per flask. This corresponds to detecting less than 1 cell in 1.9 g if only one liver sample (12.5 g) per flask was contaminated. Overall, our procedure of scaling up the repair and recovery step of the isolation procedure does not appear to adversely affect its sensitivity.

A total of 230 livers was sampled in Northern Ireland but no *Salmonella* was found. Although methodological differences might have reduced the sensitivity of the procedure used in this study, the results differ greatly with those of Sinell et al. (8) who found that 72% of fresh porcine livers in a West Berlin wholesale market were contaminated with *Salmonella*. A detailed comparison of the different methods of husbandry used in both countries would be required to define reasons for this major difference. The occurrence of *Salmonella* did not appear to be frequent enough to cause concern.

D’Aoust et al. (4) also reported a low incidence of *Salmonella* in pork liver (5%) in a Canadian survey. However, because that study dealt with retail outlets, their results are not strictly comparable with the results presented here.

Because increasing amounts of pork liver are being processed locally, guidelines for safe production have been prepared (6). A secondary conclusion of this study is that a marked rise in the APC occurs during chilling, and this 20-fold increase will significantly reduce the shelf life of fresh livers. This is in agreement with the work of Gill (5) who showed that improved techniques for the chilling of offals can markedly reduce microbial growth and hence extend shelf life.

**REFERENCES**


