Food Safety Briefs

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Risk Assessment

Research Gaps and Priorities for Quantitative Microbial Risk Assessment

Kerry A. Hamilton, Joanna Ciol Harrison, Jade Mitchell, Mark Weir, Marc Verhougstraete, Charles N. Haas, A. Pouyan Nejadhashemi, et. al. *Risk Anal.* Vol. 44, Issue 11. 9 Nov. 2024. doi.org/10.1111/risa.14318. Article link

The coronavirus disease 2019 pandemic highlighted the need for more rapid and routine application of modeling approaches such as quantitative microbial risk assessment (QMRA) for protecting public health. QMRA is a transdisciplinary science dedicated to understanding, predicting and mitigating infectious disease risks. To better equip QMRA researchers to inform policy and public health management, an Advances in Research for QMRA workshop was held to synthesize a path forward for QMRA research. We summarize insights from 41 QMRA researchers and experts to clarify the role of QMRA in risk analysis by: (1) identifying key research needs; (2) highlighting emerging applications of QMRA; and (3) describing data needs and key scientific efforts to improve the science of QMRA. Key identified research priorities included using molecular tools in QMRA, advancing dose-response methodology, addressing needed exposure assessments, harmonizing environmental monitoring for QMRA, unifying a divide between disease transmission and QMRA models, calibrating and/or validating QMRA models, modeling co-exposures and mixtures, and standardizing practices for incorporating variability and uncertainty throughout the source-to-outcome continuum. Cross-cutting needs identified were to: develop a community of research and practice, integrate QMRA with other scientific approaches, increase QMRA translation and impacts, build communication strategies, and encourage sustainable funding mechanisms. Ultimately, a vision for advancing the science of QMRA is outlined for informing national to global health assessments, controls and policies.

Foodborne Pathogens

Simultaneous Treatment with Tap Water-Based Neutral Electrolyzed Water and Citric Acid for Inactivating Foodborne Pathogens on Stainless Steel and Their Synergistic Bactericidal Mechanisms

Jae-Won Ha, Da-Young Jee. *LWT*, 1 Nov. 2024, Vol. 211, 116927. doi.org/10.1016/j.lwt.2024.116927. Article link

Electrolyzed water has many potential applications, the primary one being the eliminating microorganisms in the food industry. However, this application is limited by high chlorine levels. Tap water-based neutral electrolyzed water (TNEW)

740 15th Street NW
Washington, DC
20005

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

has the advantage of relatively low chlorine concentration (1.7–4.6 mg/L), but its sterilization effect is limited. In this study, TNEW was combined with citric acid (CA) solution, resulting in strong synergistic inactivation effect on Escherichia coli O157:H7, Salmonella Typhimurium, and Listeria monocytogenes on stainless steel surfaces. Simultaneous treatment of stainless steel with TNEW [available chlorine concentration (ACC) of 4.97 mg/L] and 0.1% CA for 15 min resulted in 4.78-, 4.26-, and >5.69 log CFU/cm2 surface reduction in E. coli O157:H7, S. Typhimurium, and L. monocytogenes, respectively, which was a synergistic cell count reductions of 3.25, 2.83, and >3.84 log units, respectively. Fluorescence and RT-qPCR analyses identified synergistic production of intracellular reactive oxygen species (ROS), damage to the cell membrane resulting from lipid peroxidation, and DNA damage as the major factors contributing to the synergistic lethal effect. The results of this study suggest that the TNEW–CA combination treatment can be applied as a potential substitute for conventional electrolyzed water treatment for food contact surface disinfection.

Foodborne Illness

Demographic Characteristics and County-Level Indicators of Social Vulnerability in salmonellosis Outbreaks Linked to Ground Beef— United States, 2012–2018

Michelle A. Waltenburg, Zainab Salah, Michelle Canning, Kelly McCain, David Rickless, Michael Ablan, Tamara N. Crawford, et. al. *JFP*, 20 Nov. 2024. Issue 100411. doi.org/10.1016/j.jfp.2024.100411. Article link

Ground beef is a common source of US *Salmonella* illnesses and outbreaks. However, the demographic and socioeconomic factors that are related to risk in ground beef-associated outbreaks of *Salmonella* infections are poorly understood. We describe the individual-level demographic characteristics and county-level indicators of social vulnerability for people infected with *Salmonella* linked to outbreaks associated with ground beef in the United States during 2012–2018. Non-Hispanic (NH) White and NH American Indian/Alaska Native persons, and people living in non-metropolitan areas, were overrepresented among people in salmonellosis outbreaks linked to ground beef. Case patients disproportionately resided in counties with high social vulnerability, suggesting that one or more community social risk factors may contribute to or be associated with some food safety risks. Collecting and analyzing socioeconomic and demographic characteristics of people in outbreaks can help identify disparities in foodborne disease, which can be further characterized and inform equity-focused interventions.

Food Classification

Refining the Role of Processing in Food Classification Systems: The IUFoST Formulation & Processing Classification Approach

Lilia Ahrn, Hongda Chen, Christiani J. Henry, Hyun-Sook Kim, Barbara Schneeman, Erich J. Windhab. *Zenodo* pre-print. Nov. 16, doi.org/10.5281/zenodo.14173011. Article link

The Task Force on Food Processing for Nutrition, Diet and Health established by the International Union of Food Science and Technology (IUFoST) has developed a rational approach to determine the impact of food processing on the nutritional value of processed foods, called the IUFoST Formulation and Processing Classification (IF&PC) scheme which is comprehensively reported here. The purpose of developing this scheme is (A) to refine and improve the currently controversial NOVA classification system by addressing the confusion between formulation and processing and the non-quantitative assessment in this system, and (B) to explore the potential for considering other relevant essential food attributes, such as (a) safety, (b) sustainability, (c) palatability, (d) affordability, and (e) convenience in food product classification. The authors recommend that this IUFoST initiative be further investigated and complemented based on concerted R&D interactions of food scientists, food engineers, and nutritionists.

From Processed Foods to Ultraprocessed Foods: Evolution of an Industry Model and Impact on Dietary Quality, Health and Society

Job Ubbink and Allen S. Levine. *Annu. Rev. Food Sci. Technol.* 2024. 16:1.1–1.24. doi.org/10.1146/annurev-food-111523-122028. Article link

The impact of food technology and product development on the nutritional quality of foods is discussed in the context of food classification schemes, clinical research, and sociocultural studies. Food processing operations are analyzed in terms of their beneficial and detrimental consequences for the nutritional value of foods and ingredients. Several classification schemes are

discussed, including dietary guidelines, nutrition information panels, and nutritional scores. The health impact of processed and ultraprocessed foods is discussed in connection with the processing–formulation scheme previously developed by the authors. The importance of product development as a driver for the food industry is highlighted, and formulation-based approaches to improve the healthfulness of industrially produced foods are discussed. Finally, the public perception of processed foods and its impact on the industry are discussed, and the need for a broad engagement among stakeholders to ensure the sustainability of our food system and healthy diets for individuals is emphasized.

Heavy Metals

Assessing Impact of Elevated CO2 on Heavy Metal Accumulation in Crops: Meta-Analysis and Implications for Food Security

Xunzhe Yang, Ping Yun, Xiaoxiang Zhao, Zhe Zhang, Chen Chen, Yonghong Zhou, Yinglong Chen, et. al. *STOTEN,* Vol. 952, 20 Nov. 2024, 175949. doi.org/10.1016/j.scitotenv.2024.175949. Article link

Human activities led to elevation in carbon dioxide (CO2) concentrations in atmosphere. While such increase per se may be beneficial for the growth of some crops, it comes with a caveat of affecting crop nutritional status. Here, we present a comprehensive analysis of changes in concentration of essential (Cu, Fe, Mn, Zn, Mo, Ni) and non-essential (Ba, Cd, Cr, Hg, Pb, and Sr) heavy metals in response to elevated CO2, drawing on a meta-analysis of 1216 paired observations. The major findings are as follows: (1) Elevated CO2 leads to reduced concentrations of Cu, Fe, Mn, and Zn in crops; (2) the extent of above reduction varies among plants species and is most pronounced in cereals and then in legumes and vegetables; (3) reduction in accumulation of non-essential (toxic) metals is less pronounced, potentially leading to an unfavorable essential/non-essential metal ratio in plants; (4) the above effects will come with significant implication to human health, exacerbating effects of the “hidden hunger” caused by the lack of Fe and Zn in the human diets. The paper also analyses the mechanistic basis of nutrient acquisition (both at physiological and molecular levels) and calls for the changes in the governmental policies to increase efforts of plant breeders to create genotypes with improved nutrient use efficiency for essential micronutrients while uncoupling their transport from non-essential (toxic) heavy metals.

Food Packaging

Composite PLA Films Incorporated with Micro/Nano Boron Nitride for Sustainable Food Packaging

Ilknur Ara, Guliz Haskaraca, Semanur Yildiz, Zehra Ayhan. *Green Materials*. 4 Nov. 2024. doi.org/10.1680/jgrma.24.00109. Article link

This study aims to develop polylactic acid (PLA)–based composite films with improved mechanical and barrier properties through incorporation of micro boron nitride (BN) and nano boron nitride (NBN). PLA-based films were produced using BN and NBN at varying concentrations (1%–10% (w/w)) and characterized in terms of physical (color and thickness), mechanical (tensile strength, elongation at break, and heat seal strength), barrier (water vapor transmission rate (WVTR)), antimicrobial, and morphological properties. ΔE and whiteness of the composite PLA films increased, while transparency decreased with increased BN and NBN concentrations. Compared with the control PLA films, the tensile strength of the 1% BN- or NBN-added films increased by 28% or 40%, respectively. Adding BN and NBN to the PLA matrix significantly reduced the WVTR ($p \leq 0.05$). Antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* was not detected. Multivariate data analysis enabled discrimination of composite PLA films based on simultaneous evaluation of their specific film characteristics. This study reveals the ideal film formulation to produce boron nitride–incorporated composite PLA films with proper properties, holding potential to be used as an alternative biodegradable material for sustainable packaging of foods to replace petroleum-based materials.

Chemical Contaminants

Integration of National Chemical Hazards Monitoring, Total Diet Study and Human Biomonitoring Programmes for Food Safety Exposure Assessment in Singapore

Angela Li, Jun Cheng Er, Wei Ching Khor, Mei Hui Liu, Valerie Sin, Sheot Harn Chan, Kyaw Thu Aung. *JFP*, 11 Nov. 2024, 100414. doi.org/10.1016/j.jfp.2024.100414. Article link

Food safety and food security can impact the quality of human life, and these two aspects are interrelated alongside many

influencing external factors. Global stressors such as climate change, recent pandemic and geopolitical tensions have demonstrated tangible impacts on food security and safety. Food and food system innovation is a key strategy towards feeding the world in a more sustainable and climate-resilient manner. This paper highlights the use of a science-based risk assessment and management in Singapore's food safety system, specifically in the integration of exposure assessment approaches to support evidence-based food safety risk analysis and decision making. The use of complementary top-down and bottom-up exposure assessment approaches through the market monitoring programme, total diet study and human biomonitoring forms a comprehensive integrated exposure assessment strategy which can ultimately inform policy and measures in ensuring and securing a supply of safe food. The discussion on such application for chemical food safety in Singapore offers additional insights to the synergistic inter-relationships contributing to the exposure assessment associated with chemicals in food.

Caffeine

Phytochemical Constituents, Ethnomedicinal Uses and Applications of Coffee (*Coffea arabica*) Leaves in Functional Beverages

Eyasu Yohannis, Tilahun A. Teka, Janet Adeyinka Adebo, Markos Makiso Urugo, Abul Hossain, Tessema Astatkie. *JFCA,* Vol. 135, Nov. 2024, 106570. doi.org/10.1016/j.jfca.2024.106570. Article link

Traditionally, coffee-growing communities have used coffee leaves to make tea-like beverages valued for their rich phytonutrient content and ethnomedicinal properties. Among these phytonutrients, phenolic compounds, mainly mangiferin, found in Coffea arabica leaves, stands out for its potential therapeutic benefits, which may surpass those of coffee beans. Moreover, bioactive molecules in coffee leaves, such as mangiferin, trigonelline, caffeine, chlorogenic acids (CGAs), and rutin, contribute to their antioxidant, anti-inflammatory, anti-hypertensive, anti-obesity, antibacterial, antifungal, anticancer, and neuroprotective effects. However, the precise mechanisms underlying these activities remain unclear. This review offers a comprehensive overview of the phytochemical constituents, ethnomedicinal uses, and potential applications of C. arabica and C. robusta leaves in functional beverages. Additionally, it examines the mechanisms through which coffee leaves exert their therapeutic effects. It emphasizes the need for further studies to fully understand the pharmacological benefits, structure-activity relationships, and the impact of processing on bioactive compounds and bio-functional characteristics. Optimizing processing methods to preserve and enhance these bioactive compounds is crucial. Thus, this review promotes a deeper understanding of coffee leaves' potential in the functional beverage market, encouraging further exploration into their bioactive properties.

Food Allergens

Prevalence and Determinants of Food Allergy in the Era of Early Allergen Introduction: The EarlyNuts Population-Based Study

Victoria X. Soriano, Katrina J. Allen, Shyamali C. Dharmage, Desalegn Markos Shifti, Kirsten P. Perrett, Rushani Wijesuriy, Jennifer J. Koplin. *JACI: In Practice*. Vol. 12, Issue 11, Nov. 2024. doi.org/10.1016/j.jaip.2024.07.001. Article link

Background: Infant feeding guidelines in Australia changed in 2016 to recommend introducing common allergy-causing foods by age 1 year to prevent food allergy. Although most Australian infants now eat peanut and egg by age 6 months, some still develop food allergy despite the early introduction of allergens. **Objectives:** To describe the prevalence of food allergy in a cohort recruited after introducing the nationwide allergy prevention recommendations; identify characteristics of infants who developed allergy despite early introduction of allergens; and estimate the causal effect of modifiable exposures on food allergy prevalence and whether this differed between infants who were introduced to allergens before or after age 6 months. **Methods:** We recruited a population-based sample of 12-month-old infants in Melbourne, Australia. Infants had skin prick tests to four foods and parents completed questionnaires. Infants with evidence of sensitization were offered oral food challenges. Prevalence estimates were adjusted using inverse probability weighting. **Results:** In a cohort of infants (n = 1,420) in which nearly all infants had been introduced to common allergens such as egg, milk, and peanut by age 1 year, the prevalence of food allergy remained high at 11.3% (95% CI, 9.6-13.4). Infants who developed food allergy despite introduction of the allergen by age 6 months were more likely to have Asian-born

parents. Early-onset moderate or severe eczema was associated with an increased odds of food allergy irrespective of whether allergens were introduced before or after age 6 months. Among infants who were introduced to peanut at age 6 months or earlier, antibiotic use by age 6 months was associated with an increased odds of peanut allergy (adjusted odds ratio = 6.03; 95% CI, 1.15-31.60). **Conclusions:** In a cohort in which early allergen introduction was common, the prevalence of food allergy remained high. Infants who developed food allergy despite introduction of the respective allergen by age 6 months were more likely to have had Asian parents and early-onset eczema. New interventions are needed for infants with a phenotype of food allergy that is not amenable to early allergen introduction.

Emerging Science Areas

Emerging Areas: Microplastics

Revivable Self-Assembled Supramolecular Biomass Fibrous Framework for Efficient Microplastic Removal

Yang Wu, Shixiong Chen, Jun Wu, Fangtian Liu, Hongbing Deng, et. al. *Science Advances*, 29 Nov 2024, Vol. 10, Issue 48. DOI: 10.1126/sciadv.adn8662. Article link

Microplastic remediation in aquatic bodies is essential for the entire ecosystem, but is challenging to achieve with a universal and efficient strategy. Here, we developed a sustainable and environmentally adaptable adsorbent through supramolecular self-assembly of chitin and cellulose. This biomass fibrous framework (Ct-Cel) showcases an excellent adsorption performance for polystyrene, polymethyl methacrylate, polypropylene, and polyethylene terephthalate. The affinity for diverse microplastics is attributed to the transformation of multiple intermolecular interactions between different microplastics and Ct-Cel. Meanwhile, the strong resistance of Ct-Cel to multiple pollutants in water enables an enhanced adsorption when coexisting with microorganisms and Pb2+. Moreover, Ct-Cel can remove 98.0 to 99.9% of microplastics in four types of real water and maintains a high removal efficiency of up to 95.1 to 98.1% after five adsorption cycles. This work may open up prospects for functional biomass materials for cost-efficient remediation of microplastics in complex aquatic environments.

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