

# Food Safety Briefs

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## Risk Assessment

### Monte Carlo Simulation Model for Predicting *Salmonella* Contamination of Chicken Liver as a Function of Serving Size for Use in Quantitative Microbial Risk Assessment

Oscar T. *J Food Prot.* 2021 Jun 4. doi: 10.4315/JFP-21-018. [Article link](#)

**Significance:** A combination of five methods were used to determine *Salmonella* prevalence, number, and serotype among servings of chicken livers at meal preparation. These data fill an important data and modeling gap in a quantitative microbial risk assessment.



The first step in quantitative microbial risk assessment (QMRA) is to determine distribution of pathogen contamination among servings of the food at some point in the farm-to-table chain. In the present study, distribution of *Salmonella* contamination among servings of chicken liver for use in QMRA was determined at meal preparation. A combination of five methods: 1) whole sample enrichment; 2) quantitative polymerase chain reaction; 3) cultural isolation; 4) serotyping; and 5) Monte Carlo simulation were used to determine *Salmonella* prevalence (P), number (N), and serotype for different serving sizes. In addition, epidemiological data were used to convert serotype data to virulence (V) values for use in QMRA. A Monte Carlo simulation model based in Excel and simulated with @Risk predicted *Salmonella* P, N, serotype, and V as a function of serving size from one (58 g) to eight (464 g) chicken livers. *Salmonella* P of chicken livers

was 72.5% (58/80) per 58 g. Four serotypes were isolated from chicken livers: 1) *Infantis* (P = 28%, V = 4.5); 2) *Enteritidis* (P = 15%, V = 5); 3) *Typhimurium* (P = 15%, V = 4.8); and 4) *Kentucky* (P = 15%, V = 0.8). Median *Salmonella* N was 1.76 log per 58 g (range: 0 to 4.67 log/58 g) and was not affected ( $P > 0.05$ ) by serotype. The model predicted a non-linear increase ( $P \leq 0.05$ ) of *Salmonella* P from 72.5% per 58 g to 100% per 464 g, minimum N from 0 log per 58 g to 1.28 log per 464 g, and median N from 1.76 log per 58 g to 3.22 log per 464 g. Regardless of serving size, predicted maximum N was 4.74 log, mean V was 3.9, and total N was 6.65 log per lot (10,000 chicken livers). The data acquired and model developed in this study fill an important data and modeling gap in QMRA for *Salmonella* and chicken liver.

## Foodborne Pathogens

### Evaluation of Foodborne Pathogen Die-off in Back-Sweetened Wine and Apple Cider Models

Xiong ZR, Chen A, Jiang GZ, Lewis AG, Sislak CD, Cobo M, Worobo RW, Gibney PA. *J Food Prot* (2021) 84 (6): 1023–1032. <https://doi.org/10.4315/JFP-20-351>. [Article link](#)

**Significance:** A combination of low pH and high ethanol content resulted in faster pathogen die-off compared with higher pH and lower ethanol conditions in juices typically used to back-sweeten wines and ciders, providing data to validate juice HACCP 5-log pathogen inactivation requirements.

Wine and alcoholic apple cider are commonly back-sweetened with unpasteurized juice to produce fresh, natural, and palatable sweetened alcoholic beverages. Foodborne pathogens may be introduced from unpasteurized juice into alcoholic beverages through this back-sweetening process. Although foodborne pathogens generally do not survive under low pH conditions or a high alcohol environment, the die-off of these pathogens has not been established to ensure the microbiological safety of the products. To establish the holding conditions that would provide the required 5-log pathogen reduction requirements for these back-sweetened beverages, we evaluated the survival of three common foodborne pathogens, *E. coli* O157:H7, *Salmonella enterica*, and *Listeria monocytogenes*, in modified white grape juice and apple juice models. White grape juice and apple juice were modified with hydrochloric acid and sodium hydroxide and with ethanol to achieve

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conditions that are similar to back-sweetened white wine and alcoholic apple cider in regard to pH and ethanol content. Foodborne pathogen cocktails were inoculated separately into modified juice models, and their survival in the juice models was recorded over a 96-h period. Our results show that a combination of low pH and high ethanol content resulted in faster pathogen die-off compared with higher pH and lower ethanol conditions. The holding times required for different combinations of pH and ethanol concentration for each juice model to achieve a 5-log reduction were reported. This research provides data to validate pathogen die-off to comply with juice hazard analysis and critical control point 5-log pathogen inactivation requirements for back-sweetened wine and alcoholic apple cider.

## Foodborne Illness

### Determining the DNA Fingerprinting Profiles of *Salmonella* Isolates from Raw Poultry Meats and Human Clinical Samples from the Same Geographic Area Using Pulsed-Field Gel Electrophoresis

Mazengia E, Meschke J, Greeson K, Zhao S, Abbott J, Eckmann K, Tate H, Huang X, Samadpour M. *J Food Prot.* 2021 Jul 1;84(7):1265-1274. DOI: 10.4315/JFP-20-421. [Article link](#)

**Significance:** There is some association between PFGE profiles from raw poultry products and those of clinical isolates from the same geographical area, but the results don't support the conclusion that all of those clinical isolates were from infections acquired through consumption or handling of poultry.

Foods of animal origin, such as poultry, eggs, and pork, are recognized sources of *Salmonella* infections, but determination of the proportion of foodborne infections associated with various food sources has been challenging. In the present study, 141 *Salmonella* isolates recovered from 1,322 poultry product samples purchased over a 1-year period from retail stores across Seattle, WA were subtyped by pulsed-field gel electrophoresis (PFGE) using restriction enzyme XbaI. The objectives of the study were (i) to analyze the longitudinal distribution of *Salmonella* PFGE profiles throughout the sampling period and their clonality within and between poultry processing establishments, (ii) to determine the association between PFGE profiles of *Salmonella* isolates from locally distributed poultry products and those of clinical isolates submitted to the Washington State Department of Health (WA-DOH) laboratories, and (iii) to compare the PFGE profiles of *Salmonella* isolates from the National Antimicrobial Resistance Monitoring System (NARMS) retail meats program. During the 1-year sampling period, multiple indistinguishable PFGE patterns were found across multiple poultry processing establishments. Twelve of the 30 unique PFGE profiles of *Salmonella* isolates from locally purchased poultry products were indistinguishable from the PFGE profiles of clinical *Salmonella* isolates submitted to the WA-DOH. When the PFGE profiles from the poultry samples were compared with those found in the NARMS database, eight indistinguishable PFGE matches were found with isolates recovered from chicken breasts, ground turkey, and ground beef from multiple states. Although this study revealed some association between PFGE profiles from raw poultry products and those of clinical isolates from the same geographical area, these results do not prove that all of those clinical isolates were from infections acquired through consumption or handling of poultry.

## Mycotoxins

### Water and Temperature Relations of *Fusarium langsethiae* Strains and Modelling of Growth and T-2 and HT-2 Mycotoxin Production on Oat-Based Matrices

Verheecke-Vaessen C, Garcia-Cela E, Lopez-Prieto A, Jonsdottir IO, Medina A, Magan N. *Int J Food Microbiol.* 2021 Jun 16;348:109203. doi: 10.1016/j.ijfoodmicro.2021.109203. [Article link](#)

**Significance:** New probabilistic models were developed and validated for growth and T-2 + HT-2 toxin production in relation to temperature  $\times$   $a_w$  conditions. When applied to stored oats, these models will help determine the risk of contamination from these toxins in the context of European Union maximum levels.

In the UK and Northern Europe, ripening oats can become contaminated with T-2 and HT-2 mycotoxins, produced mainly by *Fusarium langsethiae*. There are indicative levels related to the maximum limits for oat grain for these toxins. The objectives of this study were to examine the effect of interacting conditions of temperature (10-30 °C) and water activity ( $a_w$ , 0.995-0.90) on (a) lag times prior to growth, (b) growth and (c) T-2 and HT-2 toxins by two strains of *F. langsethiae* isolated from oats in the UK and compare this with the type strain (Fl201059) which has been genomically sequenced, and (d) develop (and validated with published data) a probabilistic models for impacts of temperature  $\times$   $a_w$  on growth and toxin production. All three strains had an optimum  $a_w$  range and temperature of 0.995-0.98 and 25 °C for growth. For T-2 + HT-2 production these were 0.995  $a_w$  and 20 °C. Overall, the type strain produced higher amounts of T-2 + HT-2 with a HT-2/T-2 ratio of up to 76. Using this study data sets and those from the literature, probabilistic models were developed and validated for growth and T-2 + HT-2 toxin production in relation to temperature  $\times$   $a_w$  conditions. These models, when applied in stored oats, will be beneficial in determining the conditions

on the relative level of risk of contamination with these two toxins in the context of the EU indicative maximum levels.

## Food Packaging

### Migration of Substances from Food Contact Plastic Materials into Foodstuff and their Implications for Human Exposure

Shin C, Kim D, Kim J, Kim JH, Song M, Oh K. *Food Chem Toxicol*. 2021 Jun 25;112373. doi: 10.1016/j.fct.2021.112373. [Article link](#)

**Significance:** Based on exposure assessments, it appears that food contact plastic materials such as PP, PE, PET, PCT, PLA and PBT are properly controlled by regulatory authorities in South Korea and the U.S.

The safety of food contact plastic materials, including PP, PE, PET, PCT, PLA, PBT and cross-linked polyester, was assessed with regard to migrated substances. The migrated concentrations of overall migrants (OMs), terephthalic acid, acetaldehyde, 1,4-butanediol and lead, were determined according to the standards and specifications for utensils, containers and packages in Korea. Food simulants of 4% acetic acid, water and n-heptane were used for the analysis of the substances. The dietary exposures of terephthalic acid, acetaldehyde and 1,4-butanediol were assessed using the dietary concentrations and the food consumption data. As a result, the dietary exposures were considered to be safe comparing to the health-based guidance values. In the case of lead, the margin of exposure (MOE) approach was applied. The MOEs calculated using the UB concentration and mean consumption data were ranged from 3 to 1000, which indicated low concern for health risk. Moreover, in this study, the dietary exposures were estimated by the Korean MFDS and U.S. FDA methods, respectively. As a result, the assessed risks were considered to be low in both cases. Based on the results of current exposure assessments, it could be considered that the food contact plastic materials are properly controlled by the regulatory authorities.

## Chemical Contaminants

### Dissipation of Chlorpyrifos in the Bottled Tea Beverages and the Effects of EGCG

Rong Z, Olomthong M, Fan Y, Wang L, Pan D, Shi Y, Ye W. *J Food Prot* (2021) June 11. <https://doi.org/10.4315/JFP-21-119>. [Article link](#)

**Significance:** The half-life values of the pesticide chlorpyrifos (CP) illustrated that EGCG increased the dissipation of CP by combination with CP and inhibited the generation of CP-oxon by scavenging the emerged oxidant ROS. This work suggests EGCG could play different roles in the dissipation and transformation of CP.

Bottled tea beverages (BTB) are popular for the benefits to human health and convenience. Because Chlorpyrifos (CP) is commonly used as a biomarker for exposure as well as a pesticide in the field, it is important to determine the dynamics of CP dissipation in BTB in order to better perform risk assessments. This study focused on the dynamic behavior of CP for 22 days by fortifying bottled green tea (GT), dark tea (DT), and Oolong tea (OT) beverages with the parent chemical and analyzing the degradation products. Photo-induction was used to generate the two transient intermediates, i.e. the reactive oxygen species (ROS) from H<sub>2</sub>O<sub>2</sub> and the triplet state of CP (3 CP\*) from the parental, in water was designed to observe the effects of (-)-Epigallocatechin-3-gallate (EGCG) on the dissipation and transformation of CP. The results indicated that the CP degraded in BTB and the main products were detected. The half-life values of CP illustrated that EGCG increased the dissipation of CP by combination with CP, and inhibited the generation of CP -oxon by scavenging the emerged oxidant ROS and interfering the transformation of 3 CP\*. This work suggests EGCG could play the various roles on the dissipation and transformation of CP. Thus, a comprehensive identification of CP degradation should be performed when assessing the exposure risk in the drinking of bottled tea beverages.



## Heavy Metals

### Interactive Effects of Lanthanum and Calcium on Cadmium Accumulation in Wheat with Special Reference to TaNrap5 Expression Regulated by Calmodulin

Yang H, Xiong Z, Xu Z, Liu R. *J Agric Food Chem*. 2021 Jun 23;69(24):6870-6878. doi: 10.1021/acs.jafc.1c00365. [Article link](#)

**Significance:** Data suggest that lanthanum, calcium and cadmium may share the same binding sites in calmodulin (TaCaM) and lanthanum could affect cadmium accumulation in wheat by interacting with TaCaM.

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Lanthanum (La), calcium (Ca), and cadmium (Cd) have similar physical and chemical properties because of their similar ionic radius. Although the interactions between La, Ca, and Cd have been frequently reported in plants, few studies have investigated the interactive effects of La and Ca on the growth and Cd accumulation in plants. Therefore, we investigated the interactive effects of La and Ca on the growth and Cd accumulation in wheat under Cd exposure by a hydroponic experiment. The results indicated that wheat growth was significantly affected by La-Cd and La-Ca interactions. The accumulation of Cd in wheat was significantly affected by La-Ca and La-Cd interactions and La-Ca-Cd interplay. Correlation analysis indicated that Ca deficiency stimulated La to promote wheat growth and mitigate Cd toxicity. Simultaneously, a low Ca supply stimulated La to decrease Cd accumulation in wheat and induce TaNramp5 expression. In addition, Cd accumulation in wheat was significantly affected by the W7-La interaction and W7-La-Ca interplay. All of the results suggested that La, Ca, and Cd probably share the same binding sites in calmodulin (TaCaM) and La could affect Cd accumulation in wheat by interacting with TaCaM and then downregulating the expression of TaNramp5.

## Caffeine

### Caffeine Supplementation in the Hospital: Potential Role for the Treatment of Caffeine Withdrawal

Agritelley MS, Goldberger JJ. *Food Chem Toxicol.* 2021;153:112228. doi: 10.1016/j.fct.2021.112228. [Article link](#)

**Significance:** This study highlights the need for a randomized controlled trial investigating in-hospital caffeine supplementation and the population that this would best serve.

Caffeine use in the population is widespread. Caffeine withdrawal in the hospital setting is an underappreciated syndrome with symptoms including drowsiness, difficulty concentrating, mood disturbances, low motivation, flu-like symptoms, and headache. Withdrawal may occur upon abstinence from chronic daily exposure at doses as low as 100 mg/day and following only 3-7 days of consumption at higher doses. There are limited data investigating how caffeine withdrawal contributes to hospital morbidity. Some studies suggest caffeine withdrawal may contribute to intensive care delirium and that caffeine may promote wakefulness post-anesthesia. Caffeine supplementation has also shown promise in patients at risk of caffeine withdrawal, such as those placed on nil per os (NPO) status, in preventing caffeine withdrawal headache. These data on caffeine supplementation are not entirely consistent, and routine caffeine administration has not been implemented into clinical practice for patients at risk of withdrawal. Notably, caffeine serves a therapeutic role in the hospital for other conditions. Our review demonstrates that caffeine is largely safe in the general population and may be an appropriate therapeutic option for future studies, if administered properly. There is a need for a randomized controlled trial investigating in-hospital caffeine supplementation and the population that this would best serve.

## Food Allergens

### Prevalence and Characteristics of Peanut Allergy in US Adults

Warren C, Lei D, Sicherer S, Schleimer R, Gupta R. *J Allergy Clin Immunol.* 2021 Jun;147(6):2263-2270.e5. doi: 10.1016/j.jaci.2020.11.046. [Article link](#)

**Significance:** Prevalence of peanut allergy is estimated at 4.6 million US adults - over 800,000 of whom appear to have developed it after age 18. Further examination of phenotypic differences between childhood-onset and adult-onset PA may improve management of adult PA.

**Background:** Peanut allergy (PA) is the leading pediatric food allergy and a common cause of anaphylaxis. Little is known, however, on the prevalence and characteristics of PA in the adult population and whether phenotypic differences exist between adult-onset and childhood-onset PA. **Objectives:** This study describes the current US population-level burden of adult PA. **Methods:** A cross-sectional food allergy survey was administered via phone and web in 2015 and 2016, resulting in nationally representative complex-survey weighted data for 40,443 adults. Reported food allergies were considered “convincing” if symptoms to specific allergens were consistent with an IgE-mediated reaction. **Results:** The prevalence of current self-reported PA was 2.9% among US adults, with 1.8% having convincing PA. Over 17% of adults with peanut allergy reported onset of their PA in adulthood. In adults with childhood-onset PA, 75.4% reported physician-diagnosed PA, compared with only 58.9% of adult-onset PA. Despite a similar frequency of food allergy-related emergency department visits within the past year (approximately 1 in 5 adults with PA allergy), adults with childhood-onset PA were significantly more likely to have a current epinephrine prescription compared with those with adult-onset PA (56% vs 44% respectively;  $P = .02$ ) and were more likely to use an epinephrine autoinjector (48% vs 35%,  $P = .01$ ). **Conclusions:** Approximately 4.6 million US adults have PA-over 800,000 of whom appear to have developed their PA after age 18 years. Further examination of phenotypic differences between childhood-onset and adult-onset PA may improve understanding



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and management of adult PA.

### **Using Data from Food Challenges to Inform Management of Consumers with Food Allergy: A Systematic Review with Individual Participant Data Meta-Analysis**

Patel N, Adelman DC, Anagnostou K, Baumert JL, Blom WM, Campbell DE, et. al. *J Allergy Clin Immunol.* 2021 Jun;147(6):2249-2262.e7. doi: 10.1016/j.jaci.2021.01.025. [Article link](#)

**Significance:** Around 5% of individuals analyzed as part of a meta-analysis of 3151 participants found that reacting to an ED01 or ED05 level of exposure to peanut protein might develop anaphylaxis in response to that dose.

**Background:** Eliciting doses (EDs) (eg, ED01 or ED05 values, which are the amounts of allergen expected to cause objective symptoms in 1% and 5% of the population with an allergy, respectively) are increasingly being used to inform allergen labeling and clinical management. These values are generated from food challenge, but the frequency of anaphylaxis in response to these low levels of allergen exposure and their reproducibility are unknown. **Objective:** Our aim was to determine (1) the rate of anaphylaxis in response to low-level peanut exposure and (2) the reproducibility of reaction thresholds (and anaphylaxis) at food challenge. **Methods:** We conducted a systematic review and individual participant data meta-analysis of studies that reported at least 50 individuals with peanut allergy reacting to peanut at double-blind, placebo-controlled food challenge (DBPCFC) and were published between January 2010 and September 2020. Risk of bias was assessed by using National Institute for Clinical Excellence methodologic checklists. **Results:** A total of 19 studies were included (covering a total of 3151 participants, 534 of whom subsequently underwent further peanut challenge). At individual participant data meta-analysis, 4.5% (95% CI, 1.9% to 10.1%) of individuals reacted to 5 mg or less of peanut protein with anaphylaxis (moderate heterogeneity [ $I^2 = 57\%$ ]). Intraindividual thresholds varied by up to 3 logs, although this variation was limited to a half-log change in 71.2% (95% CI, 56.2% to 82.6%) of individuals. In all, 2.4% (95% CI, 1.1% to 5.0%) of patients initially tolerated 5 mg of peanut protein but then reacted to this dose at subsequent challenge (low heterogeneity [ $I^2 = 16\%$ ]); none developed anaphylaxis. **Conclusion:** Around 5% of individuals reacting to an ED01 or ED05 level of exposure to peanut might develop anaphylaxis in response to that dose. This equates to 1 and 6 anaphylaxis events per 2500 patients exposed to an ED01 or ED05 dose, respectively, in the broader population of individuals with peanut allergy.