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# Food Safety Science Briefs



## Scientific Integrity

### **An Updated Framework for Industry Funding of Food and Nutrition Research: Managing Financial Conflicts and Scientific Integrity**

Brienna M Larrick, Johanna T Dwyer, John W Erdman, Richard F D'Aloisio, Wendelyn Jones. *J Nutr.* 2022 Jun 25;nxac106. doi: 10.1093/jn/nxac106. [Article link](#)

**Significance:** This timely framework paper provides updated guiding principles for industry funding of food and nutrition research to manage potential conflict of interest and to uphold scientific integrity and credibility. The updates include strengthening guardrails that separate funding from the science and emphasizing the need for increased transparency and open science.



This work was supported by the [IAFNS Assembly on Scientific Integrity](#)

Although the food and beverage industry plays a critical role in advancing food and nutrition science, industry-funded research is subject to intense scrutiny as a result of various perceived and real biases related to funding sources. To address this, the Institute for the Advancement of Food and Nutrition Sciences (IAFNS) Assembly on Scientific Integrity has updated its Guiding Principles for Funding Food Science and Nutrition Research to provide a modernized framework for minimizing bias and promoting integrity in industry-funded research. Existing best practices for managing conflicts and maintaining trust in science, as well as coverage related to conflicts in industry-funded research, were reviewed to inform the development of the updated Guiding Principles. The updated Guiding Principles continue to provide conflict-of-interest guidelines to protect the integrity and credibility of the scientific record. These updates provide clarification, strengthen the guardrails that separate the funding from the science, and reflect the shift within the scientific community toward increased transparency and open science. If the principles are followed as intended, there should be little reason to dispute the results of industry-funded studies, other than to debate the science itself. This article issues a challenge to the research community to strive for just that.

## Foodborne Pathogens

### **Survival Kinetics, Membrane Integrity and Metabolic Activity of *Salmonella enterica* in Convention-ally and Osmotically Dehydrated Coconut Flakes**

Ruthchelly Tavares da Silva, Donald W Schaffner, Geany Targino de Souza Pedrosa, Thatyane Mariano Rodrigues de Albuquerque, Janeeyre Ferreira Maciel, Evandro Leite de Souza, Verônica Ortiz Alvarenga, Marciane Magnani. *Int J Food Microbiol.* 2022 Jun 2;370:109669. doi: 10.1016/j.ijfoodmicro.2022.109669. [Article link](#)

**Significance:** These findings suggest that *S. enterica* populations decline during storage in part due to membrane integrity losses. These data can contribute to the development of risk management strategies for *S. enterica* in dehydrated coconut flakes.

Many outbreaks involving *Salmonella enterica* in dehydrated coconut have been reported. Little is known about the survival of *S. enterica* in dehydrated coconut flakes at common retail or domestic storage conditions. This study evaluated the behavior of a *S. enterica* cocktail (*S. Enteritidis* PT4, *S. Typhimurium* PT4, *S. Bredeney*, *S. Muenster* and *S. Agona*) in conventionally and osmotically dehydrated coconut flakes under four storage regimes: 25 °C for 120 days, 25 °C for 30 days then 7 °C for 90 days, 7 °C for 30 days then 25 °C for 90 days, and 7 °C for 120 days. *S. enterica* membrane integrity (using



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with propidium iodide and bis-1,3-dibutylbarbutyric acid) and metabolic activity (using 5-cyano-2,3-ditoly tetrazolium chloride) were assessed by flow cytometry analysis after dehydration and storage at 7 °C or 25 °C for 120 days. Lower *S. enterica* inactivation rates ( $k_{max}$  0.02 to 0.04 1/days) were observed in conventionally dehydrated coconut flakes compared to osmotically dehydrated coconut flakes ( $k_{max}$  0.16 to 0.20 1/days). Changes in storage temperature did not affect the behavior of *S. enterica* in conventionally or osmotically dehydrated coconut flakes. Results show that *S. enterica* inactivation in conventionally dehydrated coconut flakes could be described by log-linear with tail models. *S. enterica* inactivation in osmotically dehydrated coconut flakes could be described by log-linear with shoulder and tail models. Subpopulations of *S. enterica* cells with damaged membranes and without metabolic activity were larger in conventionally (32.1% and 90.9%, respectively) than osmotically dehydrated coconut (18.5% and 82.2%, respectively) flakes at the beginning of the storage. Subpopulations of *S. enterica* cells with damaged membrane decreased by 9.4-14.4%, while cells with membrane potential and intact membrane increased by 23.7 and 24.2% in conventionally dehydrated coconut flakes after 120 days of storage at 7 °C or 25 °C, respectively. Subpopulations of *S. enterica* with damaged membranes did not change significantly in osmotically dehydrated coconut flakes. Our findings suggest that *S. enterica* populations decline during storage occurs due in part to membrane integrity losses. These data can contribute to the development of risk management strategies for *S. enterica* in dehydrated coconut flakes.

## Foodborne Illness

### Development of a Modeling Tool to Assess and Reduce Regulatory and Recall Risks for Cold-Smoked Salmon due to *Listeria monocytogenes* Contamination

Ruixi Chen, Renato H Orsi, Veronica Guariglia-Oropeza, Martin Wiedmann. *J Food Prot.* 2022 Jun 20. doi: 10.4315/JFP-22-025. [Article link](#)

**Significance:** This study suggests that more effective reduction in recall and regulatory risks can be achieved by reducing *Listeria monocytogenes* prevalence, compared to retarding its growth.

While public health risk assessments for *Listeria monocytogenes* (Lm) have been published for different foods, firm-level decision making on interventions targeting Lm involves considerations of both public health and enterprise risks. Smoked seafood is a ready-to-eat product with a high incidence of Lm contamination and associated with several recalls. We thus used cold-smoked salmon as a model product to develop a decision support tool (the Regulatory and Recall Risk [3R] Model) to estimate (i) baseline regulatory and recall (RR) risks (i.e., overall risks of a lot sampled and tested positive [e.g., by food regulatory agencies]) due to Lm contamination and (ii) the RR risk reduction that can be achieved through interventions with different underlying mechanisms: (i) reducing the prevalence and/or level of Lm and (ii) retarding or preventing Lm growth. Given that a set number of samples (e.g., 10) are tested for a given lot, the RR risk equals the likelihood of detecting Lm in at least one sample. Under the baseline scenario, which assumes a 4% Lm prevalence and no interventions, the median predicted RR risk for a given production lot was 0.333 (95% credible interval: 0.288, 0.384) when 10 25-g samples were collected. Nisin treatments, which reduce both the prevalence and initial level of Lm, reduced RR risks in a concentration-dependent manner to 0.109 (0.074, 0.146; 5 ppm), 0.049 (0.024, 0.083; 10 ppm), and 0.017 (0.007, 0.033; 20 ppm). In general, more effective reduction in RR risks can be achieved by reducing Lm prevalence, compared to retarding Lm growth, as the RR risk was reduced to 0.182 [0.153, 0.213] by a 50% prevalence reduction, while only to 0.313 [0.268, 0.367] by bacteriostatic growth inhibitors. In addition, sensitivity analysis indicates that prevalence and initial level of Lm, as well as storage temperature have the largest impact on predicting RR risks, suggesting that reliable data for these parameters will improve model performance.

## Mycotoxins

### Occurrence of Mycotoxins and Toxigenic Fungi in Cereals and Application of Yeast Volatiles for Their Biological Control

Asma Alkuwari, Zahoor Ul Hassan, Randa Zeidan, Roda Al-Thani, Samir Jaoua. *Toxins (Basel).* 2022 Jun 13;14(6):404. doi: 10.3390/toxins14060404. [Article link](#)

**Significance:** New biocontrol methods can help address the occurrence of toxigenic fungi and mycotoxin risks in cereals.

Fungal infections in cereals lead to huge economic losses in the food and agriculture industries. This study was designed to investigate the occurrence of toxigenic fungi and their mycotoxins in marketed cereals and explore the effect of the antagonistic yeast *Cyberlindnera jadinii* volatiles against key toxigenic fungal strains. *Aspergillus* spp. were the most frequent contaminating fungi in the cereals, with an isolation frequency (Fr) of 100% in maize, followed by wheat

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(88.23%), rice (78.57%) and oats (14.28%). Morphological and molecular identification confirmed the presence of key toxigenic fungal strains in cereal samples, including *A. carbonarius*, *A. flavus*, *A. niger*, *A. ochraceus* and *A. parasiticus*. Aflatoxins (AFs) were detected in all types of tested cereal samples, with a significantly higher level in maize compared to wheat, rice, oats and breakfast cereals. Ochratoxin A (OTA) was only detected in wheat, rice and maize samples. Levels of mycotoxins in cereals were within EU permissible limits. The volatiles of *Cyberlindnera jadinii* significantly inhibited the growth of *A. parasiticus*, *A. niger* and *P. verrucosum*. The findings of this study confirm the presence of toxigenic fungi and mycotoxins in cereals within the EU permissible limits and the significant biocontrol ability of *Cyberlindnera jadinii* against these toxigenic fungi.

## Heavy Metals

### Interaction between the Accumulation of Cadmium and Deoxynivalenol Mycotoxin Produced by *Fusarium graminearum* in Durum Wheat Grains

Valérie Nicaise, Sylvain Chereau, Laetitia Pinson-Gadais, Marie-Noelle Verdal-Bonnin, Christine Ducos, Mélanie Jimenez, Cécile Coriou. *J Agric Food Chem.* 2022 June 22;70(26):8085-8096. doi: 10.1021/acs.jafc.2c01673. [Article link](#)

**Significance:** *F. graminearum* infection of durum wheat increases the Cadmium concentration in the grains. The promoting effect of *Fusarium* infection could be linked to the metal if confirmed in further studies.



Durum wheat is one of the cereal crops that accumulates the highest concentrations of cadmium (Cd) and deoxynivalenol (DON) mycotoxin in its grains, thereby affecting the safety of products made of durum wheat grains (pasta and semolina). This study investigates in planta the interaction between Cd and *Fusarium graminearum*, the main causal agent of DON accumulation in grains. A pot experiment was designed to characterize the response of durum wheat to *F. graminearum* infection at three levels of Cd exposure: 0.1, 2, and 10 mg Cd kg<sup>-1</sup> soil, which showed that the accumulation of Cd and DON resulted from interacting processes. On the one hand, plant exposure to Cd reduced the concentration of DON in grains. The mitigating effect of Cd on DON accumulation was attributed to the restricted growth of *F. graminearum*, which could result from enhanced plant resistance to the fungal pathogen induced by Cd exposure. On the other hand, *F. graminearum* infection of durum wheat increased the Cd concentration in the grains. The promoting effect of *Fusarium* infection on Cd accumulation was attributed to decoupling of the allocation of Cd and photoassimilates to the grains and to the reduced strength of the grain sink for photoassimilates caused by the fungus. Provided that this result is confirmed in field conditions, it suggests that in Cd-contaminated soils, particular attention should be paid to agronomic practices that affect *Fusarium* head blight disease to avoid further increase in the risk of exceeding the regulatory limit set by the European Union for Cd in durum wheat.

### Updated Interim Reference Levels for Dietary Lead to Support FDA's 'Closer to Zero' Action Plan

Brenna M Flannery, Karlyn B Middleton. *Regul Toxicol Pharmacol.* 2022 Jun 8;133:105202. doi: 10.1016/j.yrtph.2022.105202. [Article link](#)

**Significance:** FDA interim reference levels for lead - updated to align with CDC's updated blood lead reference value - will serve as a benchmark to evaluate whether lead exposure from food is a potential concern.

The Centers for Disease Control and Prevention (CDC) utilizes a blood lead reference value (BLRV) to identify children with elevated blood lead levels (BLLs). At or above the BLRV, the CDC recommends actions be taken to reduce children's BLLs. In 2021, the CDC updated its BLRV to 3.5 µg/dL. To align with the CDC's updated BLRV, the FDA is updating its interim reference levels (IRLs) for lead from food to 2.2 µg/day for children and 8.8 µg/day for females of childbearing age. The updated FDA IRLs for lead will serve as a benchmark to evaluate whether lead exposure from food is a potential concern. The children's BLL associated with the updated IRL is less than those predicted by other agencies to result in 1 intelligence quotient point loss. Dietary lead exposure estimates for children in the U.S. suggest exposures greater than the mean may exceed the updated FDA IRL for children, indicating a need for additional efforts to reduce lead in foods consumed by young children. The US FDA is addressing this need by implementing its Closer to Zero action plan to reduce babies' and children's dietary exposure to toxic elements (e.g., lead, cadmium, arsenic, mercury) over time.

## Food Packaging

### Promoting Sustainable Packaging Applications in the Circular Economy by Exploring and

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## Advancing Molded Pulp Materials for Food Products: A Review

Ajit Kumar Singh, Pontree Itkor, Myungho Lee, Joongmin Shin, Youn Suk Lee. *Crit Rev Food Sci Nutr.* 2022 Jun 15;1-16. doi: 10.1080/10408398.2022.2088686. [Article link](#)

**Significance:** A sustainable approach using molded pulp products encompasses the design and production of eco-friendly packaging, distribution and consumption of packaged products, and collection and recycling of used packaging.

Packaging ensures the safe handling and distribution of fresh and processed food products via diverse supply chains and has become an indispensable component of the food industry. However, the rapidly expanding use of plastics, especially single-use plastics, as packaging material leads to inadequate waste management, littering, and consequently serious environmental damage, which predominantly affects marine and freshwater sources. Thus, the use of plastics for packaging purposes has become a major public concern and hence a concern among global policymakers. Notably, 26% of the total volume of global plastic production is primarily used for packaging, of which single-use plastics account for 50%, resulting in pollution that may last hundreds of years. This review provides an overview of the manner in which molded pulp products can be utilized to improve sustainability of food packaging applications, by highlighting the manufacturing processes, signifying characteristics features of recyclable molded pulp, and coupling circularity with eco-friendly and safe food product packaging. In this regard, current concepts advocate the implementation of a dynamic and sustainable approach using molded pulp products. This approach encompasses the design and production of eco-friendly packaging, distribution and consumption of packaged products, and collection and recycling of used packaging for subsequent reuse.

## Chemical Contaminants

### Assessment of the Applicability of the Threshold of Toxicological Concern for Per- and Polyfluoroalkyl Substances

Isabel A Lea, Ly Ly Pham, Todor Antonijevic, Chad Thompson, Susan J Borghoff. *Regul Toxicol Pharmacol.* 2022 Jun 1;133:105190. doi: 10.1016/j.yrtph.2022.105190. [Article link](#)

**Significance:** Establishing safety thresholds of exposure for groups of chemicals like PFAS is practicable and could be helpful while more research is conducted.

While toxicity information is available for selected PFAS, little or no information is available for most, thereby necessitating a resource-effective approach to screen and prioritize those needing further safety assessment. The threshold of toxicological concern (TTC) approach proposes a de minimis exposure value based on chemical structure and toxicology of similar substances. The applicability of the TTC approach to PFAS was tested by incorporating a data set of no-observed-adverse-effect level (NOAEL) values for 27 PFAS into the Munro TTC data set. All substances were assigned into Cramer Class III and the cumulative distribution of the NOAELs evaluated. The TTC value for the PFAS-enriched data set was not statistically different compared to the Munro data set. Derived human exposure level for the PFAS-enriched data set was 1.3 µg/kg/day. Structural chemical profiles showed the PFAS-enriched data set had distinct chemotypes with lack of similarity to substances in the Munro data set using Maximum Common Structures. The incorporation of these 27 PFAS did not significantly change TTC Cramer Class III distribution and expanded the chemical space, supporting the potential use of the TTC approach for PFAS chemicals.

## Caffeine

### A Double-Blind, Randomized, Two-Part, Two-Period Crossover Study to Evaluate the Pharmacokinetics of Caffeine versus d<sub>9</sub>-Caffeine in Healthy Subjects

Mary M Sherman, Paul M Tarantino, Dennis N Morrison, Chun-Han Lin, Ryan M Parente, Bradford C Sippy. *Regul Toxicol Pharmacol.* 2022 Jun 8;133:105194. doi: 10.1016/j.yrtph.2022.105194. [Article link](#)

**Significance:** Comparing caffeine with a potential alternative showed some differences although both substances were well tolerated.

The deuterium kinetic isotope effect has been used to affect the cytochrome P450 metabolism of the deuterated versions of substances. This study compares the pharmacokinetics of caffeine, a Generally Recognized As Safe food and beverage ingredient, versus d<sub>9</sub>-caffeine, a potential caffeine alternative, and their respective metabolites at two dose levels in 20 healthy adults. A single dose of 50 mg or 250 mg of caffeine, or a molar-equivalent dose of d<sub>9</sub>-caffeine, were orally administered in solution with blood samples collected for up to 48 h post-dose. Plasma concentrations of parent and metabolites were analyzed using validated LC-MS/MS methods. Both d<sub>9</sub>-caffeine

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and caffeine were rapidly absorbed; however, d9-caffeine exhibited a higher (ca. 29%-43%) Cmax and 4-5-fold higher AUClast than caffeine, and lower Cmax, lower AUClast, and a 5-10-fold reduction in the relative exposure to the active metabolites of caffeine. Results were consistent in normal and rapid metabolizers, and both substances were well tolerated.

## Food Allergens

### Updating the CoFAR Grading Scale for Systemic Allergic Reactions in Food Allergy

R Sharon Chinthrajah, Stacie M Jones, Edwin H Kim, Scott H Sicherer, Wayne Shreffler, Bruce J Lanser. *J Allergy Clin Immunol.* 2022 Jun;149(6):2166-2170.e1. doi: 10.1016/j.jaci.2021.12.789. [Article link](#)

**Significance:** Broader use of a revised grading scale for food allergy reactions may expand its reach and relevance.

**Background:** Immunotherapy is promising as an efficacious treatment for food allergy. Other food allergy treatments are also under development. However, adverse allergic events during treatment, as well as during oral food challenges, are common and reporting is not standardized. **Objective:** A more nuanced grading scale is needed to create a comprehensive and universal system to categorize adverse events and their severity for food allergy clinical trials.

**Methods:** Starting with the 2012 Consortium for Food Allergy Research (CoFAR) Grading Scale and the World Allergy Organization Grading System, we developed the CoFAR Grading Scale for Systemic Allergic Reactions, Version 3.0, in collaboration with industry partners with expert opinion. **Results:** The revised CoFAR Grading Scale for Systemic Allergic Reactions has 5 levels of increasing severity, ranging from generalized urticaria, localized angioedema, rhinitis, and abdominal pain (grade 1) to death (grade 5). Systemic reactions are further categorized within each grade by relevant organ system. Mild, single-system reactions are differentiated from mild, multisystem reactions.

Lower respiratory tract symptoms are graded on the basis of response to therapy; those that are refractory to standard treatment (e.g. requiring >3 doses of intramuscular epinephrine, continuous intravenous epinephrine infusion, and continuous albuterol nebulization) and respiratory compromise requiring mechanical ventilation are classified as grade 4, life-threatening reactions. **Conclusions:** Universal and consistent use of the revised CoFAR Grading Scale beyond the CoFAR centers would allow for better data aggregation and safety comparisons in clinical trials for food allergy.

## Emerging Science Areas

### Alternative Proteins and Safety

#### Alternative Proteins for Meat and Dairy Replacers: Food Safety and Future Trends

J L Banach, J P van der Berg, G Kleter, H van Bokhorst-van de Veen, S Bastiaan-Net, L Pouvreau, E D van Asselt. *Crit Rev Food Sci Nutr.* 2022 Jun 27;1-18. doi: 10.1080/10408398.2022.2089625. [Article link](#)

**Significance:** A food safety analysis of alternative protein hazards references processing method examples from the European Union market.

Traditionally, meat and dairy products have been important protein sources in the human diet. Consumers are eating more plant-based proteins, which is reflected in current market trends. Assessing how alternative proteins are processed and their impact on food safety helps realize market opportunities while ensuring food safety. In this review, an analysis of the food safety hazards, along with current industry trends and processing methods associated with alternative proteins for meat and dairy products for the European Union market is described. Understanding the effects of processing and safety alternative proteins is paramount to ensuring food safety and understanding the risks to consumers. However, the data here is limited. With the expected further increase in protein alternatives in consumers' diets, the risk of food allergens is apparent. The occurrence of processing contaminants in plant-based alternatives may occur, along with anti-nutritional compounds, which interfere with the absorption of nutrients. Further, typical food safety hazards related to the plant, the product itself, or processing are relevant. Although hazards in insects and seaweed are being addressed, other protein alternatives like cultured meat and SCPs warrant attention. Our findings can aid industry and governmental authorities in understanding current trends and prioritizing hazards for future monitoring.

## Emerging Science Areas

### Atmosphere and Crops

#### Globally Ubiquitous Negative Effects of Nitrogen Dioxide on Crop Growth

David B. Lobell, Stefania Di Tommaso, Jennifer A. Burney. *Science Advances.* 1 Jun 2022.Vol 8, Issue 22. DOI:

**Significance:** Nitrogen oxides' crop damage and a crop greenness survey measured by satellites demonstrates that reducing nitrogen could boost crop yields in China and elsewhere.

Nitrogen oxides (NO<sub>x</sub>) are among the most widely emitted pollutants in the world, yet their impacts on agriculture remain poorly known. NO<sub>x</sub> can directly damage crop cells and indirectly affect growth by promoting ozone (O<sub>3</sub>) and aerosol formation. We use satellite measures of both crop greenness and NO<sub>x</sub> during 2018–2020 to evaluate crop impacts for five major agricultural regions. We find consistent negative associations between NO<sub>2</sub> and greenness across regions and seasons. These effects are strongest in conditions where O<sub>3</sub> formation is NO<sub>x</sub> limited but remain significant even in locations where this pathway is muted, suggesting a role for direct NO<sub>x</sub> damage. Using simple counterfactuals and leveraging published relationships between greenness and growth, we estimate that reducing NO<sub>x</sub> levels to the current fifth percentile in each region would raise yields by ~25% for winter crops in China, ~15% for summer crops in China, and up to 10% in other regions.

## Engage with IAFNS

- **What is 'Sweetness'? The Biological Role of Sweet Taste and Quality of Life for Individuals with Type 1 Diabetes.**  
**July 19, 2022, webinar, 11:00 am – 12:00 pm ET.**
  - The role of sweetness in the context of sensory perception and the total diet is complex, and the ability to change preference for sweet remains under investigation. Given the biological drive for sweet taste, low- and no-calorie sweeteners (LNCSs) have been acknowledged as a tool for reducing the intake of total carbohydrates, and particularly added sugars, in the nutritional management of diabetes. To learn more about this webinar, the CPE credits available, and to register, click [here](#).
- **'Crash Course' on Design and Implementation of Microbiome Research**  
**July 21, 2022, webinar, 2:00-3:00 pm ET.**
  - Effective application of gut microbiome research requires clinicians to critically appraise methodological elements of research when interpreting results. In this webinar, an overview of best practices for designing and conducting diet-microbiome research in humans will be provided. Topics will include not only intervention study designs but also recruitment tips, sampling methods and important metadata to collect. To learn more about this webinar, the CPE credits available, and to register, click [here](#).
- **IAFNS Sessions at IAFP 2022 Annual Meeting**  
**July 31– August 3, 2022, Pittsburgh, PA.**
  - Each year, the International Association for Food Protection hosts an Annual Meeting, providing attendees with information on current and emerging food safety issues, the latest science, innovative solutions to new and recurring problems, and the opportunity to network with thousands of food safety professionals from around the globe.
  - This year, the IAFNS Food Microbiology Committee is supporting the following **three sessions** at the IAFP Annual Meeting:
    1. How Relevant is Finished Product Testing for Pathogens to Public Health Outcomes? August 1, 2022, from 8:30 AM to 10:00 AM ET
    2. Whole Genome Sequencing: Challenging and Defining Foodborne Pathogen Species, Risk and Virulence. August 2, 2022, from 1:30 PM to 3:00 PM ET
    3. Application of New Technologies for Improved Food Safety. August 3, 2022, from 8:30 AM to 10:00 AM ET

These sessions are supported by the IAFNS [Food Microbiology Committee](#). Learn more about the [IAFP Annual Meeting](#).