Novel Predictive Analytic Tools to Inform Food Safety Decisions

Division of Risk and Decision Analysis, Office of Analytics and Outreach
Center for Food Safety and Applied Nutrition

Overview

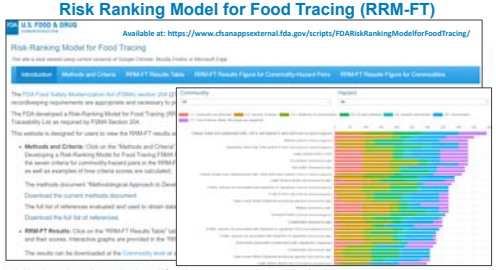
The Division of Risk and Decision Analysis, within CFSAN's Office of Analytics and Outreach, develops novel predictive analytical tools that can integrate data and information from a wide diversity of sources, sectors, and disciplines to derive new insights into particularly challenging food safety problems. These tools are virtual laboratories where scientists, stakeholders, and risk managers can explore the impact of different policies, practices, and events on the risk of illness to the consumer or population. Working with partners throughout the Agency, a suite of predictive models were developed to increase understanding of food safety and contamination pathways at various events in the food supply including restaurants, delicatessens, and production of a variety of commodities including tree nuts, cheese, fresh-cut produce, sprouts., These predictive tools have been used to investigate root cause and identify prevention strategies that inform policies, guidance, and messaging that reduce contamination of food and illness of consumers. Prioritization tools help to optimize resource allocations by ranking options, generally on the basis of risk or public health impact. The Risk Ranking Model for Food Tracing (RRM-FT) is an example of a prioritization tool used to inform the development of a Food Traceability List for the FSMA Proposed Rule on Food Traceability

Making Science useful and accessible to maximize public health impact

- What could go wrong?
- How likely is it?
- What are the consequences?
- How can we prevent/mitigate it?

Decision Analysis Tools

Risk Ranking Model for Food Tracing (RRM-FT)



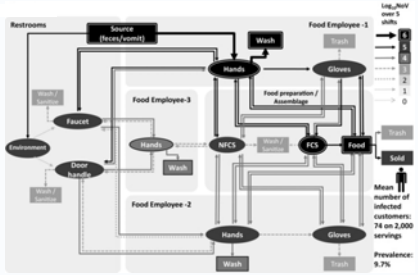
Methodological Approach to Developing a Risk-Ranking Model for Food Tracing FSMA Section 204 (21 U.S. Code § 2223). Available at: https://www.cfsanappsexternal.fda.gov/scripts/FDARiskRankingModelforFoodTracing/assets/Methodological%20Approach%20to%20Developing%20RRM-FT%2008-29-2020.pdf

Acknowledgements

The research presented in this poster benefited from the support of a number of individuals, organizations, and contracts. Full acknowledgements for each project is provided in the referenced manuscript/report.

Creating Virtual Worlds/Quantifying Public Health Impact

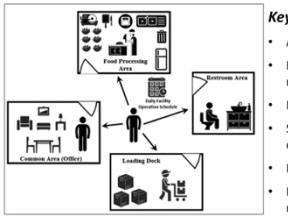
Quantitative Risk Assessment of Norovirus Transmission in Food Establishments: Evaluating the Impact of Intervention Strategies and Food Employee Behavior on the Risk Associated with Norovirus in Foods



Duret S, Pouillot R, Fanaselle W, Papafragkou E, Liggans G, Williams L, Van Doren JM. Quantitative Risk Assessment of Norovirus Transmission in Food Establishments: Evaluating the Impact of Intervention Strategies and Food Employee Behavior on the Risk Associated with Norovirus in Foods. Risk Anal. 2017 Nov;37(11):2080-2106. doi: 10.1111/risa.12758. Epub 2017 Mar 1. PMID: 28247943; PMCID: PMC6032842.

Quantitative Microbial Risk Assessment Model for Food Facilities (F^2-QMRA)

An Agent-based model for microbial persistence and cross contamination dynamics in a food facility



Key Features

- Agent-based modeling (ABM)
- Explicit facility layout representation
- Dynamic schedule of events
- Spatial representation of contamination
- Persistence, survival, and growth
- Explicit definition of risk mitigation measures

Mokhtari, A. and Van Doren, J.M. (2019), An Agent-Based Model for Pathogen Persistence and Cross-Contamination Dynamics in a Food Facility. Risk Analysis, 39: 992-1021. https://doi.org/10.1111/risa.13215

Cadmium: Mitigation Strategies to Reduce Dietary Exposure

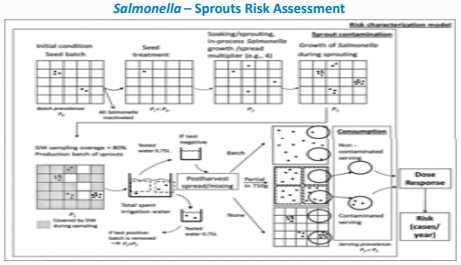
Cadmium entry into the Food Supply	Terrestrial Pathways/Agriculture Production Planting, Growing, and Harvesting	Steps that can be taken by Manufacturers	Steps that can be taken by Consumers
Mitigation and Prevention Efforts	✓ Understand contributing sources and distribution. ✓ Apply soil amendments based on characteristics of soil. ✓ Understand cadmium uptake in the crop. ✓ Select low cadmium varieties if possible. ✓ Avoid phosphate fertilizers with high cadmium content. ✓ Test irrigation water.	× Discontinuing the use of cadmium plated utensils and galvanized equipment for food production can minimize excess cadmium in food. × Reducing cadmium –bearing stabilizers in plastics can minimize cadmium exposure. × Removing cadmium-based pottery glazes on cookware can reduce cadmium exposure.	✓ Eating a variety of foods can ensure a healthy diet. ✓ Getting the proper amount of micronutrients (Zn, Fe, Ca) can protect against cadmium absorption and toxicity.

Schaefer, H.R., Dennis, S. and Fitzpatrick, S. (2020), Cadmium: Mitigation strategies to reduce dietary exposure. Journal of Food Science, 85: 260-267. https://doi.org/10.1111/1750-3841.14997

FDA Interim Reference Level for lead

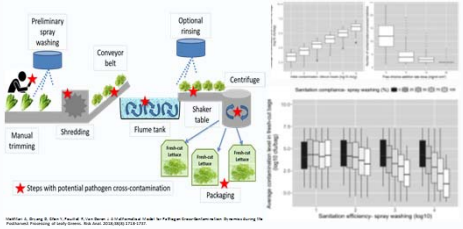
Flannery, B.M., Dolan, L.C., Hoffman-Pennesi, D., Gavelek, A., Jones, O.E., Kanwal, R., Wolpert, B., Gensheimer, K., Dennis, S., Fitzpatrick, S., 2020. U.S. Food and Drug Administration's interim reference levels for dietary lead exposure in children and women of childbearing age. Regulatory Toxicology and Pharmacology, 110: 104516. https://doi.org/10.1016/j.yrtph.2019.104516

Salmonella – Sprouts Risk Assessment



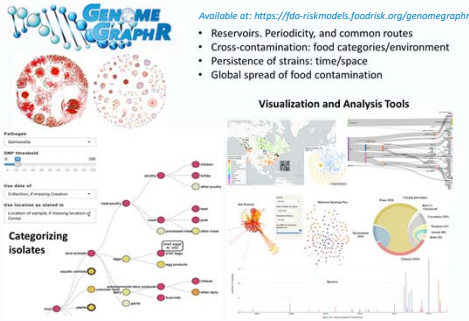
Chen, Y., Pouillot, R., Santillana Farakos, S.M., Duret, S., Spungen, J., Fu, T.-J., Shakir, F., Homola, P.A., Dennis, S. and Van Doren, J.M. 2018, Risk Assessment of Salmonellosis from Consumption of Alfalfa Sprouts and Evaluation of the Public Health Impact of Sprout Seed Treatment and Spent Irrigation Water Testing. Risk Analysis, 38: 1738-1757. https://doi.org/10.1111/risa.12964

Pathogen Cross-Contamination Model for Postharvest Processing of Leafy Greens



Revealing New Connections

Leveraging WGS Database to Enhance Risk Assessment, Attribution, and Large-scale Epidemiology Studies

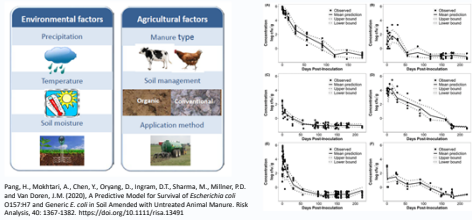


Sanaa M, Pouillot R, Vega FG, Strain E, Van Doren JM. GenomeGraphR: A user-friendly open-source web application for foodborne pathogen whole genome sequencing data integration, analysis, and visualization. PLoS One. 2019 Feb 28;14(2):e0213039. doi: 10.1371/journal.pone.0213039.

A Predictive Model for Survival of *Escherichia coli* O157:H7 and Generic *E. coli* in Soil Amended with Untreated Animal Manure

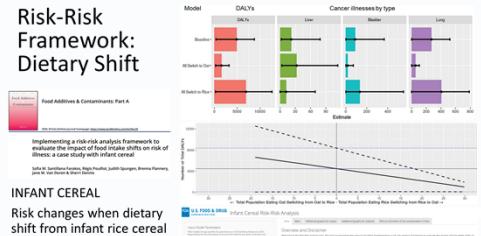
Use machine learning to:

- Quantify impact of environmental & agricultural factors
- Predict pathogen concentrations overtime under dynamic conditions



Pang, H., Mokhtari, A., Chen, Y., Oryang, D., Ingram, D.T., Sharma, M., Millner, P.D. and Van Doren, J.M. (2020), A Predictive Model for Survival of *Escherichia coli* O157:H7 and Generic *E. coli* in Soil Amended with Untreated Animal Manure. Risk Analysis, 40: 1367-1382. https://doi.org/10.1111/risa.13491

Implementing a Risk-risk Analysis Framework to Evaluate the Impact of Food Intake Shifts on Risk of Illness: A Case Study With Infant Cereal



Sofia M. Santillana Farakos, Régis Pouillot, Judith Spungen, Brenna Flannery, Jane M. Van Doren, and Sherri Dennis. 2021. Implementing a risk-risk analysis framework to evaluate the impact of food intake shifts on risk of illness: a case study with infant cereal. *Food Additives & Contaminants: Part A*. https://doi.org/10.1080/19440049.2021.1885752