Food Safety Briefs

Institute for the Advancement of Food and Nutrition Sciences

Submit an Abstract! Share Your Science! Abstracts Due November 13, 2023

Science Innovation Showcase

Join Us! December 12-14, 2023

https://iafns.org/event/2023-science-innovation-showcase/

Risk Assessment

An Update on Formaldehyde Adulteration in Food: Sources, Detection, Mechanisms and Risk Assessment

Md Bokthier Rahman, Monayem Hussain, Meera Probha Kabiraz, Noordiana Nordin, Shahida Anusha Siddiqui, Shuva Bhowmik, Mohajira Begum. *Food Chem*. 2023 Nov 30:427:136761. doi: 10.1016/j.foodchem.2023.136761. Article link

Significance: A review of study findings on food adulteration with formaldehyde and their assessment of food safety based on the analytical method applied in geographical regions, food matrix types, and their sources in foods.

Formaldehyde is added illegally to food to extend its shelf life due to its antiseptic and preservation properties. Several research has been conducted to examine the consequences of adulteration with formaldehyde in food items. These findings suggest that adding formaldehyde to food is considered harmful as it accumulates in the body with long-term consumption. In this review includes study findings on food adulteration with formaldehyde and their assessment of food safety based on the analytical method applied to various geographical regions, food matrix types, and their sources in food items. Additionally, this review sought to assess the risk of formaldehyde-tainted food and the understanding of its development in food and its impacts on food safety in light of the widespread formaldehyde adulteration. Finally, the study would be useful as a manual for implementing adequate and successful risk assessment to increase food safety.

Foodborne Pathogens

Selection of Mutant *Listeria* Phages Under Food-Relevant Conditions Can Enhance Application Potential

Claire N Schamp, Nitin Dhowlaghar, Lauren K Hudson, Daniel W Bryan, Qixin Zhong, Elizabeth M Fozo, Ahmed Gaballa, et. al. *Appl Environ Microbiol*. 2023 Oct 31;89(10):e0100723. doi: 10.1128/aem.01007-23. Article link

Significance: Experimental evolution of phages can be used to select for improved phages with better performance against *Listeria monocytogenes* under specific conditions.

Bacteriophages are viruses that infect and kill bacteria. Currently, phage products are available for the control of the pathogen *Listeria monocytogenes* in food products in the United States. In this study, we explore whether experimental evolution can be used to generate phages with improved abilities to function under specific food-relevant conditions. Ultra-pasteurized oat and whole milk were chosen as test matrices as they represent different food groups, yet have similar physical traits and macronutrient composition. We showed that (i) wild-type phage LP-125 infection kinetics are different in the two matrices and (ii) LP-125 has a significantly higher burst size in oat milk. From this, we attempted to evolve LP-125 to have improved infection kinetics in whole milk. Ancestral LP-125 was passaged through 10 rounds of amplification in milk conditions. Plaque-purified DNA samples from milk-selected phages were isolated and sequenced, and mutations present in the isolated phages were identified. We found two nonsynonymous substitutions in LP125_108 and LP125_112 genes, which encode putative baseplate-associated glycerophosphoryl diester phosphodiesterase and baseplate protein, respectively. Protein structural modeling showed that the substituted amino acids in the mutant phages are predicted to localize to surface-exposed helices on the corresponding structures, which

740 15th Street NW
Washington, DC
20005

Tel: 202.659.0184, Ext. 135
Fax: 202.659.3859
iafns@iafns.org

might affect the surface charge of proteins and their interaction with the bacterial cell. The phage containing the LP125_112 mutation adsorbed significantly faster than the ancestral phage in both oat and whole milk. Follow-up experiments suggest that fat content may be a key factor for the expression of the phenotype of this mutation. IMPORTANCE Bacteriophages are one of the tools available to control the foodborne pathogen, *Listeria monocytogenes*. Phage products must work under a broad range of food conditions to be an effective control for *L. monocytogenes*. Here, we show that the experimental evolution of phages can be used to generate new phages with phenotypes useful under specific conditions. We used this approach to select for a mutant phage that more efficiently binds to *L. monocytogenes* that is grown in whole milk and oat milk. We show that the fat content of these milks is necessary for the expression of this phenotype. Our findings show that experimental evolution can be used to select for improved phages with better performance under specific conditions. This approach has the potential to support the development of condition-specific phage-based biocontrols in the food industry.

Foodborne Illness

Investigation of a *Salmonella* Montevideo Outbreak Related to the Environmental Contamination of a Restaurant Kitchen Drainage System, Québec, Canada, 2020-2021

André Paradis, Marie-France Beaudet, Marianne Boisvert Moreau, Caroline Huot. *J Food Prot*. 2023 Oct;86(10):100131. doi: 10.1016/j.jfp.2023.100131. Article link

Significance: A restaurant's drainage system was the source of a *Salmonella* Montevideo outbreak in Canada which highlights the need to consider plumbing systems and possible aerosolization of bacteria as a potential source of restaurant-related salmonellosis outbreaks.

In May 2020, the Direction de santé publique du CIUSSS de la Capitale-Nationale (DSPu) received a report from the Laboratoire de santé publique du Québec of a cluster of three cases of *Salmonella enterica enterica*, serogroup C1, serotype Montevideo. The epidemiological investigation identified a total of 67 cases between January 1, 2020, and August 13, 2021, 66% of which were directly linked to a restaurant in the area. The *Salmonella* strains from most of these cases were found to be identical by whole-genome sequencing (cluster code 2005MontWGS-1QC). The initial inspection of the restaurant by the competent authorities (Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec) - including the evaluation of hygiene and food safety, the search for cases of illness among workers and food sampling - was unable to establish the source of the outbreak. Environmental samples showed that the restaurant's kitchen drains were contaminated with the same strain of *Salmonella* Montevideo as the cases in the outbreak. Several cleaning and disinfection methods were used repeatedly. When environmental sampling at the restaurant sites was repeatedly and consecutively negative, cases in the community stopped. The prior occurrence of a fire in the kitchen may have played a role in the contamination of the restaurant drains. In conclusion, public health professionals should consider drainage systems (plumbing) and possible aerosolization of bacteria as a potential source of a restaurant-related salmonellosis outbreak.

Mycotoxins

Advancing Mycotoxin Detection: Multivariate Rapid Analysis on Corn Using Surface Enhanced Raman Spectroscopy (SERS).

Allison Gabbitas, Gene Ahlborn, Kaitlyn Allen, Shintaro Pang. *Toxins* (Basel). 2023 Oct 12;15(10):610. doi: 10.3390/toxins15100610. Article link

Significance: The application of label-free Surface-Enhanced Raman spectroscopy and multivariate analysis is promising for swift and simultaneous detection of mycotoxins in corn and possibly other crops.

Mycotoxin contamination on food and feed can have deleterious effect on human and animal health. Agricultural crops may contain one or more mycotoxin compounds; therefore, a good multiplex detection method is desirable to ensure food safety. In this study, we developed a rapid method using label-free surface-enhanced Raman spectroscopy (SERS) to simultaneously detect three common types of mycotoxins found on corn, namely aflatoxin B1 (AFB1), zearalenone (ZEN), and ochratoxin A (OTA). The intrinsic chemical fingerprint from each mycotoxin was characterized by their unique Raman spectra, enabling clear discrimination between them. The limit of detection (LOD) of AFB1, ZEN, and OTA on corn were 10 ppb (32 nM), 20 ppb (64 nM), and 100 ppb (248 nM), respectively. Multivariate statistical analysis was used to predict concentrations of AFB1, ZEN, and OTA up to 1.5 ppm (4.8 µM) based on the SERS spectra of known concentrations, resulting in a correlation coefficient of 0.74, 0.89, and 0.72, respectively. The sampling time was less than 30 min per sample. The application of label-free SERS and multivariate analysis is a promising method for rapid and simultaneous detection of mycotoxins in corn and may be extended to other types of mycotoxins and crops.

Heavy Metals

Reassessment of the Cadmium Toxicological Reference Value for Use in Human Health Assessments of Foods

Heather R Schaefer, Brenna M Flannery, Lynn M Crosby, Régis Pouillot, Sofia M Santillana Farakos, Jane M Van Doren, Sherri Dennis, et. al. *Regul Toxicol Pharmacol*. 2023 Oct:144:105487. doi: 10.1016/j.yrtph.2023.105487. Article link

Significance: FDA has developed an oral toxicological reference value (TRV) for characterizing potential health concerns from dietary exposure to cadmium.

The U.S. Food and Drug Administration (FDA) developed an oral toxicological reference value (TRV) for characterizing potential health concerns from dietary exposure to cadmium (Cd). The development of the TRV leveraged the FDA's previously published research including (1) a systematic review for adverse health effects associated with oral Cd exposure and (2) a human physiological based pharmacokinetic (PBPK) model adapted from Kjellstrom and Nordberg (1978) for use in reverse dosimetry applied to the U.S. population.

Adverse effects of Cd on the bone and kidney are associated with similar points of departure (PODs) of approximately 0.50 µg Cd/g creatinine for females aged 50-60 based on available epidemiologic data. We also used the upper bound estimate of the renal cortical concentration (50 µg/g Cd) occurring in the U.S. population at 50 years of age as a POD. Based on the output from our reverse dosimetry PBPK Model, a range of 0.21-0.36 µg/kg bw/day was developed for the TRV. The animal data used for the animal TRV derivation (0.63-1.8 µg/kg bw/day) confirms biological plausibility for both the bone and kidney endpoints.

Food Packaging

Global Plastic Waste Recycling and Extended Producer Responsibility Laws

Significance: Extended Producer Responsibility laws increase a producer's responsibility for product generation and disposal which can be mandated at a local regulatory level to create more effective recycling programs.

This work was supported by IAFNS' Food Packaging Safety & Sustainability Committee

In the USA, 8.66% of municipal solid waste (MSW) plastic was recycled and 75.9% landfilled (2018). Some critical challenges in widespread adoption of post-consumer recycled (PCR) plastic include high collection costs, sortation complexity, inconsistent feedstock properties, and unknown contamination leading to safety considerations. The objective of this review is to discuss global Extended Producer Responsibility (EPR) policies/regulations and their ability to facilitate coordination of domestic/international policies and business to overcome critical recycling complications. Global EPR and recycling laws were examined to compare and contrast initiatives to increase recycling and avoid plastic waste generation. EPR laws increase producers' liability towards product generation, marketing, and disposal by applying fees and taxes on products depending on product recyclability and volume generation. Countries with established plastic EPR regulations and landfill bans often possess higher recycling rates. The results of this research can facilitate development of local regulatory mandates to increase recycling rates.

Chemical Contaminants

Research Recommendations for Selected IARC-Classified Agents: Impact and Lessons Learned

Significance: During the past decade, new research addressed a range of the International Agency for Research on Cancer's 2009 recommendations and supported updated classifications for priority agents.

Background: The International Agency for Research on Cancer (IARC) Monographs program assembles expert working groups who publish a critical review and evaluation of data on agents of interest. These comprehensive reviews provide a unique opportunity to identify research needs to address classification uncertainties. A multidisciplinary expert review and workshop held in 2009 identified research gaps and needs for 20 priority occupational chemicals, metals, dusts, and physical agents, with the goal of stimulating advances in epidemiological studies of cancer and carcinogen mechanisms. Overarching issues were also described. **Objectives:** In this commentary we review the current status of the evidence for the 20 priority agents identified in 2009. We examine whether identified Research Recommendations for each agent were addressed and their potential impact on resolving classification uncertainties. **Methods:** We reviewed the IARC classifications of each of the 20 priority agents and identified major new epidemiological and human mechanistic studies published since the last evaluation. Information sources were either the published Monograph for agents that have been reevaluated or, for agents not yet reevaluated, Advisory Group reports and literature searches. Findings are described in view of recent methodological developments in Monographs evidence evaluation processes. **Discussion:** The majority of the 20 priority agents were reevaluated by IARC since 2009. The overall carcinogen classifications of 9 agents advanced, and new cancer sites with either "sufficient" or "limited" evidence of carcinogenicity were also identified for 9 agents. Examination of published findings revealed whether evidence gaps and Research Recommendations have been addressed and highlighted remaining uncertainties. During the past decade, new research addressed a range of the 2009 recommendations and supported updated classifications for priority agents. This supports future efforts to systematically apply findings of Monograph reviews to identify research gaps and priorities relevant to evaluation criteria established in the updated IARC Monograph Preamble.

Caffeine

Consumption of Coffee, Tea, and Caffeine at Midlife, and the Risk of Physical Frailty in Late Life
Significance: Higher consumption of caffeine at midlife, via coffee or tea, was associated with a reduced likelihood of later physical frailty in a dose-response relationship.
Objectives: Our study evaluated the prospective association between the consumption of caffeine-containing beverages at midlife and the risk of physical frailty at late life within a population-based cohort of Chinese adults living in Singapore over a follow-up period of 20 years. **Design:** Prospective cohort study. **Setting and Participants**: We used data from 12,583 participants from the baseline and third follow-up interviews of the Singapore Chinese Health Study (SCHS). Participants had a mean age of 53 years at baseline (1993-1998), and a mean age of 73 years during the third follow-up (2014-2017).

Methods: At baseline, habitual consumption of caffeine-containing beverages was evaluated using a validated semi-quantitative food-frequency questionnaire. During the third follow-up, physical frailty was assessed using the modified Cardiovascular Health Study phenotype. **Results:** Compared with non-daily drinkers, those who drank 4 or more cups of coffee daily had reduced odds of physical frailty [odds ratio (OR), 0.54; 95% CI, 0.38-0.76]. Similarly, compared with those who hardly drank tea, participants who drank tea everyday also had reduced odds (OR, 0.82; 95% CI, 0.71-0.95). Total daily caffeine intake at midlife was associated with reduced likelihood of frailty at late life in a dose-response relationship (Ptrend < .001). Relative to their counterparts in the lowest quartile of daily caffeine intake (0-67.6 mg/d), participants in the highest quartile (223.0-910.4 mg/d) had an OR of 0.77 (95% CI, 0.66-0.91). Higher caffeine consumption was associated with lower likelihood of being in the slowest quintile for timed up-and-go (TUG) and weakest quintile for handgrip strength. **Conclusions and Implications:** In this cohort of Chinese adults, higher consumption of caffeine at midlife, via coffee and tea, was associated with a reduced likelihood of physical frailty in late life.

Food Allergens

Effects of Early Diet on the Prevalence of Allergic Disease in Children: A Systematic Review and Meta-Analysis

Shumin Wang, Pingping Yin, Leilei Yu, Fengwei Tian, Wei Chen, Qixiao Zhai. *Adv Nutr.* 2023 Oct 10:S2161-8313(23)01389-3. doi: 10.1016/j.advnut.2023.10.001. Article link

Significance: Introduction to potential allergens for normal infants or probiotics for infants at high risk of allergies may protect against later development of allergic disease.

Recent evidence suggests that the timing of introduction, types, and amounts of complementary foods/allergenic foods may influence the risk of allergic disease. However, the evidence has not been updated and comprehensively synthesized. The Cochrane Library, EMBASE, Web of Science, and PubMed databases were searched from the inception of each database up to 31 May 2023 (articles prior to 2000 were excluded manually). Statistical analyses were performed using RevMan 5. The GRADE approach was followed to rate the certainty of evidence. Compared with >6 mo, early introduction of eggs (≤6 mo of age) might reduce the risk of food allergies in preschoolers aged <6 y (odds ratio [OR], 0.65; 95% confidence interval [CI], 0.53, 0.81), but had no effect on asthma or atopic dermatitis (AD). Consumption of fish at 6-12 mo might reduce the risk of asthma in children (aged 5-17 y) compared with late introduction after 12 mo (OR, 0.61; 95% CI: 0.52, 0.72). Introduction of allergenic foods for ≤6 mo of age, compared with >6 mos, was a protective factor for the future risk (children aged ≤10 y) of AD (OR, 0.93; 95% CI: 0.89, 0.97). Probiotic intervention for infants at high risk of allergic disease significantly reduced the risk of food allergy at ages 0-3 y (OR, 0.72; 95% CI: 0.56, 0.94), asthma at 6-12 y (OR, 0.61; 95% CI: 0.41, 0.90), and AD at aged <6 y (3-6 y: OR, 0.70; 95% CI: 0.52, 0.94; 0-3 y: OR, 0.73; 95% CI: 0.59, 0.91). Early introduction of complementary foods or the high-dose vitamin D supplementation in infancy was not associated with the risk of developing food allergies, asthma, or AD during childhood. Early introduction to potential allergen foods for normal infants or probiotics for infants at high risk of allergies may protect against development of allergic disease.

Emerging Science Areas

Emerging Areas Food Safety – Packaging

Bisphenol-A and Phthalate Metabolism in Children with Neurodevelopmental Disorders

T. Peter Stein, Margaret D. Schluter, Robert A. Steer, Xue Ming. *PLOS One.* Sept. 13, 2023. doi.org/10.1371/journal.pone.0289841. Article link

Significance: Children with ADHD and ASD compared to healthy controls shared statistically significant reduced efficiency in detoxifying BPA

Background: The etiology of autism spectrum (ASD) and Attention Deficit/Hyperactivity (ADHD) disorders are multifactorial. Epidemiological studies have shown associations with environmental pollutants, such as plasticizers. This study focused on two of these compounds, the Bisphenol-A (BPA) and Diethylhexyl Phthalate (DEHP). The major pathway for BPA and DEHP excretion is via glucuronidation. Glucuronidation makes insoluble substances more water-soluble allowing for their subsequent elimination in urine. **Hypothesis:** Detoxification of these two plasticizers is compromised in children with ASD and ADHD. Consequently, their tissues are more exposed to these two plasticizers. **Methods:** We measured the efficiency of glucuronidation in three groups of children, ASD (n = 66), ADHD (n = 46) and healthy controls (CTR, n = 37). The children were recruited from the clinics of Rutgers-NJ Medical School. A urine specimen was collected from each child. Multiple mass spectrometric analyses including the complete metabolome were determined and used to derive values for the efficiency of glucuronidation for 12 varied glucuronidation pathways including those for BPA and MEHP. **Results:** (1) Both fold differences and metabolome analyses showed that the three groups of children were metabolically different from each other. (2) Of the 12 pathways examined, only the BPA and DEHP pathways discriminated between the three groups. (3) Glucuronidation efficiencies for BPA were reduced by 11% for ASD (p = 0.020) and 17% for ADHD (p<0.001) compared to controls. DEHP showed similar, but not significant trends. **Conclusion:** ASD and ADHD are clinically and metabolically different but share a reduction in the efficiency of detoxification for both BPA and DEHP with the reductions for BPA being statistically significant.

Food Safety Extension Workshop — McGill University & IAFNS
November 28, 2023, Virtual Event
Join us for a day-long workshop to cover a range of key food safety topics.
The agenda includes:
* Good manufacturing practices & other prerequisite programs for preventive control in food production
* Biological food safety hazards
* Chemical, physical and adulterated food safety hazards, and more
Read more

Myths and Realities of Artificial Intelligence: Setting the Record Straight
December 5, 2023, Virtual Event
AI is commonly viewed as a 'black box' which challenges trust and brings concerns about bias. What is really going on 'in there', and how can users be sure that the output is ready for use? Join IAFNS and Payam Mousavi of Google to address these and other myths and realities of AI.
Read more

2023 Science Innovation Showcase
December 12, 2023 – December 14, 2023, Afternoons-Only Virtual, Event
This science-first and science-focused event brings together scientists from multiple sectors, at all stages of their careers from graduate students to professors, technical experts to CEOs.
Read more

https://www.linkedin.com/company/iafns-science   https://www.youtube.com/@IAFNS/videos

https://twitter.com/IAFNS_science

iafns

www.iafns.org