Foodborne Pathogens

Similar Levels of Antimicrobial Resistance in U.S. Food Service Ground Beef Products with and without a "Raised without Antibiotics" Claim


Significance: The findings from this study suggest that antimicrobial resistance of bacteria found in ground beef does not differ between U.S. beef cattle raised conventionally and those raised without antibiotics.

U.S. ground beef with “raised without antibiotics” (RWA) label claims are perceived as harboring fewer bacteria with antimicrobial resistance (AMR) than are found in conventional (CONV) ground beef with no such label claim. A total of 370 ground beef samples from CONV (n = 191) and RWA (n = 179) production systems were collected over 13 months from three food service suppliers. The following bacteria were cultured: Escherichia coli, tetracycline-resistant (TET r) E. coli, third-generation cephalosporin-resistant (3GC) E. coli, Salmonella enterica, TET r S. enterica, 3GC r S. enterica, nalidixic acid-resistant S. enterica, Enterococcus spp., erythromycin-resistant Enterococcus spp., TET r Enterococcus spp., Staphylococcus aureus, and methicillin-resistant S. aureus. TET r E. coli was more frequently detected in CONV ground beef (CONV, 54.2%; RWA, 35.2%; P < 0.01), but supplier (P < 0.01) and production system × supplier interaction (P < 0.01) effects were also significant. Metagenomic DNA was isolated from each sample, and equal amounts of metagenomic DNA were pooled by supplier, month, and production system for 75 pooled samples (38 CONV, 37 RWA). The abundance of aac(6’)-Ie-aph(2”)-Ia, aadA1, bla CMY-2, bla CTX-M, bla KPC-2, erm(B), mecA, tet(A), tet(B), and tet(M) genes was assessed by quantitative PCR. The tet(A) (2.9-log2-fold change, P = 0.04) and tet(B) (5.6-log2-fold change) (P = 0.03) genes were significantly more abundant in RWA ground beef. Phylogenetic analyses revealed that ground beef microbiomes differed more by supplier than by production system. These results were consistent with prior research suggesting antimicrobial use in U.S. beef cattle has minimal impact on the AMR of bacteria found in these products. These results should spur a reevaluation of assumptions regarding the impact of antimicrobial use during U.S. beef production on the AMR of bacteria in ground beef.

Biofilms and Meat Safety: A Mini-Review


Significance: This review highlights major concerns related to biofilm formation and identifies strategies for preventing contamination and improving meat safety.

Biofilms are surface-attached microbial communities with distinct properties, which have a tremendous impact on public health and food safety. In the meat industry, biofilms remain a serious concern because many foodborne pathogens can form biofilms in areas at meat plants that are difficult to sanitize properly, and biofilm cells are more tolerant to sanitization than their planktonic counterparts. Furthermore, nearly all biofilms in commercial environments consist of multiple species of microorganisms, and the complex interactions within the community significantly influence the architecture, activity, and sanitizer tolerance of the biofilm society. This review focuses on the effect of microbial coexistence on mixed biofilm formation with foodborne pathogens of major concern in the fresh meat industry and their resultant sanitizer tolerance. The factors that would affect biofilm cell transfer from contact surfaces to meat products, one of the most common transmission routes that could lead to product contamination, are discussed as well. Available results from recent studies relevant to the meat industry, implying the potential role of bacterial persistence and biofilm formation in meat contamination, are reviewed in response to the pressing need.
to understand the mechanisms that cause “high event period” contamination at commercial meat processing plants. A better understanding of these events would help the industry to enhance strategies to prevent contamination and improve meat safety.

Pathogen Detection

Validation of Standard Method EN ISO 11290 - Part 1 - Detection of *Listeria monocytogenes* in Food


**Significance:** Standard method EN ISO 11290-Part 1 for detection of *L. monocytogenes* in foods and food processing environments has been validated.

The reference method for the detection and enumeration of *L. monocytogenes* in food (Standards EN ISO 11290-1&2) has been validated by inter-laboratory studies in the frame of the Mandate M381 from European Commission to CEN. In this paper, the collaborative studies led in 2013 on 5 matrices (cold-smoked salmon, milk powdered infant food formula, vegetables, environment, and cheese) to validate the recently revised Standard EN ISO 11290-Part 1 are reported. According to the results obtained, the revised Standard EN ISO 11290-1 can be considered as a good method for the detection of *L. monocytogenes* in foods and food processing environments, in particular for the matrices included in the study. According to the matrices, the sensitivity rate varied from 91.1% to 100%, and the specificity rate varied from 97.6% to 100%. Positive samples were most often detected after 24 h half-Fraser enrichment.

Loop-Mediated Isothermal Amplification-Based Microfluidic Chip for Pathogen Detection


**Significance:** LAMP technology provides rapid and sensitive detection of pathogens. Recent advances in this technology are highlighted.

Due to the significant growth of food production, the potential likelihood of food contamination is increasing. Foodborne illness caused by bacterial pathogens has considerably increased over the past decades, while at the same time, the species of harmful microorganisms also varied. Conventional bacterial culturing methods have been unable to satisfy the growing requirement for food safety inspections and food quality assurance. Therefore, rapid and simple detection methods are urgently needed. The loop-mediated isothermal amplification (LAMP) technology is a highly promising approach for the rapid and sensitive detection of pathogens, which allows nucleic acid amplification under isothermal conditions. The integration of the LAMP assay onto a microfluidic chip is highly compatible with point-of-care or resource-limited settings, as it offers the capability to perform experiments in combination with high screening efficiency. Here, we provide an overview of recent advances in LAMP-based microfluidic chip technology for detecting pathogens, based on real-time or endpoint determination mechanisms. We also discuss the promoting aspects of using the LAMP technique in a microfluidic platform, to supply a guideline for further molecular diagnosis and genetic analysis.

Mycotoxins

The Epigenetic Mechanisms in Fusarium Mycotoxins Induced Toxicities


**Significance:** The relationship between epigenetic modification and Fusarium mycotoxin-induced toxicities is discussed.

Fusarium mycotoxins are the most economically important fungal toxins. Fumonisins, zearalenone and trichothecenes (T-2 toxin, HT-2 toxin, deoxynivalenol, nivalenol etc) are the major representatives and most studied of Fusarium mycotoxins. The Fusarium mycotoxins contaminate cereal grains, animal feeds and human food products, and cause huge economic losses and pose a threat to animal and human health globally. Depending on the type, the toxicity of Fusarium mycotoxins and the mechanisms have been well investigated. Epigenetic modifications (DNA methylation, histone modifications and regulation of non-coding RNA) have been implicated in various human diseases and the toxicities in animals caused by Fusarium mycotoxins, including carcinogenesis, genotoxicity and reproductive disorders. On the basis of recently documented data, this review discussed the
relationship between the epigenetic modifications and Fusarium mycotoxins-induced toxicities.

Food Processing Safety

Biofilms in Food Processing Environments: Challenges and Opportunities

Significance: The impacts of biofilm formation by beneficial and pathogenic microbes on the food processing environment is discussed.

This review examines the impact of microbial communities colonizing food processing environments in the form of biofilms on food safety and food quality. The focus is both on biofilms formed by pathogenic and spoilage microorganisms and on those formed by harmless or beneficial microbes, which are of particular relevance in the processing of fermented foods. Information is presented on intraspecies variability in biofilm formation, interspecies relationships of cooperativism or competition within biofilms, the factors influencing biofilm ecology and architecture, and how these factors may influence removal. The effect on biofilm formation ability of particular food components and different environmental conditions that commonly prevail during food processing is discussed. Finally, research on novel agents or strategies for the control of biofilm formation or removal is summarized. Expected final online publication date for the Annual Review of Food Science and Technology Volume 15 is March 25, 2019. Please see http://www.annualreviews.org/page/journal/pubdates for revised estimates.

Risk Assessment

Overview on Legislation and Scientific Approaches for Risk Assessment of Combined Exposure to Multiple Chemicals: The Potential EuroMix Contribution

Significance: EuroMix aims to harmonize international approaches to risk assessment of combined exposure to multiple chemicals, with an emphasis on food-related chemicals.

This article reviews the current legislative requirements for risk assessment of combined exposure to multiple chemicals via multiple exposure routes, focusing on human health and particularly on food-related chemicals. The aim is to identify regulatory needs and current approaches for this type of risk assessment as well as challenges of the implementation of appropriate and harmonized guidance at international level. It provides an overview of the current legal requirements in the European Union (EU), the United States and Canada. Substantial differences were identified in the legal requirements for risk assessment of combined exposure to multiple chemicals and its implementation between EU and non-EU countries and across several regulatory sectors. Frameworks currently proposed and in use for assessing risks from combined exposure to multiple chemicals via multiple routes and different durations of exposure are summarized. In order to avoid significant discrepancies between regulatory sectors or countries, the approach for assessing risks of combined exposure should be based on similar principles for all types of chemicals. OECD and EFSA identified the development of harmonized methodologies for combined exposure to multiple chemicals as a key priority area. The Horizon 2020 project ”EuroMix” aims to contribute to the further development of internationally harmonized approaches for such risk assessments by the development of an integrated test strategy using in vitro and in silico tests verified for chemical mixtures based on more appropriate data on potential combined effects. These approaches and testing strategies should be integrated in a scientifically based weight of evidence approach to account for complexity and uncertainty, to improve risk assessment.

Next Generation Microbiological Risk Assessment: Opportunities of Whole Genome Sequencing (WGS) for Foodborne Pathogen Surveillance, Source Tracking and Risk Assessment

Significance: This article highlights the current and potential future applications of whole genome sequencing as they relate to food safety and public health.

Whole genome sequencing (WGS) of important foodborne pathogens is a technology under development, but is already employed in routine surveillance by public health agencies and is being increasingly exploited in tracing transmission routes and identifying contamination events (source tracking) that take place in the farm-to-fork continuum. Furthermore, data generated from WGS,
complemented by other –omics data, have the potential to be integrated into and strengthen microbiological risk assessment. In this paper, we discuss the contribution of WGS in diverse areas important to food safety and public health. Additionally, an outlook of future WGS applications, which should contribute to our understanding of the ecology and physiology of foodborne microorganisms, is presented.

This article is part of a special issue: Omics in MRA - the integration of omics in microbiological risk assessment https://www.sciencedirect.com/journal/international-journal-of-food-microbiology/vol/287/suppl/C.

Heavy Metals

Systematic Review of Arsenic in Fresh Seafood from the Mediterranean Sea and European Atlantic Coasts: A Health Risk Assessment


**Significance:** Areas in the Mediterranean Sea and European coast with increased arsenic bioavailability from seafood are identified.

Arsenic in the environment pose major threats to human health, and especially the inorganic form can result in adverse health effects. This review analyse papers from 2004 to 2017 on As in fresh fish and molluscs caught in the Mediterranean sea and the European coast of the Atlantic ocean allowing the identification of the marine area with a greater As bioavailability and in particular the identification of the European populations more exposed to In-As by consuming fresh seafood. Results were separated on the base of the fishing site and the concentrations were reworked to assess the average daily intake to In-As as well as Target Hazard Quotient and Cancer Risk. Overall, the greater availability in Tot-As concentration in the pelagic compartment found in the Mediterranean Sea is not present along the European coasts of Atlantic Ocean. Furthermore, only in the Mediterranean Sea, results highlighted significant differences between Tot-As concentrations in seafood subgroups. In both areas, In-As concentrations showed the following trend: molluscs > pelagic > demersal with significant differences between subgroups. The European populations more exposed to In-As from fish and molluscs are the French, Spanish, Italian and Greek, with particular regards to children of 3-6 years old, which should minimize the consumption of molluscs to avoid carcinogenic and non-carcinogenic risks.

Food Packaging

Recent Advances in Protein Derived Bionanocomposites for Food Packaging Applications


**Significance:** Bionanocomposites exhibit several advantages over non-biodegradable food packaging plastics.

This review article critically presents a comprehensive overview of the current advances in the research and development of proteins derived bionanocomposites used in food packaging applications. The recent interest in protein-based biomaterials is due to sustainability, renewability, biodegradability and low carbon footprint. The inherent drawbacks of proteins-based materials for food packaging applications are their low mechanical strength, poor thermal, barrier and inferior physicochemical properties. The nanoreinforced bio-based polymers called bionanocomposites provide an opportunity to overcome these issues and have ability to supersede non-biodegradable food packaging plastics produced from petroleum resources. So far, most studied protein derived bionanocomposites suitable for food packaging are soy protein isolates (SPI) and gelatin proteins. Layered silicates are the most promising nanofillers used to increase strength, improve heat resistance and enhance barrier properties of proteins derived materials while montmorillonites (MMT) is the most commonly used silicate nanofiller. This review emphases on the processing strategies used for proteins-based biomaterials, their mechanical and moisture barrier properties for food packaging applications. Different proteins and nanofillers that have been studied to date in proteins derived food packaging applications are also discussed in detail.

Caffeine

Hourly and Daily Intake Patterns Among U.S. Caffeinated Beverage Consumers Based on the National Health and Nutrition Examination Survey (NHANES, 2013-2016)


**Significance:** Individual patterns of caffeinated beverage intake are identified.
Characterization of ‘hour-of-day’ or ‘day-of-week’ caffeine intake for the National Health and Nutrition Examination Survey (NHANES) population is limited. No study has focused on patterns from an individual perspective. The NHANES 2013-2016 survey respondents’ dietary recalls were analyzed to gain a better understanding of caffeine intake patterns for different caffeinated beverage consumer types - defined by beverage type consumed and daily caffeine intake levels. Dominant caffeinated beverage consumers (≥143 mg) were identified by a reported daily caffeine intake level greater than or equal to the 50th percentile among those 1-80 y. Dominant caffeinated beverage consumers - irrespective of age groups investigated - typically reported the greatest caffeine intake early in the day from coffee. Analyses by consumer type, relevant age brackets and ‘hour-of-day’ or ‘day-of-week’ indicated that caffeinated beverage consumers generally do not cluster multiple caffeine intake events over short periods of time (i.e., less than fours). Dominant caffeinated beverage consumers appear to maintain a relatively stable daily caffeine intake by substitution of secondary sources of caffeine. Only a small fraction (4.1%) of individuals within 13-29 y respondents consumed caffeine at levels in excess of 400 mg/day, compared to 14% within the 30-80 y old survey respondent group.

**Evaluation of a 24-Hour Caffeine Intake Assessment Compared with Urinary Biomarkers of Caffeine Intake among Young Adults in Canada**


**Significance:** The 24-Hour Caffeine Intake Recall method more accurately evaluates caffeine intake in young adults than the caffeinated beverage intake frequency screener.

**Food Allergy**

The Consortium for Food Allergy Research (CoFAR) The First Generation


**Significance:** The results of efforts to better understand the pathogenesis and history of food allergy by the Consortium for Food Allergy Research are reviewed.

The Consortium for Food Allergy Research (CoFAR) was established by the The National Institute of Allergy and Infectious Diseases (NIAID) in 2005 as a collaborative research program bringing together centers focused on the study of food allergy. The Consortium was charged with developing studies to better understand the pathogenesis and natural history of food allergy, as well as potential approaches to the treatment of food allergy. In its first iteration, an observational study of infants with milk and egg allergy was established and studies of oral immunotherapy for egg allergy and sublingual immunotherapy for peanut allergy were initiated, as was a Phase 1 study of a recombinant peanut protein vaccine. The CoFAR was renewed in 2010 for
an additional 5-year period during which the initial observational study was continued, a study of eosinophilic esophagitis was initiated, and new therapeutic trials were established to study epicutaneous immunotherapy for peanut allergy and to compare the safety and efficacy of egg OIT to the ingestion of baked egg for the treatment of egg allergy. The results of these efforts will be reviewed in this Rostrum, with a brief look to the future of the Consortium.

**Advances in Food Allergy in 2017**

Article Link

**Significance:** Recent scientific and policy advances related to treatment of food allergy are reviewed.

This review highlights research and policy advances in food allergy that were published in 2017 in the Journal and beyond. In 2017, many important studies on the treatment of food allergy were published, bringing us ever closer to a standardized treatment for food allergy. Other important advancements included research into other management strategies, including thresholds for avoidance, management of food allergies in schools, and development of new guidelines for prevention of food allergy. There were several important epidemiologic studies helping us understand the phenotypes of allergic disease, and new hypotheses were proposed for how best to prevent food allergy. Finally, there was a welcome increased attention to non-IgE-mediated food allergies.

**Sensitivity Analysis to Derive a Food Consumption Point Estimate for Deterministic Food Allergy Risk Assessment**

Article Link

**Significance:** The optimal food consumption estimate for deterministic food allergy risk assessment is established.

One of the input parameters in food allergy risk assessment is the amount of a given food consumed at an eating occasion. There is no consensus on how to use food consumption data when assessing the risk from unintended allergen presence in food products. A sensitivity analysis was performed to establish the optimal food consumption estimate for a deterministic food allergy risk assessment. Exposure was calculated for consumption percentiles (50th percentile, P50 to maximum) using the iFAAM consumption database in conjunction with an allergen concentration range from 1 to 1000 ppm. The resulting allergen intakes were compared to the allergic population reference doses proposed by Taylor et al. (2014) for 10 major allergenic foods. Optimal consumption percentiles were defined as those which predicted an intake below the relevant reference dose and met the defined acceptable risk level confirmed by probabilistic risk assessments. Analysis showed that, for 99% of the food groups, the P50 consumption met our criteria, while the P75 did so for 100% of the food groups. We suggest that the P75 is the optimal point estimate for use in deterministic food allergy risk assessment. It meets the safety objective and is adequately conservative for a public health context.