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Food Safety Science Briefs



Risk Assessment

Comparison of Toxicological Effects and Exposure Levels Between Triclosan and its Structurally Similar Chemicals Using *in vitro* Tests for Read-Across Case Study

Shota Nakagawa, Akane Hayashi, Yuko Nukada, Masayuki Yamane. *Regul Toxicol Pharmacol.* 2022 Jul;132:105181. doi: 10.1016/j.yrtph.2022.105181. [Article link](#)

Significance: Comparing toxicological effects and exposure levels using read-across chemicals is a promising approach for evaluating systemic toxicity.



Read-across based on structural and biological similarities is expected to be a promising alternative method for assessing systemic toxicity. A concrete strategy for quantitative chemical risk assessment would be to stack read-across case studies and extract key considerations from them. Thus, we developed a read-across case study by comparing the toxicological effects based on adverse outcome pathways and exposure levels of different structurally similar chemicals for a target organ. In this study, we selected the hepatotoxicity of triclosan and its structurally similar chemicals including diclosan and 1-chloro-3-(4-chlorophenoxy) benzene. The results of *in vitro* toxicogenomics showed that disorders of cholesterol synthesis were commonly detected with both triclosan and diclosan. The decrease in hepatocellular cholesterol

levels was similar in the cells treated with triclosan and diclosan. Furthermore, the exposure levels of triclosan and diclosan for the liver were similar. Collectively, these results suggest that triclosan and diclosan show similar toxicological effects and severity of hepatotoxicity. Considering the existing repeated dose toxicity data, our prediction results are reasonable regarding the toxicological effect and its severity. Thus, the present study demonstrated the usability of comparing toxicological effects and exposure levels using read-across for quantitative chemical risk assessment.

Foodborne Pathogens

Vacuum Packaging Improved Inactivation Efficacy of Moderate Dry Heat for Decontamination of *Salmonella* on Almond Kernels

Shiwei Xu, Haiqiang Chen. *Int J Food Microbiol.* 2022 Jul 27;379:109849. doi: 10.1016/j.ijfoodmicro.2022.109849. [Article link](#)

Significance: Dry heat treatments for almonds that sharply reduce food pathogens is shown in combination with vacuum packaging to have minimal impact on nut quality.

The goal of this study was to develop dry heat processing conditions that could achieve a >5-log reduction of *Salmonella* with minimal negative impact on almond quality. The effects of almond's water activity (aw) levels and packaging methods on *Salmonella* inactivation by dry heat were determined. Almonds were dip-inoculated in a four-strain *Salmonella* cocktail and conditioned to aw of 0.43, 0.33, 0.23, and 0.20. The inoculated almonds were then placed in vacuum-sealed mylar bags (vacuum packaging), ambient-sealed glass tubes (non-vacuum packaging), and petri dishes without covers (no packaging). The packaged and un-packaged almonds were treated by dry heat with 13 % relative humidity at 73 °C. Vacuum packaging in general achieved slightly better (in some cases significantly better ($p < 0.05$)) or similar inactivation effect on *Salmonella* than non-vacuum packaging. Both vacuum and non-vacuum packaging methods achieved much greater *Salmonella* inactivation than the no packaging method. For example, a 4-h treatment at 73 °C reduced *Salmonella* on

almonds with aw of 0.43 by 5.1-, 4.4-, and 1.3-log for mylar bag, tube, and petri dish, respectively. Higher aw levels resulted in better inactivation of *Salmonella*. To achieve a >4-log reduction of *Salmonella* on almonds packaged in mylar bags, 3-, 6-, 8-, and 8-h of heat treatment were needed for almonds with aw values of 0.43, 0.33, 0.23 and 0.20, respectively. Vacuum packaging in combination with a 4-h heat treatment of almonds with initial aw of 0.43 or 8-h heat treatment of almonds with initial aw of 0.33 could achieved a ≥ 5 -log reduction of *Salmonella*. Those two combinations resulted in very little weight loss (≤ 0.05 %), insignificant color change ($\Delta E \leq 1.26$), and unnoticeable change in visual appearance of almonds, demonstrating that they could be potentially used for raw almond pasteurization.

Foodborne Illness

Regulation of Enterotoxins Associated with *Bacillus cereus Sensu Lato* Toxicoinfection

Cassidy Prince, Jasna Kovac. *Appl Environ Microbiol.* 2022 Jul 12;88(13):e0040522. doi: 10.1128/aem.00405-22. [Article link](#)

Significance: This review summarizes current understanding of the regulation of enterotoxins associated with the *B. cereus s.l.* toxicoinfection and identifies gaps in knowledge.

Bacillus cereus sensu lato (s.l.) includes foodborne pathogens, as well as beneficial microorganisms, such as bioinsecticides. Some of the beneficial and commercially used *B. cereus s.l.* strains have been shown to carry enterotoxin genes, the products of which can cause toxicoinfection in humans. Furthermore, recent epidemiological reports indicated that some bioinsecticidal strains have been linked with foodborne illness outbreaks. This demonstrates the need for improved surveillance of *B. cereus s.l.*, which includes characterization of isolates' virulence capacity. However, the prediction of virulence capacity of *B. cereus s.l.* strains is challenging. Genetic screening for enterotoxin gene presence has proven to be insufficient for accurate discrimination between virulent and avirulent strains, given that nearly all *B. cereus s.l.* strains carry at least one enterotoxin gene. Furthermore, complex regulatory networks governing the expression of enterotoxins, and potential synergistic interactions between enterotoxins and other virulence factors make the prediction of toxicoinfection based on isolates' genome sequences challenging. In this review, we summarize and synthesize the current understanding of the regulation of enterotoxins associated with the *B. cereus s.l.* toxicoinfection and identify gaps in the knowledge that need to be addressed to facilitate identification of genetic markers predictive of cytotoxicity and toxicoinfection.

Mycotoxins

Detoxification of Mycotoxins in Agricultural Products by Non-Thermal Physical Technologies: A Review of the Past Five Years

Yan Wang, Jie Shang, Ming Cai, Yang Liu, Kai Yang. *Crit Rev Food Sci Nutr.* 2022 Jul 6;1-12. doi: 10.1080/10408398.2022.2095554. [Article link](#)

Significance: Non-thermal physical detoxification technologies for mycotoxins are easily applied and effective, with fewer adverse impacts on the nutrition of agricultural products.

Mycotoxins produced by *Aspergillus spp.*, *Penicillium spp.* and *Fusarium spp.* with small molecular weight and thermal stability, are highly toxic and carcinogenic secondary metabolites. Mycotoxins have caused widespread concern regarding food safety internationally because of their adverse effects on the health of humans and animals, and the major economic losses they cause. There is an urgent need to find ways to reduce or eliminate the impact of mycotoxins in food and feed without introducing new safety issues or reducing nutritional quality. Non-thermal physical technology is the basis for new techniques to degrade mycotoxins, with great potential for practical detoxification applications in the food industry. Compared with conventional thermal treatments, non-thermal physical detoxification technologies are easier to apply and effective, with less adverse impact on the nutritional value of agricultural products. The advantages, limitations and development prospects of these new detoxification technologies are discussed. Further studies are recommended to standardize the treatment conditions for each detoxification technology, evaluate the safety of the degradation products, and to combine different detoxification technologies to achieve synergistic effects. This will facilitate realization of the great potential of the new technologies and the development of practical applications.

Heavy Metals

Research Progress of Soil Microorganisms in Response to Heavy Metals in Rice

Yangbin Mao, Haifeng Tan, Maomao Wang, Tianheng Jiang, Hewen Wei, Wenping Xu, Qiong Jiang, et. al. *J Agric Food Chem.* 2022 Jul 20;70(28):8513-8522. doi: 10.1021/acs.jafc.2c01437. [Article link](#)

Significance: A review of the role and mechanism of soil microorganisms in alleviating heavy-metal stress in rice points up the need for more field trials under natural conditions.

Soil heavy-metal pollution leads to excessive heavy metals in rice and other food crops, which has caused serious impacts on the ecological environment and on human health. In recent years, environmentally friendly treatment methods that reduce the bioavailability of heavy metals in soil by soil microorganisms improving the tolerance of heavy metals in rice and reducing the transfer of heavy metals from the roots to the above-ground parts of rice have attracted much attention. This paper reviews the role and mechanism of soil microorganisms in alleviating heavy-metal stress in rice at home and abroad in recent years. At present, microorganisms tolerant to heavy metals mainly include bacteria and fungi, and their mechanisms include the adsorption of heavy metals by microorganisms, the secretion of growth-promoting substances (growth hormone, ACC deaminase, IAA), changing the physical and chemical properties of the soil and the composition of the microbial community, changing the transport mode of heavy metals in soil, the improvement of the antioxidant capacity of rice, etc. Hence, soil microorganisms have good application value and prospects in rice and other crops. However, the vast majority of current research focuses on a single strain, the screening principles of strains are limited, the pathogenicities of the strains have not been evaluated, and there are still few field experiments under natural conditions. In the future, we should strengthen the action of soil microorganisms on rice in response to the above problems in heavy metals, to better promote the microbial remediation technology.

Food Packaging

Bio-based Antibacterial Food Packaging Films and Coatings Containing Cinnamaldehyde: A Review

Jishuai Sun, Xiaojing Leng, Jiachen Zang, Guanghua Zhao. *Crit Rev Food Sci Nutr.* 2022 Jul 28;1-13. doi: 10.1080/10408398.2022.2105300. [Article link](#)

Significance: Cinnamaldehyde is both natural and safe and its antibacterial activity against microorganisms is promising for enhancing the properties of bio-based packaging.

As a typical bioactive compound from the bark and leaves of the trees of the genus *Cinnamomum*, cinnamaldehyde (CIN) is natural and safe. Its excellent antibacterial activity against various foodborne microorganisms is growingly regarded as a promising additive for improving and enhancing the properties of bio-based packaging films/coatings. This review systematically summarized the bio-based food packaging films/coatings containing CIN developed recently. The effects of CIN incorporation on physical and chemical properties of the antibacterial food packaging films/coatings, including thickness, color index, transparency, water content, water solubility, water contact angle, mechanical performances, water barrier performances, and antibacterial performances, were discussed. Simultaneously, this work also concluded that an explanation of the antibacterial mechanism of CIN and preparation methods of bio-based packaging films/coatings containing CIN/CIN carriers. Notably, the incorporation of CIN into the films/coatings could enhance their antibacterial performance extend the shelf-life of various foods, such as fish, meats, vegetables, fruits, and other perishable food, while improving their physical and chemical properties. Although incorporating CIN into food packaging films/coatings has been extensively studied, long-term follow-up research on the human safety of active food packaging films/coatings containing CIN needs to be carried out.

Chemical Contaminants

Dimethylated Thioarsenates: A Potentially Dangerous Blind Spot in Current Worldwide Regulatory Limits for Arsenic in Rice

Britta Planer-Friedrich, Carolin F Kerl, Andrea E Colina Blanco, Stephan Clemens. *J Agric Food Chem.* 2022 Jul 28. doi: 10.1021/acs.jafc.2c02425. [Article link](#)

Significance: Emerging evidence suggests that dimethylated oxyarsenate hides a substantial share of dimethylated thioarsenates that have similar or higher cytotoxicities than arsenite itself, warranting more scrutiny.

Arsenic (As) occurrence in rice is a serious human health threat. Worldwide, regulations typically limit only carcinogenic inorganic As, but not possibly carcinogenic dimethylated oxyarsenate (DMA). However, there is emerging evidence that “DMA”, determined by routine acid-based extraction and analysis, hides a substantial share of dimethylated thioarsenates that have similar or higher cytotoxicities than arsenite. Risk assessments characterizing the *in vivo* toxicity of rice-derived dimethylated thioarsenates are urgently needed. In the meantime, either more sophisticated methods based on enzymatic extraction and separation of dimethylated oxy- and thioarsenates have to become

mandatory or total As should be regulated.

Caffeine

Effects of Caffeine Ingestion on Cardiopulmonary Responses during a Maximal Graded Exercise Test: A Systematic Review with Meta-Analysis and Meta-Regression

Alisson Henrique Marinho, João Paulo Lopes-Silva, Gislaine Cristina-Souza, Filipe Antônio de Barros Sousa, Thays Ataíde-Silva, Adriano Eduardo Lima-Silva, Gustavo Gomes de Araujo, et. al. *Crit Rev Food Sci Nutr.* 2022 Jul 27;1-13. doi: 10.1080/10408398.2022.2104807. [Article link](#)

Significance: This study suggests that caffeine increases the time to exhaustion and peak minute ventilation, among the cardiopulmonary variables examined.

While the effects of caffeine ingestion on endurance performance are well known, its effects on cardiopulmonary responses during a maximal graded exercise test have been less explored. This study systematically reviewed and meta-analyzed studies investigating the effects of caffeine ingestion on cardiopulmonary responses during a maximal graded exercise test. A search was performed in four databases, and study quality was assessed using the PEDro scale. Data reported by the selected studies were pooled using random-effects meta-analysis, with selected moderator effects assessed via meta-regression. Twenty-one studies with good and excellent methodological quality were included in this review. Compared to placebo, caffeine increased peak minute ventilation (SMD = 0.33; $p = 0.01$) and time to exhaustion (SMD = 0.41; $p = 0.01$). However, meta-regression showed no moderating effects of dosage and timing of caffeine ingestion, stage length, or total length of GXT (all $p > 0.05$). Caffeine ingestion did not affect peak oxygen uptake (SMD = 0.13; $p = 0.42$), peak heart rate (SMD = 0.27; $p = 0.07$), peak blood lactate concentration (SMD = 0.60; $p = 0.09$), peak tidal volume (SMD = 0.10; $p = 0.69$), peak breathing frequency (SMD = 0.20; $p = 0.23$), or peak power output (SMD = 0.22; $p = 0.28$). The results of this systematic review with meta-analysis suggest that caffeine increases time to exhaustion and peak minute ventilation among the cardiopulmonary variables assessed during GXT.

Food Allergens

Changes in Australian Food Anaphylaxis Admission Rates Following Introduction of Updated Allergy Prevention Guidelines

Raymond James Mullins, Keith B G Dear, Mimi L K Tang. *J Allergy Clin Immunol.* 2022 Jul;150(1):140-145.e1. doi: 10.1016/j.jaci.2021.12.795. [Article link](#)

Significance: This study tracks the impact of new food allergy prevention recommendations in Australia by examining food anaphylaxis admission rates in hospitals.

Background: Food anaphylaxis admission rates have increased steadily in recent decades. Global food allergy prevention guidelines recommending early introduction of allergenic foods were introduced in 2015-2016. Australian guidelines to not delay the introduction of allergenic foods were introduced in 2007-2008. **Objective:** Our aim was to examine whether introduction of Australian guidelines (2007-2008) and global allergy prevention guidelines (2015-2016) were associated with reductions in food anaphylaxis admission rates. **Methods:** We compared food anaphylaxis admission rates across 3 periods: 1998-1999 to 2006-2007, 2007-2008 to 2014-2015, and 2015-2016 to 2018-2019. **Results:** Annual food anaphylaxis admission rates increased 9-fold between 1998-1999 and 2018-2019, from 2.0 per 105 population to 18.2 per 105 population; the highest absolute rates were in those younger than 1 year. When year-on-year rates of change were examined across the 3 time periods, the annual rate of increase slowed after 2007-2008 in those aged 1 to 4 years (17.6%, 6.2%, and 3.9% per year, respectively) and those aged 5 to 9 years (22%, 13.9%, and -2.4%, respectively), and after 2015-2016, in those aged 10 to 14 years (17.5%, 18.0%, and 10.8%, respectively). By contrast, the year-on-year rate of increase accelerated in those younger than 1 year (5.2%, 8.0%, and 18.0%, respectively) and in all age groups older than 15 years. **Conclusions:** Although food anaphylaxis continues to increase overall, there is preliminary evidence indicating a slowing in the year-on-year rate of increase among those aged 1 to 4, 5 to 9, and 10 to 14 years, coinciding with introduction of updated infant feeding and allergy prevention guidelines in 2007-2008 and 2015-2016. Changes to the guidelines may have contributed to an attenuated rate of increase in food anaphylaxis in these age groups, as well as to increased rates in those younger than 1 year.

Emerging Science Areas

Emerging Area: PFAS Clinical Recommendations

Category: Food Safety

National Academies of Sciences, Engineering, and Medicine 2022. Guidance on PFAS Exposure, Testing, and Clinical Follow-Up.

Washington, DC: *The National Academies Press*. <https://doi.org/10.17226/26156>. July 2022. [Article link](#)

Significance: New NAS report found evidence of association between PFAS exposure and increased risks of decreased antibody response, abnormally high cholesterol, decreased infant and fetal growth, and increased risk of kidney cancer. The report outlines guidance for testing PFAS exposure, and subsequent clinical follow-up.

Testing for exposure to perfluoroalkyl and polyfluoroalkyl substances, also known as PFAS, should be offered to patients who are likely to have a history of elevated exposure — such as those exposed to PFAS through their work or who live in areas with known PFAS contamination, says a new report from the National Academies of Sciences, Engineering, and Medicine. The report finds evidence of association between PFAS exposure and increased risk of decreased antibody response, dyslipidemia (abnormally high cholesterol), decreased infant and fetal growth, and increased risk of kidney cancer. Intended to inform CDC clinical guidance, the report says if testing reveals PFAS levels associated with an increased risk of adverse effects, patients should receive regular screenings and monitoring for these and other health impacts. Used worldwide for decades, PFAS are a group of thousands of manufactured chemicals with properties that can make products oil- and water-repellent, reduce their friction, and make them resistant to temperature change. They are used in a broad range of consumer products, from nonstick cookware and stain-resistant fabric to firefighting foams.

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- **Invitation-Only Dialogue: Exploring Evidence on Food-Based Strategies and Weight Virtual, Event**
 - Join Dr. Jamy Ard of Wake Forest University and Dr. Barbara Rolls of the Pennsylvania State University to discuss the relationship between food-based strategies and weight-related outcomes.
 - August 25, 2022, 10:00 am – 11:00 am ET. To learn more, please email science@iafns.org
- **FNCE 2022: Are We Ready? Dietary Recommendations Based on Direct-to-Consumer Gut Microbiome Tests**
Orlando, Florida. October 8 - October 11, 2022
 - Join IAFNS, the Academy of Nutrition and Dietetics Research Dietetic Practice Group (RDPG), and the American Society for Nutrition Microbiology Research Interest Section (RIS) for this session at the annual meeting of nutrition professionals. Find information about FNCE 2022 [here](#).
- **Invitation-Only: Food Service Sector Sodium Dialogue**
Washington, DC. October 25, 2022
 - IAFNS will bring together leaders from across the food service sector and government to participate in an open dialogue about sodium reduction opportunities and challenges specific to this sector. This event is a project of the Sodium in Foods and Health Implications Committee. To learn more, and to join us, please email science@iafns.org.
- **Impact of Ingested Live Microbes on Health: An Evidence Map**
Las Vegas, Nevada. October 31 – November 4, 2022.
 - Despite the large body of evidence on the health benefits of specific probiotics and Functional Foods, there is an absence of recommended dietary allowances relating to the consumption of live microbes. Evidence for the benefits of live dietary microbes for health is building. However, the volume and nature of evidence that supports specific health benefits must be characterized, with gaps identified and addressed in order to develop more specific and quantitative guidance. Join in crafting an evidence-map. To learn more, please email science@iafns.org.