Food Safety Briefs

Institute for the Advancement of Food and Nutrition Sciences

June 2024

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Risk Assessment

Salmonella Prevalence in Raw Cocoa Beans and a Microbiological Risk Assessment to Evaluate the Impact of Cocoa Liquor Processing on the Reduction of *Salmonella*

Xingchen Zhao, Liesbeth Jacxsens, Vesela Tzeneva, Michiel Kokken, Anett Winkler, Cécile Vadier, Nicolau de Toledo, et. al. *J. Food Prot.* July 2024. doi.org/10.1016/j.jfp.2024.100327. Article link

Salmonella in raw cocoa beans (n= 870) from main sourcing areas over nine months was analyzed. It was detected in 71 (ca. 8.2%) samples, with a contamination level of 0.3-46 MPN/g except for one sample (4.1×104 CFU/g). Using prevalence and concentration data as input, the impact of thermal treatment in cocoa processing on the risk estimate of acquiring salmonellosis by a random Belgian chocolate consumer was calculated by a quantitative microbiological risk assessment (QMRA) approach. A modular process risk model from raw cocoa beans to cocoa liquor up to a hypothetical final product (70-90% dark chocolate tablet), was set up to understand changes of *Salmonella* concentrations following the production process. Different thermal treatments during bean or nib steam, nib roasting or liquor sterilization (achieving a 0-6 log reduction of *Salmonella*) were simulated. Based on the generic FAO/WHO *Salmonella* dose-response model and the chocolate consumption data in Belgium, salmonellosis risk per serving and cases per year at population level were estimated. When a 5 log reduction of *Salmonella* was achieved, the estimated mean risk per serving was 3.35×10-8 (95% CI: 3.27×10-10-1.59×10-7), and estimated salmonellosis cases per year (11.7 million population) was 88 (95% CI: <1-418). The estimated mean risk per serving was 3.35×10-9 (95% CI: 3.27×10-11-1.59×10-8), and the estimated salmonellosis cases per year was 9 (95% CI: <1-42), for a 6 log reduction. The current QMRA model solely considered *Salmonella* reduction in a single-step thermal treatment in the cocoa process. Inactivation obtained during other process steps (e.g. grinding) might occur but was not considered. As the purpose was to use QMRA as a tool to evaluate the log reduction in the cocoa processing, no post-contamination from the processing environment and ingredients was included. A minimum of 5 log reduction of *Salmonella* in the single-step thermal treatment of cocoa process, was considered to be adequate.

Foodborne Pathogens

Inhibition of *Listeria monocytogenes* and *Clostridium botulinum* in Uncured Shredded Pork and Turkey Packaged Under Reduced Oxygen Conditions

Kathleen A. Glass, Max C. Golden, Brandon J. Wanless, Tina Conklin, Jeannine P. Schweihofer, Kristin M. Schill. *J. Food Prot.* Volume 87, Issue 6, June 2024, doi.org/10.1016/j.jfp.2024.100271. Article link

Cooked, uncured meat products packaged under reduced oxygen packaging conditions require the control of anaerobic and facultative anaerobic pathogens if they are held at temperatures greater than 3°C at retail or consumer level. The objective of this study was to determine the inhibition of *Listeria monocytogenes* and *Clostridium botulinum* in cooked, uncured shredded turkey and pork formulated with synthetic or clean-label antimicrobials. Treatments of shredded meat products were prepared with or without antimicrobials using turkey thigh or breast that were cooked to 85°C, shredded, and chilled before inoculation with the target pathogen. *L. monocytogenes* inoculated samples were stored at 7.2°C, whereas *C. botulinum* samples were stored at 12.8°C; triplicate samples were assayed every 2 weeks. In the first set of experiments, *L. monocytogenes* populations increased 2 to 3 logs within 2 weeks of storage at 7.2°C in both meat control treatments without antimicrobials and in pork with 4% lactate-diacetate blend (LD). A 1-log increase was observed in turkey with 4% LD and Pork with 2% cultured dextrose-vinegar-rosemary (CDVR) under the same storage conditions; a 1-log increase was observed in turkey with CDVR at 4 weeks. The second set of experiments tested the effect of pH reduction (to less than 5.5 by the addition of

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0.5% citric acid) in combination with 2% CDVR when added to the brine precook or postcook during shredding. Populations of *L. monocytogenes* increased 4-log within 2 and 4 weeks at 7.2°C for the control turkey and pork formulations, respectively. No growth was observed in 12 weeks for any antimicrobial CDVR-CA treatments regardless of how antimicrobial was added. Similarly, botulinum toxin was detected in both control treatments at week 2 at 12.8°C, but no toxicity was observed in either antimicrobial treatment through 12 weeks. These data suggest that a combination of 2% cultured dextrose-vinegar-rosemary extract plus 0.5% citric acid to reduce pH inhibits the growth of *L. monocytogenes* and toxin production of *C. botulinum* in uncured shredded turkey and pork products stored under mild temperature abuse conditions for up to 12 weeks in reduced oxygen packaging.

Foodborne Illness

CRISPR/Cas-Based Colorimetric Biosensors: A Promising Tool for the Diagnosis of Bacterial Foodborne Pathogens in Food Products

Ebraheem Abdu Musad Saleh, Eyhab Ali, Giyazova Malika Muxamadovna, Asmaa F Kassem, Irwanjot Kaur, Abhinav Kumar, Hijran Sanaan Jabbar, et. al. *Analytical Methods*. 2024 Jun 6;16(22):3448-3463. doi: 10.1039/d4ay00578c. Article link

Some physical phenomena and various chemical substances newly introduced in nanotechnology have allowed scientists to develop valuable devices in the field of food sciences. Regarding such progress, the identification of foodborne pathogenic microorganisms is an imperative subject nowadays. These bacterial species have been found to cause severe health impacts after food ingestion and can result in high mortality in acute cases. The rapid detection of foodborne bacterial species at low concentrations is in high demand in recent diagnostics. CRISPR/Cas-mediated biosensors possess the potential to overcome several challenges in classical assays such as complex pretreatments, long turnaround time, and insensitivity. Among them, colorimetric nanoprobes based on the CRISPR strategy afford promising devices for POCT (point-of-care testing) since they can be visualized with the naked eye and do not require diagnostic apparatus. In this study, we briefly classify and discuss the working principles of the different CRISPR/Cas protein agents that have been employed in biosensors so far. We assess the current status of the CRISPR system, specifically focusing on colorimetric biosensing platforms. We discuss the utilization of each Cas effector in the detection of foodborne pathogens and examine the restrictions of the existing technology. The challenges and future opportunities are also indicated and addressed.

Mycotoxins

***Fusarium* Mycotoxins: The Major Food Contaminants**

Zheng Qu, Xianfeng Ren, Zhaolin Du, Jie Hou, Ye Li, Yanpo Yao, Yi An. *mLife*. 2024, June;3(2):176-206. doi: 10.1002/mlf2.12112. Article link

Mycotoxins, which are secondary metabolites produced by toxicogenic fungi, are natural food toxins that cause acute and chronic adverse reactions in humans and animals. The genus *Fusarium* is one of three major genera of mycotoxin-producing fungi. Trichothecenes, fumonisins, and zearalenone are the major *Fusarium* mycotoxins that occur worldwide. *Fusarium* mycotoxins have the potential to infiltrate the human food chain via contamination during crop production and food processing, eventually threatening human health. The occurrence and development of *Fusarium* mycotoxin contamination will change with climate change, especially with variations in temperature, precipitation, and carbon dioxide concentration. To address these challenges, researchers have built a series of effective models to forecast the occurrence of *Fusarium* mycotoxins and provide guidance for crop production. *Fusarium* mycotoxins frequently exist in food products at extremely low levels, thus necessitating the development of highly sensitive and reliable detection techniques. Numerous successful detection methods have been developed to meet the requirements of various situations, and an increasing number of methods are moving toward high-throughput features. Although *Fusarium* mycotoxins cannot be completely eliminated, numerous agronomic, chemical, physical, and biological methods can lower *Fusarium* mycotoxin contamination to safe levels during the preharvest and postharvest stages. These theoretical innovations and technological advances have the potential to facilitate the development of comprehensive strategies for effectively managing *Fusarium* mycotoxin contamination in the future.

Heavy Metals

Mitigating Toxic Metal Exposure Through Leafy Greens: A Comprehensive Review Contrasting Cadmium and Lead in Spinach

Angelia L. Seyfferth, Matt A. Limmer, Benjamin R. K. Runkle, Rufus L. Chaney. *GeoHealth*, Vol. 8, Issue 6. 17 June 2024 https://doi.org/10.1029/2024GH001081. Article link

This study was supported by IAFNS Food & Chemical Safety Committee

Metals and metalloids (hereafter, metal(loid)s) in plant-based foods are a source of exposure to humans, but not all metal(loid)-food interactions are the same. Differences exist between metal(loid)s in terms of their behavior in soils and in how they are taken up by plants and stored in the edible plant tissue/food. Thus, there cannot be one consistent solution to reducing toxic metal(loid)s exposure to humans from foods. In addition, how metal(loid)s are absorbed, distributed, metabolized, and excreted by the human body differs based on both the metal(loid), other elements and nutrients in the food, and the nutritional status of the human. Initiatives like the United States Food and Drug Administration's Closer to Zero initiative to reduce the exposure of young children to the toxic elements cadmium, lead, arsenic, and mercury from foods warrant careful consideration of each metal(loid) and plant interaction. This review explores such plant-metal(loid) interactions using the example of spinach and the metals cadmium and lead. This review highlights differences in the magnitude of exposure, bioavailability, and the practicality of mitigation strategies while outlining research gaps and future needs. A focus on feasibility and producer needs, informed via stakeholder interviews, emphasizes the need for better analytical testing facilities and grower and consumer education. More research should focus on minimization of chloride inputs for leafy greens to lessen plant-availability of Cd and the role of oxalate in reducing Cd bioavailability from spinach. These findings are applicable to other leafy greens (e.g., kale, lettuce), but not for other plants or metal(loid)s.

Food Packaging

Sustainable Production of Cellulosic Biopolymers for Enhanced Smart Food Packaging: An Up-to-Date Review

Pinku Chandra Nath, Ramesh Sharma, Uttara Mahapatra, Yugal Kishore Mohanta, Sarvesh Rustagi, Minaxi Sharma, Shikha Mahajan, et. al. *Int J Biol Macromol*. 2024 Jun 13;273(Pt 2):133090. doi: 10.1016/j.ijbiomac.2024.133090. Article link

Biodegradable and sustainable food packaging (FP) materials have gained immense global importance to reduce plastic pollution and environmental impact. Therefore, this review focused on the recent advances in biopolymers based on cellulose derivatives for FP applications. Cellulose, an abundant and renewable biopolymer, and its various derivatives, namely cellulose acetate, cellulose sulphate, nanocellulose, carboxymethyl cellulose, and methylcellulose, are explored as promising substitutes for conventional plastic in FP. These reviews focused on the production, modification processes, and properties of cellulose derivatives and highlighted their potential for their application in FP. Finally, we reviewed the effects of incorporating cellulose derivatives into film in various aspects of packaging properties, including barrier, mechanical, thermal, preservation aspects, antimicrobial, and antioxidant properties. Overall, the findings suggest that cellulose derivatives have the potential to replace conventional plastics in food packaging applications. This can contribute to reducing plastic pollution and lessening the environmental impact of food packaging materials. The review likely provides insights into the current state of research and development in this field and underscores the significance of sustainable food packaging solutions.

Chemical Contaminants

Public Health Risks of PFAS-Related Immunotoxicity Are Real

Abigail P Bline, Jamie C DeWitt, Carol F Kwiatkowski, Katherine E Pelch, Anna Reade, Julia R Varshavsky. *Curr Environ Health Rep*. 2024 Jun;11(2):118-127. doi: 10.1007/s40572-024-00441-y. Article link

Purpose of Review: The discovery of per- and polyfluoroalkyl substances (PFAS) in the environment and humans worldwide has ignited scientific research, government inquiry, and public concern over numerous adverse health effects associated with PFAS exposure. In this review, we discuss the use of PFAS immunotoxicity data in regulatory and clinical

decision-making contexts and question whether recent efforts adequately account for PFAS immunotoxicity in public health decision-making. **Recent Findings:** Government and academic reviews confirm the strongest human evidence for PFAS immunotoxicity is reduced antibody production in response to vaccinations, particularly for tetanus and diphtheria. However, recent events, such as the economic analysis supporting the proposed national primary drinking water regulations and clinical monitoring recommendations, indicate a failure to adequately incorporate these data into regulatory and clinical decisions. To be more protective of public health, we recommend using all relevant immunotoxicity data to inform current and future PFAS-related chemical risk assessment and regulation. Biological measures of immune system effects, such as reduced antibody levels in response to vaccination, should be used as valid and informative markers of health outcomes and risks associated with PFAS exposure. Routine toxicity testing should be expanded to include immunotoxicity evaluations in adult and developing organisms. In addition, clinical recommendations for PFAS-exposed individuals and communities should be revisited and strengthened to provide guidance on incorporating immune system monitoring and other actions that can be taken to protect against adverse health outcomes.

Caffeine

The Complexity of Coffee and its Impact on Metabolism

Huanan Zhang, John Speakman. *J Endocrinol*. 2024 Jun 1:JOE-24-0075. doi: 10.1530/JOE-24-0075. Article link

Coffee is one of the three most consumed beverages in the world. It is made by first roasting coffee beans and then grinding and boiling or steeping the roasted beans in water (brewing). The process of roasting and brewing produces a complex mix of bioactive compounds which include methylxanthines (caffeine, theobromine, theophylline), diterpenes, chlorogenic acid, trigonelline, flavonoids and hydroxycinnamic acid. In the body these compounds may be metabolized to produce other bioactive compounds. For example, caffeine is primarily (80%) broken down by demethylation to produce paraxanthine. In the post ingestion period levels of paraxanthine may be higher than caffeine due to its slower elimination. Hence, while paraxanthine is not found in coffee itself, it has many of the same properties of caffeine and may be a major contributor to its metabolic effects. The impacts of caffeine and paraxanthine on metabolism relate to their impact on adenosine receptors (notably the A2A receptor). It has been known for almost 100 years that intake of coffee stimulates metabolism by between 5 and 20% for at least 3 hours. About half of the increase in metabolic rate after drinking coffee is due to caffeine and derivatives, but the source of the other half is unclear. There are large differences in the response to the same amount of coffee in different individuals, which may be related to caffeine clearance rates, effects of other unknown pathways, genetic polymorphism, age, sex and body composition.

Food Allergens

Perspectives in the Validation of DEFASE: A Paradigm Shift in Food Allergy Management

Stefania Arasi, Carmen Mazzuca, Sara Urbani, Arianna Cafarotti, Alessandro Fiocchi. *Curr Opin Allergy Clin Immunol*. 2024 Jun 1;24(3):171-176. doi: 10.1097/ACI.0000000000000988. Article link

Purpose of Review: To explore the groundbreaking international consensus on the DEFASE (DEfinition of Food Allergy Severity) project as a revolutionary grading system for IgE-mediated food allergy severity. Against the backdrop of the growing public health challenge posed by food allergy, this article delves into the importance of validating and implementing DEFASE in real-world clinical settings. **Recent Findings:** With new therapeutic options available for food allergy, including biologics alongside immunotherapy, it is urgent to properly support clinical decision-making in the management of the disease. The DEFASE score is the first international consensus-based grading system of severity associated with food allergy as a whole disease embracing multidisciplinary perspectives from different stakeholders involved. In its current version, this comprehensive scoring system has been developed to be used in research settings. **Summary:** The review emphasizes the potential impact of DEFASE on patient outcomes, healthcare management, and resource allocation, underscoring its significance for the allergy scientific community. Future research should focus on internal and external validation of the scoring system, targeting these models to various food allergenic sources, populations, and settings.

Emerging Science Areas

Emerging Area: Microplastics

Soil Microplastic Pollution and Microbial Breeding Techniques for Green Degradation: A Review

Zhuang Xiong, Yunfeng Zhang, Xiaodie Chen, Ajia Sha, Wenqi Xiao, Yingyong Luo, Jialiang Han, et. al. *Microorganisms*. 2024 Jun 5;12(6):1147. doi: 10.3390/microorganisms12061147. Article link

Microplastics (MPs), found in many places around the world, are thought to be more detrimental than other forms of plastics. At present, physical, chemical, and biological methods are being used to break down MPs. Compared with physical and chemical methods, biodegradation methods have been extensively studied by scholars because of their advantages of greenness and sustainability. There have been numerous reports in recent years summarizing the microorganisms capable of degrading MPs. However, there is a noticeable absence of a systematic summary on the technology for breeding strains that can degrade MPs. This paper summarizes the strain-breeding technology of MP-degrading strains for the first time in a systematic way, which provides a new idea for the breeding of efficient MP-degrading strains. Meanwhile, potential techniques for breeding bacteria that can degrade MPs are proposed, providing a new direction for selecting and breeding MP-degrading bacteria in the future. In addition, this paper reviews the sources and pollution status of soil MPs, discusses the current challenges related to the biodegradation of MPs, and emphasizes the safety of MP biodegradation.

Emerging Area: Risk Negotiation

Risk Negotiation: A Framework for One Health Risk Analysis

Monika Ehling-Schulz, Matthias Filter, Jakob Zinsstag, Konstantinos Koutsoumanis, Mariem Ellouze, Josef Teichmann, Angelika Hilbeck, Mauro Tonolla, Danai Etter, Katharina Stärk, Martin Wiedmann, Sophia Johleri. *Bulletin of the World Health Organization*. 2024. 02:453–456. doi: http://dx.doi.org/10.2471/BLT.23.290672. Article link

The world faces global health risks that need to be effectively addressed in integrated, participatory efforts. However, risk analysis frameworks do not account for the complex nature of systems that span multiple sectors or disciplines. We propose the participatory and interdisciplinary concept of risk negotiation to transform the way we tackle global health challenges such as pandemics, physical and mental health inequities, environmental problems and food security. To allow such risk analysis, we need to recognize the value of risks and trade-offs and negotiate them with stakeholder groups representing different disciplines and sectors. This approach becomes feasible through recent technological breakthroughs such as artificial intelligence-assisted multiagent negotiations or large language models. These models are accessible, hold promise in negotiating agreements and can be used to accommodate the complexity of real-world decision-making.

Engage with IAFNS

Re-Engineering Foods for Health: An Opportunity to Engage in Research – Continuing the Dialogue
July 11, 2024, Virtual Event
IAFNS is continuing the dialogue on developing a research program on ultra-processed foods with ARPA-H.
Join us

IAFNS Nutrition for Gut Health Committee Meeting
August 7, 2024, Washington, DC
IAFNS' Nutrition for Gut Health Committee advances and communicates the scientific understanding of the impact of diet and dietary constituents on gut and host health.
Join us

Low- and No-Calorie Sweeteners and Body Weight: What Does the Science Really Say?
September 10, 2024, Virtual Event
A webinar on how systematic reviews on low-calorie sweeteners produce disparate results.
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