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The effect of time in lairage on the frequency of salmonella infection in slaughtered pigs

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SUMMARY

Groups of pigs were brought to an abattoir by truck and approximately 25 were killed on each of the next 3 days.

While the pigs were in lairage they were given water but were not fed. After slaughter the caecal contents of all pigs were cultured to detect *Salmonella* spp. The organism was isolated from 70 % of 145 pigs killed after 1 day in lairage, 49 % of 143 pigs that had been in lairage for 2 days and 41 % of 135 pigs that had been held for 3 days.

INTRODUCTION

It has been shown by a number of workers that substantial numbers of pigs are carrying *Salmonella* spp. at slaughter (Riley 1970; Edel & Kampelmacher 1976; Harvey, Price & Morgan 1977). These studies have shown that the intestinal tract and mesenteric lymph nodes are frequently infected and provide a source from which salmonella may be spread in the abattoir during evisceration and dressing.

It is difficult to determine the level of salmonella infection in healthy pigs on farms because it is not possible to collect mesenteric lymph nodes and caecal contents for culture. Studies that have been reported were based on examination of rectal swabs and faecal samples, which are unreliable for assessing the salmonella status of pigs (McCall, Martin & Boring 1966; Haddock 1970). However, it is generally agreed that the level of salmonella infection on the farm is low but increases rapidly while pigs are being transported and held in lairage prior to slaughter (Galton *et al.* 1954; McDonagh & Smith 1958; Shotts, Martin & Galton 1961; Williams & Newell 1967, 1970).

Most of the published information is based on investigations in which the pigs were killed less than 24 h after leaving the farm. In the present study the caeca of pigs held in lairage for 1, 2 or 3 days prior to slaughter were examined for the presence of salmonella.

MATERIALS AND METHODS

Experimental design

The experimental program was conducted over a 6 week period in late winter and early spring. Pigs were collected from a number of farms in northern Victoria and transported to a Melbourne abattoir by truck. At the abattoir, all the pigs in a particular truckload were kept together in one pen until the day after arrival when approximately 75 were randomly selected for study. These pigs were branded so that they could be identified on the killing line. About one third of the pigs were killed almost immediately and specimens collected. Another third were killed 24 h later and the remainder were killed on the third day. After collection from the farm the pigs were given water but were not fed. This experimental program was repeated at the same abattoir for 6 consecutive weeks.

Collection of samples

Pigs were killed and processed under normal conditions prevailing at the abattoir. As soon as possible after evisceration the caecum of each experimental pig was separated from the remainder of the gastrointestinal tract, together with a piece of ileum which was tied off to prevent spillage. Each caecum was placed in a separate plastic bag for transport to the laboratory.

Bacteriological procedures

Within 2 h of collection the surface of the caecum was seared and opened with sterile scissors and forceps. A loopful of caecal contents was inoculated into 10 ml of each of the following selective enrichment media: selenite broth (Oxoid), tetrathionate broth (Oxoid) and MacConkey broth (Oxoid) with added brilliant green. In addition, a loopful of caecal contents was inoculated into 5 ml of Rappaports' Medium (Rappaport, Konforti & Navon 1956). The tetrathionate and brilliant green MacConkey broths were incubated for 24 h at 37 °C, the selenite broth for 24 h at 43 °C and the Rappaports' Medium for 48 h at 37 °C.

After incubation, each of the enrichment broths were plated out on both brilliant green agar (Oxoid) and MacConkey agar (Oxoid). After overnight incubation the plates were examined and up to three suspect salmonella colonies were picked from each plate and submitted to biochemical and serological identification procedures. The identity of all salmonella isolates was confirmed at the Salmonella Reference Centre in Adelaide.

RESULTS

Salmonella organisms were isolated from 70 % of pigs killed on the first day, 49 % on the second and 41 % on the third (Table 1). In groups 2, 3 and 5 the numbers of infected pigs dropped rapidly over the 3-day period whereas in the other three groups the level of salmonella infection remained relatively high.

Twelve salmonella serotypes were isolated during the course of the investigation, the frequencies shown in Table 2. Except in the first group of pigs the serotypes isolated did not change greatly over the 3-day period. In this group *S. cambridge* was present only on day 1 and *S. bredeney* became predominant on days 2 and 3.

Of the pigs infected with salmonella 51 (22 %) were found to be carrying more than one serotype.

Table 1. *Isolation of* Salmonella *spp. from the caeca of pigs held for* 1, 2 *or* 3 *days before slaughter*

	Length of holding period					
	1 day		2 days		3 days	
Pig group	No. pigs	No. +ve	No. pigs	No. +ve	No. pigs	No. +ve
1	25	18	24	18	25	20
2	25	16	25	2	17	0
3	25	18	25	7	27	6
4	25	20	25	19	24	14
5	25	10	21	2	25	3
6	20	20	23	22	17	12
Total	145	102	143	70	135	55
	—	(70%)	—	(49%)	—	(41%)

DISCUSSION

A large proportion of the pigs in this study were found to be infected with *Salmonella* spp. on the first day of the experiment. The pigs had been collected from their farm of origin about 24 h earlier and in the intervening period they had been deprived of food, mixed with unfamiliar pigs and transported.

In this study it was not possible to determine the level of salmonella infection on the farm but in previous work salmonella were isolated from 8% of faecal samples collected from apparently healthy pigs on Victorian farms (Craven & Hurst 1976). It is recognized that care must be taken in comparing the prevalence of salmonella in faeces and caecal contents. However, it seems to be a reasonable conclusion that the big difference between the levels of salmonella infection on the farm (8%) and the abattoir (70%) indicates that the organisms spread rapidly during the journey. This conclusion is consistent with the findings of other workers (Shotts *et al.* 1961; Williams & Newell 1970).

The finding that the proportion of pigs infected with salmonella declined during the period from 24 to 72 h after leaving the farm was unexpected. However, it cannot be assumed from previous work (Williams & Newell 1967, 1970; Hansen *et al.* 1964; Shotts *et al.* 1961) that infection rates will remain high during holding prior to slaughter. The studies of Williams & Newell (1967, 1970) did not extend beyond 24 h and it is not possible to determine from the paper by Shotts *et al.* (1961) how long their pigs were under study. Hansen *et al.* (1964) found that 10% of pigs slaughtered immediately after arrival at the abattoir were infected with salmonella and that when the pigs were held for 3 days prior to slaughter the infection rate rose to 35%. This result could be interpreted as a steady increase in infection with increased holding time, or, considering the results of the present experiment, it may be that the number of infected pigs had reached a maximum and was declining.

In the present investigations it was found that infection persisted at a relatively high level in some groups of pigs (groups 1, 4 and 6) whereas the other groups appeared to be eliminating their salmonella infection relatively quickly. The reason for these differences is not known.

Table 2. *Serotypes of salmonella isolated from the caeca of pigs held for* 1, 2 *or* 3 *days before slaughter*

Salmonella serotypes	Pig group no. 1			2			3			4			5			6		
	Days held			Days held			Days held			Days held			Days held			Days held		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S. bredeney	—	15	12	—	1	—	9	3	4	4	1	—	1	1	—	2	5	2
S. derby	1	—	3	9	—	—	2	4	—	1	1	—	—	—	—	14	17	6
S. bovis-morbificans	—	2	1	—	—	—	1	—	—	13	14	13	—	—	—	—	1	1
S anatum	8	1	3	1	—	—	—	—	—	7	3	1	1	1	1	15	1	—
S. typhimurium	11	5	3	1	—	—	2	—	2	—	—	—	5	—	—	1	—	3
S. newport	—	—	—	7	1	—	—	—	—	—	—	—	2	—	1	1	—	—
S. cambridge	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S. infantis	—	—	—	—	—	—	8	—	—	1	—	—	—	—	—	—	—	1
S. havana	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
S. saint-paul	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
S. meleagridis	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Untypable	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

The presence of salmonella in the alimentary tract and its associated lymph nodes provides a potent source of contamination for pig carcases. Another potential source of carcase contamination is salmonella on the skin of pigs. The level of skin contamination will probably be related to the degree of soiling that occurs during transport and holding and is therefore likely to be related to the level of salmonella infection in the group of pigs. The effect of scalding and dehairing on salmonella numbers is not known. It has been shown that the level of carcase contamination can be very high with figures of 23·3 % reported by Carpenter, Elliot & Reynolds (1973) and 56 % by Weissman & Carpenter (1969). If this level of contamination is to be effectively reduced it will be necessary to reduce the level of salmonella being carried into the abattoir in the alimentary tract, lymph nodes and skin of pigs. This objective is only likely to be achieved if it is possible to prevent the rapid proliferation of salmonella that occurs in the 24 h after the pigs leave their farm of origin.

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