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Food Safety Briefs



Risk Assessment

A Comprehensive Risk Pathway of the Qualitative Likelihood of Human Exposure to SARS-CoV-2 from the Food Chain

Annie Locas, Julie Brassard, Megan Rose-Martel, Dominic Lambert, Alyssa Green, Anne Deckert, Michelle Illing. *J Food Prot.* 2021 Sep 9. doi: 10.4315/JFP-21-218. [Article link](#)

Significance: Canadian experts conclude there is no comprehensive epidemiological evidence of confirmed cases of SARS-CoV-2 causing COVID-19 from transmission through food or food packaging.



A group of experts from all Canadian federal food safety partners was formed to monitor the potential issues relating to SARS-CoV-2 food contamination, to gather and consider all of the relevant evidence and to determine the impact for Canadian food safety. A comprehensive risk pathway was generated to consider the likelihood of a SARS-CoV-2 contamination event at any of the relevant steps of the food processing and handling chain, and potential for exposure and transmission of the virus to the consumer. The scientific evidence was reviewed and assessed for each event in the pathway, taking into consideration relevant elements that could increase or mitigate the risk of contamination. The advantage of having an event-wise contextualization of

the SARS-CoV-2 transmission pathway through the food chain, is that it provides a systematic and consistent approach to evaluate any new data and communicate its importance and impact. The pathway also increases the objectivity and consistency of the assessment in a rapidly evolving and high-stakes situation. Based on our review and analysis, there is currently no comprehensive epidemiological evidence of confirmed cases of SARS-CoV-2, or its variants, causing COVID-19 from transmission through food or food packaging. Considering the remote possibility of exposure through food, the likelihood of exposure by ingestion or contact with mucosa is considered negligible to very low and good hygiene practices during food preparation should continue to be followed.

Foodborne Pathogens

Photo-Activated Carbon Dots for Inactivation of Foodborne Pathogens *Listeria* and *Salmonella*

Xiuli Dong, Ping Wang, Jasmine Darby, Yongan Tang, Christopher M Overton, Sophia Kathariou, Ya-Ping Sun, Liju Yang. *Appl Environ Microbiol.* 2021 Sep 22. doi: 10.1128/AEM.01042-21. [Article link](#)

Significance: Carbon-based nanoparticles were highly effective at inactivating *Listeria* but less so with *Salmonella* cells.

Foodborne pathogens have long been recognized as major challenges for the food industry and repeatedly implicated in food product recalls and outbreaks of foodborne diseases. This study demonstrated the application of a recently discovered class of visible-light activated carbon-based nanoparticles, namely carbon dots (CDots), for photodynamic inactivation of foodborne pathogens. The results demonstrated that CDots were highly effective in the photo-inactivation of *Listeria monocytogenes* in suspensions and on stainless steel surfaces. However, it was much less effective to *Salmonella* cells, but treatments with higher CDots concentration and longer time were still able to inactivate *Salmonella* cells. Mechanistic implications of the observed different antibacterial effects on the two types of cells were discussed, and the associated generation of intracellular reactive oxygen species (ROS), the resulted lipid peroxidation, and the leakage of nucleic acid and proteins from the treated cells were analyzed, with the results collectively suggesting CDots as a class of promising photodynamic inactivation agents for foodborne pathogens. Importance: Foodborne infectious diseases have long been recognized as major challenges in public health.



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Contaminations of food processing facilities and equipment with foodborne pathogens occur often. There is a critical need for new tools/approaches to control the pathogens and prevent such contaminations in food processing facilities and other settings. This study reports a newly established antimicrobial nanomaterials platform, carbon dots (CDots) coupled with visible/natural light, for effectively and efficiently inactivation of representative foodborne bacterial pathogens. The study will contribute to promoting the practical application of CDots as a new class of promising nanomaterial-based photodynamic inactivation agents for foodborne pathogens.

Foodborne Illness

Presence of Biogenic Amines in Food and Their Public Health Implications: A Review

Abdullah Khalid Omer, Rebin Rafaat Mohammed, Peshraw S Mohammed Ameen, Zaniar Ali Abas, Kamil Ekici. *J Food Prot.* 2021 Sep 1;84(9):1539-1548. doi: 10.4315/JFP-21-047. [Article link](#)

Significance: The presence of biogenic amines are linked to foodborne disease outbreaks and cancers. Reducing bacterial loads in foods is critical to addressing the public health threats they pose.

Essential foods as part of a daily meal may include numerous kinds of biogenic amines (BAs) at various concentrations. BAs have a variety of toxicological effects on human health and have been linked to multiple outbreaks of foodborne disease. BAs also are known to cause cancer based on their ability to react with nitrite salts, resulting in the production of carcinogenic organic compounds (nitrosamines). Ingestion of large quantities of BAs in food causes toxicological effects and health disorders, including psychoactive, vasoactive, and hypertensive effects and respiratory, gastrointestinal, cardiovascular, and neurological disorders. The toxicity of BAs is linked closely to the BAs histamine and tyramine. Other amines, such as phenylethylamine, putrescine, and cadaverine, are important because they can increase the negative effects of histamine. The key method for reducing BA concentrations and thus foodborne illness is management of the bacterial load in foods. Basic good handling and hygiene practices should be used to control the formation of histamine and other BAs and reduce the toxicity histamine and tyramine. A better understanding of BAs is essential to enhance food safety and quality. This review also includes a discussion of the public health implications of BAs in foods.

Mycotoxins

Mimotope-Based Immunoassays for the Rapid Analysis of Mycotoxin: A Review

Dan-Tong Huang, Hui-Jun Fu, Jia-Jia Huang, Lin Luo, Hong-Tao Lei, Yu-Dong Shen, Zi-Jian Chen, et. al. *J Agric Food Chem.* 2021 Sep 28. DOI: 10.1021/acs.jafc.1c04169. [Article link](#)

Significance: Two mimotopes could improve immunoassays for testing mycotoxin contamination by their use as substitutes in the analysis.

Mycotoxins are toxic contaminants in foods and feeds that are naturally occurring and largely unavoidable. Determining their contents in these products is essential to protect humans from harm. Immunoassays of mycotoxins have been well-established because they are fast, sensitive, simple, and cost-effective. However, a major limitation of immunoassays is the requirement of toxic mycotoxins as competing antigens, standards, or competing tracers. Mimotopes are peptides or proteins that can specifically bind to antibodies and compete with analytes for binding sites by mimicking antigenic epitopes. They can be employed as substitutes for competing antigens, standards, or competing tracers to avoid use of mycotoxins. This review summarizes the production and functionalization of the two main kinds of mimotopes, mimic peptides and anti-idiotypic antibodies (Ab₂), and their applications in rapid analysis of mycotoxins.

Food Packaging

Chemical contaminants in canned food and can-packaged food: a review

Jingyun Zheng, Lei Tian, Stéphane Bayen. *Crit Rev Food Sci Nutr.* 2021 Sep 29;1-32. doi: 10.1080/10408398.2021.1980369. [Article link](#)

Significance: Metals, polymeric contaminants and biogenic amine contaminants have been reported in canned foods and in relation to the canning process. This review discusses the occurrence of these contaminants, the analytical techniques involved, and the factors influencing the presence of these contaminants in canned and can-packaged food.

Canning, as a preservation technique, is widely used to extend the shelf life as well as to maintain the quality of perishable

foods. During the canning process, most of the microorganisms are killed, reducing their impact on food quality and safety. However, the presence of a range of undesirable chemical contaminants has been reported in canned foods and in relation to the canning process. The present review provides an overview of these chemical contaminants, including metals, polymeric contaminants and biogenic amine contaminants. They have various origins, including migration from the can materials, formation during the canning process, or contamination during steps required prior to canning (e.g. the disinfection step). Some other can-packaged foods (e.g. beverages or milk powder), which are not canned foods by definition, were also discussed in this review, as they have been frequently studied simultaneously with canned foods in terms of contamination. The occurrence of these contaminants, the analytical techniques involved, and the factors influencing the presence of these contaminants in canned food and can-packaged food are summarized and discussed.

Chemical Contaminants

Utilizing High-Throughput Screening Data, Integrative Toxicological Prioritization Index Score, and Exposure-Activity Ratios for Chemical Prioritization: A Case Study of Endocrine-Active Pesticides in Food Crops

Yu-Syuan Luo, Tsung Hsien Wu. *J Agric Food Chem.* 2021 Sep 29;69(38):11427-11439. doi: 10.1021/acs.jafc.1c03191. [Article link](#)



Significance: The exposure-activity ratio approach to identifying endocrine active chemical contaminants could be an aid in prioritizing chemicals for risk assessment.

Endocrine-active chemicals can directly act on nuclear receptors and trigger the disturbances of metabolism and a homeostatic system, which are important risk factors for complicating chronic diseases in humans. The endocrine-active potentials of pesticides acting on estrogen, androgen, and thyroid hormone receptors have been extensively evaluated for pesticides; however, the effects on other receptors are less understood. This study aims to comprehensively characterize and prioritize the endocrine-active pesticides using an exposure-activity ratio (EAR) method and toxicological prioritization index (ToxPi). The aggregate exposure assessment of pesticides was performed using a computational exposure model [stochastic human exposure and dose simulation high-throughput model (SHEDS-HT)]. Minimum in vitro point of departure values were converted to human oral equivalent doses via in vitro-to-in vivo extrapolation. The overall endocrine-disrupting potentials of pesticides were evaluated via 76 assays, representing 11 nuclear receptors. EARs and ToxPi scores were then derived to prioritize 79 pesticides in food. This case study demonstrates that EAR profiling can inform the regulatory agencies for a relevant chemical prioritization, which would direct in-depth health risk assessments in the future.

Polychlorinated Dibenzo-p-dioxins and Dibenzofurans (PCDD/Fs) in Food and Human Dietary Intake: An Update of the Scientific Literature

González N, Domingo JL. *Food Chem Toxicol.* 2021 Sep 24;157:112585. doi: 10.1016/j.fct.2021.112585. [Article link](#)

Significance: Decreases in the environmental presence of dioxins and furans has reduced their presence in the food supply of these toxic and carcinogenic groups of compounds.

It is well established that for non-occupationally exposed populations, dietary intake is, by far, the main way of human exposure to polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-p-furans (PCDD/Fs), a family of environmental POPs with a well-known potential toxicity - including carcinogenicity - in humans. We here summarize the results of recent studies (2010-2021) (databases: Scopus and PubMed), focused on determining the levels of PCDD/Fs in food samples of different origins, as well as the dietary intake of these pollutants. We have revised studies conducted in various Asian, American and European countries. However, information is rather limited, with no recent data for most countries over the world. Due to the enormous differences in the methodologies of the studies, to conduct a detailed comparison of the results for the different regions and countries has not been possible. Notwithstanding, where data over time are available, important reductions have been observed. These reductions have been linked to the decreases in the environmental emissions of PCDD/Fs noted in recent years. Interestingly, reductions in the levels of PCDD/Fs in biological tissues are also occurring in parallel. In general, the tolerable daily/weekly/monthly dietary intakes of PCDD/Fs are not being currently exceeded where data are available.

Heavy Metals

A Critical Review on the Interactions of Microplastics with Heavy Metals: Mechanism and Their Combined Effect on Organisms and Humans.

Yanxiao Cao, Mengjie Zhao, Xianying Ma, Yongwei Song, Shihan Zuo, Honghu Li, Wenzhuo Deng. *Sci Total Environ.* 2021 Sept. 20;788:147620. doi: 10.1016/j.scitotenv.2021.147620. [Article link](#)

Significance: The attachment of metals to microplastics are considered in this broad review of how they interact and their public health impact.

Although individual toxicity of microplastics (MPs) to organisms has been widely studied, limited knowledge is available on the interactions between heavy metals and MPs, as well as potential biological impacts from their combinations. The interaction between MPs and heavy metals may alter their environmental behaviors, bioavailability and potential toxicity, leading to ecological risks. In this paper, an overview of different sources of heavy metals on MPs is provided. Then the recent achievements in adsorption isotherms, adsorption kinetics and interaction mechanism between MPs and heavy metals are discussed. Besides that, the factors that influence the adsorption of heavy metals on MPs such as polymer properties, chemical properties of heavy metals, and other environmental factors are also considered. Furthermore, potential combined toxic effects from MPs and heavy metals on organisms and human health are further summarized.

Caffeine

Coffee Consumption and Incident Tachyarrhythmias: Reported Behavior, Mendelian Randomization, and Their Interactions

Eun-Jeong Kim 1, Thomas J Hoffmann 2 3, Gregory Nah 1, Eric Vittinghoff 3, Francesca Delling 1, Gregory M Marcus. *JAMA Intern Med.* 2021 Sep 1;181(9):1185-1193. doi: 10.1001/jamainternmed.2021.3616. [Article link](#)

Significance: In this prospective cohort study, greater amounts of coffee consumption were associated with a lower risk of arrhythmia, with no clear evidence that genetically mediated caffeine metabolism affected the association.

Importance: The notion that caffeine increases the risk of cardiac arrhythmias is common. However, evidence that the consumption of caffeinated products increases the risk of arrhythmias remains poorly substantiated. **Objective:** To assess the association between consumption of common caffeinated products and the risk of arrhythmias. **Design, setting, and participants:** This prospective cohort study analyzed longitudinal data from the UK Biobank between January 1, 2006, and December 31, 2018. After exclusion criteria were applied, 386 258 individuals were available for analyses. **Exposures:** Daily coffee intake and genetic polymorphisms that affect caffeine metabolism. **Main outcomes and measures:** Any cardiac arrhythmia, including atrial fibrillation or flutter, supraventricular tachycardia, ventricular tachycardia, premature atrial complexes, and premature ventricular complexes. **Results:** A total of 386 258 individuals (mean [SD] age, 56 [8] years; 52.3% female) were assessed. During a mean (SD) follow-up of 4.5 (3.1) years, 16 979 participants developed an incident arrhythmia. After adjustment for demographic characteristics, comorbid conditions, and lifestyle habits, each additional cup of habitual coffee consumed was associated with a 3% lower risk of incident arrhythmia (hazard ratio [HR], 0.97; 95% CI, 0.96-0.98; $P < .001$). In analyses of each arrhythmia alone, statistically significant associations exhibiting a similar magnitude were observed for atrial fibrillation and/or flutter (HR, 0.97; 95% CI, 0.96-0.98; $P < .001$) and supraventricular tachycardia (HR, 0.96; 95% CI, 0.94-0.99; $P = .002$). Two distinct interaction analyses, one using a caffeine metabolism-related polygenic score of 7 genetic polymorphisms and another restricted to CYP1A2 rs762551 alone, did not reveal any evidence of effect modification. A mendelian randomization study that used these same genetic variants revealed no significant association between underlying propensities to differing caffeine metabolism and the risk of incident arrhythmia. **Conclusions and relevance:** In this prospective cohort study, greater amounts of habitual coffee consumption were associated with a lower risk of arrhythmia, with no evidence that genetically mediated caffeine metabolism affected that association. Mendelian randomization failed to provide evidence that caffeine consumption was associated with arrhythmias.

Food Allergens

Natural Immunomodulating Substances Used for Alleviating Food Allergy

Tian Yang, Cheng Li, Wentong Xue, Linjuan Huang, Zhongfu Wang. *Crit Rev Food Sci Nutr*. 2021 Sep 8;1-19. doi: 10.1080/10408398.2021.1975257. [Article link](#)

Significance: Promising new advances in developing anti-allergic foods and/or using natural, immunomodulating food ingredients have the potential to alleviate food allergies, estimated to affect 10 percent of the global population.

Food allergy is a serious health problem affecting more than 10% of the human population worldwide. Medical treatments for food allergy remain limited because immune therapy is risky and costly, and anti-allergic drugs have many harmful side effects and can cause drug dependence. In this paper, we review natural bioactive substances capable of alleviating food allergy. The sources of the anti-allergic substances reviewed include plants, animals, and microbes, and the types of substances include polysaccharides, oligosaccharides, polyphenols, phycocyanin, polyunsaturated fatty acids, flavonoids, terpenoids, quinones, alkaloids, phenylpropanoids, and probiotics. We describe five mechanisms involved in anti-allergic activities, including binding with epitopes located in allergens, affecting the gut microbiota, influencing intestinal epithelial cells, altering antigen presentation and T cell differentiation, and inhibiting the degranulation of effector cells. In the discussion, we present the limitations of existing research as well as promising advances in the development of anti-allergic foods and/or immunomodulating food ingredients that can effectively prevent or alleviate food allergy. This review provides a reference for further research on anti-allergic materials and their hyposensitizing mechanisms.