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RISK PROFILE: *SALMONELLA* (NON TYPHOID) IN POULTRY (WHOLE AND PIECES)

Prepared as part of a New Zealand Food Safety Authority
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by

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2 HAZARD IDENTIFICATION: THE ORGANISM

The following information is taken from data sheets prepared by ESR under a contract for the Ministry of Health. The data sheets are intended for use by regional public health units.

2.1 *Salmonella*

2.1.1 The organism

This group of organisms is comprised of two species: *Salmonella enterica*, which is divided into 6 subspecies, and *Salmonella bongori* (Jay *et al.*, 1997). Most isolates from humans and warm-blooded animals belong to subspecies I: *Salmonella enterica* subspecies *enterica*. Other *Salmonella enterica* subspecies and *Salmonella bongori* occur more commonly from cold-blooded animals and the environment, and are of lower pathogenicity.

Salmonella typing is primarily performed using serological identification of somatic (O), flagella (H), and capsular (K) antigens.

Salmonella enterica serotypes are normally denoted in a shortened form that includes a non-italicised serotype name, e.g. *Salmonella enterica* subsp *enterica* serovar Enteritidis becomes *Salmonella* Enteritidis. In older publications this may be represented as a full species name i.e. *Salmonella enteritidis*. Further subtyping may be performed using susceptibility to bacteriophages. These types are denoted as Phage Type (PT) or Definitive Phage Type (DT) numbers. These two terms are interchangeable and both are used in the literature.

Salmonella Typhi and *Salmonella* Paratyphoid are serotypes which cause a serious enteric fever and are particularly well adapted to invasion and survival in human tissue. They have a particular antigen makeup and a differing ecology to other serotypes of *Salmonella*. They are not included in this Risk Profile.

Note that in microbiological terms "D" refers to a 90% (or decimal or 1 log cycle) reduction in the number of organisms.

2.1.2 Growth and survival

Growth:

Temperature: Minimum 7°C, growth greatly reduced at <15°C. Maximum 49.5°C. Optimum 35-37°C. Some evidence for growth at temperatures <7°C exists, but this is serotype specific and the data are still not universally accepted and doubts surrounding the experimentation noted (ICMSF, 1996).

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.

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

Survival:

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

Temperature: *Salmonella* can survive for long periods under refrigeration. 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. Some foods, including meat appear to be protective of *Salmonella* during freezing (ICMSF, 1996).

pH: *Salmonella* are less acid resistant than *Escherichia coli.*

Water Activity: Survival in dry environments is a characteristic of these organisms. For example, they 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.

2.1.3 Inactivation (CCPs and Hurdles)

Temperature: Death can occur 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. Some rare serotypes (e.g. *S.* Senftenberg) are significantly more heat resistant than the others, but this organism is not important as a food pathogen (Doyle and Mazzotta, 2000).

N.B. D times for *Salmonella* can depend on the type of food involved. 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.

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: Decline in numbers is greatest at water activities just below that allowing growth. Lower a_w values appear to have a protective effect.

Preservatives: Growth was inhibited in the presence of 0.1% acetic acid (pH 5.1).

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

2.1.4 Sources

Human: 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. A small proportion (<1%) of cases 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, by direct contact and 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 can be important vehicles of salmonellosis. Other animal products, e.g. unpasteurised or re-contaminated pasteurised milk and dairy products, can also act as vehicles.

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.

2.2 *Salmonella* Serotypes in New Zealand

The non-typhoid *Salmonella* are divided into many (thousands of) serotypes. Most of these are capable of causing disease in humans, although a few have restricted host ranges. Similarly some are restricted to humans.

The ESR Enteric Reference Laboratory at the Kenepuru Science Centre provides *Salmonella* typing services for New Zealand. In addition to isolates from human cases sent by clinical laboratories, the laboratory also provides typing for isolates from animals and foods submitted by various sources. Isolates derived from poultry originate from Animal Health Laboratories (sent to ESR via the Ministry of Agriculture and Forestry (MAF)) as well as directly from poultry producers). Summaries of the isolates submitted by Animal Health Laboratories are published in the MAF Biosecurity Authority journal Surveillance, while a summary of all poultry derived isolates is published annually in the journal Lablink.

Detailed information on serotypes from poultry and human isolates in New Zealand is given in Sections 5 and 6 respectively.

2.2.1 *S.* Enteritidis Phage Type 4 (PT4) and *S.* Typhimurium Definitive Phage Type 104 (DT104)

Two serotypes that have caused major problems overseas are *S.* Enteritidis Phage Type 4 (PT4) and the antibiotic resistant *S.* Typhimurium Definitive Phage Type 104 (DT104).
S. Enteritidis PT4 became the most prevalent *Salmonella* causing human infection in the United Kingdom during the 1980s and 1990s. This was, in part, due to the fact that chicken eggs can be infected with *S.* Enteritidis PT4 internally or externally by the time they are laid, or can subsequently become contaminated after lay (Advisory Committee on the Microbiological Safety of Food, 1993).