Microbial update

viruses

by Dr Roy Betts, Head of Microbiology, Campden-BRI, Chipping Campden, Gloucestershire, GL55 6LD, UK.
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Viruses are very small obligate parasitic organisms found in many environments and able to infect a variety of different types of living organism. In size, they are far smaller than bacterial cells, many being less than 100nm (nanometres = 10^{-6} metre) in diameter. Their lifestyle is very different to other micro-organisms such as bacteria or fungi, in that they cannot multiply and increase in numbers outside of a host cell. They are truly intracellular parasites, they attach to and infect their host cell, they force that cell to make viral nucleic acid and proteins, the host cell will then break open (lyse) releasing perhaps hundreds or thousands of virus particles each able to infect other host cells.

What do they infect

Most viruses are very specific to the host that they can infect, and as noted before most living organisms can play host to viral infection of one form or another.

Bacteria have specific viruses that can infect them, these are known as bacteriophage or more simply phage and they can cause severe problems in the manufacture of fermented foods such as cheese. If phage infects the bacterial starter culture at a cheese manufacturer, then the culture will not grow and the cheese fermentation will not take place. But phage can also be used positively, they have been used for many years as a system for identifying bacteria such as salmonella allowing outbreaks to be quickly identified and tracked to a source, and more recently phages that specifically infect and kill pathogenic bacteria such as listeria, have been researched as a method of controlling such pathogens within the food manufacturing environment.

Plants can be infected by specific viruses, in fact the Tobacco Mosaic Virus was the first virus to be discovered in 1898 by Martinus Beijerinck. Since that time a large number of other plant viruses have been discovered and it has been estimated they cause an estimated $60 billion loss of crop yields worldwide every year.

Animal/human viruses are also well known, many are very host specific and affect only certain species of animal (for example myxomatosis in rabbits).

In humans the severity of virus illnesses ranges from those that cause simple warts, the common cold and influenza, to those causing very serious human illness such as smallpox and rabies.

Viruses and food

When considering the issue of viruses and foods, it must always be remembered that the virus will never grow in the food itself, it can however be carried on the food and cause infection when that food is eaten, food can be contaminated from water supplies, or directly from human contact particularly if a food handler is themselves contaminated and shedding virus either orally or faecally. The main viruses associated with foodborne infections are rotavirus, hepatitis and norovirus.

Rotavirus

This virus was first discovered in 1973 and is a common cause of diarrhoea in young children. It has been estimated that by the age of five virtually every child in the world has been infected by rotavirus at least once.

However, with each infection the child becomes more immune to the illness and is soon completely resistant to it. Adults are very rarely affected by this virus. The virus itself is known as a double stranded RNA virus (its genetic material is not DNA as it is in animals, plants and bacteria, but a double stranded RNA) and belongs to the family Reoviridae. The virus is transmitted by the faecal – oral route, and it is easy to see how children that are infected with the virus will

shed large numbers of virus particles through bouts of diarrhoea. The faeces of an infected person can contain more than 10 trillion infectious virus particles per gram and only 10-100 of these are required to transmit infection to another person. It is believed that these viruses can be quite stable in the environment and can survive for long periods outside of the host.

Poor hygiene will then pass infected virus particles onto surfaces and foods that other children will place into their mouths thus passing the infection on.

Whilst rotavirus is an important consideration in foods, they are mainly an illness of the young and can be controlled.

Hepatitis

Hepatitis A is one of five types of this virus (Hepatitis A, B, C, D and E), that mainly affect the liver and cause illness. Hepatitis viruses are known as picornaviruses, they are non-enveloped and contain single stranded RNA as their genetic material. With respect to foodborne illness its is only Hepatitis A that is commonly linked to a food source.

The Hepatitis A virus enters through the mouth, multiplies in the body and is passed in the faeces. The virus can be carried on improperly washed hands, and can be spread by direct contact, or by consuming food or drink that has been handled by a contaminated/infected person.

Contaminated drinking water or eating contaminated raw shellfish can also be

sources of infection, water can itself be contaminated by faecal material, and shellfish are filter feeders that can concentrate waterborne contaminants to high levels. If the virus has contaminated surfaces, it has been estimated that it can remain infective for up to 30 days.

Once a person has become infected, there is a considerable delay until symptoms begin, indeed it has been estimated that the peak shedding of virus particles from an infected individual begins two weeks before any obvious signs of illness, this is a great problem as these individuals can continue to handle and prepare foods during this time, potentially helping to infect large numbers of other people.

Foods that have been implicated in hepatitis outbreaks include cooked sliced meats sandwiches, fruits and juices, milk and milk products, vegetables, salads, improperly cooked shellfish and iced drinks (ice made with contaminated water). Control of contamination can be achieved by use of good hygienic practices and in suitable foods (for example shellfish) by heating (90°C with a holding time of 90 seconds is one potential process noted by the UK ACMSF).

Norovirus

Perhaps the most important virus that can cause foodborne illness is norovirus. The norovirus group was originally named the Norwalk virus after the town of Norwalk in Ohio USA, where an outbreak food poisoning occurred amongst children at a school in November 1968. Since that this the name of the particle has changed to Small Round Structured Virus (SRSV) and finally to norovirus. The virus is a single stranded non-enveloped RNA virus and they have a genetic information indicating that they belong to the family Caliciviridae.

Common names of the illness caused by noroviruses are winter vomiting disease, viral gastroenteritis, acute non-bacterial gastroenteritis, and even stomach flu.

Noroviruses are mainly transmitted by two routes:

- The faecal-oral route, by consumption of faecally contaminated food or water.
- By direct person-to-person spread. If someone comes into close contact with an infected individual having a bout of norovirus caused sickness, virus particles in aerosolised vomit can enter the mouth and nose and be swallowed.

There is no evidence that the virus can infect through the respiratory tract, it infects through the gastrointestinal tract and must be swallowed to begin infection, however, it has been estimated that the infective dose can be as low as 10 virus particles.

Once consumed the incubation period is usually between 24 and 48 hours but cases can occur within 12 hours of exposure. The classic symptoms of illness are very acute onset vomiting, that may be accompanied by watery non-bloody diarrhoea. The symptoms will usually last for 24 to 72 hours and recovery is complete with no long term problems.

It is believed that infective virus particles can be shed by infected persons before symptoms begin, however large scale shedding begins with onset of symptoms and may continue for two weeks or more after recovery. Some reports suggest that asymptomatic infection can occur, but the role of this in transmission to other individuals is not understood.

It is widely believed that the number of reported cases of norovirus infection vastly underestimates real levels of infection, indeed some estimates suggest that they may be responsible for 50% of all cases of foodborne gastroenteritis. The underestimation can occur because the relatively mild symptoms result in those affected not visiting their doctor and reporting the illness, and also because of difficulties in detecting the virus. Major outbreaks of norovirus illness have been widely reported to occur in hospitals and confined areas such as cruise ships, and these have resulted in the closure of hospital wards and the cancellation of cruises whilst major decontamination activities are done.

There is no method of detecting infective virus particles, until very recently the only method of detecting any particles, whether infective or non-infective, was by observing the particles under electron microscopy, an expensive and time consuming procedure that could only be done in specialised laboratories. Recently a range of molecular detection methods based on the Polymerase Chain Reaction (PCR) have been developed, this has meant more laboratories can confidently detect this virus in human samples. However two major methodological issues remain:

- The PCR method simply detects virus particles, and will give no information as to whether they are infective or not.
- While the PCR method works well with the very high virus titres found in infected human samples, in foods the virus will be present at low levels and significant separation and concentration of the particles would be required before the detection techniques could be employed.

The lack of methods to detect infective norovirus has meant that our knowledge of methods to inactivate it is scarce. Most work has utilised surrogate viruses that are similar to norovirus, but may not respond to inactivating procedures in the same way.

Various reports suggest that norovirus show 'good inactivation' after heating at 90°C for five minuttes, while work with other similar viruses indicate Feline Calicivirus shows a 7 log reduction after 75°C for two minutes and Murine Norovirus shows a 1.86 log reduction after 65°C for 30 seconds.

This still leaves some uncertainty over the heat resistance of human norovirus. Reports suggest that hypochlorite based sanitisers will inactivate norovirus, however alcohol based sanitisers (hand sanitiser gels) do not have a great effect.

Conclusions

Human norovirus is one of the great unknowns of foodborne illness, it is believed to cause a large number of cases and outbreaks each year, its is very infective and the dose required to cause illness is low. It does not grow on or in foods, but can be carried by food items to new hosts. It would appear to be inactivated by heat in the normal cooking range of temperature, however care must be taken to avoid cross contamination through poor hygiene after the cooking process has been applied.

This is an organism that we still cannot culture, detection methods have only just become usable by general laboratories and we have few ways of isolating and concentrating the organisms from foods. It is a microbiological risk we need to be aware of and design suitable controls for it into food handling and production methods. ■

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

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