Survival of SARS-CoV-2 on food surfaces: Executive Summary

There is also a potential risk of the droplets containing the virus, contaminating fomites such as foods and food packaging, leading to consumer and food handlers' exposure. A risk assessment published by the Food Standards Agency (FSA) in 2020 (Qualitative Risk Assessment (food.gov.uk)) concluded that it was very unlikely that you could catch coronavirus via food. This assessment included the worst-case assumption that, if food became contaminated during production, no significant inactivation of virus would occur before consumption. However, the rate of inactivation of virus on products sold at various temperatures was identified as a key uncertainty, because if inactivation does occur more rapidly in some situations, then a lower risk may be more appropriate. This project was commissioned to measure the rate of inactivation of virus on the surface of a range of food and food packaging, reducing that uncertainty. The results will be used to consider whether the assumption currently made in the risk assessment remains appropriate for food kept at a range of temperatures, or whether a lower risk is more appropriate for some.

We conducted a laboratory-based study artificially contaminating infectious SARS-CoV-2 virus onto the surfaces of foods, including broccoli, peppers, apple, raspberry, cheddar cheese, sliced ham, olives, brine from the olives, white and brown bread crusts, croissants and pain au chocolat. The foods tested were selected as they are commonly sold loose on supermarkets shelves or uncovered at deli counters or market stalls, they may be difficult to wash, and they are often consumed without any further processing, i.e. cooking. Food packaging tested were: Polyethylene terephthalate (PET1) trays and bottles, aluminium cans and composite drinks cartons. These were selected as they are the most commonly used food packaging materials or consumption of the product may involve direct mouth contact with the packaging. We measured how the amount of infectious virus present on those surfaces declined over time, at a range of temperatures and relative humidity levels, reflecting typical storage conditions.

Results showed that virus survival was varied for the different foods and food packaging examined. In several cases, e.g. peppers, bread crust, sliced ham, and cheddar cheese, infectious virus was detected for several days under some conditions tested. On the surfaces of pastries, infectious virus could be found for several hours.

A significant decrease in virus levels of >90% (i.e. 1-$\log_{10}$ reduction) was seen on broccoli and peppers at 24 hours after artificial contamination, and low levels, above the limit of detection (LOD) remained for several days. The virus levels on raspberry dropped significantly by 97% (1.5-log10 reduction) after 24 hours incubation in ambient (21°C +/- 3°C) and chill conditions (6°C +/- 1°). When apple or olives were tested, the virus levels significantly decreased within just a few minutes of the virus being added, to less than the LOD of 25 PFU per sample. We speculate that chemicals, such as flavonoids, in the apple and olive skin are responsible for this inactivation. The recovery of active SARS-CoV-2 when added to brine, obtained from packaged olives, gradually decreased over time. There was less than a 1-log10 reduction after 1 day, reaching the limit of detection by day 4 under all conditions tested.

SARS-CoV-2 added to brown and white bread crust decreased >90% (i.e. 1-log10 reduction) after 24 hours. However, the rate of viral decrease was much faster for pastries, croissants and pain au chocolat, with >90% reduction (> 1-log10) within 6 hours and to less than the LOD of 25

PFU per sample. Both pastries are coated with a liquid egg wash, which may have an inhibitory effect on the virus. It has been suggested that arachidonic acid and other unsaturated fatty acids which are present in high levels in eggs, may serve as anti-viral compounds.

Virus added to either cheddar cheese or sliced ham, remained infectious at high levels, with only a 1-log10 reduction by 7 days, when the testing period was stopped. Both cheddar cheese and sliced ham are high in moisture, protein and saturated fat content, possibly offering protection to the virus.

Food packaging materials were also tested and had variable virus survival at the different incubation temperatures and humidity levels investigated. In ambient conditions, at 21°C, on PET1 bottles, there was a significant decrease in virus levels of >90% (i.e. 1-log10 reduction) after 24 hours. However, at 53% RH, virus levels did not reach the LOD of 25 PFU until day 3 (2.4-log10 decrease). At 6°C, virus was still detectable at 5 days after artificial contamination in some conditions. The virus survival was similar for PET1 trays, with a significant decrease in virus levels of >90% (i.e. 1-log10 reduction) after 24 hours but levels did not reach the LOD until day 6 at 6°C, 20% RH. When aluminium cans were tested, there was a significant decrease in virus levels of >90% (i.e. 1-log10 reduction) after 24 hours, on cans stored in ambient (23°C) conditions. In chilled conditions, the virus survived longer; at 6C and 80% RH, levels did not reach the LOD until day 4. For composite drinks cartons a significant decrease in virus levels of >90% (i.e. 1-log10 reduction) was observed after 24 hours stored in ambient (23°C) conditions. However, for cartons stored in some chilled conditions (6°C and 80% RH), the virus did not reach the LOD until day 4. The addition of mucin, to simulate respiratory mucus surrounding the virus particles, made no statistical difference to virus survival on any of the food packaging tested.