Risk Assessment

A Common Approach for Ranking of Microbiological and Chemical Hazards in Foods Based on Risk Assessment - Useful But Is It Possible?

Significance: This article identifies the advancements needed to develop a common framework for ranking of risk of chemical and microbiological hazards.

This article compares and contrasts microbial and chemical risk assessment methodologies in order to evaluate the potential for a common framework for ranking of risk of chemical and microbiological hazards, and developments needed for such a framework. An overview of microbial (MRA) and chemical (CRA) risk assessment is presented and important differences are highlighted. Two microbiological and two chemical hazard-food combinations were ranked based on both a margin of exposure and a risk assessment approach. The comparisons illustrated that it is possible to rank chemical and microbiological hazard-food combinations with traditional approaches from each domain and indicated that the rank order but not the absolute measures is similar using either approach. Including severity in the assessment using DALY reduced differences between hazards and affected the outcome more than which approach was used. Ranking frameworks should include assessment of uncertainty as an integral part of the ranking, and be based on assessment of risk, not safety, and expressed in a common health metric such as disease burden. Necessary simplifications to address data gaps can involve the use of default scenarios. Challenges include comparisons of case-based vs. non-case-based health-endpoints, e.g. biomarker concentration, and integration of the severity of health effects into ranking.

Foodborne Pathogens

Characterization of Virulence and Persistence Abilities of Listeria monocytogenes Strains Isolated From Food Processing Premises

Significance: Multivirulence locus sequence typing was used to determine virulence types and epidemic clones of 15 Listeria monocytogenes strains isolated from various food processing plants.

We report the characterization of 15 Listeria monocytogenes strains isolated from various food processing plants by multivirulence locus sequence typing to determine virulence types (VTs) and epidemic clones. Molecular mechanisms involved in adaptation to food processing environments and related to virulence were also studied. Phenotypic behaviors associated with various antimicrobials, biofilm formations, and invasiveness were assessed. There were 11 VTs among the 15 L. monocytogenes strains. Strains belonging to six VTs were stress survival islet 1 (SSI-1) and one strain of VT94 was SSI-2. Tn6188 was found in VT6 and VT94 strains, and bcrABC cassette genes were identified in VT21, VT60, and VT63 strains. Only one strain, in VT20, showed ilkS, whereas a full-size inlA was detected in strains belonging to VT8, VT20, VT21, and VT63. VT10, VT20, VT21, VT60, and VT63 strains were the most tolerant to studied disinfectants. A VT6 strain showed the strongest biofilm formation ability in polyvinyl chloride, and strains belonging to VT10, VT11, VT20, and VT94 had moderate abilities. Antimicrobial sensitivity tests showed that all the L. monocytogenes strains were multidrug resistant. P tests revealed that only strains of VT10, VT60, and VT94 were significantly noninvasive (P < 0.05) in Caco-2 cells. Our findings illustrate how L. monocytogenes isolates exploit diverse mechanisms to adapt to adverse conditions. Consequently, detailed characterization of L. monocytogenes isolates is required for comprehensive elimination of this pathogenic bacterium in food processing environments.
Evaluation of a Bead-Based Salmonella Molecular Serotyping Method for Salmonella Isolated From Food and Environmental Samples

Significance: A rapid bead-based Salmonella molecular serotyping method was evaluated relative to traditional serotyping.

Salmonella is a leading cause of foodborne illness worldwide, and foods containing Salmonella (except raw meat and poultry products) are considered adulterated. Serotyping of Salmonella is an essential part of surveillance and investigation of outbreaks. This study evaluated a bead-based Salmonella molecular serotyping (SMS) method, which included the O-group 1, H-antigen, alternate target, and O-group 2 assays, compared with traditional serotyping. Salmonella was isolated from food, pet food, and environmental samples or were reference strains. A total of 572 isolates were analyzed by using two formats of the SMS method in comparison with traditional methods: 485 were analyzed by using Radix SMS (a custom user-mixed format), 218 were analyzed by using Luminex SMS (a commercial kit format), and 131 of the total isolates were analyzed by both formats for comparison. The SMS method was evaluated on the basis of the successful identification of antigens by the probes included in the method. The method identified 550 (96.2%) isolates as expected, 6 (1.0%) isolates were not identified as initially expected but were shown to be correctly identified by SMS after reanalysis by traditional serotyping, and 16 (2.8%) isolates not identified as expected possessed an antigen that should have been detected by the method but was not. Among the isolates considered correctly identified, 255 (44.6%) were identified to a single serovar, 44 (7.7%) required additional biochemical testing to differentiate variants or subspecies, and 251 (43.9%) were partially serotyped because probes for some antigens were not in the assay or had allelic variation for known serovars. Whole genome sequencing, SeqSero, and the Salmonella In Silico Typing Resource gave added confirmation for three isolates. Addition of the O-group 2 assay enabled the identification of 55 (9.6%) of 572 isolates. The SMS method could fully or partially serotype most isolates within a day. The SMS method should be a valuable tool when faster screening methods are needed, such as outbreaks and screening large numbers of environmental isolates.

Foodborne Illness
Recalls of Foods Due to Microbial Contamination Classified by the Canadian Food Inspection Agency, 2000 to 2017

Significance: This article summarizes the number and nature of foods recalled as a result of microbial contamination, classified by the Canadian Food Inspection Agency, from 2000 to 2017.

Recall of microbial-contaminated food products is an important intervention in preventing the transmission of foodborne illness. Here, we summarize the number and nature of foods recalled as a result of microbial contamination, classified by the Canadian Food Inspection Agency, for the period 1 January 2000 through 31 December 2017. A total of 10,432 food products were recalled from 2,094 recall events in Canada because of microbial contamination during this period. The meat, meat products and poultry category, followed by fishery and seafood products and nuts and edible seeds, contained the food products most commonly associated with microbial contamination. Most microbial-contaminated food products reported were recalled because of the presence bacterial pathogens. Salmonella contamination was responsible for the largest number of recall events, whereas Listeria monocytogenes contamination accounted for the greatest number of food products recalled because of microbial contamination. L. monocytogenes contamination was also most commonly associated with major food recall events, although records may be inflated because of an invested effort to prevent future L. monocytogenes outbreaks following a 2008 deli meat recall. The findings and data we present in this study will support future surveillance and analysis of microbial-contaminated food recalls in Canada.

Mycotoxins
From Hypoxia and Hypoxia-Inducible Factors (HIF) to Oxidative Stress: A New Understanding of the Toxic Mechanism of Mycotoxins

Significance: This review highlights the underlying mechanisms of hypoxia and HIF-1α in the mycotoxin-induced oxidative stress effect, which may have applications for early diagnosis and treatment of mycotoxicosis.

This October, the Nobel Prize in Physiology or Medicine 2019 was jointly awarded to William G. Kaelin Jr., Sir Peter J. Ratcliffe, and Gregg L. Semenza for their discoveries of "how cells sense and adapt to oxygen availability." Importantly, the protein...
named hypoxia-inducible factors (HIF) were revealed in the molecular machinery that how cells regulate the activity of genes in response to hypoxia. Hypoxia has a close relationship with oxidative stress and its related diseases including cancer. Actually, accumulating evidence and recent advances show that mycotoxins, including ochratoxin A, trichothecene mycotoxins T-2 toxin, deoxynivalenol, and diacetoxyscirpenol have the potential of triggering hypoxia in cells. Moreover, HIF-1α activation is involved in the mycotoxin-induced oxidative stress response. As is known, oxidative stress is considered to be a common mechanism of various toxicities of mycotoxins; however, an in-depth molecular mechanism, especially the molecular target in this context is not fully understood. Therefore, in this work, we have discussed the underlying mechanism(s) of hypoxia and HIF-1α in the mycotoxin-induced oxidative stress effect. We believe that the explanation of hypoxia and HIF-1α would open up new avenues for early diagnosis and treatment of mycotoxicosis. More importantly, under these circumstances, we compile a special issue, “Mycotoxins in Food: New Determination Methods, Toxic Mechanisms, and Control Strategies” for Food and Chemical Toxicology. Researchers are encouraged to submit their newest research articles and excellent work within this topic for the readers of Food and Chemical Toxicology.

**Food Packaging**

**Long-Term Wear Effects on Nanosilver Release From Commercially Available Food Contact Materials**


**Significance:** A quantitative assessment of nanoparticle release from commercially available nanosilver-enabled food contact materials was performed.

Potential consumer exposure to nanoparticles (NPs) from nanoenabled food contact materials (FCMs) has been a driving force for migration studies of NPs from FCMs. Although NP migration from fresh, unused FCMs was not previously observed, conditions that result in significant changes to the surface of FCMs have not been investigated for NP migration into food. Therefore, a quantitative assessment of nanoparticle release from commercially available nanosilver-enabled FCMs was performed using an abrasion protocol to simulate cleaning, cutting, scraping and other stressful use conditions. Laser scanning confocal microscopy (LSCM) analysis showed a general increase in root mean square (RMS) roughness after FCM abrasion, and particle count (for particle sizes from 80 nm to 960 nm) at the surface was 4 orders of magnitude higher for the abraded FCMs. Migration was evaluated using both water and 3% (v/v, volume fraction) acetic acid as food simulants. Low concentrations of total Ag were detected in water simulants with a small portion (<10 ng dm⁻²) in the form of silver nanoparticles (AgNPs). Median particle diameter ranged from 39 nm to 50 nm with particle number concentrations on the order of 10⁶ particles dm⁻². Total Ag migration into 3% (v/v) acetic acid was significantly higher than in water; however, 3% (v/v) acetic acid was not suitable for evaluation of NP release due to dissolution of AgNPs to Ag⁺ under acidic solution chemistries.

**Heavy Metals**

**A New Method for Evaluating the Bioaccessibility of Different Foodborne Forms of Cadmium**


**Significance:** An in vitro physiologically based extraction test combined with Visual MINTEQ modeling was used to predict the toxicity of different forms of cadmium in food.

The bioabsorption and biotoxicity of cadmium are closely related to its binding form. Currently, total concentration is used as the indicator for evaluating cadmium toxicity in food, but it might not accurately reflect cadmium’s toxic effects. This study attempted to evaluate the toxicity of the different forms of cadmium including cadmium-malate, cadmium-glutathione, and cadmium-metallothionein that are commonly found in food. The in vitro physiologically based extraction test (PBET) combined with Visual MINTEQ modeling was used to predict the toxicity of different forms of cadmium, and acute toxicity testing was performed in mice for validating their results. The in vivo experimental results showed that different forms of cadmium had diverse biotoxicities of which PBET was a good predictor. In particular, the simulation of cadmium ions in PBET using the MINTEQ software revealed that the free cadmium ion content in the simulated intestinal fluid had a superior linear relationship than the total cadmium concentration with the toxicology indexes. Verification using the other two forms of cadmium confirmed the accuracy of the prediction of their biotoxicity. These findings hopefully provide an important reference for a more accurate and rapid safety assessment of cadmium in food.
Caffeine

Caffeine, Type of Coffee, and Risk of Ovarian Cancer: A Dose-Response Meta-Analysis of Prospective Studies

Significance: This systematic review and meta-analysis found no statistically significant association between caffeine intake or different types of coffee and the risk of ovarian cancer.

Context: Prospective studies on caffeine and different types of coffee intake in relation to the risk of ovarian cancer have shown conflicting results. Objective: The aim of the present study was to perform a dose–response meta-analysis of cohort studies on the association between dietary caffeine intake, different types of coffee consumption, and the risk of ovarian cancer. Data sources: PubMed/Medline, ISI Web of Science, Scopus, and EMBASE were searched to identify relevant studies reported until October 2018. Study selection: Prospective cohort studies that had considered caffeine or different types of coffee as the exposure variable and ovarian cancer as the main outcome variable or as one of the outcome variables were included in our systematic review and meta-analysis. Two of us independently screened 9344 publications. A total of 14 cohort studies were included in the meta-analysis. Data extraction: Two of us independently extracted the data. Any disagreements were resolved in consultation with the principal investigator. Results: Combining 13 effect sizes, we found no substantial association between coffee consumption and risk of ovarian cancer [risk ratio (RR), 1.08; 95% CI, 0.89 to 1.33]. Also, one additional cup daily of coffee consumption was marginally associated with an increased risk of ovarian cancer (RR, 1.02; 95% CI, 0.99 to 1.05; P = 0.21; I² = 0.0%; P heterogeneity = 0.68). No statistically significant association was observed between caffeine intake or caffeinated or decaffeinated coffee consumption and the risk of ovarian cancer. Conclusions: We found no statistically significant association between caffeine intake or different types of coffee and the risk of ovarian cancer.

Food Allergens

Long-Term Sublingual Immunotherapy for Peanut Allergy in Children: Clinical and Immunologic Evidence of Desensitization

Significance: Extended-therapy peanut sublingual immunotherapy provided clinically meaningful desensitization in the majority of children with peanut allergy.

Background: Peanut sublingual immunotherapy (SLIT) for 1 year has been shown to induce modest clinical desensitization in allergic children. Studies of oral immunotherapy, epicutaneous immunotherapy, and SLIT have suggested additional benefit with extended treatment. Objective: We sought to investigate the safety, clinical effectiveness, and immunologic changes with long-term SLIT in children with peanut allergy. Methods: Children with peanut allergy aged 1 to 11 years underwent extended maintenance SLIT with 2 mg/d peanut protein for up to 5 years. Subjects with peanut skin test wheals of less than 5 mm and peanut-specific IgE levels of less than 15 kU/L were allowed to discontinue therapy early. Desensitization was assessed through a double-blind, placebo-controlled food challenge (DBPCFC) with up to 5000 mg of peanut protein after completion of SLIT dosing. Sustained unresponsiveness was further assessed by using identical DBPCFCs after 2 to 4 weeks without peanut exposure. Results: Thirty-seven of 48 subjects completed 3 to 5 years of peanut SLIT, with 67% (32/48) successfully consuming 750 mg or more during DBPCFCs. Furthermore, 25% (12/48) passed the 5000-mg DBPCFC without clinical symptoms, with 10 of these 12 demonstrating sustained unresponsiveness after 2 to 4 weeks. Side effects were reported with 4.8% of doses, with transient oropharyngeal itching reported most commonly. Side effects requiring antihistamine treatment were uncommon (0.21%), and no epinephrine was administered. Peanut skin test wheals, peanut-specific IgE levels, and basophil activation decreased significantly, and peanut-specific IgG4 levels increased significantly after peanut SLIT. Conclusion: Extended-therapy peanut SLIT provided clinically meaningful desensitization in the majority of children with peanut allergy that was balanced with ease of administration and a favorable safety profile.