Salmonella and Food Safety

Subjects: Agriculture, Dairy & Animal Science

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Salmonellosis is the second most reported gastrointestinal disorder in the EU resulting from the consumption of Salmonella-contaminated foods. Symptoms include gastroenteritis, abdominal cramps, bloody diarrhoea, fever, myalgia, headache, nausea and vomiting.

food safety food handling food hygiene Salmonella Salmonellosis foodborne illness

1. Introduction

Food poisoning due to pathogens is a major issue of public health concern worldwide with countries expending many resources to overcome it. Bacterial food infections are a source of worry for developed and developing countries. Salmonellosis is linked to the consumption of *Salmonella*-contaminated food products mostly from poultry, pork and egg products. Poor hand washing and contact with infected pets are some of the contamination routes [1]. When infective doses are ingested, the pathogen causes sickness by colonizing the intestinal tract. It is increasingly becoming a major concern with the global push towards ready-to-eat food products [2]. This group of products is of greater concern because of the minimal heating they are subjected to. The fact they can be consumed without high heat treatment further increases the risk.

2. Salmonella

Salmonella is a Gram-negative bacterium that uses flagella for movement. *Salmonella* is known to survive for extended periods in low moisture food products [3]. Table 1 shows how long different serotypes survive in dry products. Its ability to survive in low moisture environments is a problem with spices and herbs that are used globally because if contaminated, these organisms survive for extended periods. Worldwide trade of spices and herbs means these organisms could travel and break geographical barriers [4].

Table 1. *Salmonella* survival times in low water activity environments.

Food	*Salmonella* Serotypes	Survival Times	Reference
Dried milk products	*S.* Infantis, *S.* Typhimurium, *S.* Eastbourne	≤10 months	[5]

Food	*Salmonella* Serotypes	Survival Times	Reference
Desiccated plastic surface Pasta	*S.* Typhimurium *SL 1344*, *S.* Infantis, *S.* Typhimurium, *S.* Eastbourne	<100 weeks	[6]
		≤12 months	[7]
Milk chocolate	*S.* Infantis, *S.* Typhimurium, *S.* Eastbourne	>9 months at 20 °C	[8]
Bitter chocolate	*S.* Eastbourne	≤9 months at 20 °C	[8]
Halva	*S.* Enteritidis	>8 months at refrigeration temp	[9]
Peanut butter	*S.* Agona, *S.* Enteritidis, *S.* Michigan, *S.* Montevideo, *S.* Typhimurium	≤24 weeks at 5 °C ≤6 weeks at 21 °C	[10][11]
Paprika powder	multiple serotypes	>8 months	[12]

3. Global Burden of Salmonellosis

Stanaway et al. [13], while reporting on the global burden of non-typhoidal *Salmonella* invasive disease, asserted that non-typhoidal *Salmonella* remains a major cause of disease and death worldwide. Malnourished young children, the elderly, immunocompromised adults (such as HIV patients), sufferers of acute malaria and those with pre-existing debilitating sickness have greater risks. This infection can attack healthy hosts and in addition to diarrhoea, causes bacteraemia, meningitis and infections in the tonsils.

Food illnesses from invasive non-typhoidal *S. enterica* presented the highest disease burden. This is due to the pervasive nature of this organism, the acute diarrhoea it causes and frequent infection of children [14]. Kirk et al. [15] evaluated the health impact of all the serotypes of *Salmonella* and concluded that it presents the greatest foodborne burden. Combining data associated with *S. enterica* from both the invasive Non- Typhoidal *Salmonella* (iNTS), *Salmonella* Typhi and *Salmonella* Paratyphi A and diarrheal infections, a total of 8.76 million Disability-Adjusted Life Year (DALY) from all transmission sources and 6.43 million attributed to infected foods.

4. Control of Salmonellosis

4.1. Food Hygiene Practices

Food hygiene refers to the encompassing conditions and measures that prevent food contamination from production to consumption. Poor hygiene practices along the food chain from slaughtering or harvesting, processing, storage, distribution, transportation to preparation can expose the consumer to foodborne infections

that may be fatal [16]. Proper food hygiene practices centre on cleanliness, separating raw meat from other raw/cooked foods, cooking at correct temperatures and chilling (storing) foods before and after cooking [17].

4.2. Food Handler Effects

The Codex Alimentarius defines a food handler as “any person who directly handles packaged or unpackaged food, food equipment and utensils, or food contact surfaces and is therefore expected to comply with food hygiene requirements” [18]. Food handlers play a major role in food production and serving. They are responsible for preparing the food and this means they have more direct contact with food systems and can invariably be agents of contamination. The chance for contamination largely depends on how healthy the food handlers are, their personal hygiene, knowledge and application of food hygiene rules [19]. FSAI further stressed that handlers can indirectly contaminate foods by touching cooked foods after preparing raw foods without prior washing of hands, using the same equipment and utensils meant for raw foods for cooked foods, displaying cooked foods in places meant for raw foods or by poor personal hygiene.

4.3. Ready-to-Eat (RTE) Foods and Processed Foods with Needed Control

Processed food is defined as any food that has changed in its preparation. This alteration can be freezing, canning, heating, baking, etc. [20]. *Salmonella* has been isolated from processed foods such as nut butter, frozen pot pies, chicken nuggets, and stuffed chicken entrees [21]. Huang and Hwang [22] defined RTE foods “as a group of food products that are pre-cleaned, precooked, mostly packaged and ready for consumption without prior preparation or cooking”. The fact that RTE foods need no further heating step means the consumers have a heavy reliance on the control programs put in place by processors. RTE foods have a shorter shelf life compared to other processed foods. The shelf life is usually a maximum of three weeks after manufacture because they have not been subjected to lethal temperatures to conserve organoleptic properties. These foods depend on hurdle preservative steps such as acidic environment, packaging used, isotonic medium, refrigeration, etc. There is a necessity for all food handlers to be trained and retrained periodically on food safety especially when dealing with RTE foods to improve knowledge of food handling and food poisoning.

4.4. Knowledge vs. Behavioural Training Models

Well-trained food handlers with adequate knowledge of food safety can reduce the risk of food hazards [23]. Husain et al. [24] focused their study on three factors that can influence behaviour: attitude, normative beliefs, and perceived behavioural control. This study centred on food handler having a clear understanding of the importance of food safety in preventing foodborne illness. If they do not understand why they do what they do, then the behaviour would not change. Results showed that there was an improvement in personal hygiene and safe preparation of food for 12 weeks but did not translate to technical procedures such as time-temperature abuse, proper sanitation, etc. [25]. It is also very important to tailor training based on the role the employee takes and their background. The language is spoken and the level of education becomes very important. Type of training material is also important such as videos instead of text, pictures instead of just words and other languages instead of English [26].

5. Future Perspective and Conclusions

Efforts to control salmonellosis should involve both the public and private sectors. Government regulations and stricter measures being put in place can provide a framework that guides both domestic production and international importation requirements. However, this has to be infused into periodic training for food handlers. Industrially, stricter control systems need to be put in place. There should be more focus on production and process controls than on testing finished products. Consumers need to be educated both formally and informally on the basic steps of food safety. There is a need for studies that identify the most suitable means of communicating scientific information and raising awareness on salmonellosis to all strata of the population.

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