AMERICAN FROZEN FOOD INSTITUTE

Scientific Review of SARS-CoV-2/COVID-19 and Implications for Foods

Frequently Asked Questions

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Many questions have been raised about the nature of infectivity and persistence of SARS-CoV-2, the virus that causes COVID-19, in or on foods, food contact surfaces and food packaging materials, and the potential for foodborne transmission. The American Frozen Food Institute (AFFI) and Drs. Lee-Ann Jaykus and Benjamin Chapman, researchers at North Carolina State University, have monitored technical developments in the field and reviewed relevant literature to better understand the scientific nature of these questions.

Key takeaways that are critical to the discussion on potential foodborne transmission:

- There is no scientifically vetted protocol/method available for detection of SARS-CoV-2 in foods. Interpretation of any reports of detection of the virus in food must be approached with caution.
- Recent reports of purported foodborne transmission, be it by detection of viral RNA in foods and/or environmental samples, or by epidemiological means, have not been transparent in terms of methodologies and findings. As such, they cannot be adequately validated by the scientific community.
- Nucleic acid-based detection methods, which are the cornerstone of SARS-CoV-2 detection in food and environmental samples, cannot discriminate between infectious and non-infectious virus and should not be used to assess the risk of virus transmission.
- The food industry has responded rapidly and effectively to the COVID-19 crisis, with a focus on protecting the essential workforce. The measures almost universally taken (e.g., universal face masking, face and plexiglass shield, physical distancing, contact tracing and quarantine, increased hand hygiene and surface disinfection, among others) will also decrease the likelihood of virus contamination of foods during harvesting, processing, and preparation.
- An emphasis on foodborne SARS-CoV-2 transmission in the absence of any evidence for this route, misdirects attention, efforts and resources from the primary mode of transmission which is between persons via aerosols and their associated droplets.

1. **What is the likelihood of the presence of SARS-CoV-2 on food or of food becoming contaminated with this virus?**
    a. There is a slight possibility that food could become contaminated with SARS-CoV-2. Even if food was contaminated, it is generally agreed that SARS-CoV-2 is transmitted by respiratory, not foodborne routes. The overwhelmingly higher and most significant mode of disease transmission is through exchange or release of respiratory (aerosol) droplets laden with the virus, resulting in person-to-person transmission usually through contact with an infected individual.
    b. There are two major pathways that have been recognized by food safety professionals in which food contamination by the SARS-CoV-2 virus could potentially occur:
        i. Presence of the virus in foodstuffs of animal origin (in which the animal has been infected by SARS-CoV-2); or
        ii. (a) Contamination of food products with relevant secretions from infected individuals who are shedding the virus
        (b) Contact of food with a surface or hands that have become contaminated by the deposition of virus-laden aerosol droplets.
    c. There is also no evidence that consumption of food of animal origin from infected animals can cause illness.[1] To-date, there is no evidence for cross-species transmission of SARS-CoV-2 among domesticated animals that constitute the normal American food supply, hence livestock are unlikely to play a role in the transmission of the virus.
    d. The virus could be transferred by a sick or infected individual who is in close contact with food for a prolonged period by the following actions: touching food with virus-laden hands (after touching their face, eyes, and nose); breathing, sneezing, or yelling in the proximity of food (aerosol transmission). Although less likely, the virus could be transferred by indirect contact between the food and a surface on which there is virus contamination as a result of falling droplets from breathing, talking, sneezing, coughing, etc. Food manufacturers are actively taking steps to identify employees who show symptoms of and/or test positive for COVID-19, ensuring they stay home and are not involved in food operations, and performing contact tracing when applicable. Further, they are instituting strict physical distancing policies and enforcing the use of face coverings such as masks and/or face shields. Again, it is important to note that the respiratory/person-to-person route remains the predominant mode of transmission and the primary driver of the pandemic.
    e. The food industry is working diligently to prevent food contamination with SARS-CoV-2 as summarized below:
        i. Adherence to Good Manufacturing Practices (GMPs), including, but not limited to the following: maintain a clean and hygienic manufacturing area, ensure good sanitation practices, sustain controlled environmental conditions to prevent cross-contamination, and assure critical operations and processes are validated

ii. Identification and exclusion of ill and/or infected food workers (discussed below), including contact tracing
iii. Emphasis on proper and frequent washing of hands, frequent use of alcohol-based hand sanitizers between handwashing events, avoiding bare-hand contact of foods, frequent cleaning and sanitizing of food contact surfaces and equipment, and enhanced surface disinfection of high touch and contact areas as well as restrooms.

f. To-date there is no credible evidence of foodborne illness, or a measurable risk of transmission through food contamination or recovery of infective SARS-CoV-2 virus from a food or food ingredient.

2. How long is the SARS-CoV-2 virus known to persist on food?

a. There are limited studies on SARS-CoV-2 persistence. Comprehensive data comes from a review of similar information for the highly pathogenic MERS coronavirus and SARS-CoV-1, with one or two studies specific to SARS-CoV-2. Collectively, it appears that SARS-CoV-2 persists for a long time (months or years) under frozen conditions. It likely survives for days under refrigeration conditions. The virus in its infectious state can persist on surfaces, at room temperature, for a maximum of a few days, depending on the surface, as discussed below.[2,3]

b. Survivability of SARS-CoV-2 on foods depends on the starting concentration, rate of decline, ambient temperature, time and detection limit of a potential testing method. Unpublished data on environmental sampling in food manufacturing facilities shows the detection rate to be very low (<1%). Currently, there is no reliable method for sampling or testing SARS-CoV-2 in foods, that has been published in the literature or released by a national government. Therefore, any evidence or data of food contaminated with SARS-CoV-2 has not been subject to rigorous scientific vetting and should be considered anecdotal at the current time.

3. How effective are commonly used cleaning and disinfection products?

a. SARS CoV-2 should theoretically be sensitive to cleaning compounds, disinfectants and sanitizers used by the food industry. However, based on data for the MERS and SARS-CoV-1 surrogates, they are less fragile than most enveloped viruses. This has been summarized by Kampf et al. (2020)[2]:

i. Human coronavirus can be efficiently inactivated by surface disinfection procedures with 62-71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite within 1 minute.
ii. Other biocidal agents such as 0.05-0.2% benzalkonium chloride or 0.02% chlorhexidine digluconate are less effective.
iii. When using disinfection products, the entire formulation, not just the active ingredient, must be considered. U.S. CDC refers to EPA List N for approved disinfectants to use against SARS-

CoV-2,[4] although many have not been specifically tested against SARS CoV-2.

iv. As an enveloped virus, SARS-CoV-2 is likely to be more sensitive to detergents than non-enveloped viruses like norovirus and hepatitis A virus; however, which detergents at what concentrations have not yet been determined.

b. In the absence of much data, we must rely on strict adherence of GMPs which are already the cornerstone of food safety. This includes rigorous attention to good hygiene practices, employee health policies, proper usage of personal protective equipment, cleaning and disinfection, sanitation practices, and adherence to standard operating procedures.

4. **Studies have identified human ACE-2 receptors in the colon, esophagus, small intestine and salivary glands as the molecular target for SARS-CoV-2. Can the digestive systems serve as an alternate route of infection? What are the implications of these potential receptors for SARS-CoV-2 in the human gastrointestinal (GI) tract, given this is considered to primarily be a respiratory infection?**

   a. While ACE-2 receptors for SARS-CoV-2 are necessary for the virus to enter cells, many other cellular factors are also required for viral replication and these have not been well characterized.[5,6] The mere identification of these receptors in the GI tract does not mean that the primary infection is digestive in origin. A recent paper showed that SARS-CoV-2 could establish infection in an ACE2 humanized mouse model via the intragastric route, but only at a dose 10-fold higher than was needed for respiratory challenge, and even then the infection was inefficient (Sun et al., 2020).[7] In fact, all the epidemiology points to an exclusive respiratory transmission route. While it is possible the virus uses the GI tract as a secondary infection site, that has not been clearly established.

5. **What is the possibility of SARS-CoV-2 fecal-oral transmission?**

   a. Studies have demonstrated the presence of SARS-CoV-2 viral RNA from fecal samples of sick individuals [7,8], but there is conflicting evidence as to whether this virus is infectious or not. Studies also show a wide range of prevalence of virus in fecal specimens of infected individuals, although the concentration of the virus in fecal specimens appears to be lower than in more relevant respiratory specimens. We need more information on virus infectivity and quantitative data on virus load in feces before we can seriously consider a possibility for fecal-oral transmission.

   b. Fecal material from an infected individual can be transferred as a result of poor hygiene during food preparation or manufacturing (again, food manufacturers adhere to GMPs to address this problem), but there is no evidence that the virus ingested this way causes infection and results in disease.

a. CDC and other federal and international agencies have not reported any known instances of fecal-oral or foodborne transmission of the virus.

6. **What is the risk of consuming ready-to-eat (RTE) foods such as raw fruits and vegetables, deli meats, ice cream, frozen fruits, etc. that may be contaminated with SARS-CoV-2? What happens if a person consumes RTE food contaminated with SARS-CoV-2?**
    a. The likelihood that ready-to-eat foods such as raw fruits and vegetables,[9] deli-meats, frozen fruits, etc. may be contaminated with SARS-CoV-2 is low. The probability that other foods could become contaminated by the virus at the end of the food chain just prior to consumption is likewise low. Even if this were to occur, there is no evidence such contamination would lead to infection and/or result in the disease.
    b. FDA reiterates, currently there is no evidence of food being associated with transmission of the virus.[10] At the time of this writing, the risk of disease transmission by foodborne routes is so remote as to be considered inconsequential compared to the wide reach of community-spread we are currently experiencing.[11]

7. **What is the likelihood of the presence of SARS-CoV-2 on food packaging and potential transmission of the virus to a person?**
    a. There is a small possibility that food packaging and materials could become contaminated with SARS-CoV-2 due to contact with an ill or infected individual. However, the magnitude of that contamination event would be limited to the region in which the contact occurred and by the fact that the virus will degrade over time. It is important to recognize that the overwhelmingly higher and more significant mode of disease transmission is from person-to-person, specifically through close contact and exposure to respiratory droplets laden with the virus.
    b. The methodology used to detect SARS-CoV-2 on food packaging materials as reported from China[12] has not been publicly released or published. Nor have the specific results, making it impossible for the scientific community to weigh in on the validity of the reports on evidence of virus contamination on these materials.

8. **How long can this virus persist on food packaging?**
    a. A recent study has shown that infectious SARS-CoV-2 can survive on inanimate surfaces commonly used in food packaging such as cardboard (24 hours), plastic (3 days), glass and paper and may serve as a fomite (a material likely to transmit infection) and serve as a contact hazard. SARS-CoV-2 can persist on plastic and steel surfaces for up to three days.**Error! Bookmark not defined.** [3] Similar to foods, survivability of SARS-CoV-2 on food packaging will also depend on the starting virus concentration, rate of decline, ambient temperature, time and detection limit of a potential testing method.

b. Recent studies have shown that SARS-CoV-2 can also remain stable for prolonged periods of time on fomites, albeit with diminishing infectivity that is dependent on the type of surface and nature of respiratory fluids that settle on them.[13]
c. How readily the virus is transferred from inanimate surfaces to hands or foods is unknown. However, based on studies with other viruses, viral load would likely be low on contaminated food packaging material and it is unlikely that all the virus on one surface would be efficiently transferred to another. Furthermore, the transfer rate is very low when both surfaces are dry, as the presence of moisture facilitates transfer.

9. Can we test for the presence of SARS-CoV-2 in food?

a. Currently, there are no methods for sampling and testing SARS-CoV-2 in foods that have been scientifically vetted or published in the literature. While an interesting scientific exercise, the practical utility of food product testing at the current time is highly questionable, and were it to be done, the results should be considered unreliable and a poor use of resources. Because testing will be based on molecular diagnostics, a positive test result will not provide any evidence as to whether the virus (if present) is infectious or not.
b. There have been several reports originating from China about positive SARS-CoV-2 tests from foods (frozen shrimp, frozen chicken wings, and frozen salmon);[12] however, in the absence of published methods and results, the scientific validity of these reports cannot be definitively established. Similarly, epidemiological linkages have been reported by China implicating potentially contaminated food to illness, but details have been scant, meaning that the validity of the epidemiological investigations is unknown. It is also important to note that no other country has reported the finding of SARS-CoV-2 in foods.
c. Environmental testing services by commercial laboratories have recently been offered and advertised, particularly to validate disinfection efficacy. Again, this testing is based on molecular diagnostics, the results of which do not indicate the infectivity status of the virus. The value of such environmental screening has yet to be determined.

10. How can we inactivate SARS-CoV-2 in food?

a. Although there is no thermal inactivation data specifically associated with the SARS-CoV-2 virus, other coronavirus research shows, cooking for 4 minutes at 63°C inactivates this class of viruses.[2] It is important note that time-temperature are impacted by the heating matrix so these estimates would likely vary based on food type.
b. It is safe to assume that pasteurization guidelines for many different foods are enough to inactivate SARS-CoV-2.

11. What is the risk with food products or ingredients that are imported from a country or region impacted by SARS-CoV-2?

a. FDA states there is currently no evidence to support transmission of COVID-19 associated with imported goods and no reported cases of COVID-19 in the U.S. associated with imported goods.[10]

12. Can SARS-CoV-2 survive in refrigerated and frozen foods?

a. In general, coronaviruses are stable at frozen temperatures; therefore, SARS-CoV-2 is unlikely to be inactivated by freezing.[14] The virus would be expected to be less stable at refrigeration temperatures but may persist for days to weeks in refrigerated foods.[15] To-date there is no credible evidence of contamination of frozen and refrigerated foods or recovery of SARS-CoV-2 from these food products, much less any indication of transmission of the virus from consumption of refrigerated and frozen foods.

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