



# 2009 CSL/JIFSAN Joint Symposium



## Food Safety and Nutrition: Methods and Systems for Tracking, Tracing and Verifying Foods

May 13-15, 2009

Greenbelt Marriott Hotel  
6400 Ivy Lane  
Greenbelt, Maryland USA

Sponsored by

Central Science Laboratory (CSL)  
York, UK



Joint Institute for Food Safety  
and Applied Nutrition (JIFSAN)  
University of Maryland  
College Park, Maryland USA



## Objective

This is the tenth in a series of annual symposia in food safety and applied nutrition jointly organized by the Central Science Laboratory (CSL), York, UK, and the Joint Institute for Food Safety and Applied Nutrition (JIFSAN), University of Maryland. Each year, a different theme is selected.

The increasingly global nature of the food supply presents new challenges for assuring food safety and for responding to emergency situations. Meeting these challenges will require the proactive development of improved documentation systems; response strategies, flexible technical capabilities, and communication channels. These tools can serve as the basis for establishing enhanced management systems for coordinating responses to emergencies, confirming the origin of a food and for protecting public health worldwide.

The focus of the 2009 Annual CSL/JIFSAN Joint Symposium of Food Safety and Nutrition is on tracking, tracing and verifying food throughout the supply chain. The symposium will provide an overview of advances in research related to tracking, tracing and verifying foods and ingredients and tools for the electronic exchange of product information within the food supply chain. Invited speakers will be drawn from regulatory agencies, public interest groups, universities and research institutions in Europe and North America. Additionally speakers involved with the EU Trace Project (<http://www.trace.eu.org/>) will participate. Symposium sessions will include discussions on advances in analytical technologies to characterize the origin of a food products; application of technologies for tracking food through the supply chain; IT tools for electronic exchange of information; and barriers to adopting these technologies.

In addition to the symposium sessions, a poster session is simultaneously being offered.

The symposium will culminate in a final session primarily devoted to looking at “the way forward” with an interactive emphasis on challenges and opportunities as we move into the future with issues raised by expanding interests in tracking, tracing and verifying foods. The symposium is developed to be of interest to scientists, food industry personnel, students, educators, and others involved with this area.

## Organizing Committee

Dr. Jianghong Meng, Host, JIFSAN (United States)  
Dr. Martin Rose, Co-Hosts, Fera, formerly CSL (United Kingdom)  
Dr. Paul Brereton, Co-Hosts, Fera  
Dr. Elizabeth Calvey, FDA/Center for Food Safety and Applied Nutrition (USA)  
Dr. Renate Reimscheuessel, FDA, Center for Veterinary Medicine (USA)  
Dr. Mickey Parish, University of Maryland (USA)

### NOTICE

**Effective April 1, 2009 Central Science Laboratory (CSL), became The Food and Environment Research Agency (Fera).**

# PROGRAMME

## 10<sup>th</sup> CSL/JIFSAN Symposium Methods and Systems for Tracking, Tracing and Verifying Foods College Park, MD

May 13-15, 2009

### Wednesday, May 13, 2009

12:00 noon Registration and Lunch

1:10 pm Welcome

JIFSAN – *Dr. Jianghong Meng, Interim Director (USA)*

Fera (formerly CSL) – *Dr. Pete Robertson, Head, Science Strategy, Research and Innovation (UK)*

### Session One: The Global Food Supply

*Session Chair: Martin Rose, Fera, formerly, CSL (UK)*

1:30 New Approaches to Tracing the Origin of Food  
*Paul Brereton, The Food and Environment Research Agency (Fera - formerly CSL); TRACE*

2:00 Why Do You Need Traceability Systems?  
*Shaun Kennedy, National Center for Food Protection, University of Minnesota, USA*

2:30 Surveillance Networks and the Detection and Investigation of Foodborne Disease Outbreaks – What You See Is What you Get  
*Robert Tauxe, Center for Disease Control (CDC), USA*

3:00 Source Investigations – The Follow-up to Tracebacks from Foodborne Outbreaks  
*Ingrid Zambrana, Food and Drug Administration, USA*

3:30 **DISCUSSION**

*End of Day One*

## Thursday, May 14, 2009

8:00 am Sign-in and Continental Breakfast

### Session Two: Laboratory Tools

*Session Chair: Renate Reimschuessel, FDA/Center for Veterinary Medicine (USA)*

9:00 am Determining Geographical Origin of Food Using Stable Isotopes  
*James Ehleringer, University of Utah; TRACE*

9:30 The Use of DART –TOFMS for Characterizing Food  
*Jana Hajšlová, ICT, CK, TRACE*

10:00 Spectroscopic Fingerprinting Techniques for Verifying Food  
*Gerry Downey, Teagasc, IE, TRACE*

10:30 **BREAK**

11:00 Overview of Molecular Sub-Typing of Methods for Bacteria Pathogens  
*Christine Keys, Center for Food Safety and Applied Nutrition (CFSAN), FDA, USA*

11:30 DNA Barcoding: Regulatory Application at FDA  
*Haile Yancy, Center for Veterinary Medicine (CVM), FDA, USA*

12:00 pm Proteomics (Species Identification)  
*Paul Reece, The Food and Environment Research Agency (Fera - formerly CSL), UK*

12:30 **LUNCH**

### Session Three: Other Traceability and Tracking Tools

*Session Chair: Jianghong Meng, JIFSAN, University of Maryland (USA)*

1:30 Tracking Technologies (e.g., GPS; RFID)  
*Marc Cohen, University of Maryland, USA*

2:00 Models for Predicting Geographical Origin  
*Grishja van der Veer, Geochem, NL, TRACE*  
*Stefán Torfi Höskuldsson, Maritech, IS, TRACE*

Chain Information Management Systems (TraceCore XML)  
*Stefán Torfi Höskuldsson, Maritech, IS, TRACE*

- 3:00           **BREAK**
- 3:30           PulseNet Network  
*Kelley Hise, Center for Disease Control and Prevention (CDC), USA*
- 4:00           Computer Based Tracking Protocols: Improving Communication Between  
Databases  
*Amol Deshpande, University of Maryland, USA*
- 4:30           **DISCUSSION**
- End of Day Two Session*
- 5:00           **Participant's Dinner** – *Cruise on the Baltimore Harbor, Spirit of Washington*

## **Friday, May 15, 2009**

- 8:00 am       Sign-in and Continental Breakfast

### **Fourth Session: Issues and Future Needs**

*Session Chair: Paul Brereton, Fera, formerly CSL (UK)*

- 9:00           Drivers for Implementation of Traceability in the Food Sector  
*Kathryn Donnelly, Nofima, NO; TRACE*
- 9:30           Bulk Material Tracing Needs  
*Charles Hurburgh, Iowa Grain Quality Initiative, Iowa State University, USA*
- 10:00          Product Tracking Systems for Fresh Produce  
*Sherri McGarry, Center for Food Safety and Applied Nutrition (CFSAN), FDA, USA*
- 10:30          Traceability Systems for Foods: An Industry Perspective  
*Robert Brackett, Grocery Manufacturers of America, USA*
- 11:00          Traceability Systems for Foods: A Consumer Perspective  
*Jean Halloran, Consumers Union, USA*
- 11:30          **DISCUSSION**
- 12:00 pm      **LUNCH**

*End of Symposium*

## **Symposium Organizers & Session Chairs**



**JIANGHONG MENG, PH.D**

***Interim Director, JIFSAN***

***Host Symposium Program Organizer, Opening Speaker, and Session 3 Chair***

Dr. Meng, Professor, Department of Nutrition and Food Science, and Interim Director, Joint Institute for Food Safety & Applied Nutrition, University of Maryland, College Park, Maryland. Dr. Meng received his veterinary medicine degree in China, and Mater of Preventive Medicine and Ph.D. from University of California, Davis. His research interests focus on food safety microbiology. Dr. Meng has extensive research experience in the identification and characterization of foodborne pathogens and bacterial antimicrobial resistance. He has published over 90 papers and book chapters on food microbiology and safety.

Dr. Meng is a member of American Society for Microbiology, American Society for the Advancement of Science, Institute of Food Technologists, and International Association of Food Protection, and has served on Editorial Board of Journal of Food Protection and Applied & Environmental Microbiology. He has been appointed by the Secretary of the US Department of Agriculture member of National Advisory Committee on Microbiological Criteria of Foods (NACMAF) since 2005. Dr. Meng also serves on National Academies' Committee on Review of Risk-Based Approach to Public Health Attribution. He is a Chang Jiang Scholar at the Northwest A&F University of China.



***PETE ROBERTSON, PH.D***  
***Opening Speaker***

Dr Robertson is currently Head of Science Strategy, Research and Innovation at the Food and Environment Research Agency (Fera), an Executive Agency of the UK Department for Food and Rural Affairs (Defra). Trained as an ecologist, Pete has variously been responsible for the agency's wildlife management and food science groups before taking on his current role in 2009.





***MARTIN ROSE, PH.D***  
***Host Symposium Program Organizer and Session 1 Chair***

Dr. Martin Rose works for the UK Government at the Food and Environment Research Agency in York, UK (part of the Department for Environment, Food and Rural Affairs). Dr. Rose studied Chemistry at the University of East Anglia, Norwich where he received his B.Sc, M.Sc., and Ph.D. Dr. Rose helped establish the UK's first laboratory for measuring dioxins in food and other biological/environmental samples in the 1980s. From 1990-1999 Dr. Rose worked on veterinary drug residues with particular interests in method development and the effects on residues of cooking and storage (post-mortem metabolism). From 1999 to the present, Dr. Rose returned to research dioxins and other environmental contaminants, including emerging contaminants (organofluorine compounds such as PFOS and brominated organic contaminants such as flame retardants). Dr. Rose specializes in the application of analytical chemistry to multi-disciplinary research projects looking at aspects such as environmental pathways, remediation, risk assessment methodologies, emergency response, bioanalytical methods, ecotoxicology, reproductive toxicology and identification and prioritization schemes for emerging contaminants.



**ELIZABETH CALVEY, PH.D**  
**Host Symposium Program Organizer**

Dr. Calvey received her PhD in Analytical Chemistry from Virginia Tech in 1990. In April 1984 she accepted a position as a research chemist at the Food and Drug Administration (FDA), Center for Food Safety and Applied Nutrition (CFSAN). Her research interests centered on the use of alternative extraction and chromatography technologies in the analysis of natural products and the use of spectroscopic methodologies in the analysis of chemical and microbial contaminants in food matrices. She has authored over 25 peer reviewed publications, given over 50 presentations, and serves on multiple advisory panels. In 1996 she began her transition from doing hands-on laboratory research to providing leadership on matters related to CFSAN's ongoing Centers of Excellence programs and other leveraging activities. She is currently the Team Leader for the CFSAN Liaison and Partnership Team and Associate Director for the Joint Institute for Food Safety and Applied Nutrition (JIFSAN), a jointly administered program between the FDA and the University of Maryland College Park.



***RENATE REIMSCHUESSEL, PH.D***  
***Host Symposium Program Organizer and Session 2 Chair***

Dr. Reimschuessel is currently directing aquaculture research at the Center for Veterinary Medicine at the FDA. She graduated cum laude from the University of Pennsylvania in 1975 and later received her degree in Veterinary Medicine from the University of Pennsylvania in 1981. Following graduation, she went into small and exotic animal practice for 5 years. She then returned to school and received her Ph.D. in Pathology from the University of Maryland, specializing in aquatic animal pathology. She was the Director of the Aquatic Pathobiology Center at the University of Maryland School of Medicine from 1989 till 1999. Her major research interests include: Drug development for aquaculture including: biodistribution, residue persistence, metabolism, drug efficacy, and environmental effects of drugs and other chemicals used in aquaculture. Past research included - Renal toxicologic pathology - studying fish kidney repair responses Immunotoxicology - evaluating fish immune function as an indicator of environmental pollution, and Diagnostic aquatic animal pathology.

Dr. Reimschuessel is still active as a mentor for graduate students and for many other students, including veterinary interns, college students and high school science teachers. She has over 50 publications in peer-reviewed journals and has authored multiple book chapters. In addition, she has led numerous workshops on aquatic animal medicine and research. Recently she was a finalist for the 2008 Service to America Awards for her work during the Pet Food Recall of 2007 – “**Achievement:** Made the scientific breakthrough to identify the cause of the largest pet food recall in history and is currently conducting critical research to guarantee the safety of imported foods.”



***PAUL BRERETON, PH.D***

***Head, The Food and Environmental Research Agency***

***Host Symposium Program Organizer, Symposium Speaker and Session 4 Chair***

Paul Brereton is Head of Fera International at the Food and Environment Research Agency in York. He has published over 60 peer reviewed papers on food safety and quality and currently sits on the Editorial Board of the Journal of the Science of Food and Agriculture.

Paul currently manages TRACE, a 19M€EU integrated project, that comprises a portfolio of international research and training activities on food traceability and authenticity. He has close links with the food industry, Food Standards Agency, academia and the European Commission.



**MICKEY PARISH, PH.D**  
**Host Symposium Program Organizer**

Dr. Parish is Professor and Chair, Department of Nutrition and Food Science at the University of Maryland, College Park. He received a Ph.D. in Food Science with a minor in Microbiology from North Carolina State University. Prior to moving to UM in 2005, Dr. Parish was on the faculty at the University of Florida for 19 years (Citrus Research and Education Center in Lake Alfred, and Food Science & Human Nutrition Department in Gainesville) and was Co-Director of the UFL Juice & Beverage Center. His current research activities and interests are related to the safety and quality of beverages and produce as well as food policy and risk analysis. Dr. Parish is a former IFT/AAAS Congressional Science Fellow and worked as a food safety policy analyst in Congress for one year. He has published over 150 refereed journal articles, abstracts, proceeding papers, and book chapters. He serves on the Editorial Boards for the Journal of Food Protection, and the Journal of Food Safety.

# **SPEAKERS & ABSTRACTS**



***ROBERT BRACKETT, PH.D***

Dr. Brackett serves as Senior Vice President and Chief Science and Regulatory Officer at the Grocery Manufacturer's Association (GMA). GMA represents the world's leading food, beverage and consumer products companies. The Association promotes sound public policy, champions initiatives that increase productivity and growth and helps to protect the safety and security of the food supply through scientific excellence. Dr. Brackett oversees all of the association's scientific and regulatory activity, including the operation of its in-house food safety laboratory.

Prior to coming to GMA, Dr. Brackett served in various positions within the U.S Food and Drug Administration's Center for Food Safety and Applied Nutrition, eventually attaining the position of Center Director. As Center Director, he provided executive leadership to the Center's development and implementation of programs and policies relative to the composition, quality, safety, and labeling of foods, food and color additives, dietary supplements and cosmetics

From 1994 until 2000, Dr Brackett served as Professor of Food Science and Technology in the Center for Food Safety at the University of Georgia, where he was an active researcher in the area of food microbiology, specializing in microbiological safety of foods. Dr. Brackett has also served on the faculty of North Carolina State University where he held the title of Extension Food Safety Specialist and Assistant Professor. Dr. Brackett received his B.S. in bacteriology and his M.S. and Ph.D. in food microbiology, all from the University of Wisconsin-Madison.

Dr. Brackett has served elected leadership positions in several professional associations, and is a Fellow of the American Academy of Microbiology and the International Association for Food Protection. He is also the recipient of numerous professional awards and serves on the Advisory Boards of the National Center for Food Protection and Defense, and the National Center for Food Safety and Technology.

# **Traceability Systems for Foods: An Industry Perspective**

Robert E. Brackett, Ph.D.  
Grocery Manufacturers Association  
Washington, DC USA

## **ABSTRACT**

Product safety is the foundation of consumer trust. The food industry devotes enormous resources to ensure that products are safe, and continually strives to improve the safety of its products. However, studies confirm that consumer confidence waivers with each food safety event. It is apparent that current traceability systems are not meeting industry needs and are not efficient and expedient in identifying and facilitating the removal of recalled product from the market place. The consumer product goods (CPG) industry is prepared to work collaboratively with government to identify and address gaps in our current traceability system, including measures that will ensure that responsibility for traceability is shared throughout the supply chain, measures that will improve the interoperability of current and future traceability systems, and that which build upon and encourage industry innovation. Regardless of what traceability system is adopted, it is clear that a “one size fits all” approach to address traceability will be neither effective nor practical. The industry is stepping up food safety efforts and working with Congress and the Obama Administration to enact food safety modernization legislation so that problems can be prevented before they occur and to bolster consumer confidence in the safety and security of the food supply.





***PAUL BRERETON, PH.D***

Dr. Brereton has published over 60 peer reviewed papers on food safety and quality and currently sits on the Editorial Board of the Journal of the Science of Food and Agriculture.

Paul currently manages TRACE, a 19M€EU integrated project, that comprises a portfolio of international research and training activities on food traceability and authenticity. He has close links with the food industry, Food Standards Agency, academia and the European Commission.

# NEW APPROACHES TO TRACING THE ORIGIN OF FOOD

Paul Brereton, Ph.D  
The Food and Environment Research Agency,  
York, UK

## ABSTRACT

Recent high profile food incidents in China, US and Europe have emphasized the need for improved procedures for tracing where our food has come from and its route from farm to fork. Although many of the drivers for adopting of good traceability practices differ considerably in different continents they all share the common requirement to be able to track and trace food products along the production chain. There is also a need for food safety and quality reasons to be able to verify the integrity of the food supply.

Within Europe there is an increased emphasis on the need to satisfy an ever more discerning consumer's preference for accurately labeled food. This has translated into a need for traceability systems and methods that can more accurately verify the origin of food and supply accurate and verifiable information on its processing history. It is against this background that the European Union have funded **TRACE** a 5 year 19M€ research programme aimed at providing systems that can confirm as well as trace the origin of food. Comprising over 50 organizations from Europe, Asia and South America, **TRACE** is multi disciplinary in nature and involves analytical chemistry, geochemistry, statistics, molecular biology, ICT and consumer science disciplines. A non proprietary electronic language (TraceCore<sup>XML</sup>) has been developed within **TRACE** to allow for electronic interchange between actors within a traceability chain and has been integrated into a Tracefood platform ([www.tracefood.org](http://www.tracefood.org)).

Along side developments in tracing and tracing food products new methods of confirming their origin have also been developed. Predictive food maps for determining the origin of food based on the use of climatic and geological markers have been developed. Spectroscopic verification methods and microarray methods for species/variety confirmation are being produced together with novel analytical parameters for compliance assessment.

An overview of the **TRACE** project will be provided together with some of the latest developments in the metabolomics area that can be used to verify the integrity of the food supply.

*Keywords:* traceability, authenticity, origin, foodmaps



**MARC H. COHEN, PH.D**

Dr. Cohen received his Ph.D. in Electrical and Computer Engineering from Johns Hopkins University, Baltimore, MD, in 2001. As a Research Scientist in the Institute for Systems Research, A. J. Clark School of Engineering, University of Maryland, College Park, MD, his R&D work focuses on (i) low voltage, low power, adaptive analog – digital VLSI, most recently applied to the design of high speed adaptive analog-to-digital converters, (ii) Opto-Electronic Micro-Electro-Mechanical Sensors and Systems applied to detection of pathogens and explosives, (iii) Harvesting radio frequency energy for powering passive wireless sensors used for remote monitoring and (iv) RFID applied to military logistics. Marc is a member of the Institute of Electrical and Electronics Engineers (IEEE) and serves on two technical committees in the Circuits and Systems Societies; Biomedical Circuits and Systems and Sensory Systems.

Marc is founder and CTO of Prognosis LLC, where we develop and build a variety of diagnostic sensors that are imbedded directly inside barcodes as well as diagnostic instruments for detecting bacterial ATP.

# Tracking Technologies for the Agri-Food Industry

Marc H. Cohen, Ph.D  
Institute for Systems Research  
University of Maryland  
College Park, MD

## ABSTRACT

There are several commercially available Track-and-Trace technologies and Real-Time Location systems which have application in the Agri-Food industry. This presentation will give an application oriented overview of the following technologies;

1. Barcodes and Sensor-Imbedded Barcodes (machine readable codes),
2. Radio Frequency Identification (RFID) devices, including active, battery assisted passive and passive tags,
3. Surface Acoustic Wave (SAW) devices, and
4. Global Positioning Systems (GPS).

The idea that universal identification facilitates “total visibility” throughout the lifecycle (farm-to-fork) of the commodity/consumable will be addressed.



***AMOL DESHPANDE, PH.D.***

Dr. Deshpande received his B.Tech. degree from the Indian Institute of Technology, Bombay in 1998, and his M.S. and Ph.D. in Computer Science from the University of California at Berkeley in 2001 and 2004 respectively. After briefly working as a Senior Researcher at Intel Research Labs, Berkeley, he joined the Department of Computer Science at the University of Maryland, College Park as an Assistant Professor in 2005; he also has a joint appointment with the University of Maryland Institute of Advanced Computer Studies (UMIACS).

Prof. Deshpande's research spans a spectrum of data management topics in a variety of environments, including query optimization in traditional databases, adaptive query processing over data streams, sensor network data management, scalable statistical modeling of data, and uncertain data management. His current research focuses on the challenges in managing and querying the inherently noisy, imprecise, incomplete, and uncertain data generated in environments like sensor networks, data streams, data integration, information extraction, and social networks. He received the best paper award at the International Conference on Very Large Databases (VLDB), 2004, for his work on "Model-driven Data Acquisition in Sensor Networks". His paper titled "Predictive Modeling-based Data Collection in Sensor Networks" was selected as one of three best papers at the European Conference on Wireless Sensor Networks (EWSN), 2008. Prof. Deshpande is also a recipient of the NSF CAREER Award. Prof. Deshpande has served on or is currently serving on the program committees of numerous leading academic conferences in both database systems and sensor networks, including ACM SIGMOD (2006, 2009), VLDB (2007, 2008, 2009), ICDE (2005, 2006, 2007, 2009), IPSN (2006, 2008), and Sensys (2009). He was a PC Vice Chair for the International Conference on Data Mining (ICDM), 2008, and was the General Chair for the International Workshop on Data Management for Sensor Networks (DMSN), held in conjunction with VLDB 2007. He also regularly serves as a reviewer for many prestigious ACM and IEEE journals on database systems, sensor networks, and data mining.

Prof. Deshpande has presented several tutorials at leading database conferences: "Adaptive Query Processing" at SIGMOD 2006 and VLDB 2007, and "Probabilistic Graphical Models and their Role in Databases" at VLDB 2007. He has also given invited talks at many venues including EPFL Summer Institute, New England Database Society, University of Wisconsin at Madison, and University of Waterloo.

## **Computer-Based Tracking Protocols: Improving Communication between Databases**

Amol Deshpande, Ph.D  
University of Maryland  
College Park, MD USA

### **ABSTRACT**

Recent advances in sensing and monitoring technologies have resulted in an over abundance of data that may potentially be useful in tracking and tracing foods through the supply chain. In this talk, I will discuss some of the key challenges in utilizing this data to quickly and effectively respond to events such as an outbreak of a foodborne illness. In particular, I will focus on how to integrate and combine the data that may be stored in heterogenous database systems, possibly in different formats, and how to analyze and sift through large volumes of such monitoring data, much of it likely useless, in real time. I will also present some recent developments in database systems research that may help with addressing these challenges.



***KATHRYN DONNELLY***

Kathryn Anne-Marie Donnelly holds a BA (Honors) from University College London (UCL) – University of London with a dissertation focused on International Environmental Regimes. She completed a BSc in Biology and an MSc in Marine Biology at the Norwegian College of Fishery Science, University of Tromsø (2006). Ms. Donnelly currently works at Nofima as a scientist in the area of traceability and other national projects related to traceability and food safety. She has participated in the Traceability Systems Group in the EU 6FP TRACE project; and served on the organizing committee of the 4th annual TRACE conference.

# **Drivers for Implementation of Traceability in the Food Sector**

Kathryn Anne-Marie Donnelly  
Nofima Norwegian Institute of Food Fisheries and Aquaculture Research  
Tromsø, Norway

## **ABSTRACT**

Much of the food that reaches the modern consumer's plate is globally sourced. Production and distribution patterns have become much more complex than was common even 50 years ago and consumer preferences have evolved to include both specialist and out of season foods. At the same time the type and number of food related health incidents, from BSE to Dioxins is growing. When these factors are combined the need for greater transparency in food supply chains becomes apparent. Creating this transparency requires the ability to trace and track ingredients in food stuff rapidly and precisely.

The main motivating factors for traceability are food safety, certification, compliance management, production control rationalization, supply chain communication and competitive advantage.

Experience from traceability implementation projects such as TRACE provides evidence and insights into these factors and can give pointers to the way forwards for successful traceability implementation.





**GERRY DOWNEY, PH.D**

Dr. Downey is Head of the Prepared Foods Department at the Ashtown Food Research Centre of Teagasc, Ireland's Agriculture and Food Development Agency. After qualifying as a biochemist from The Queen's University, Belfast, Northern Ireland, he joined Teagasc as a food scientist with specific responsibilities in the dairy & plant food areas. He began research into the application of near infrared spectroscopy 25 years ago and was responsible for the introduction of the technique into the Irish grain trade. Over the last 15 years, he has extended his research effort into the use of NIR spectroscopy for qualitative analysis of foodstuffs in general. His Ph.D. thesis was granted for work in the area of food authenticity and quality while, in 2005, he was awarded the degree of DSc by Queen's University Belfast for a thesis entitled "Studies on the Application of Near Infrared Spectroscopy and Chemometrics to the Analysis of Food and Agricultural Commodities." He is currently Editor of NIR news, European Editor of the Journal of Near Infrared Spectroscopy and is a member of the editorial boards of Near Infrared Analysis (published by the Korean Society of Near Infrared Spectroscopy) and Sciences des Aliments. From 2001 to 2005, he was Chairman of the International Council of Near Infrared Spectroscopy and is currently Chairman of a project team supported by the International Union of Pure & Applied Chemistry (IUPAC) on global standards for spectroscopic and chemometric data exchange. With regard to European R&D projects, he was a member of the management team of the QUEST project (1990 - 1994) which investigated a range of spectroscopic techniques for food quality measurement, the FAIM project (1994 - 1997) which dealt with food authenticity issues and STAFANIR (1996 - 1998) which was concerned with NIR instrument standardization. He was also on the management group of the European dissemination project FLAIR-FLOW EUROPE (1999-2003). He is a Work Package Leader and member of the both the Scientific Committee and Project Management Board of TRACE, an integrated project funded under the EU FP6 programme which commenced on January 1 2005.

# Spectroscopic Fingerprinting Techniques for Verifying Food

Gerry Downey, Ph.D  
Head, Prepared Foods Department  
Agriculture and Food Development Agency  
Ashtown Food Research Centre  
Teagasc, Ireland

## ABSTRACT

Consumer confidence in the food production, process and supply industries is probably at an all-time low in the Western world. This distrust has arisen through a steady succession of incidents concerning economic fraud or potentially-harmful adulteration and contaminations which have been experienced and well-documented throughout Europe, Asia and the US. While greater regulatory vigilance is one way to redress this crisis of confidence, a suite of appropriate and useful analytical techniques is a necessary prerequisite.

Spectroscopic techniques have well-known potential advantages as methods for screening large numbers of a wide range of sample types; these include their non-destructive nature, ease of operation, relatively low cost and, critically, speed of analysis. What is not immediately obvious in any given application is that spectra collected by the most common methods in use (UV-VIS, NIR, IR and Raman) actually contain sufficient information to address quality or conformity issues. Of equal importance with the fingerprinting approach generally favored with these methods is the selection of the appropriate or best chemometric processing techniques for development of required models. A wide variety of approaches have been reported but little comprehensive comparison of the results obtained has been published. Perhaps the most critical factor in model development however is the exact question which should be asked before any sample or data collection begins.

The importance of these general points will be explored using data collected during the EU-funded TRACE ([www.trace.eu.org](http://www.trace.eu.org)) project. Methods for model development and verification will be discussed using a holistic approach. Emphasis will be on the translation of laboratory studies into the marketplace and, in particular, on trying to provide readily-understood measurement indicators of relevance to the international consumer. An attempt will be made to define the potential for spectroscopic fingerprinting techniques in these applications.



***JAMES EHLERINGER, PH.D***

Dr. Ehleringer is a Distinguished Professor of Biology at the University of Utah, where he also serves as Director of the Stable Isotope Ratio Facility for Environmental Research (SIRFER). Over the past 32 years at the University of Utah, he has developed a multi-disciplinary research and teaching program spanning the environmental sciences. He has published over 400 research articles and served as advisor to more than 50 graduate students and postdoctoral investigators. His research ranges from global change impacts on ecosystems through forensic investigations. Dr. Ehleringer's current foci include stable isotopes in biosphere-atmosphere interactions, particularly in urban and arid regions; water relations in ecosystems; geographic variation in human foods; isotopes in animal and human physiology; and stable isotopes applied to forensic and homeland security issues. He is also associated with IsoForensics Inc., a small University Research Park company focusing on applications of stable isotope analyses.

## Determining Geographical Origin of Food Using Stable Isotopes

James Ehleringer, Ph.D and Lesley Chesson, Ph.D

IsoForensics Inc.

Salt Lake City, UT

and

University of Utah

Department of Biology

Salt Lake City, UT USA

### ABSTRACT

Using a mass spectrometer, it is easily possible to measure the ratios of the heavy-to-light stable isotopes of an element (e.g.,  $^2\text{H}/^1\text{H}$ ,  $^{13}\text{C}/^{12}\text{C}$ ,  $^{18}\text{O}/^{16}\text{O}$ ) in biological materials. The stable isotope ratios of hydrogen and oxygen at natural abundances provide a powerful tool for determining the region-of-origin of many food items, whereas the stable isotope ratios of carbon provide information on the  $\text{C}_3/\text{C}_4$  diet of animals and the degree of food adulteration by corn sugars. The basis of the geographical region-of-origin “stable isotope signal” in the organic matter and/or water within food items is the result of naturally occurring geographical gradients in the isotope ratios of water across a continent. Once water has been taken up by the organisms that eventually become food items (both plants and animals), the hydrogen and oxygen atoms undergo a series of fractionation events, for which the biochemical and mathematical bases are understood in many cases. After the hydrogen and oxygen atoms are incorporated into organic compounds within plant or animal food items, the “stable isotope signal” is permanent and will persist until the food is decomposed. All types of food items and biochemical components can be analyzed, including carbohydrates, lipid and fats, proteins, and food water. For dried or frozen materials, stable isotope analyses can be performed on food items many years after the product was produced. Stable isotope analyses are measured on an isotope ratioing mass spectrometer. This specialized mass spectrometer is typically coupled upstream to gas chromatography, liquid chromatography, or elemental analyzer peripherals to separate and combust or pyrolyze the compounds or food items of interest.

In this talk, we will present the theoretical basis for expecting geographic patterns in stable isotopes and then show the magnitude of hydrogen and oxygen isotope ratio variations in meats, dairy products, breads, wines, bottled waters, and oils from studies in our laboratory. We then present “isoscapes” or geographic information system color maps depicting the predicted variations in stable isotope ratios of a food item across the USA. The precision of the stable isotope ratio approach using hydrogen and oxygen isotopes is shown to be regional, allowing one to define zone or bands of locations from which a food could have originated and to as easily show where a food item could not have originated from. We will complete this presentation with a discussion of two of the many possible applications of stable isotope ratios to food-security interest. First, use of stable isotope analyses as a tool to determine or verify region-of-origin authenticity for a food with high-value interest. Second, in the event of a toxic food scare, use of stable isotope analyses to identify those regions that are not consistent with the contaminated source region (therefore might be deemed safe and excluded from embargo or recall) versus those regions where officials should focus their investigations.



**JANA HAJŠLOVÁ, PH.D**

Dr. Hajšlová graduated from Institute of Chemical Technology (ICT) Prague, Czech Republic. Following her doctoral studies (thesis: Flavour significant compounds in protein hydrolyzates), she was appointed as a visiting scientist at Free University of Amsterdam, the Netherlands, and Institute of Food Research, Norwich, UK. At present, she is the Head of Accredited Laboratory (ISO 17025), vice-head of Department Food Chemistry and Analysis (ICT), lecturer responsible for Food analysis course, and supervisor of 12 Ph.D. students. Prof. Hajšlová's research interests focus on the chemical food safety and biologically active compounds in food chains and issues related to the implementation of novel hyphenated analytical strategies, mainly those employing mass spectrometry.

Currently, Prof. Hajšlová is a member of 5 consortia of EU collaborative projects (6th and 7th Framework program). She worked as a board member of the EU-backed Advisory Group on Food Quality and Safety and was a member of the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Professor Hajšlová has participated in many international research activities and has established close collaboration with many institutions, including the UN's WHO and FAO, USDA and the European Commission's Joint Research Centre. She has published widely (over 150 original papers) on organic contaminants and chemical food safety and is a member of the international editorial board for the journal, Food Additives and Contaminants. In 2007, she has become a national delegate for EU 7th Framework Research Program Committee.

# The Use of DART –TOFMS for Characterizing Food

Jana Hajšlová, Lukáš Václavík and Tomáš Čajka  
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## ABSTRACT

A lot of scientific effort has been spent to develop rapid, reliable, and cost effective analytical approaches applicable for the authentication of various food commodities. Besides of spectroscopic techniques employing nuclear magnetic resonance (NMR), Raman, or infrared spectra, a wide range of methods employing gas chromatography–mass spectrometry (GC–MS), and/or high-performance liquid chromatography (HPLC) hyphenated to MS with atmospheric pressure chemical ionization (APCI), has been implemented for this purpose. Some procedures, such as matrix assisted laser desorption/ionization mass spectrometry (MALDI), direct head-space mass spectrometry (HS-MS), and/or direct infusion MS allow reduction of analysis time thanks to elimination of chromatographic separation step.

Recently, a large number of novel ambient desorption ionization techniques, such as desorption electrospray ionization (DESI), atmospheric-pressure solids analysis probe (ASAP), direct analysis in real time (DART) and some others, have become available providing further improvements. Their main advantages compared to conventional techniques, involve the possibility of direct sample examination in the open atmosphere, minimal, or no sample preparation requirements, and, remarkably high sample throughput. DART, which has been investigated in our laboratory, represents one of APCI-related techniques employing a corona discharge for the ionization. Metastable helium atoms, originated in the plasma, react with ambient water, oxygen, or other atmospheric components to produce the reactive ionizing species. DART ion source has been shown to be efficient for soft ionization of a wide range of both polar and non-polar compounds.

In this presentation, several studies employing DART-TOF MS for tracing of food origin and safety assessment will document the potential of this challenging technique:

- plant oils adulteration
- type of meat and its freshness
- characterization of different beers
- potential of potato tubers to yield acrylamide when thermally processed
- treatment of stored cereals by fungicides



***JEAN HALLORAN, PH.D***

Dr. Halloran is Director of Food Policy Initiatives at Consumers Union, publisher of Consumer Reports. In her 25 years at Consumers Union she has led many projects on food safety, sustainable consumption and trade issues. She is currently responsible for developing policy and staff initiatives on biotechnology, mad cow disease prevention, mercury in fish, and bacteria in meat, poultry and produce. As Director of the Consumers Union Consumer Policy Institute from 1981 to 2005, she developed and supervised conferences, reports and input to government agencies on pesticides, sustainable agriculture, organic labeling, toxic chemicals, as well as intellectual property issues and health care, funded by the National Science Foundation, government agencies, and numerous private foundations. She presently serves on the U.S. State Department's Advisory Committee on International Economic Policy. Ms. Halloran helped organize the TransAtlantic Consumer Dialogue (TACD), a coalition of groups in Europe and the US, and serves as its US liaison point. She represented Consumers International at Codex Alimentarius, in negotiations that developed standards for safety assessment of genetically engineered foods. Ms. Halloran speaks frequently at conferences and to media. She served on the US FDA's Food Advisory Committee from 2004 to 2006 as well as on the National Academy of Sciences' Board on Agriculture and Natural Resources. In 1996, she co-authored the recent Consumers Union book *Pest Management at the Crossroads*, which discusses how to move the United States toward Integrated Pest Management, an approach that minimizes pesticide use. Ms. Halloran came to Consumers Union's Consumer Policy Institute in 1981 to direct the Regulatory Information Network project, whose goal was to help consumer groups participate in federal regulatory decisions on issues such as getting lead out of gasoline.

In 1979-1980, as a staff member of the President's Council on Environmental Quality, Ms. Halloran was one of the principal drafters of an Executive Order issued by President Carter designed to prevent export of banned and severely restricted pesticides, pharmaceuticals and consumer products. From 1972 to 1979, Ms. Halloran was Director of Research at INFORM, an environmental research organization in New York City, where she did research, writing and editing on land use, pollution and other environmental issues. Ms. Halloran has also served on the staffs of the Council on Economic Priorities and of *Harper's Magazine*. Jean Halloran received her B.A. with Honors from Swarthmore College. She resides in Brooklyn, New York.

ABSTRACT: Not Available





***KELLY B. HISE, M.P.H.***

Kelley Hise is the PulseNet USA Database Unit Chief in the Enteric Diseases Laboratory Branch at the Centers for Disease Control and Prevention in Atlanta, GA. PulseNet USA is the national molecular subtyping network for foodborne disease surveillance. Mrs. Hise manages and coordinates the foodborne bacterial pathogen databases of PulseNet USA, provides support for foodborne disease outbreak investigations, and coordinates technical and troubleshooting support on computer-based applications.

Mrs. Hise began her work with PulseNet in 2002 as a *Listeria* and *E. coli* PulseNet database manager and became the chief of the PulseNet USA database team in 2004. Since then, Mrs. Hise has led the database team in hundreds of investigations of foodborne disease case clusters, and in the process vastly improved the system by organizing all cluster information, improving the communication with epidemiologists and PulseNet participants, and decreasing response time. Mrs. Hise has also helped in the organization of several annual PulseNet update meetings and BioNumerics (analysis software for PFGE subtyping analysis) trainings for PulseNet participants.

Mrs. Hise received her Master of Public Health degree in epidemiology from Emory University in Atlanta, Georgia in 2000. She completed her undergraduate work in microbiology from The University of Alabama in 1998.



## PulseNet Network

KELLEY B. HISE, M.P.H.

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National Center for Zoonotic, Vector-Borne, and Enteric Diseases  
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### ABSTRACT

PulseNet USA is the national molecular subtyping network for foodborne disease surveillance. It is coordinated by the Enteric Diseases Laboratory Branch at the Centers for Disease Control and Prevention (CDC) and the Association of Public Health Laboratories (APHL). It now has more than 70 participants including state and local public health departments, federal food regulatory agency laboratories, as well as agricultural and veterinary laboratories. Since its inception, PulseNet USA has become an indispensable part of the surveillance of foodborne infections in the United States by facilitating the detection and investigation of outbreaks, as well as the confirmation of their source.

**History of PulseNet:** By the beginning of the 1990's, Pulsed-Field gel electrophoresis (PFGE) had become the gold standard for subtyping of bacterial pathogens and was increasingly used by the Central Reference Laboratory at the Foodborne and Diarrheal Diseases Branch at CDC for investigations of outbreaks of bacterial foodborne disease. An increasing number of outbreaks, especially of Shiga toxin-producing *E. coli* O157, were being investigated and it became impossible for the CDC laboratory to subtype all strains received in real-time, which slowed down the investigations. It was therefore decided to decentralize subtyping activities for foodborne pathogens to where the outbreaks were occurring: the states. This decentralization signaled the birth of PulseNet USA in 1996. Since then, PulseNet has evolved from a small network of laboratories in the U.S., to a network that includes all 50 states and sister networks that have been established in Canada, Europe, the Asia Pacific, Latin America, and the Middle East. The group of organisms under surveillance now includes Shiga toxin-producing *E. coli*, *Listeria monocytogenes*, *Salmonella*, *Shigella*, *Campylobacter*, *Vibrio cholerae* and *V. parahaemolyticus*.

**How PulseNet works:** PulseNet participants perform DNA "fingerprinting" by pulsed-field gel electrophoresis (PFGE) on disease-causing bacteria isolated from humans and from suspected non-human sources using highly standardized methodology and equipment. Once the PFGE patterns are generated, they are entered into an electronic database of DNA fingerprints at the local PulseNet laboratory. The patterns are then uploaded to national databases located at CDC. Laboratorians in the states perform regular searches on their local databases, looking for clusters of patterns that are indistinguishable. If an outbreak is suspected, the results are reported to the state epidemiologists, CDC, and the whole PulseNet community on the PulseNet web-based discussion forum. An outbreak investigation is initiated. Database managers at CDC also perform cluster searches at least once every week. This allows the detection of geographically dispersed clusters that are not apparent locally, as well as the linking of seemingly local clusters

occurring in different states but originating from the same source to each other. If an outbreak is suspected, the results are reported back to the laboratories, the epidemiologists at CDC and to the PulseNet web forum triggering an outbreak investigation.

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*STEFAN HOSKULDSSON, PH.D*

Dr. Hoskuldsson, Senior Software Developer and Traceability specialist at Maritech, Iceland. He is a professional executive, with 17 years experience in the aquaculture industry in the areas of software development, system and data analysis, traceability procedures, marketing and business development.

ABSTRACT: see Grishja van der Veer



***CHARLES R. HURBURGH, PH.D***

Dr. Hurburgh, Charlie to most everyone, is a native Iowan from Rockwell City (Iowa, USA). He continues to operate the family farm, and is a Professor of Agricultural Engineering at Iowa State University. He has BS, MS, and doctorate degrees from Iowa State, and specializes in quality management systems with related traceability, measurement and sensor technologies. He is the author of more than 200 technical and general articles on grain quality, measurement science and grain marketing. Dr. Hurburgh manages the ISU Grain Quality Research Laboratory and the Extension-based Iowa Grain Quality Initiative. Dr. Hurburgh participates in European Union projects on GMO marketing and traceability. He also serves on the US Technical Advisory committees for three ISO working groups – biotechnology testing, traceability, and ISO 22006 guidance standards for agriculture; and on the GEAPS Grades and Weights Advisory Committee.

# **Bulk Materials Tracing Needs**

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## **ABSTRACT**

Bulk materials are inherently a challenge for food traceability systems. Traceability is enhanced by progressively smaller granularity (unit size) of raw material inputs, and by increasing specialization in handling input units through processes. Efficiency in handling bulk materials is normally increased, however, by commingling before and during processes. Grains are a prime example of progressively larger lots, subdivided lots, and recombined or partitioned lots; most buyers purchase grain with generic, mostly physical, attributes. Fluid systems are similar.

Traceability in bulk materials will never be perfect; rather it is an estimation of probabilities. Traceability can facilitate many needs beyond documentation of custody, if it is implemented within the framework of a quality management system such as ISO 22000, so that operational, regulatory and other costs can be reduced at the same time the accuracy of traceability is increased. Recent studies at Iowa State University have shown that significant cost savings in grain handling (through redesigned operational practices) can be realized at the same that the specificity of tracing or tracking was improved. Bulk materials traceability must be analyzed as a system of operations, internal and external; analysis of one operation alone will not yield results that have future value. Bulk materials are handled at levels in the market chain where quality management and other procedures-based concepts are less familiar.

Major needs for bulk systems traceability include:

- Mathematical modeling of bulk materials movements and flows.
- Process mapping procedures for systems
- Application and cost-benefit calculation templates
- Guidance information for industry
- Training for industry users in improved operational procedures and quality management systems.
- Auditing skills.

This presentation will present the data and specifics of bulk materials traceability and its future.



***SHAUN KENNEDY, PH.D***

Dr. Kennedy is deputy director of the National Center for Food Protection and Defense (NCPFD), a Department of Homeland Security Center of Excellence and an assistant professor in Veterinary Population Medicine at the University Of Minnesota. At the University, Mr. Kennedy leads research and education programs that advance animal health, food safety and food system biosecurity. Prior to the University, Shaun held executive research and development positions at Ecolab where he was vice president of global food and beverage research and development, and at Procter & Gamble. At Procter & Gamble his positions included leading research and development programs in Japan and China. Shaun's publications and patents cover food defense, food safety testing systems, novel antimicrobial systems and other food system research areas.

# Why Do You Need Traceability Systems?

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## ABSTRACT

Recent and ongoing foodborne illness outbreaks and significant food recalls have brought renewed attention to the importance of effective food traceability systems in protecting public health, maintaining consumer confidence and reducing the economic harm to the private sector. Spinach, wheat gluten, ground beef, peppers, peanut paste and pistachios have all illustrated different aspects of how the degree to which firms can effectively trace food and food ingredients, both forward and backward, can drive the final overall impact of the event. When an inability to quickly trace an ingredient all the way to its final end use products results in additional human illness, as in the case of the Peanut Corporation of America contamination, the public is quite understandably outraged. The inability to limit the scope of a recall because of an ineffective traceability system can topple a firm, as in the case of Topps. When inconclusive epidemiological information intersects with traceability systems that can't easily ascertain probable origin of produce items, entire producer groups can be negatively impacted as happened in the *Salmonella* Saintpaul outbreak. This talk will examine each of these examples and the impact of the limitations of the traceability systems that were in place. From there it will explore the potential consequences of similar limited traceability systems in the context of an intentional contamination of the food system to cause catastrophic public health or economic harm.



***CHRISTINE KEYS***

Christine Keys is with the FDA's Center for Food Safety and Applied Nutrition (CFSAN) in the Division of Microbiology. She received her B.S. and M.S. degrees from Northern Arizona University (NAU) with emphasis in Environmental Microbiology. While at the university, she gained experience in molecular subtyping methods used to track pathogens in the environment with an emphasis on AFLP (Amplified Fragment Length Polymorphism). After receiving her Master's degree, she remained at NAU to work as a Research Assistant to Dr. Paul Keim with the development and optimization of MLVA (Multi-Locus VNTR Analysis) for anthrax, plague, *E. coli* O157:H7, *Listeria*, and *Salmonella*. In 2003, she joined the FDA where she became part of the PulseNet program. She is currently leading CFSAN's PFGE data analysis team where she works with FDA epidemiologists, compliance officers and emergency response teams to provide data support during outbreaks and regulatory activities.



# Overview of Molecular Subtyping Methods for Bacterial Pathogens

Christine Keys  
Food and Drug Administration  
Center for Food Safety and Applied Nutrition  
PulseNet Team  
College Park, MD USA

## ABSTRACT

Currently, investigations into foodborne outbreaks rely heavily upon pulsed-field gel electrophoresis (PFGE) to define case clusters and to link clinical cases with food sources. While conventional PFGE subtyping protocols are capable of differentiating most bacterial pathogens at an epidemiologically relevant scale, it is just one of many tools available for use during and after an outbreak. Effective strain discrimination is necessary for successful traceback during an outbreak. Additionally, not all subtyping methods are adequate for all pathogens, such as when discriminating the highly homogeneous serovar, *Salmonella* Enteritidis. Some of the methods to be addressed in this talk include Single Nucleotide Polymorphisms (SNPs), Multilocus Sequence Analysis, and protein profiling.



***SHERRI MCGARRY***

Ms. McGarry is the Director of the Division of Public Health and Biostatistics in the Office of Food Defense, Communications, and Emergency Response, at the Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration. She is also the Center's Emergency Coordinator and has over 16 years of experience working at the FDA. In addition to managing statisticians, epidemiologists, emergency coordinators, and spatial technologists, she has hands-on field experience investigating foodborne outbreaks. These activities involve coordination with other federal agencies, industry, states, foreign governments, and other stakeholders, the use of incident command structures, and traceback investigations. In addition, Ms. McGarry is involved in preventive produce safety activities from a technical and policy perspective. Some of these activities include development and implementation of the Leafy Greens Safety Initiative, Product Trace Initiatives, and providing training in good agricultural practices and produce farm investigations.

# **Product Tracking Systems from Fresh Produce**

Sherri McGarry  
Center for Food Safety and Applied Nutrition  
US Food and Drug Administration  
College Park, MD USA

## **ABSTRACT**

Traceback investigations and traceforward operations are components of a 'product tracing system'. Traceback investigations involving fresh produce are among the most challenging investigations regulatory agencies face because the food is perishable and may no longer be available for testing, by the time the investigation is conducted. Industry practices, such as repacking produce from multiple sources and not assigning specific identifiers to the produce can complicate traceback investigations further.

The US FDA held two public meetings in the fall of 2008 to stimulate and focus a discussion about mechanisms to enhance product tracing systems for fresh produce and to improve the US FDA's ability to use the information in such systems to identify the source of contamination associated with fresh produce-related outbreaks of food-borne illness. This presentation will include a brief review of the information elements in current product tracing systems (e.g., "one up and one back"), some of the challenges faced in recent outbreaks, and an update on the findings from the public meetings that will assist the US FDA to identify and determine the short-term and long-term steps necessary to enhance the current product tracing system. The presentation will also discuss other activities FDA is involved present and future that will contribute to this effort.



***PAUL REECE, PH.D***

Dr. Reece is a Biochemist with over 25 years experience in food safety and authenticity. His work has included the development of methods to identify fish species, through the detection of allergens and GMO in food, the use of stable isotopes to detect the geographic origin of food. He is currently investigating the use of proteomics to confirm the authenticity of food and animal feed.

# The application of Proteomics to Food Authenticity

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Sand Hutton  
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## ABSTRACT

Although DNA techniques have proved invaluable in the identification of species, and traces of allergens and GMO in foods, they have a number of drawbacks in the authenticity of food ingredients. DNA approaches cannot distinguish different tissues from the same organism e.g. bovine milk, meat or offal; low pH and high temperature processing destroys the quantitative relationship between DNA and the weight of an ingredient, and DNA techniques can be too sensitive, so accidental rather than deliberate contamination is detected, which is often used as a defense by unscrupulous producers who deliberately adulterate foods with highly processed low cost ingredients.

We have been interrogating protein sequence information to provide food authenticity information that overcomes many of these problems. Three examples highlight the approaches we have been taking.

1) Meat binding agents based on bovine and porcine blood plasma have been approved by the EFSA for use in a range of meat products. The UK FSA need to enforce appropriate labeling legislation on species, meat content and cut of meat, while protecting religious sensitivities, so they requested a method that 1) was compatible with instrumental platforms used by enforcement authorities 2) which could determine when this technology had been used, 3) could determine whether bovine or porcine blood had been used to produce the gelling agent.

We investigated the use of SPE and a Waters MicroMass Quattro Ultima *LC/MS/MS* to detect the presence of the two fibrinopeptides released during the clotting of the blood protein fibrinogen. The amino acid sequence of these peptides is unique to each species of blood. We have shown that it is possible to distinguish the two species of blood based gelling agent by MS/MS characterization of these peptides. The method is not interfered with by indigenous blood protein in meat samples so can determine when the porcine binding agent has been used on pork products as well as other species of meat.

2) At present there is a total ban on animal protein being incorporated into animal feed in Europe to minimize the risk of spread of Transmissible Spongiform Encephalopathy's (TSE's). Current scientific evidence suggests that spread of TSE's can be minimized by simply avoiding cannibalism and consumption of ruminant tissues by other species. A selective lifting of the total ban on animal protein in feed is dependent on the development of methods to speciate all animal protein in animal feed after processing the feed to 145°C for 30min.

A proteomics approach is being investigated to interrogate the sequences of protein fragments in high temperature processed meat and bone meal in order to identify consistent species markers of animal proteins. A number of candidate proteins have been identified by tryptic digestion of the

meat and bone meal followed by LC ESI MS/MS of the resultant peptides on a QSTAR MS at the Technology Facility at the University of York.

At present selected tryptic peptides from the muscle protein myosin, are proving to be reliable species-specific markers. Intact myosin protein is fragmented during the high temperature processing of the meat and bone meal; however the fragments are extracted from the sample using the standard selective extraction procedure used for the intact protein so enabling a relatively rapid enrichment of most of the myosin sequence. Work is currently underway to evaluate myosin and other potential species-specific protein markers.

3) Gelatine is a ubiquitous protein in food production since it is tasteless, has good 'mouth-feel' and has significant water binding capacity. It is produced by low pH treatment followed by high temperature extraction of collagen in bones and skin principally of pig, cow and to a lesser extent fish and birds. Because of its ability to bind water it is frequently injected into low value frozen poultry products along with salts and water to increase product weight. This addition of water to meat products must be accompanied by an appropriate declaration of added water content. However more recent EU legislation states that raw meat products must also declare when protein from other animal species has been added.

There has been a suspicion for some time that the gelatine added to poultry is not of avian origin although all recent attempts to identify the species origin by DNA techniques have failed. In collaboration with Prof Collins at the Department of Archaeology at the University of York we have developed a technique to extract and sequence analyse the added gelatine from low value frozen poultry products using LC- QSTAR MS. With the aid of the collagen (gelatine) sequence database for a range of domestic, wild and extinct animal species held at the Department of Archaeology we have been able to clearly identify porcine and bovine specific tryptic peptides from the gelatine added to some of the chicken products. Moreover the database has enabled us to determine whether bone or skin was used in the production of the gelatine.

The speciation of gelatine is likely to have a significant impact on the future production of Halal foods as well as improve traceability of ingredients in the meat, confectionary, dairy, wine and gelatine capsule industries.

The presentation hopefully shows that the key to further developments in the application of proteomics to food authenticity will rely on access to comprehensive protein sequence databases and knowledge of protein enrichment techniques and there will be further opportunities for chemists to transfer the detection of marker peptides onto low cost analytical MS platforms or ELISA.



***ROBERT TAUXE, MD, M.P.H***

Dr. Tauxe is Deputy Director of the Division that is charged with prevention and control of intestinal bacterial, zoonotic and fungal infections at the Centers for Disease Control and Prevention. The Division monitors the frequency of these infections in the United States, investigates outbreaks, and develops strategies to reduce the disease, disability and deaths that they cause.

Dr. Tauxe graduated from Yale University, in New Haven, Connecticut cum laude in 1975, and received his medical degree from Vanderbilt Medical School in Nashville, Tennessee. In addition, he holds a Masters in Public Health degree from Yale University in New Haven, Connecticut.

Dr. Tauxe completed an internal medicine residency at the University of Washington, and is certified in internal medicine. He then trained at CDC in the Epidemic Intelligence Service for two years, and joined the CDC staff in 1985.

Dr. Tauxe's interests include bacterial enteric diseases, epidemiology and pathogenesis of infectious diseases, epidemiologic and clinical consequences of bacterial genetic exchange, antimicrobial use and resistance to antimicrobial agents, and teaching epidemiologic methods.

Dr. Tauxe's memberships include the American Epidemiology Society, the American College of Physicians, and the American Society for Microbiology, and the American Academy of Microbiology; he is a Fellow of the Infectious Diseases Society of America, and member of the National Advisory Committee on Microbial Criteria for Foods.

Dr. Tauxe has served internationally in Belgium, Mali, Rwanda, Peru and Guatemala and has supervised numerous overseas epidemiologic investigations.

Dr. Tauxe's faculty appointments include the School of Public Health, Department of International Health, and the Department of Biology, both at Emory University.

Dr. Tauxe has authored/co-authored 229 journal articles, letters and book chapters.

# Surveillance Networks and the Detection and Investigation of Foodborne Infections: What You See is What you Get

Robert V Tauxe, M.D., M.P.H.  
Division of Foodborne, Bacterial and Mycotic Diseases  
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## ABSTRACT

The burden of foodborne infections on the public health is substantial, complex, and continuing. New and emerging problems are identified with regularity, as a result of microbial change, of changing patterns of production and trade, and the complex ecologies in which we produce and process the foods we eat. Public health surveillance is a vital and evolving part of the food safety system. Local surveillance based on local disease notification can identify local problems. Since 1996, the expansion of systematic molecular surveillance network PulseNet has made the identification and investigation of dispersed multi-state outbreaks faster, and had meant that some large and dispersed outbreaks have been detected that would otherwise be inapparent in the sea of sporadic cases. This network also makes it possible to rapidly establish the potential public health consequences when a ready-to-eat product is found to be contaminated with a pathogen.

Investigation of recent multi-state outbreaks of illnesses has established new food vehicles for infection with *Salmonella* (peanut butter, dry dog food, microwaveable poultry pot pies), and *E. coli* O157 (fresh bagged spinach). When these investigations lead to traceback and environmental assessment, they can identify likely points of contamination high in the chain of production that can have lessons for the entire industry. These findings from these outbreak investigations can help to prioritize multi-disciplinary research in food science, veterinary and ecological sectors that is critical to improving prevention upstream from the consumer. Because microbes travel freely across boundaries, this increasingly requires a transnational approach. A Memorandum of Understanding with Canada means that the results of subtyping in PulseNet Canada can be compared with the results in PulseNet USA in real time. PulseNet International now includes 40 other partner nations. The molecular subtyping surveillance network currently focuses on three main bacterial pathogens. In the United States, similar approaches are being launched or planned for noroviruses (CaliciNet), *Cryptosporidia* (CryptoNet) and Hepatitis A. The success of these laboratory networks is now pushing our public health epidemiology groups to investigate the clusters that are detected in collaborative and more standardized ways.

As a result of PulseNet, more investigations are national in scope, and the impact of investigating an apparently local outbreak can be felt through the whole food safety system. Even in the current fiscal environment, robust, stable and flexible public health platforms for surveillance and investigation are important to have sustained progress in the field of food safety.



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**GRISHJA VAN DER VEER, PH.D**

Dr. van der Veer has a background in geochemistry and geochemical mapping and modeling. During his PhD at Utrecht University, Grishja worked on the geochemical soil survey in the Netherlands, focusing on the effects of diffuse anthropogenic pollution. Since then, he has been working as a post-doc on food authentication and food specification mapping within the framework of the TRACE project. Since 2007, Grishja is working for Geochem Research where he continues his work for the TRACE project as WP-leader of Work Package 16. Work Package 16 is concerned with development of food specification maps of different food commodities as well as the dissemination of the food specification mapping approach to a broader audience.

# Food Specification Maps for European Mineral Water: An Interactive Demonstration of the Tracetool

G. van der Veer<sup>1(\*)</sup> and S. T. Höskuldsson<sup>2(\*)</sup>

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<sup>2</sup> Maritech ehf, Kopavogur, Iceland

## ABSTRACT

The isotopic and trace element composition of locally produced food commonly reflects the prevailing geo-climatic conditions of the production area, whereby providing a characteristic local fingerprint. As the isotopic and trace element composition provides information about the geographical origin, which can be used to define geographical specifications for food. Food specification maps are maps provide the predicted isotopic and trace element specifications of food commodities. As different regions can have overlapping climatic conditions and/or geologies – resulting in similar specifications –, the strength of the food map approach is based on using of a *combination* of multiple maps that each provide additional detail and allow to further confine the area where certain isotopic and trace element specifications occur.

Within the framework of the European TRACE project, food specification maps are being developed for different food commodities including mineral water, olive oil, cereal and meat. During this presentation we will mainly focus on the food specification maps for European mineral water. These maps contain the predicted upper and lower confidence limits (specifications) of the  $\delta^2\text{H}$ ,  $\delta^{18}\text{O}$  and  $^{87}\text{Sr}/^{86}\text{Sr}$  composition of European mineral water. The specifications can be used to verify the geographical origin of food by comparing the actual isotopic composition of an unknown sample with the predicted specifications from its acclaimed production region.

To facilitate working with a combination of different food specification maps the TraceTool has been developed. The TraceTool is a web-embedded application that allows to both retrieve specifications for a certain location as well as to view the cross-section area where a combination of certain specifications occurs. It is an n-tier application where the presentation layer calls a web service which gets the data from a database and formats it into a structure known as Keyhole Markup Language (KML) to display the results onto a virtual globe. During this interactive presentation, the theoretical background of the food maps will be reviewed and the TraceTool will be further demonstrated.



**HAILE YANCY, PHD**

Dr. Yancy obtained his Bachelors of Science degree in biology from Jarvis Christian College and his Ph. D. degree in Biology with a minor in molecular and forensic biology from the Department of Biology at Howard University. Dr. Yancy was introduced to the Center for Veterinary Medicine (CVM) as an intern. Upon completion of his degree, he began a two and a half year post-doctoral fellowship in the laboratory of Dr. Michael J. Myers, at the FDA's Center for Veterinary Medicine. He is currently a research biologist at the FDA's Center for Veterinary Medicine in the Division of Animal Research.

# Barcoding: The Potential use in Regulatory Science.

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## ABSTRACT

The United States Food and Drug Administration (FDA) currently rely upon the AOAC Isoelectric Focusing Method for fish species identification to confirm regulatory compliance. FDA is working with their regulatory science and field staffs to access and validate an alternative method for fish species identification based on the comparison of short standardized gene sequences from the cytochrome *c* oxidase 1 (CO1) mitochondrial gene to a library of sequences derived from authenticated specimens. This method is commonly known as “DNA bar-coding”. Appropriate species identification is important in determining associated hazards as well as addressing economic issues and aiding in seafood outbreak trace back investigations. DNA barcoding” was investigated for updating the FDA’s Regulatory Fish Encyclopedia (RFE). The RFE is compilation of data used to identify fish species. For each of a number of aquatic species commonly sold in the U.S., the RFE includes high-resolution photographs of whole fish and their marketed product forms together with species-characteristic biochemical patterns of authenticated fish species. In this study we describe the generation of DNA barcodes for 172 individual authenticated fish representing 72 species from 27 families contained in the RFE. The barcoding sequences provide an additional and unique identification resource. In a blind study, 60 unknown fish muscle samples were barcoded and compared to the RFE barcode reference library and all 60 samples were correctly identified to the species level based on barcoding data. Our study indicated that DNA barcoding can be a powerful tool for species identification and has broad potential applications.

## **INGRID ZAMBRANA, PH.D**

Dr. Zambrana, is an DFI National Expert in Food Outbreak Investigations and Food Defense, based in FDA District Office, Atlanta, I have conducted numerous in-depth outbreak investigations, domestic and international, including serving as team leader representing US FDA in various multi-agency, multi-disciplinary teams conducting on-site environmental and trace back investigations in response to various multi-state food borne illness outbreaks, including *Salmonella* Litchfield outbreak associated with cantaloupes originating from Honduras; *Salmonella* St. Paul associated with peppers from Mexico, *E. coli O157:H7* outbreak investigation associated with bagged salads; and *Salmonella Enteritidis* outbreak associated with whole raw almonds.

In this capacity, I also provide inspectional and technical assistance to FDA field offices as needed as well as help develop and/or evaluate agency policy and procedures for conduct of these types of investigation/inspection. I also participates in the design, implementation, and presentation of training and career development programs for field investigations staff and related personnel and may coordinate activities with other state and federal organizations through interagency agreements and informal working relationships.

## **Source Investigations-The Follow-up to Tracebacks from Foodborne Outbreaks**

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### **ABSTRACT**

Provides an overview of the “anatomy of an outbreak” focusing on what we cover; what we have found and what we have learned from various source investigations while highlighting the challenges faced with conducting these types of investigations, domestic and international, as well as provide an overview of the complexity and some of the limitations encountered due to various systems used for tracking and tracing of raw agricultural commodities throughout the supply chain.

# **POSTER ABSTRACTS**



## Geographical Origin of Beef

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### POSTER ABSTRACT

European beef labeling rules require the origin to be declared to consumers. In addition, consumers in the UK are increasingly interested in regional foods. The reasons for this vary from a) patriotism; b) worries (justified or not) about the quality and safety of food produced in some regions or countries; c) characteristic organoleptic or culinary qualities or d) concerns about 'food miles'?

Isotope Ratio Mass Spectrometry (IRMS) and Inductively Coupled Plasma ? Mass Spectrometry (ICP-MS) was used to identify sixteen key variables that provided maximum discrimination between beef reared in England, Scotland and Wales. These variables were the concentrations of Strontium ( $^{88}\text{Sr}$ ), Rubidium ( $^{85}\text{Rb}$ ), Erbium ( $^{166}\text{Er}$ ), Barium ( $^{138}\text{Ba}$ ), Tungsten ( $^{184}\text{W}$ ), Platinum ( $^{195}\text{Pt}$ ), Zinc ( $^{66}\text{Zn}$ ), Iron ( $^{56}\text{Fe}$ ), Phosphorus ( $^{31}\text{P}$ ), Aluminium ( $^{27}\text{Al}$ ), Tin ( $^{120}\text{Sn}$ ), Calcium ( $^{43}\text{Ca}$ ), Yttrium ( $^{89}\text{Y}$ ) and the isotope ratios of Hydrogen ( $d_2\text{H}$ ?), Nitrogen ( $d_{15}\text{N}$ ?) and Strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ). 88.8% of cross-validated grouped cases were correctly classified on the basis of these 16 variables using stepwise Canonical Discriminant Analysis. 87.5% of the English ( $n=40$ ), 83.3% of Scottish ( $n=30$ ) and 92.7% of Welsh ( $n=55$ ) beef samples were correctly classified by cross-validation. None of the English samples were misclassified as Scottish, but 12.5% were misclassified as Welsh. 16.6% of the Scottish beef samples were misclassified (3.3% as English and 13.3% as Welsh) and 7.3% of the Welsh beef was misclassified (5.5% as English and 1.8% as Scottish).

Assessment of the stable isotope and trace element data derived from authentic British beef samples has shown that nearly 90% of samples can be correctly classified as English, Scottish or Welsh using the more robust discriminant technique of cross validation. These results will form the basis for further research and a blind test of the methodology when the database is completed.

# **Methodology to Insure U.S. Genetically Modified (CM) Grain Sales into Approved Foreign Markets—Integrating ISO Traceability Standards with Agricultural Quality Management Systems (QMS)**

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## **POSTER ABSTRACT**

Expansion and rapid introduction of new transgenic events will continue to be critical elements in increasing grain production, which is needed to fore fill rising world food and energy demands. The U.S. approval process for biotech products is likely to continue to operate faster than that of our major customer nations, potentially creating market disruptions, and artificial barriers to trade. Most likely, new Genetically Modified (GM) events will be used to create increased yield, although GM quality trait events are also being developed. A workable quality management system framework, supported by specific procedures and practices as needed to satisfy individual markets, could provide the customer assurance necessary for US production to move forward with fewer problems.

The Iowa Grain Quality Initiative group, have been developing the theory and practice of traceability of grains, from farmer and receiving elevators to the end users, for several years, has also played a major role in the ongoing development of the ISO 22006 standard—the quality management systems for production agriculture. This poster incorporates ISO 22005 & 22006 standards to help facilitate trade with the help of two software models of Lot Traceability Data Map (Farm & Elevator) and Traceability Management Data Map (center), and two interrelated worksheets; the Traceability Compliance Scorecard and Cost-Benefit Spreadsheet (right side). This methodology accounts for traceability and the flow of essential data in specific cases. The traceability of all grains, especially GMOs (to include partially and incompletely approved GMO varieties), will become increasingly important to retain the value of traits or segregate them from commercial grain marketing channels due to customer requirements.

# **Maize to Milk: An Analysis of the Traceability Systems of Bulk Commodities**

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## **POSTER ABSTRACT**

Traceability is the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all the stages of production, processing, and distribution (European Union, 2002). In this study, an analysis of the traceability systems of three bulk commodities, from feed to milk, was conducted to analyze internal traceability system by each respective entity, the external traceability system among all entities, and the information exchange and communication between each entity. The objectives of this study were to create a model/map for tracing these commodities, to identify gaps in the internal and external traceability systems, and to provide quality control/quality management strategies to improve the external traceability system.

The first step of analysis involved comparing the ISO 22005 traceability standard to the current tracing and tracking system used by the processor. Only 2 of the 9 design components of the Standard were met by the processor due to lack of specific objectives. A concept map was created using supplier/recipient records from the dairy processor and dairy farm. Using records from the processor, information gaps were identified in the traceability system. After identifying gaps, quality control and quality management strategies were developed to help close the gaps and essentially strengthen the external traceability system. A product flow model was also created to determine the location of products from corn to processed milk and to determine what records are kept at each point in the chain.

The study showed that once the dairy processor has developed specific objectives to serve as the foundation for their traceability system, the established safety and quality programs that have been implemented and executed can be easily integrated into an ISO 22005 certified traceability system. Because developing an ISO certified traceability system will be time consuming and will possibly require capital, small changes that will yield timely results can be made in the area of quality control.

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# **Food Traceability and Authenticity in Developing Countries through Isotope Ratio Techniques**

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## **POSTER ABSTRACT**

The use of agrochemicals such as pesticides and veterinary drugs is vital for modern agricultural production, especially given the need for increased productivity to meet demands in the context of the current global food security crisis. However, residues of these substances in food, and other natural and environmental contaminants such as mycotoxins and persistent organic pollutants can present risks to human health and may create barriers to agricultural trade. Global factors such as climate change and changing crop and livestock production practices are predicted to exacerbate food contamination problems. Control of these hazards requires a holistic approach addressing the entire food production chain, which depends on the application of guidelines to minimise risks and incorporates feedback mechanisms to ensure the effectiveness of the controls. An essential element of this holistic approach to food safety is the ability to trace food products to their source in order to facilitate corrective actions when contamination or unacceptable levels of chemical residues are detected.

In many developed countries and regions, traceability mechanisms for food commodities based on sound record keeping, product marking or labeling and well controlled production and distribution practices have been developed as components of food safety systems. Analytical techniques may be used to complement these mechanisms. However, in less developed countries, these traceability mechanisms are often missing or ineffective. Traceability is currently a problematic area and new approaches are required to provide feasible solutions at national and international levels.

The International Atomic Energy Agency (IAEA), through its Joint Programme with the Food and Agriculture Organisation of the United Nations (FAO) on Nuclear Techniques in Food and Agriculture, provides key assistance to IAEA and FAO member states through the coordination of thematic, adaptive and innovative research on the development and application of nuclear and nuclear-related techniques to address such issues, and in linking the outputs of these research activities to capacity building. Research and capacity building activities have recently been instigated to assist member states, especially less developed countries, to establish feasible and sustainable mechanisms to facilitate the traceability and authenticity of food commodities in international trade, based on both conventional record-based systems and robust analytical techniques. Stable isotope measurements provide a unique and powerful tool to control food contamination at source (a food safety issue), food authenticity (a trade issue) and food adulteration (food quality/safety). Techniques such as isotope ratio mass spectrometry and cavity ring-down laser spectrometry, when allied with an array of biotechnological, metabolomic and chemical techniques, can provide feasible solutions in both developed and developing countries.

Within this framework, a coordinated research project on “Food Traceability and Authenticity through Isotope Ratio Techniques” is planned to commence in 2010. The project will bring together research institutes in up to 10 developing countries, with several developed countries acting as advisors. Stable isotope measurements are also currently being investigated to provide information on the spread and epidemiology of transboundary diseases, such as avian influenza, which impact on food safety and trade as well as animal and human health.

## Investigating the Region-of-Origin of American Milk Using Stable Isotope Analysis

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### POSTER ABSTRACT

Americans dine at a continental table, consuming foods and beverages produced in non-local (to the consumer) regions of the USA. The complexity of the distribution systems used in the modern human food chain presents unique challenges to food tracking and authentication. Recent advances in stable isotope analysis at natural abundance levels make it possible to investigate the region-of-origin claims of many food and fiber items. The stable isotope ratios of hydrogen ( $\delta^2\text{H}$ ) and oxygen ( $\delta^{18}\text{O}$ ) within the global water cycle vary across continents, with decreasing values from low-latitude, low-elevation coastal regions towards inland, high-latitude mountainous areas. Because plants and animals incorporate local water isotopes, stable isotope analysis can provide quantitative information about the region-of-origin of different food items.

Milk is an example of a food with widespread and multiple origins within the USA. The ability to determine the region-of-origin for milk and other dairy products would be an indispensable tool for today's food industry. To explore links between a dairy product's purchase location and region-of-origin, we collected milk from 26 outlets of a national chain fast food restaurant located in 17 states in the USA. We also purchased milk from a traditional grocery retailer (supermarket) in these same cities. Water extracted from the milk was analyzed for its  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values. Additionally, we collected and analyzed tap water samples from each city.

The  $\delta^2\text{H}$  values of water extracted from restaurant milk ranged from -107 to -27‰ and  $\delta^{18}\text{O}$  values ranged from -13.2 to -4.0‰. Both  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values of water extracted from restaurant milk samples were positively correlated with local tap water ( $r^2 = 0.29$  and  $P < 0.01$ ;  $r^2 = 0.28$  and  $P < 0.01$ , respectively). We observed three distinct groups within the restaurant milk data set. The group with the lowest mean  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  water values ( $-105 \pm 1\text{‰}$  and  $-12.9 \pm 0.2\text{‰}$ , respectively) was comprised of samples collected in interior states (e.g., NV, UT, and WY) where we also measured low tap water values. The group with the highest mean  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  extracted water values ( $-31 \pm 3.4\text{‰}$  and  $-4.7 \pm 0.4\text{‰}$ , respectively) included samples collected in TX and east coast states, where tap water values were also high.

In contrast, water extracted from supermarket milk had  $\delta^2\text{H}$  values that ranged from -102 to -16‰, while  $\delta^{18}\text{O}$  values ranged from -12.3 to -3.6‰. Stable isotopes of water extracted from the supermarket milk samples were also positively correlated with local tap water ( $r^2 = 0.63$  and  $P < 0.0001$  for H;  $r^2 = 0.56$  and  $P < 0.0001$  for O). Similar to the restaurant samples, the lowest  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  extracted water values were measured from a milk sample collected in WY, where we collected tap water samples with low  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values. The highest  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  extracted water values were from a sample collected in TX, where we also measured high tap water values.

We did not observe three distinct groups, as in the restaurant milk data set; the majority of supermarket milk samples fell within one large data cluster.

While the stable isotope ratios of water extracted from both restaurant and supermarket samples were significantly correlated with local tap water, the presence of distinct groups among the restaurant samples suggests large-scale regionality in the production of milk distributed by a national chain fast food restaurant. On the other hand, the absence of distinct groups among the supermarket milk samples suggests a closer link between region-of-production and region-of-purchase. Thus, this dataset highlights both the usefulness of the stable isotope technique and points out the real differences in the distribution systems used for supplying milk to the food industry: a regional system for restaurants and a more local system for grocery retailers.

# **Spectral Fingerprints and Analysis of Variance-Principal Component Analysis for Chemical Differentiation of Botanicals Species**

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## **POSTER ABSTRACT**

Spectral fingerprinting (analysis of solids or extracts with no prior separation) in combination with chemometric analysis can be used to detect differences in chemical composition arising from genetic and environmental factors. We have obtained fingerprints using UV, IR, NIR, and MS techniques. We examined 15 botanical materials and determined that discrimination between genera is readily accomplished. Three in depth studies with 1.) *Ginkgo biloba*, 2.) *Scutellaria* and *Teucrium*, and 3.) *Panax ginseng* and *Panax quinquefolius* demonstrated that it was also possible to discriminate on the basis of species, growing location, and processing of materials. Spectral processing using analysis of variance-principal component analysis provides score plots that are easily interpreted visually and statistically. To date, spectra obtained with UV spectrophotometry have proven to be, statistically, as informative as mass spectra.



## **Food Commodity Intake Database (FCID): Its Utility in Quickly Identifying Foods Which May Contain Ingredients of Interest**

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### **POSTER ABSTRACT**

The U.S. EPA's Office of Pesticide Programs (OPP) in its conduct of dietary risk assessment for pesticides is most interested in consumption of food *commodities* in the form of ingredients such as beef, wheat flour, tomato sauce, soybean oil, etc. rather than foods "as eaten" (e.g., lasagna). While the USDA's Continuing Survey of Food Intake by Individuals (CSFII) provides extensive, statistically-representative information on food consumption for approximately 22,000 surveyed individuals, information on *food commodity* commodity with foods expressed in terms of ingredients is not present. As a result, the Food Commodity Intake Database (FCID) was developed as a cooperative effort by USDA and the Office of Pesticide Programs for use by EPA and other organizations when conducting exposure assessments for food ingredients. FCID was developed using reported intake data from CSFII 1994-96/1998 which was translated to a food commodity basis: more specifically, the FCID database uses recipe files to break down all foods into their agricultural commodity equivalents. For example, what is reported by a CSFII survey respondent as consumption of a 1/8 slice of a 12" pepperoni pizza would be converted in FCID to gram amounts of wheat flour, beef, milk, tomato sauce, soybean oil, etc for that respondent. Of course, all the demographic, geographic, socio-economic, racial/ethnic and other information reported for that respondent in CSFII would also be available in FCID. FCID would also contain additional information with respect to the cooked status and food form (e.g., fresh, canned, baked, frozen, etc) of the ingredients which is not reported in CSFII. In total, commodity intakes in FCID are expressed as grams consumed per kilogram of body weight per day for over 500 commodities derived from more than 6 000 different foods and beverages reported in the CSFII.

Although FCID is primarily used by US EPA's Office of Pesticide Programs to evaluate dietary exposures to pesticides, the utility of this database could extend toward other areas such as investigating ingredient-driven food poisoning outbreaks in which a contaminated ingredient affects many different products that are distributed through various channels and consumed in various settings. Specifically, the FCID database permits finding commonalities in consumption on an ingredient ("food commodity") basis that may be hidden but extremely important in investigating and tracking a widespread ingredient-based outbreak. Thus, the data contained in FCID can assist in making a connection between the thousands of foods that may be reported consumed by individuals and the 500 or so fundamental constituent ingredients expressed as food commodities.

EPA's OPP is currently updating this database to include the more recent NHANES (National Health and Nutrition Examination Survey) consumption data as determined by the USDA's "What We Eat in America" program. This updated database is expected to cover food commodity consumption through 2006 and should be freely available to the public in 2009.

## **DART-MS for Rapid Characterization of Food Contact Materials**

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### **POSTER ABSTRACT**

Direct analysis in real time-mass spectrometry (DART-MS) is an emerging atmospheric ionization technique which has been used to analyze for a wide range of compounds in liquid and solid matrices. Most often the analysis is performed without sample extraction and only limited sample preparation, saving valuable time and resources. We have been evaluating the application of DART-MS to the identification of food contact substances (fluorochemical grease-proofing agents), and the determination of additives (UV stabilizers and plasticizers) and contaminants (diisopropyl naphthalene) often found in food contact materials. When analyzing solutions of fluorochemical grease-proofing agents, DART-MS produced characteristic ions for all agents analyzed. These characteristic ions can accurately identify the type of grease-proofing agent found on commercial products. Additionally, the direct analysis of food contact polymers showed ions characteristic to the additives, but not always the molecular ions. For both the grease-proofing agents and polymer additives, ion source conditions, sample introduction parameters, and mass spectrometric conditions affected accurate detection and identification of the analytes. Changes to these operating conditions usually produce “false negative” results. Therefore, while DART-MS sample preparation may be straightforward, reliable DART-MS data collection and interpretation can be challenging. We will focus on operational parameters of both the DART source and the mass spectrometer and their impact on determining the presence of additives in food contact materials. We will discuss effects of DART source positioning, operating voltages, temperatures and gas flow rates, sample positioning and introduction, and mass spectrometer scan rates and inlet conditions.

## Molecular Typing of *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* after Temperature and pH Stresses

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### POSTER ABSTRACT

The genus *Yersinia* consists of three human pathogenic species; *Y. pestis* the causative agent of plague and food borne pathogens, *Y. enterocolitica* and *Y. pseudotuberculosis*. *Yersinia* can be easily contaminated intentionally or non-intentionally with a variety of food matrices. It has been frequently isolated from different foods like milk, chocolate milk, dairy cream and other food items. Adaptation of *Yersinia* to temperature and pH shifts revealed significant phenotype variations such as in virulence, nutrient requirements, enzyme activity, capsule formation, and pigment production. The objective of this work was to determine and characterize genomic profile alterations associated with temperature and pH stresses.

Orange juice, undiluted (pH 3.9) was adjusted to pH 4.02 (diluted with double distilled water 1:4) and pH 7.0 using 1N NaOH was inoculated by both *Yersinia* 4°C, mimicking the species. Samples were then incubated at a temperature of normal storage temperature for 3 hrs, 24 hrs, 3 days and 7 days. For temperature stresses, milk was inoculated and subjected to different temperature ranges (-80°C, -20°C, 4°C, 10°C, room temperature, 37°C, 67°C for 30 min, and 72°C for 15 seconds). Real time PCR assay and pulsed field gel electrophoresis (PFGE) were adopted to study the gene amplification patterns. The virulence gene targeted by real time PCR assay to *Y. enterocolitica* were *ail*, *ystA* and for *Y. pseudotuberculosis* were *inv*, *ypI*, *Wbyx* and *manA*. The genes are responsible in the attachment and pathogenicity. The restriction enzymes used in PFGE were *FseI*, *NotI*, *SpeI* and *XbaI*. The electrophoretic restriction fragments, obtained were analyzed from scanned photographs.

*Y. enterocolitica* inoculated in milk and stored at 37°C didn't amplify *ystA* gene, whereas in other treatment groups the gene was amplified. The genomic profile of both strains was assessed after incubations using pulsed field gel electrophoresis. *Y. pseudotuberculosis* showed different pulsotype in the genetic profile after 7 days of incubation in a 1:4 diluted orange juice, generated by using restriction enzyme *FseI*. *Y. pseudotuberculosis* inoculated in milk and incubated at room temperature revealed different PFGE typing after *XbaI* and *SpeI* digestion.

The generated information and further study on genome profile diversity *vis a vis* environmental stresses will be important to improve the diagnostic protocol, and better preparedness to ascertain the food safety and quality.

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# Internal Traceability System Database Modeling for a Grain Elevator

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## POSTER ABSTRACT

Consumer experiences with food safety issues combined with a growing demand for high quality food and feed products have increased interest in systems to aid in food traceability efforts. Implementation of a traceability system in the bulk grain supply chain is a complex task. Food safety and traceability laws exist in several countries but traceability is important for several reasons other than just a legal obligation. These reasons include efficient response to food security threats, documenting chain of custody, documenting production practices, meeting regulatory compliance, and analyzing logistics and production costs.

According to The Bioterrorism Preparedness and Response Act of 2002, in case of a food related emergency, a company should be able to produce records of the product, the related suppliers and customers based on one step up and down in the supply chain within a 24 hour time frame. Effective supply chain traceability can only be achieved with a combination of internal traceability and chain traceability.

The purpose of this work is to design a traceability systems database model for internal traceability at a grain elevator. Different lot-activities take place as the grain moves through the supply chain from the farm to the consumer. Grain elevators handle bulk commodities marketed against generic grade standards that are based on physical attributes. At an elevator, grain lots (inbound deliveries) are commingled to meet buyer specifications, and lot identity is not maintained. As a result, an outbound shipment to a customer can contain grain from many sources. In a food related emergency, it would be almost impossible to trace the problem source and to track other affected lots. This process is very time intensive, increases the recall costs, and can lead to a tainted brand name. This problem can be mitigated by an efficient internal record keeping system that would document all grain activities, including movement, aggregation, segregation, transformation and destruction.

A relational database management system is developed for internal traceability at a grain elevator. This system stores all the information related to grain lots and can be queried to retrieve information related to incoming and outgoing lots. This system can be used to trace back the source of a given lot and track forward information related to the shipped lots. Following the RDBMS approach for recording all grain movements is an efficient way to link the incoming and outgoing grain lots at an elevator.

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