NON-TYPHOID SALMONELLAE

THE ORGANISM/TOXIN

This group of organisms of is comprised of a large number of different serotypes of the species *Salmonella enterica*. However, in general, a few serotypes tend to dominate those identified as causing disease. These serotypes are normally denoted as a non-italicised "species" name, e.g. Salmonella Enteritidis. Serotypes may be associated with particular geographical areas.

GROWTH AND ITS CONTROL

Growth:

Temperature: Minimum 7°C, growth greatly reduced at <15°C. Maximum 49.5°C. Optimum 35-37°C. Some evidence for growth at 5.2°C exists, but this is serotype specific and the data are still not universally accepted.

Water activity: Minimum 0.94, optimum 0.99 maximum >0.99.

pH: Minimum 3.8, optimum, 7-7.5, maximum 9.5. The minimum pH is influenced by other factors such as, temperature, the acid present, and the presence of nitrite etc. For example at 10°C the minimum pH allowing growth was 4.4-4.8 (13 isolates tested), while at 30°C it was 3.8-4.0.

Atmosphere: Can grow in the presence or absence of air. Growth under nitrogen is only slightly less than that under air.

Grows at 8-11°C in the presence of 20-50% CO_2.

Growth at low temperatures is retarded in the presence of 80% CO_2 compared to air.

Survival: *Salmonella* is known to survive well in foods and on surfaces.

Temperature: Survival for >10 weeks in butter held at –23 and 25°C has been noted. Salmonellae can survive for 28 days on the surfaces of vegetables under refrigeration.

In essence *Salmonella* can survive for long periods under refrigeration.

Water Activity: Survival in dry environments is a characteristic of these organisms. For example can survive in chocolate (a_w 0.3-0.5) for months. Exposure to low a_w environments can greatly increase the subsequent heat resistance of these organisms.

pH: *Salmonella* are less acid resistant at low pH than *E. coli*.

Inactivation (CCPs and Hurdles):

Temperature: Death occurs during the freezing process, but those that survive remain viable during frozen storage. Freezing does not ensure the inactivation of salmonellae in foods.

D times:

60°C usually 2-6 min.

70°C usually 1 min or less.

N.B. Extremely high D times have been reported for experiments with milk chocolate. Values reported were up to 1050 min at 70°C, 222 min at 80°C and 78 min at 90°C. This also applies to other low water content foods.

Some rare serotypes (e.g. *S.* Senftenberg) are significantly more heat resistant than the others, which are not particularly resistant to heat.

A comprehensive review of the thermal destruction properties of salmonellae is cited in the references.

pH: Inactivation at sub-optimal pH depends on many factors including the type of acid present and the temperature. For example inactivation is more rapid in commercial mayonnaise at 20°C than it is at 4°C.

Water activity: At water activities less than that allowing growth the decline in numbers is reduced at lower a_w values.

Preservatives: (NB: Some of the preservatives discussed here may not be permitted in New Zealand). Growth was inhibited in the presence of 0.1% acetic acid (pH 5.1).

Sanitisers/Disinfectants: Not resistant to disinfectants used in the food industry.

20,000 ppm chlorine results in a 2.3 to 2.5 log reduction in numbers of salmonellae on alfalfa seeds after exposure for 30 min.

Ethylene oxide has been used to fumigate dried spices.

Radiation: D value around 0.5 kGy, up to 0.8. D times are higher in drier foods such as desiccated coconut.

THE ILLNESS

Incubation: 6-48 hours (usually 12-36 hours).

Symptoms: Diarrhoea, abdominal pain, vomiting, nausea and fever lasting 1-7 days.

Hospitalisation rate estimated at 22.1% cases fatality rate 0.8%.

Condition: Salmonellosis.

Toxins: Toxins are not produced in foods.

At Risk Groups: The young, old, and immunocompromised are particularly at risk. In addition people of less privileged socioeconomic groups and those living in higher population densities are more at risk.

Long Term Effects: Septicaemia and subsequent non-intestinal infections can occur. Reactive arthritis may occur 3-4 weeks after gastrointestinal symptoms.

Dose: The dose required to cause disease varies with many factors. Low attack rates have been observed in one outbreak where 4-45 cells were consumed, and another where the dose was 6 cells. Different serotypes may have different dose responses, and generally recognised doses to cause disease at high attack rates are in the range of 10^5 to 10^6 cells.

Foods with high fat content, like chocolate or peanut butter may protect cells from gastric juices so permitting a lower dose than usual to cause infection.

NZ Incidence: Annual rate (as at October 2000) 49.6/100,000.

Treatment: The infection is usually self-limiting although fluid replacement may be required. Antibiotic treatment seems to be either ineffective or results in relapse or prolonged faecal shedding. Certain groups, e.g. new born children, may benefit from antibiotic treatment.

SOURCES

Human: Some serotypes are confined to humans (e.g. Typhi and Paratyphi B).

Faeces of infected people contain large numbers of the organism and shedding may continue for up to 3 months. The median period for shedding is 5 weeks, <1% become chronic carriers.

Animal: Some serotypes are confined to particular animal reservoirs, but many are capable of crossing between species to cause disease in man, often via food. Most *Salmonella* infections in animals are symptomless.

Poultry and pigs are regarded as major reservoirs of the organism.

Animal feeds made from animal products may be contaminated by *Salmonella*.

Salmonella can also be found in fish, terrapins, frogs and birds.

Food: Meat or other products derived from infected animals are important vehicles of salmonellosis. Other animal products, e.g. unpasteurised or re-contaminated pasteurised milk and dairy products, can also act as vehicles.

So far in New Zealand the serotype *S.* Enteritidis PT4, which can contaminate hens' eggs, has not been detected in laying hens.

Environment: *Salmonella* shed in faeces can contaminate pasture, soil and water. It can survive for months in the soil. Contamination in the environment can serve to act as a source of infection of other animals.

Transmission Routes: May be transmitted to humans via contaminated food or water, animal contact, or from a contaminated environment.

A simple overview is a cycle of events involving feedstuffs, animals, foodstuffs then man.

OUTBREAKS AND INCIDENTS

Outbreaks:

New Zealand:

Cocktail sausages: 8 cases, serotype *S.* Typhimurium 135. Control point failure: Inadequate cooking and/or cross contamination.

Overseas:

Peanut flavoured snack: 27 cases, serotype *S.* Agona. Control measure failure: Contamination by food handler.

Ham: 39 cases, serotype *S.* Typhimurium. Control point failure: Inadequate cooking.

Paprika flavoured potato chips: 1,000 cases, serotypes *S.* Saintpaul, *S.* Rubislaw and *S.* Javiana. Control point failure: Contaminated flavouring.

Epidemiological studies. Foods identified by epidemiological studies as acting as outbreak vehicles include poultry meat and eggs (in the USA and UK), mung bean sprouts, paprika flavoured potato chips and salami sticks.

ADEQUATE PROCESSING GUIDELINES

N.B. These guidelines have been derived from published information. Industry is advised to ensure that processing steps they are using are adequate to meet their particular food safety objectives.

Cook meats to:	**Internal temperature reached**	**Time**
Minced meats (beef, veal, lamb, pork) + pork cuts	71°C	15 sec
Minced poultry	74°C	″
Meat cuts (beef, veal, lamb), fish, seafood	63°C	″
Poultry, breast	77°C	″
Poultry, whole	82°C	″
Hold foods at	≤ 5°C or ≥ 60°C	
Reheat cooked foods to	74°C	
Acidify foods to pH 3.8 or below		
Avoid direct handling of food by infected food handlers		

REFERENCES

Doyle, M.E. and Mazzotta, A.S. (2000) Review of studies on the thermal resistances of salmonellae. Journal of Food Protection **63**, 779-795.

Jay, S., Grau, F.H., Smith, K., Lightfoot, D., Murray, C. and Davey, G.R. (1997) *Salmonella* pp 169-232 In: Foodborne microorganisms of public health importance, 5th Edition. AIFST (NSW Branch), Sydney, Australia

The International Commission on Microbiological Specifications for Foods (1996) *Salmonella*. In Micro-organisms in Foods 5 Microbiological Specifications of Food Pathogens, pp 217-264. Blackie Academic and Professional, London.