Microbial update
salmonella

by Roy Betts, Head of Microbiology, Campden-BRI, Chipping Campden, Gloucestershire, GL55 6LD, UK. Produced as a service to the food industry by Oxoid Ltd, part of Thermo Fisher Scientific.

The history of the organism that we now call salmonella is long and interesting. The knowledge of the role of the organism in the human disease of typhoid, dates back to the beginning of the 19th Century. Its role in foodborne disease was first documented in the 1880s.

In 1885, D. E. Salmon, an American bacteriologist, isolated an organism he named Bacillus cholera-suis from pigs suffering from hog cholera. Similar organisms were isolated from outbreaks of foodborne illness and the Genus Salmonella was named in 1900 in honour of Salmon. Even as late as 1929 however, authors were expressing doubts as to whether the Genus would get official recognition, as there were so many differences between the 'salmonellas' being isolated by different bacteriologists.

As time has progressed, the characteristics and definition on the Genus has become clearer, and they have become an acknowledged group of organisms causing a range of disease types in man and other animals. In most countries salmonella now cause more outbreaks of food poisoning than any other micro-organism or group.

What is it?

In microbiological terms, the Genus Salmonella falls into the Enterobacteriaceae family, together with other well known organisms such as Escherichia coli, citrobacter, cronobacter, enterobacter, hafnia, klebsiella, morganella, pantoea, proteus, and yersinia.

The salmonellas are Gram negative rod shaped bacteria and can grow well in the presence or absence of oxygen, they are also motile and can move around in liquids.

They are widely dispersed in nature and can be isolated fairly easily from a variety of sources using methods that have been developed over many years.

What does it cause?

Salmonella can cause a number of different type of illness in humans, ranging from typhoid, an extremely serious illness caused by Salmonella typhi, to various forms of more or less severe food poisoning caused by a range of other salmonellae. Infection of humans with food poisoning forms will begin with the ingestion of a 'dose' of the organism that can evade the host defences and colonise the intestinal tract.

The dose required to cause infection will vary and is dependent on the type of salmonella, whether the organism is injured or not, the fitness of the person consuming the food, and the type of food that is eaten.

It was thought some years ago, that the infective dose was high, however, it is now well known that in some cases consuming extremely low numbers of salmonella can cause a severe food poisoning, and from the view of the food producer, there is no 'safe' level of salmonella in food products that are ready to eat.

Gastroenteritis is caused by the growth of salmonella in the small intestine, invading the intestinal tissues. This results in the formation of various toxins and an inflammatory reaction within the gut resulting in diarrhoea and sometimes vomiting. Due to the need for the salmonella to grow within the gut, symptoms will usually become apparent somewhere around 24-48 hours after the contaminated food has been eaten.

In some rare occasions the organism can overcome host defences completely and invade the bloodstream, spreading around the body and causing a much more serious infection.

In most cases individuals will recover from salmonellosis without the need for antibiotic treatment, and full recovery is achieved within 2-7 days. Deaths resulting from salmonellosis are rare, but can occur if those affected are very young, old or have some other underlying illness.

It is important for those working within the food producing industries to understand that during recovery from illness, salmonella can still be excreted, even after symptoms have ceased. It is therefore important to ensure that food production workers that have suffered from salmonellosis are excluded from food contact work until it is known that they have fully recovered and are no longer excreting the organism.

Failure to do this will increase the risks of foods becoming contaminated with the pathogen.

Where does it come from?

Salmonella is a zoonotic organism. It is derived from animals and is passed by various vectors to humans who consume it in foods or drinks. The types of vector are numerous and large numbers of different food types have been linked to salmonellosis. Foods that originate from an animal source, such as raw meats, raw meat products, milk and milk products, have all been linked to outbreaks of salmonellosis.

Raw fruit and vegetable materials that may have come into contact with animals or animal products (untreated manures, or other faecal materials, contaminated irrigation water) may also become contaminated, as can water supplies where run off from contaminated land can cause contamination.

Foods that have been associated with outbreaks of salmonellosis include poultry, red meats, sausage, offal, eggs, unpasteurised milk, raw shellfish, various types of seafood, beansprouts, cabbage, cauliflower, lettuce, peppers, tomatoes, melon, unpasteurised fruit juices, coconut, spices, flavourings, infant formula, nuts, chocolate and ice cream. In the UK the biggest reservoir for salmonella has been poultry and poultry products. In the mid 1980s a very large proportion of raw poultry was contaminated with salmonella, as were raw shell eggs.

Since that time, poultry producers have introduced a range of intervention measures to control the organism.

These have been extremely successful and have considerably reduced the amount of raw poultry and eggs that are contaminated, and this has resulted in a great reduction in human illness caused by salmonella.

However, it is important to remain constantly aware of the potential risks from salmonella from a whole range of foods, and put into place adequate controls to eliminate the organism, if it were present, in any raw food product.

Controls for salmonella

Salmonella is not a difficult organism to control. It is not particularly heat resistant and can be prevented from growing by reducing pH, or water activity of foods. But it is important that food producers consider the risks of salmonella in their own production environments and introduce appropriate controls if required.

Adequate cooking will kill salmonella and in the UK a process of 70°C for two minutes at the slowest heating point within the product is considered appropriate to reduce the risk of salmonella considerably from all products (note: milk pasteurisation treatments are covered by legislation and must be followed).

Adjusting product pH, water activity or decreasing the temperature will prevent the growth of the organism. However, food producers using such techniques must remember that whilst growth may be prevented by reducing these factors, if the organism is present in the food or ingredient, it will remain viable and thus will be a risk to the consumer.

Key control factors that can be used to prevent growth are pH <3.8, water activity <0.92, temperature <5.2 C. Combinations of these factors well above the values noted previously may be equally as inhibitory to growth, but these should be established using predictive microbiology or challenge testing techniques before they are used.

Interestingly, some research has indicated that storage of salmonella cultures at or below control factor levels that prevent growth, does result in formation of very long cells. These can rapidly subdivide into much smaller individual cells when environmental conditions become favourable.

It is important that all food producers consider salmonella in their HACCP plans, and ensure that these plans cover the potential risks of salmonella presence in raw materials and ingredients.

Methods of detection

As noted previously, methods to detect salmonella have been developed over many years and are detailed in various British Standards, European Standards, International Standards and in the USA, FDA and USDA procedures.

Most of these methods are based around the use of conventional broths and agars and can give a result in around 3-5 days.

These methods usually require a pre-enrichment (to allow injured cells to recover and grow), a selective enrichment (to allow salmonella to outgrow all of the other organisms that are present in the food), and finally an isolation on one or more selective agars.

This will result in either a negative result, or a presumptive positive. Presumptive positive results do not mean that salmonella is present in a food, but simply that an organism that gives the same reaction of salmonella has been isolated.

Presumptive results must always be confirmed using serology or biochemistry and in the meantime companies may wish to take some preliminary action with implicated foods (for example quarantine until the confimatory test result is available).

Over recent years a number of more rapid methods have been produced by commercial method producers, and these can now give results in 30-50 hours.

Popular and well validated rapid methods include those based on immunoassay procedures and the polymerase chain reaction (PCR) technique. It is recommended that any company wishing to use a rapid method for salmonella detection, should only consider those that are well validated (for example by MicroVal, AFNOR, NordVal or AOAC) and they should also check that these methods work with their own ingredient/product types.

Salmonella (purple colonies) growing on Oxoid Brilliance Salmonella Agar (Oxoid Ltd).

Conclusions

Salmonella have been recognised as significant pathogens for over a century. Since their initial isolation, microbiologists have learned much about them, how they grow and survive in foods, how to prevent their growth and destroy them.

However, they still form the single biggest cause of outbreaks of food poisoning in most countries. This means that food producers must remain ever careful of salmonella risks, and include every appropriate control to eliminate them from their products. We must remember that many outbreaks have indicated that the ingestion of very low levels of the organism can result in illness.

Additionally, it would appear that salmonella can remain viable for long periods of time within food manufacturing environments, so any environmental or product isolation must be tracked down to find its route cause and then eliminated to ensure the production of safe foods. ■

FaxNOW +44 1256 329728
✉ val.stroud@thermofisher.com

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