THE ISOLATION OF *SALMONELLA* FROM RAW, COOKED AND DRIED FOODS*

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SUMMARY

Between June 1977 and May 1982, 2,291 samples of raw, cooked and dried foods were examined for the presence of Salmonella. *Of these samples, 43 were positive, isolations being made from raw foods (4.8%) and cooked foods (0.4%) but not from dried foods. 14* Salmonella *serotypes were isolated,* Salmonella anatum *being the most predominant. The significance of these isolations is discussed and the need for consumer education to reduce the incidence of human salmonellosis is emphasised.*

INTRODUCTION

The genus *Salmonella* now comprises about 2,000 serotypes which can infect a wide range of warm- and cold-blooded animals. Salmonellosis in man most commonly results from the ingestion of contaminated food.[1] The relative frequency of salmonellosis as a cause of foodborne disease varies from country to country. It depends on such factors as dietary habits, hygienic standards in food production and service establishments, and animal husbandry practices.[1]

In the USA, about 40% of reported food poisoning cases are due to *Salmonella.* In England and Wales, the comparable figure is about 80%.[1] In these countries, meat and poultry remain the commonest sources of *Salmonella* infection. The incidence of *Salmonella* food poisoning outbreaks in many other countries is under reported. This is mainly due to the difficulty in obtaining food samples for microbiological examination because the incubation period of salmonellosis is long. Surveillance is a powerful tool for protecting the consumer by discovering ongoing epidemics. In view of this, we decided to survey various types of raw, cooked and dried foods to determine the prevalence of *Salmonella* in these foods.

MATERIALS AND METHODS

A total of 2,291 samples of food were examined for the presence of *Salmonella* between June 1977 and May 1982. These consisted of 774, 1,393 and 124 samples of raw, cooked and dried foods,

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respectively. The samples were received either directly from the manufacturers or via local public health inspectors.

Depending on the sample size, 25g or 50g portions were weighed and placed into 225 ml or 450 ml of nutrient pre-enrichment broth, respectively. After incubation for 24h at 37°C, 1 ml of the pre-enriched samples was transferred to 10 ml each of selenite broth and tetrathionate broth. The selective enrichment broths were incubated for 24h at 37°C and 43°C, respectively, and were each streaked onto desoxycholate citrate (DC), brilliant green (BG) and bismuth sulphite (BS) agar plates and incubated at 37°C to isolate *Salmonella*. The DC and BG plates were examined after 24h and the BS plates after 48h. Suspect colonies present were picked and confirmed by conventional biochemical and serological procedures.[2] All the media used were purchased from Oxoid.

RESULTS

Salmonella was isolated from 43 (1.9%) of 2,291 food samples examined. The numbers of isolations made from raw, cooked and dried foods are summarised in Table I. A total of 774 raw food samples were examined of which 37 (4.8%) yielded *Salmonella*. From 1,393 samples of cooked food, only six (0.4%, all seafood samples) showed the presence of *Salmonella*. No isolations were made from any of the 124 dried food samples examined.

TABLE I
***SALMONELLA* ISOLATIONS FROM VARIOUS FOOD ITEMS**

Samples	No. of samples tested	no. of *Salmonella*-positive samples (%)
RAW FOODS		
Meat: beef	146	13 (8.9)
mutton	77	3 (3.9)
pork	49	2 (4.1)
chicken	44	4 (9.1)
Edible offals (ox, pig, chicken)	38	4 (10.5)
Processed meats (burgers, sausages, frankfurters)	97	4 (4.1)
Seafoods (fish, shellfish, prawn, squid, crab)	303	7 (2.3)
Vegetable salads	20	0
COOKED FOODS		
Western meals	503	0
Malaysian meals	160	0
Vegetarian dishes	72	0
Snacks (sandwiches, cakes)	106	0
Seafoods (fish, prawn, squid, crab)	503	6 (1.2)
Ice creams	49	0
DRIED FOODS		
Milk powder	63	0
Chocolates	13	0
Cereals	14	0
Biscuits	9	0
Snacks (meat floss, coconut shreds, fish crackers, cheese crackers)	16	0
Dessicated coconut	9	0
Total	2,291	43 (1.9)

The number of isolations of different serotypes of *Salmonella* from raw and cooked foods are shown in Table II. A total of 14 different serotypes was recovered. *Salmonella anatum* was the predominant serotype isolated. *S. agona* was next in frequency, followed by *S. give, S. lexington, S. muenchen* and *S. raus* in equal number of isolations (Table III).

DISCUSSION

Of the total of 774 raw food samples tested, 37 (4.8%) were found to be contaminated with *Salmonella.* Majority of these (30 out of 37 or 81.1%) were from foods of animal origin, namely meats (beef, mutton, pork and chicken), edible offals

TABLE II
***SALMONELLA* SEROTYPES ISOLATED FROM RAW AND COOKED FOODS**

Samples	*Salmonella* serotypes
RAW FOODS	
Meat:	
Beef	*S. anatum* (4)*, *S. give* (3), *S. muenchen* (2), *S. derby, S. newport, S. raus, S. virchow*
Mutton	*S. anatum* (2), *S. agona*
Pork	*S. anatum, S. agona*
Chicken	*S. newport* (2), *S. indiana, S. virchow*
Edible Offals:	
Ox liver	*S. give*
Pig liver	*S. virchow*
Pig pancreas	*S. typhimurium*
Chicken liver	*S. senftenberg*
Processed meats:	
Beef burger	*S. raus, S. senftenberg, S. typhimurium*
Chicken burger	*S. muenchen*
Seafoods:	
Fish	*S. lexington, S. london, S. muenchen, S. weltevreden*
Prawn	*S. raus, S. weltevreden*
Squid	*S. lexington*
Total	37
COOKED FOODS	
Seafoods:	
Prawn	*S. agona* (3), , *S. lexington* (2), *S. raus*
Total	6

* Figures in parentheses give the number of isolates.

TABLE III
SIX MOST COMMONLY ISOLATED *SALMONELLA* SEROTYPES

Salmonella serotypes	No. of isolates	% of total isolates
S. anatum	7	16.3
S. agona	5	11.6
S. give	4	9.3
S. lexington	4	9.3
S. muenchen	4	9.3
S. raus	4	9.3

and processed meats. In a study conducted by Barrell,[3] isolation rates of *Salmonella* ranging from 5.2% for raw beef to 36.6% for raw poultry were obtained. Infection of animals usually occurs on the farm and infected animals transmit the disease to uninfected animals during transit to processing plants or while being held before slaughter.

Many measures have been shown to reduce infection in animals or the contamination by *Salmonella* of carcase meat and comminuted meat products.[4] These include attention to methods of transport, reduction of stress in the animals, improved systems of lairaging and improved methods of slaughter. Also the design, construction and hygiene of lairages, and the relation between the lairage, abattoir and meat products plant are all essential in reducing the incidence of *Salmonella* contamination.

Only six out of the 1,393 (0.4%) samples of cooked food examined yielded *Salmonella*. This finding reflects the hygienic conditions under which these foods were produced. The six contaminated cooked foods were all prawn samples. Contamination probably occurred while the workers were peeling and processing the cooked prawns in the factory.

In a study conducted by Gabis and Silliker,[5] *Salmonella* was detected in 44 of the 98 samples of dried food and feed ingredients. In this survey, however, *Salmonella* was not isolated from any of the 124 samples of dried food. These were foods which had undergone certain process of heat treatment. The absence of *Salmonella* in these samples probably suggests that careful control over the quality of raw materials, the hygiene of production and preparation, and temperature control at all stages of processing had been achieved. The spread of disease due to the presence of *Salmonella* in dried foods has been recorded by other workers. Collins *et al.*,[6] reported an interstate outbreak of *S. newbrunswick* traced to powdered milk and D'Aoust *et al.*,[7] reported an outbreak of *S. eastbourne* associated with chocolate.

A total of 14 different serotypes of *Salmonella* was discovered in this study. *S. anatum* was the most frequently isolated serotype and the isolations were made from beef, mutton and pork. The second most common serotype was found to be *S. agona*. *S. anatum* has been shown to occur in poultry[8,9] and pork.[10] In a review on food poisoning and salmonellosis surveillance in England and Wales for the year 1979,[11] it was reported that *S. typhimurium* was the most common serotype accounting for 27% of all *Salmonella* isolations reported from man. *S. hadar, S. virchow, S. enteritidis* and *S. agona* came next in rank order. These five serotypes were also among the most common ones causing incidents in animals.

The use of clean ingredients free from contamination in food processing ensures the production of food of satisfactory quality. Food of animal origin is frequently contaminated with organisms originating in the animal's gut. Visual inspection of fresh meat and poultry will not detect the presence of *Salmonella*. The subsequent handling of food of animal origin must therefore ensure that processing is sufficient to destroy any pathogens which may be present. Thus, those who prepare foods at home or commercially should be educated on the sanitary practices required to prepare safe foods before serving them to the consumer. Sanitation should be practised at home, on the farm, in the factory and especially in food service establishments so that a reduction in the incidence of salmonellosis can be achieved.

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REFERENCES

[1] World Health Organization. Enteric infections due to *Campylobacter, Yersinia, Salmonella,* and *Shigella. WHO/DDC/EPE/80.4,* 1980.

[2] Edwards PR, Ewing WH. *Identification of Enterobacteriaceae,* 3rd ed. Minneapolis: Burgess Publishing Co., 1972.

[3] Barrell RAE. Isolations of salmonellas from human, food and environmental sources in the Manchester area: 1976-1980. *J Hyg Camb* 1982; 88: 403-411.

[4] Williams EF, Spencer R. Abattoir practices and their effect on the incidence of salmonellae in meat. In: Hobbs BC, Christian JHB, eds. *The Microbiological Safety of Food.* London: Academic Press, Inc., 1973.

[5] Gabis DA, Sillikder JH. ICMSF methods. Studies IX. The influence of selective enrichment broths, differential planting media, and incubation temperatures on the detection of *Salmonella* in dried foods and feed ingredients. *Can J Microbiol* 1977; 23: 1225-1231.

[6] Collins RN, Treger MD, Goldsby JB, Boring JR, Coohon DB, Barr RN. Interstate outbreak of *Salmonella newbrunswick* infection traced to powdered milk. *J Am Med Assoc* 1968; 203: 838-844.

[7] D'Aoust JY, Aris DN, Thisdele P, Durante A, Brisson N, Dragon D, Lachapelle G, Johnston M, Laidley RP. *Salmonella eastbourne* outbreak associated with chocolate. *Can Inst Food Sci Technol J* 1975; 8: 181-184.

[8] Woodburn M. Incidence of salmonellae in dressed broiler-fryer chickens. *Appl Microbiol* 1964; 12: 492-495.

[9] Morris GK, Wells JG. *Salmonella* contamination in a poultry-processing plant. *Appl Microbiol* 1970; 19: 795-799.

[10] Roberts D, Boag K, Hall MLM, Shipp CR. The isolation of salmonellas from British pork sausages and sausage meat. *J Hyg Camb* 1975; 75: 173-184.

[11] Communicable Disease Surveillance Centre. Food poisoning and salmonellosis surveillance in England and Wales, 1979. *Br Med J* 1980; 281: 1360-1361.