SEROTYPES AND ANTIMICROBIAL RESISTANCE OF *SALMONELLA ENTERICA* ON RED MEAT CARCASSES AND IN THE LAIRAGES AFTER CLEANING, IN THE SOUTH-WEST OF ENGLAND

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Keywords: abattoir, lairage, carcass, *Salmonella*, pathogen

Introduction

Foodborne pathogens such as *Salmonella enterica* are carried in the gut of domestic livestock and are shed into the environment with the faeces (Fedorka-Cray *et al.*, 1998). This contamination may build up on animal coats and in the lairage prior to slaughter, and may be transferred through cross-contamination between animals and between animals and the environment, and ultimately be found on the resultant carcasses (Collis *et al*, 2004). In order to further understand this cross-contamination process, isolates of *Salmonella enterica* that had been taken from lairages and carcasses at five red meat abattoirs were compared with regard to serotype, Plasmid Profile and PFGE banding pattern.

Materials and Methods

One hundred and thirty-eight isolates of *Salmonella enterica* were serogrouped and tested for resistance to a panel of 16 antimicrobial agents (Amikacin {AK}; Ampicillin {AM}; Amoxycillin/Clavulanic Acid {AMC}; Apramycin {APR}; Chloramphenicol {C}; Ceftazidime {CAZ}; Ciprofloxacin {CIP};Cefotaxime {CTX}; Furazolidone {F}; Gentamicin {GN}; Neomycin {N}; Nalidixic Acid {NAL}; Streptomycin {S}; Compound Sulphonamides {SU}; Sulphamethoxazole/Trimethoprim {SXT} and Tetracycline {TET}). Selected isolates from each of the broad groupings thus determined were further subtyped and analysed by Pulsed-Field Gel Electrophoresis (PFGE) and Plasmid Profiling. The 137 isolates originated from survey samples taken from carcasses (n=102) and lairages following routine cleansing and prior to the onset of processing (n=35) of five red meat abattoirs (Small, *et al* 2005, 2006).

Results and Discussion

Seven serogroups of *Salmonella enterica* were found, of which serogroup C1 was the most predominant, comprising 46 isolates in total. All of these were sensitive to all 16 antimicrobials tested, and they originated from the lairages of two abattoirs, and from carcasses at one. Thirteen were fully typed and shown to be *Salmonella* Mbandaka. These all belonged to the same PFGE cluster (4), and fell within a group of Plasmid Profile clusters differing by only one band (4a, 4b,4c). The second most predominant serogroup was the ROUGH serogroup, comprising 32 isolates, all of which originated from carcasses at three abattoirs. Eight of these were sensitive to all 16 antimicrobials tested, and the two isolates undergoing further typing were identified as Orough:z10:e,n,z15, and belonged to the same PFGE cluster (4) and Plasmid Profile cluster (4b) as the *S.* Mbandaka isolates described above. The remaining 24 ROUGH isolates were Nalidixic Acid resistant, and a representative set of 6 were typed as Orough:i;l,w, carried no plasmids, and belonged to PFGE cluster 3.

There were 29 isolates in serogroup B: *S.* Kimuenza was found on one carcass at one abattoir, sensitive to all antimicrobials tested; Tetracycline resistant *S.* Typhimurium DT208 was associated with 11 pig carcass isolates from a second abattoir, and *S.* Derby was associated with carcasses and the lairage environment in another. These last belonged to PFGE cluster 2 and Plasmid Profile clusters 2a and 2b, and some isolates were resistant to Sulphamethoxazole/Trimethoprim and Compound Sulphonamides. *S.* Dublin (serogroup D) made up 16 isloates, taken from calf and sheep carcasses at a single abattoir. These were sensitive to the antimicrobials tested, and belonged to PFGE clusters 1A, 1B and 1C, and to Plasmid Profile clusters 1a and 1b, all of which differed by only one band. *S.* Anatum (serogroup E1) was identified in 3 lairage isolates, from two abattoirs (all fully sensitive), and from 6 carcass isolates from a third abattoir. The carcass isolates came from bobby calves, and were Chloramphenicol resistant. There was a single isolate of serogroup C3 (8,20:-:z6) from a lairage, resistant to Sulphamethoxazole/Trimethoprim and Compund Sulphonamides, and a single isolate of IIIb O61:-:1,5,7 which was fully sensitive, and originated from a lairage.

On only two occasions could lairage isolates be related to carcass isolates. In both instances, *S.* Mbandaka was found in the lairage before start and on beef carcasses later in the day. Of the 138 isolates, 90 (65.7%) were sensitive to all 16 antimicrobials in the panel, 24 (17.5%) were resistant to Nalidixic Acid, 11 (8%) to Tetracycline, 8 (5.8%) to Compound Sulphonamides and Sulphamethoxazole/Trimethoprim, and 4 (3%) to Chloramphenicol.

There seemed to be little similarity between abattoirs with regard to serotypes present, each abattoir yielding a particular population of *Salmonella enterica* isolates. For example, *S.* Derby and *S.* Dublin were found only at an abattoir processing sheep, calves and pigs. The former was the second most commonly isolated serotype from pigs, and the fourth most common in sheep in 2004 in Great Britain, while the latter is the most common serotype in cattle and the third most common in sheep (Kidd and Papadopoulou 2005). Similarly, *S.* Typhimurium DT208 was found on a single occasion on pig carcasses, and is probably an indication of the *Salmonella* carriage of that particular group of pigs (Botteldoorn *et al* 2004).

S. Mbandaka was isolated from both carcasses and lairage at a cattle abattoir, and was found in the lairage on more than one occasion, suggesting that the organism may be persisting in the lairage, or may be repeatedly introduced with cattle from a particular source. Its presence in the lairage of another cattle abattoir, and the genetic similarity of the isolates may suggest that both abattoirs receive cattle from the same supplier, but this was not possible to ascertain in the present study. The similarity between the *S.* Mbandaka isolates from the lairage and beef carcasses from one abattoir on the related processing day may suggest that the organism has been transferred from the lairage to the slaughterline through cross-contamination, as no cattle were present in the lairage at the time of sampling. Rostagno and others (2003) found similar evidence of environmental contamination matching carcass contamination in pig processing.

A number of isolates were resistant to Nalidixic Acid, an antimicrobial commonly used in marker organism studies. The finding of resistance in a large proportion of field isolates may have implications in such research.

Conclusions

Individual abattoirs yield distinct populations of *Salmonella enterica*, which may be harboured in the lairage environment, or may be repeatedly brought in by the animals processed. It is possible that a persistent strain may develop a stable population within the lairage and could lead to contamination of carcasses, through mechanical transfer onto the animals passing through the facility. Further work is required to explore this possibility. In England, it would appear that antimicrobial resistance of *Salmonella enterica* in the red meat species is quite low, but not zero, and it would be desirable to reduce this further.

References

Botteldoorn, N., Herman, L., Rijpens, N. and Heyndrickx, M. (2004). Phenotypic and molecular typing of *Salmonella* strains reveals different contamination sources in two commercial pig slaughterhouses. *Applied and Environmental Microbiology* 70: 5305-5324

Collis, V. J., C.-A. Reid, M. L. Hutchison, M. H. Davies, K. P. A. Wheeler, A. Small and S. Buncic (2004). Spread of marker bacteria from the hides of cattle in a simulated livestock market and at an abattoir. Journal of Food Protection, 67, 11, 2397-2402.

Kidd, S. and Papadopoulou (2005). Salmonella in Livestock Production in GB 2004, VLA, Addlestone, UK.

Rostagno, M. H., Hurd, H. S., McKean, J. D., Zeimer, C. J., Gailey, J. K. and Leite, R. C. (2003). Preslaughter holding environment in pork plants is highly contaminated with *Salmonella enterica*. *Applied and Environmental Microbiology* 69, 4489-4494.

Small, A. and Buncic, S. (2005). Prevalence of *Salmonella* spp. In red meat abattoir lairages in the South-west of England, prior to animals entering after routine cleaning operations. In: *Proceedings of the 51st International Congress of Meat Science and Technology*, Baltimore, USA, 7-12 August.

Small, A., James, C., Purnell, G. James, S., Davies, R., Howell, M., Hutchison M. and Buncic S. (2006). Presence of *Salmonella enterica* in the red meat abattoir lairage after routine cleansing and disinfection, and on carcasses. *Journal of Food Protection* submitted.

Acknowledgements

This project was funded by the Food Standards Agency, UK, and would not have been possible without the cooperation of the participating abattoirs.