J. Hyg., Camb. (1972), **70**, 113
Printed in Great Britain

Enteritis due to *Salmonella panama* from infected ham

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(*Received* 5 *August* 1971)

SUMMARY

After the appearance of sporadic cases of enteritis due to *Salmonella panama*, baked ham from one supplier was implicated as the source of infection. No pathogenic organisms were isolated from the working surfaces of the factory involved or from samples of a day's bacon output, but *S. panama* was isolated from the factory sewers. Stool examinations of the 500 employees showed one man in the baked ham section to be excreting *S. panama*. He was removed from work and no further infections were reported from the district. The organism could no longer be found in the sewers.

Some weeks later, further infections were reported in the London and Southend areas, which could be traced to ham from the original source. Sewer swabs at the factory were again positive. A further examination of all the employees revealed three cases and 82 symptomless excretors. Eight of 192 family contacts were also found to be excretors. Trimethoprim-sulphamethoxazole appeared to have no effect on the carrier state.

Examination of the hams in cold store showed some to be infected with *S. panama*, and a number of these had been consumed in the canteen.

Subsequent examination of pigs at slaughter and pig food prepared locally failed to isolate *S. panama*. The source of infection at the factory is unknown.

THE OUTBREAK

Initial local infections

In April 1970 a village shopkeeper had a mild 2-day illness with diarrhoea and *Salmonella panama* was isolated from her stool. She blamed her illness on cooked ham she had eaten recently. Subsequently her parents, who lived with her, her husband and two children, became symptomless excretors and continued so for 6 months, despite a wide variety of treatment. The organism was also isolated from a road worker in the village, and thereafter his wife and three children became symptomless excretors for the next 4 months. Shortly after this, two children in an adjacent village developed gastro-enteritis and the organism was isolated from them. Their parents remained unaffected. The common factor among the victims was baked ham produced at a factory 3 miles away.

The original shop and adjoining living premises were clean and no pathogenic

organism was found in unwrapped foodstuffs or on working surfaces or refrigeration equipment. The shop was closed and the owners prohibited from handling unwrapped food.

Sewer swabs from the one other village store and from the two public houses failed to show salmonellas.

The bacon factory

This was the major industry in a rural area, employing about 500 people. On average 600 pigs were processed each day on 5 days a week and only rarely were animals held in lairage overnight. A complete range of raw and cooked pork was distributed in the south-east of the country, and the factory management claimed that their products were consumed by half a million people each day.

Investigations at the bacon factory

One week after the detection of the original case in the village, sewer swabs in the factory drains proved positive for *S. panama*. Swabs from the working surfaces in the ham and gammon steak areas of the factory were negative, as were samples from baked ham in local shops. A selection of a day's product of baked hams was examined, but no pathogens were found.

Because infection was obviously present in the factory, a stool sample from each employee was examined, and one man in the baked-ham area was found to be a symptomless excretor of *S. panama*. His main job was to operate the vacuum machine making gammon billets. He was removed from work and all subsequent stool examinations were negative. After three consecutive examinations he was allowed to return to non-meat-handling duties. His wife and two children remained negative throughout.

Further spread of the infections

This seemed to have removed the source of infection, as no further fresh cases were seen in the district for the next month. The sewer swabs in the factory also became negative. However, in the summer, sporadic cases began to appear in the London and Southend areas, in which baked ham from this factory had been eaten, and therefore might have been the cause. Exposed surfaces in the working area were again swabbed, including some areas remote from the suspected source of infection. *S. panama* was isolated from behind a baking oven, a meat packing table, a meat packing machine, and the conveyor belt in the gammon packing room. A factory order directed that working surfaces should be swabbed twice daily with a hypochlorite/detergent mixture, but there may have been lapses during heavy work periods. A square root sample from the week's product of baked ham in cold store was examined by slitting the plastic envelope and swabbing the surfaces, and six of 47 hams were found positive for *S. panama*. All hams were now withdrawn from retail outlets and destroyed. On Ministry advice, the hams in cold store were recooked in their covers at a temperature of 82° C to a depth of 2·5 cm and released for sale. At this time two workers reported with mild enteritis and *S. panama* was isolated from their stools. A further examination

of the employees showed 82 symptomless excretors, plus one further case with symptoms. Of 192 family contacts of positive individuals, eight were found to be excreting the organism.

The factory was now closed, new equipment installed, and work flow redesigned. After 2 weeks, employees with a negative stool examination were allowed to return to meat handling after a further negative examination. Excretors were allowed back after three consecutive negative stools, and thereafter the plant slowly returned to full production. No further cases could be traced to the product and no further isolations of *S. panama* were obtained from the factory or the personnel.

LABORATORY METHODS

Before this outbreak, a selective solid medium for the isolation of enteric pathogens – Hektoen enteric agar (King & Metzger, 1968*a*, *b*) – had been under investigation. This contains rather more peptone (1·2 %) than usual to offset the inhibitory concentration of bile salts (1·5 %) and sodium deoxycholate (0·2 %). The indicator system is bromothymol blue and Andrade's indicator, which produces a clear medium with a green background. The object was to identify salmonellas and shigellas on the same plate. Throughout the *S. panama* outbreak, a small outbreak of *Shigella sonnei* was running. This has not been reported. With pressure of work during the incident, technique was simplified to overnight incubation of faecal samples in single strength selenite at 37° C. followed by plating on Hektoen agar. After further overnight incubation, *S. panama* colonies showed up as clear to blue-green with a black centre; shigellas produced green colonies without blackening; and coliforms produced orange-coloured colonies. The medium was satisfactory as regards colour contrasts.

FACTORY METHODS

Baked ham and gammon steak

Boneless cuts of pork are soaked for 48 hr. in a solution of brine and saltpetre with added flavouring agents, hydrolysed vegetable protein, sugar and monosodium glutamate. The final concentration of salt in the cuts ranges between 3 and 3·5 %. They are then placed in metal moulds with spring lids and cooked for an average of 6 hr. in steam-heated ovens at 82° C. A sensor in the middle records a temperature of 70° C. and this must be reached before the hams are considered to be cooked. The moulds are then removed from the oven, the bases clamped down by manual pressure and passed through a cold shower. After cooling, the hams are removed from the moulds and wrapped. A small proportion are covered with breadcrumbs to suit regional tastes. The life of this product in the shop is about 1 week and they are normally held for 2 to 3 days in the factory cold store. For gammon steaks the pickled cuts are fed into a vacuum machine, which produces a cylindrical billet of uncooked meat wrapped in polythene. These are placed in an oven and the temperature raised to 37° C. over a period of 1 hr. They are held at this temperature for 1 hr. and finally steam-cooked until a sensor in the middle records a temperature of 53° C. This product requires further cooking before

consumption. The object of pickling is to flavour and preserve the product and it was thought that, as a result of this, the surface of the hams and gammons might acquire some bactericidal effect. Accordingly 1 in. squares of pickled gammon were inoculated with dilutions of an overnight broth culture of *S. panama* in quarter strength Ringer's solution to give inocula of about 5, 50, and 500 organisms. At weekly intervals a surface inoculated with each dilution was rubbed over a culture plate. At 4 weeks the organism could still be recovered from all dilutions. After 2 weeks storage at 4° C. ham and gammon had an unpleasant smell and appearance. During their edible life they obviously had no inhibitory effect on bacterial growth. *S. panama* could still be recovered from artificially infected ham stored at −20° C. for 1 year. Examination of the pickling fluid, cooling water, and breadcrumbs, yielded no enteric pathogens.

Salmonella panama

Incidence

In recent years the incidence of infections has been increasing, and Public Health Laboratory Service Reports (Vernon, 1966, 1967, 1969, 1970) and E. Vernon (personal communication) demonstrate the establishment of *S. panama* as an important human pathogen (Table 1).

Environmental contamination in outbreaks has been massive, with stools, window ledges, curtains, and personal items around the excretors heavily infected. In recent incidents the organism has been isolated from the blood and spinal fluid (*British Medical Journal*, 1971).

Properties

Organisms isolated from the original cases and from the bacon factory workers were dulcitol negative and sensitive to trimethoprim-sulphamethoxazole, ampicillin, tetracycline, chloramphenicol, colistin sulphate and neomycin but insensitive to streptomycin. At the end of the outbreak, the sensitivity pattern was unchanged.

Most Enterobacteriaciae can utilize nitrate anaerobically. In tinned corned beef the growth of *Salmonella typhi* is enhanced by up to 0·5 % sodium nitrate, but inhibited by 3 % sodium chloride (Meers & Goode, 1965*a*). These are the approximate concentrations in pickled meat and pork. Repeating the chequer board titration of Meers & Goode (1965*b*) we found that *S. panama* could grow at a salt concentration of 6 % but that growth was inhibited by the addition of 0·8 % sodium nitrate.

Table 1. *Incidents of* Salmonella panama *infection as reported by the Public Health Laboratory Service and associated laboratories*

Year	*S. panama*
1965	86
1966	95
1967	209
1968	379
1969	307

Incidence in pigs

S. panama is not a common pathogen of pigs in East Anglia. Since the beginning of the outbreak 500 caecal swabs from pigs killed in the factory and in the district have been examined for *S. panama* with negative results, although six other salmonella isolations were made: *S. typhimurium*, 3; *S. tennessee*, 1; *S. menston*, 1; and one unidentified serotype. Mesenteric gland swabs were examined with 154 of the caecal specimens and one was positive for *S. typhimurium*. The associated caecal swab was negative.

From 1958 to 1967 two porcine isolations were made from 19,371 incidents of animal infection at the Central Veterinary Laboratory, Weybridge (Sojka & Field, 1970), with three more in 1970 (W. J. Sojka, personal communication).

Incidence in animal feed

From 1969 until June 1971, 614 samples of raw material, mainly meat and bone meal from cattle food merchants in the area, were examined. There were no isolations of *S. panama*, but 141 samples (23 %) were positive for other serotypes, 26 in all.

No salmonellas were isolated from 124 samples of finished feed products. It would appear that steaming and subsequent pelleting sterilizes the product.

Treatment of carriers with trimethoprim-sulphamethoxazole

Apart from their usefulness in treatment of the typhoid group of fevers, antibiotics appear to have no beneficial effect on salmonella enteritis, and the carrier state may actually be prolonged by such treatment (Dixon, 1965; *British Medical Journal*, 1969). Some effective method of eliminating the organism from the bowel would be an advantage in the food industry, and trimethoprim-sulphamethoxazole seemed to offer some promise. It had proved effective in the treatment of typhoid fever (Kamat, 1970) and with a 4 to 5 weeks course Brodie, MacQueen & Livingstone (1970) reported that they eradicated the organism from two of five carriers of *S. typhi* and one of *S. saintpaul*.

Most of the bacon-factory workers were on the list of one group practice, and by arrangement one tablet of trimethoprim 80 mg. and sulphamethoxazole 400 mg. was given to 76 excretors four times a day for 10 days. Twenty-one excretors, acting as controls, received no treatment of any kind. After 1 month 28 of the treated and five of the untreated group were still excreting *S. panama*. After 2 months 11 (14 %) of the treated were still positive, but none of the controls

Table 2. *Length of infection in treated and untreated excretors*

Duration of infection	Treated patients	Untreated patients	Total
< 1 month	53 (70 %)	16 (76 %)	69
1–2 months	12	5	17
> 2 months	11	0	11
Total	76	21	97

https://doi.org/10.1017/S0022172400022154 Published online by Cambridge University Press

(Table 2). Treatment appeared to prolong the carrier state, but the differences between the two groups are not statistically significant.

There were three instances of a skin eruption, two of the sufferers being withdrawn from the trial, and two of mild dyspepsia.

Many of the factory workers submitted weekly stools for examination for several months. In seven infected individuals a positive result was recorded after a mean of four negative examinations, and in one case, after eight negative examinations. These may have been due to a low level of residual bowel infection, but the possibility of re-infection from an unknown source remains. In most instances of salmonella infection, the symptoms are mild and intestinal carriage is self-limiting (Murdoch, 1971). Normal hygienic measures are usually sufficient to prevent family spread.

DISCUSSION

It is not known how infection entered the factory, although the original symptomless excretor may have been the culprit. After the outbreak caecal swabs from 500 pigs from the factory and surrounding slaughterhouses were examined and six salmonella isolations were obtained, none of them *S. panama*. About a quarter of the basic animal food ingredients examined locally contained salmonellas but steaming and pelleting seemed to eliminate this.

The original contamination of the hams may have been light. This is suggested because in the first 5 months of 1970 only 25 instances of *S. panama* infection were reported in the south-eastern region by the Public Health Laboratory Service and associated labaratories, 15 of them from this laboratory. Considering the popularity of cooked ham, this is a low score from a product which was widely distributed.

Although general hygienic measures at the factory appeared to be satisfactory, male cleaners tended to forget under surfaces of tables. However, it is likely that a clean working surface of low bacterial count was created twice a day on most working days.

Examination of stools from all employees, coupled with improved hygiene in the factory, should have detected excretors and dealt with any pockets of infection in the plant, but this did not prevent new infections. Apparently infected hams in the cold store were still being served in the canteen. The factory products were available to the workers at an economical price and were popular with their families, but considering that 192 were at risk and only 8 (4%) were found to be excreting the organism, the contamination must have been light and intermittent.

The policy of the Public Health Laboratory Service regarding stool examinations of food handlers has been stated by the Director (Howie, 1970). As a purely routine measure in non-epidemic conditions no useful purpose is served.

The pickling process appeared to have no effect on the growth of *S. panama*, which would be expected from its salt tolerance, and a small inoculum on the ham was viable long after the end of its shop life. Treatment with trimethoprim-sulphamethoxazole appeared to have no effect on the carrier state.

Since the factory re-opened, the stools of all employees have been examined on

two occasions with negative results. Frequent examinations of sewers and working surfaces have been negative.

The source of the original infection remains a matter for conjecture.

We are indebted to Drs Russell, Hodgkin, Dean and Cockayne, who treated their patients with trimethoprim-sulphamethoxazole, and to numerous other practitioners who so kindly refrained from treating the controls, also to Miss Hilary Mogford who analysed the results.

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