Food Safety Briefs

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Risk Assessment

Essential Oils as Green Promising Alternatives to Chemical Preservatives for Agri-Food Products: New Insight into Molecular Mechanism, Toxicity Assessment and Safety Profile

Bhanu Prakash, Prem Pratap Singh, Vishal Gupta, Tanya Singh Raghuvanshi. *Food Chemical Tox*. 2024 Jan:183:114241. doi: 10.1016/j.fct.2023.114241. Article link

Significance: The food sector is looking for natural, clean-label alternatives to chemical preservatives and essential oils (EOs) show broad-range antimicrobial effectiveness and low toxicity.

Microbial food spoilage caused by food-borne bacteria, molds, and associated toxic chemicals significantly alters the nutritional quality of food products and makes them unpalatable to the consumer. In view of potential adverse effects (resistance development, residual toxicity, and negative effects on consumer health) of some of the currently used preservative agents and consumer preferences towards safe, minimally processed, and chemical-free products, food industries are looking for natural alternatives to the chemical preservatives. In this context, essential oils (EOs) showed broad-range antimicrobial effectiveness, low toxicity, and diverse mechanisms of action, and could be considered promising natural plant-based antimicrobials. The existing technical barriers related to the screening of plants, extraction methods, characterization, dose optimization, and unpredicted mechanism of toxicity in the food system, could be overcome using recent scientific and technological advancements, especially bioinformatics, nanotechnology, and mathematical approaches. The review focused on the potential antimicrobial efficacy of EOs against food-borne microbes and the role of recent scientific technology and social networking platform in addressing the major obstacles with EOs-based antimicrobial agents. In addition, a detailed mechanistic understanding of the antimicrobial efficacy of EOs, safety profile, and risk assessment using bioinformatics approaches are summarized to explore their potential application as food preservatives.

Foodborne Pathogens

Analysis of Alternative Methods of Environmental Monitoring for *Listeria* in Food Production Facilities

Yukako Shimojima, Yuji Kanai, Takatoshi Moriyama, Sayoko Arakawa, Yumi Tamura, Yukio Morita. *J Food Prot*. 2024 Jan 3;87(2):100214. doi: 10.1016/j.jfp.2023.100214. Article link

Significance: Validated alternative test methodologies that are rapid, simple, and useful could replace culture-based methods recommended for environmental monitoring programs for Listeria in food facilities but require more robust comparisons

Validated alternative test methodologies may be used in place of culture-based methods recommended for environmental monitoring programs (EMPs) for *Listeria* in food production facilities. In order to help guide decisions on which testing method to use to simplify *Listeria* EMP implementation in food production facilities, alternative methods were compared to the culture-based method in actual EMPs for Listeria. Seventy-two samples collected from two facilities of souzai production businesses that use meat and meat products as ingredients, one facility of processed meat product production business, and one facility of processed meat product and souzai production business were applied to EMPs for *Listeria* using the culture-based method, 3MTM Molecular Detection System (MDS), and InSite L. mono Glo (InSite). The kappa coefficient in MDS was 0.65 for *Listeria monocytogenes* and 0.74 for *Listeria* spp., both of which were deemed substantial compared with the culture-based method. The kappa coefficient in InSite was -0.01 for *L. monocytogenes* and 0.50 for *Listeria* spp., which indicated poor and moderate reproducibility, respectively. When the medium of InSite was smeared on agar medium, 7 of the 19 samples tested positive only for *Listeria* spp. (negative for *L. monocytogenes*) but *L. monocytogenes* was cultured, indicating that the sensitivity of detecting *L. monocytogenes* via fluorescence may be low. MDS was considered a useful alternative for both *L. monocytogenes* and *Listeria* spp. as targets, and InSite was not possible as a substitute for detecting *L. monocytogenes*; however, it is considered a helpful alternative method for detecting *Listeria* spp. EMPs for *Listeria* often target *Listeria* spp. as an indicator of *L. monocytogenes*. The alternative methods studied in this study are rapid, simple, and useful in EMPs for *Listeria*. However, the data in this study were a comparatively small sample set and impacted by variability, so more robust comparisons are desirable in the future.

Foodborne Illness

Food Safety Practices of Food Handlers in China and their Correlation with Self-reported Foodborne Illness

Yujuan Chen, Gaihong Wan, Jiangen Song, Jiajia Dai, Wei Shi, Lei Wang. *J Food Prot*. 2024 Jan;87(1):100202. doi: 10.1016/j.jfp.2023.100202. Article link

Significance: Improved supervision of the food-safety practices of caterers may reduce the frequency of foodborne-disease outbreaks.

740 15th Street NW
Washington, DC
20005

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

Food service facilities are important sites where foodborne diseases have been reported to occur frequently. This study aims to determine the correlation between self-reported foodborne diseases and food-safety practices followed by food handlers of various food service facilities. A cross-sectional survey was conducted from March 1, 2022, to December 30, 2022, in Wuhu City, Anhui Province, China. Data were collected through face-to-face interviews and having the selected food handlers fill in a self-compiled questionnaire. Of the 1072 food handlers included in the study, 88 (8.2%) reported having experienced symptoms of foodborne diseases in the past 4 weeks. The following food-safety practices correlated with self-reported foodborne diseases: (1) infrequently using 3-compartment sinks to separately clean different types of raw food materials ($P < 0.05$, OR = 2.312); (2) infrequently removing non-edible parts of aquatic products outside a specific room for food processing ($P < 0.001$, OR = 3.916); (3) infrequently immediately refrigerating cold dishes prepared in advance to be consumed later ($P < 0.001$, OR = 4.048); (4) often store perishable foods at 8-60°C in the indoor environment after cooking and before eating ($P < 0.05$, OR = 2.068); (5) infrequently reheating cooked perishable food stored at 8-60°C for more than 2 h before eating ($P < 0.05$, OR = 1.934); and (6) often storing raw and cooked food in the same container ($P < 0.001$, OR = 3.818). Hence, a better supervision of food-safety practices of catering workers may reduce the frequency of foodborne-disease outbreaks in food service facilities.

Mycotoxins

Comprehensive and Cumulative Risk Evaluation of Dietary Exposure to Aflatoxins and Ochratoxin A on Fermented Teas Worldwide by a New Assessment Model

Hangbin Yan, Weifan Zhao, Asma Parveen, Ziling Ye, Qingru Fei, Xu Wang, Yu Zhou. *Food Chem Toxicol*. 2024 Feb:184:114321. doi: 10.1016/j.fct.2023.114321. Article link

Significance: A cumulative risk assessment of aflatoxins and ochratoxin A was performed using a tea assessment model and demonstrated the need to include mycotoxin transfer rates in future assessments

Recently, mycotoxin risks in fermented tea have received high attention, but mycotoxin transfer rates from tealeaf to infusion during brewing were rarely considered. In addition, the assessment data (i.e., mycotoxin occurrences and tea consumption) in previous assessments were usually limited. Here, a comprehensive and cumulative risk assessment of aflatoxins and ochratoxin A was performed using a tea assessment model, by which mycotoxin transfer rates were included and the assessment data were collected worldwide. By 10 times of brewing, the aflatoxin transfer rate was only 2.94% and OTA was 63.65%. Besides the extreme case, hazard quotients (HQs) from all consumers were lower than the threshold of 1.0, indicating no noncarcinogenic risk; the P95 cumulative margin of exposure (1/MoET) values were 2.52E-04 (30-39 years of age) and 2.42E-04 (≥50 years of age) for two high exposure groups under the upper bound scenario, which a little higher than the carcinogenic risk threshold of 1.00E-04. Notably, the P95 cumulative 1/MoET values (3.24E-03 -7.95E-03) by food assessment model were ten times higher than those of by tea assessment model. The comparative results showed that mycotoxin dietary risks on tea consumption by food assessment model were much overestimated. The result of this study indicated that the contaminants transfer rates should be considered for risk assessment on tea consumption in future work.

Heavy Metals

Competition of Cd(II) and Pb(II) on the Bacterial Cells: A New Insight from Bioaccumulation based on NanoSIMS Imaging

Zhijun Wang, Ying Zhang, Yunhui Chen, Feiyu Han, Yixiao Shi, Shang Pan, Zhen Li. *Appl Environ Microbiol*. 2024 Jan 11:e0145323. doi: 10.1128/aem.01453-23. Article link

Significance: Exposure to combinations of metals can be measured using microbial bioactivity and mirrors real-world exposures more accurately than studies of single metals.

Microbial tolerance and resistance to heavy metals have been widely studied under stress of single metals. However, the polymetallic exposure seems to prevail in the environment. Though microbial resistance can alleviate the effects of exogenous stress, the taxonomic or functional response to polymetallic exposure is still not fully understood. We determined the strong cytotoxicity of cadmium (Cd) on growth, and cell elongation would be driven by Cd stress. The addition of appropriate lead (Pb) showed a stimulating effect on microbial bioactivity. Meanwhile, the biosorption of Pb was more intense during co-existence of Pb and Cd. Our work also revealed the spatial coupling of intracellular S and Cd/Pb. In particular, the S assimilation was promoted by Pb stress. This work elucidated the microbial responses to polymetallic exposure and may provide new insights into the antagonistic function during metal stresses.

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*. 2024;64(1):140-152. doi: 10.1080/10408398.2022.2105300. Article link

Significance: The incorporation of cinnamaldehyde into food packaging films and coatings could enhance antibacterial performance and extend the shelf-life of various foods.

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

Characterizing Chemical Exposure Trends from NHANES Urinary Biomonitoring Data

Zachary Stanfield, R Woodrow Setzer, Victoria Hull, Risa R Sayre, Kristin K Isaacs, John F Wambaugh. *Environ Health Perspect*. 2024 Jan;132(1):17009. doi: 10.1289/EHP12188. Article link

Significance: Decreases in exposure to chemicals are observable as the result of regulatory action, with some being accompanied by increases in replacement chemicals, according to a review of NHANES data over two decades.

Background: Xenobiotic metabolites are widely present in human urine and can indicate recent exposure to environmental chemicals. Proper inference of which chemicals contribute to these metabolites can inform human exposure and risk. Furthermore, longitudinal biomonitoring studies provide insight into how chemical exposures change over time. **Objectives:** We constructed an exposure landscape for as many human-exposure relevant chemicals over as large a time span as possible to characterize exposure trends across demographic groups and chemical types. **Methods:** We analyzed urine data of nine 2-y cohorts (1999-2016) from the National Health and Nutrition Examination Survey (NHANES). Chemical daily intake rates (in milligrams per kilogram bodyweight per day) were inferred, using the R package bayesmarker, from metabolite concentrations in each cohort individually to identify exposure trends. Trends for metabolites and parents were clustered to find chemicals with similar exposure patterns. Exposure variation by age, gender, and body mass index were also assessed. **Results:** Intake rates for 179 parent chemicals were inferred from 151 metabolites (96 measured in five or more cohorts). Seventeen metabolites and 44 parent chemicals exhibited fold-changes ≥ 10 between any two cohorts (deltamethrin, di-n-octyl phthalate, and di-isononyl phthalate had the greatest exposure increases). Di-2-ethylhexyl phthalate intake began decreasing in 2007, whereas both di-isobutyl and di-isononyl phthalate began increasing shortly before. Intake for four parabens was markedly higher in females, especially reproductive-age females, compared with males and children. Cadmium and arsenobetaine exhibited higher exposure for individuals > 65 years of age and lower for individuals < 20 years of age. **Discussion:** With appropriate analysis, NHANES indicates trends in chemical exposures over the past two decades. Decreases in exposure are observable as the result of regulatory action, with some being accompanied by increases in replacement chemicals. Age- and gender-specific variations in exposure were observed for multiple chemicals. Continued estimation of demographic-specific exposures is needed to both monitor and identify potential vulnerable populations.

Caffeine

Effects of Caffeine on Cerebral Blood Flow

Catarina Gaspar, Clara Rocha, Jorge Balteiro, Helder Santos. *Nutrition*. 2024 Jan:117:112217. doi: 10.1016/j.nut.2023.112217. Article link

Significance: Caffeine was shown to strongly influence the cardiovascular system a causing a decrease in middle cerebral artery velocities that is accentuated with higher doses of caffeine.

Objective: The objective of the present study is to evaluate whether, after caffeine ingestion, there are variations in blood velocity of the middle cerebral arteries in clinically healthy young people as well as to evaluate whether this variation is dependent on the administered dose. **Methods:** We used transcranial Doppler ultrasonography to record blood velocities of the middle cerebral arteries in three groups of 15 clinically healthy young adults each: no caffeine, a45 mg, and 120 mg of caffeine groups. Transcranial Doppler ultrasonography provided simultaneous bilateral velocity of the middle cerebral arteries measurements while participants performed functional tests (hyperventilation and hypoventilation orders) and three cognitive activities (test 1, short-term memory; test 2, solving a vocabulary problem; and test 3, solving a math problem) each in 31-s tests with 1-min rests between them. Participants were assessed before and 30 min after caffeine ingestion. **Results:** There was a significant decrease in mean velocity, peak systolic velocity, end-diastolic velocity, and heart rate after high caffeine intake, except in hyperventilation, which was only observed in peak systolic velocity. With the intake of a lower dose, significant decreases were seen with hypoventilation and with test 1. In hyperventilation, there was only a significant decrease in end-diastolic velocity and heart rate; in test 2, it was found in mean velocity and peak systolic velocity; and in test 3, only in heart rate. **Conclusion:** With this study, we conclude that caffeine influences the cardiovascular system acutely, interfering with the velocity of the middle cerebral arteries, causing its decrease. We also conclude that this acute effect causes vasodilation of the cerebral arteries, more accentuated with higher doses of caffeine.

Food Allergens

Widespread Monoclonal IgE Antibody Convergence to an Immunodominant, Proanaphylactic Ara h 2 Epitope in Peanut Allergy

Derek Croote, Joyce J W Wong, Cyprien Pecalvel, Edouard Leveque, Natacha Casanovas, Jasper B J Kamphuis, Paige Creeks, et. al. *J Allergy Clin Immunol*. 2024 Jan;153(1):182-192.e7. doi: 10.1016/j.jaci.2023.08.035. Article link

Significance: Understanding the functional properties of key molecules is needed to develop therapeutics, such as competitive IgG inhibitors, that are able to stoichiometrically outcompete endogenous IgE for allergen.

Background: Despite their central role in peanut allergy, human monoclonal IgE antibodies have eluded characterization. **Objective:** We sought to define the sequences, affinities, clonality, and functional properties of human monoclonal IgE antibodies in peanut allergy. **Methods:** We applied our single-cell RNA sequencing-based SEQ SIFTER discovery platform to samples from allergic individuals who varied by age, sex, ethnicity, and geographic location in order to understand commonalities in the human IgE response to peanut allergens. Select antibodies were then recombinantly expressed and characterized for their allergen and epitope specificity, affinity, and functional properties. **Results:** We found striking convergent evolution of IgE monoclonal antibodies (mAbs) from several clonal families comprising both memory B cells and plasmablasts. These antibodies bound with subnanomolar affinity to the immunodominant peanut allergen Ara h 2, specifically a linear, repetitive motif. Further characterization of these mAbs revealed their ability to single-handedly cause affinity-dependent degranulation of human mast cells and systemic anaphylaxis on peanut allergen challenge in humanized mice. Finally, we demonstrated that these mAbs, reengineered as IgGs, inhibit significant, but variable, amounts of Ara h 2- and peanut-mediated degranulation of mast cells sensitized with allergic plasma. **Conclusions:** Convergent evolution of IgE mAbs in peanut allergy is a common phenomenon that can reveal immunodominant epitopes on major allergenic proteins. Understanding the functional properties of these molecules is key to developing therapeutics, such as competitive IgG inhibitors, that are able to stoichiometrically outcompete endogenous IgE for allergen and thereby prevent allergic cascade in cases of accidental allergen exposure.

Emerging Science Areas

Emerging Area: Biocontrols and Food Safety

Adhesion To and Survival of Foodborne Pathogens in Produce and Strategies for their Biocontrol

Jeannette Barba-León, Aurora Dolores Arista-Regalado, Lilia Mercedes Mancilla-Becerra, Mario Alberto Flores-Valdez, Delia Guillermina González-Aguilar. *Jrnl of Food Safety*. 2 January 2024. doi.org/10.1111/jfs.13100. Article link

Significance: Three biocontrol strategies such as bacteria, lytic bacteriophages, and some fungi are reviewed as an alternative approach to control both foodborne and plant pathogens.

Foodborne pathogens can cause gastrointestinal infections in consumers and in some cases can even lead to outbreaks. In the last decade, it has been observed that some zoonotic pathogenic bacteria can use plants as secondary hosts. Contamination with foodborne bacteria becomes relevant in foods that are regularly eaten raw, such as lettuce, cilantro, fenugreek, rocket leaves, basil, and so forth, and some fruits such as tomatoes, melons, and green peppers; because the elimination of these pathogenic bacteria is difficult to achieve with conventional sanitization processes. Contamination of produce can occur throughout the entire production chain. In farmlands, pathogenic bacteria can contaminate the seed, mainly when contaminated water is used for irrigation. Later, bacteria can reach other plant tissues such as the stems, leaves, and fruits. Another form of contamination is when the produce is in contact with feces from domestic, production, or wild animals. Additionally, poor handling practices during harvest, packaging, distribution, and sale can contaminate produce. Studies have shown that foodborne pathogens can adhere to produce, sometimes forming a biofilm, and can also be internalized into the plant or fruit, which protects them from sanitation processes. For this reason, in this text we address three biocontrol strategies such as bacteria, lytic bacteriophages, and some fungi, as an alternative approach for the control of both foodborne and plant pathogens. Additionally, the use of these biological agents can represent an advantage for the development of the plant, making them a good strategy to favor yield.

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