Summary of the ACS Symposium on Advances in Food Allergen Detection

ABSTRACT: A symposium titled "Advances in Food Allergen Detection" was held at the 243rd National Meeting of the American Chemical Society (ACS) in March 2012 in San Diego, CA, and was sponsored by the ACS Division of Agricultural and Food Chemistry. The purpose of the symposium was to convene the leaders in the food allergen analysis field for presentations on, and discussions of, the state of the art, new developments, and critical challenges in the detection and quantitation of allergenic proteins in foods. Twenty-five presentations were delivered by speakers representing academic, government, and industrial institutions in 10 countries. The presentations covered all aspects of food allergens, including a historical progress review, regulatory policies, clinical practices, food-processing effects, food production equipment cross-contamination and cleaning, and the performance of several food allergen analytical strategies and technologies. This paper is intended to provide a brief summary of the presentations as well as a record of the proceedings of the symposium, which was deemed a great success in advancing food allergen analysis.

Food allergies affect 1–3% of the U.S. population,[1–3] and there is evidence that the incidence is increasing, especially in children.[4–6] The food supply is increasingly complex due to an ever-widening variety of ingredients, compositions, and processing methods, as well as more suppliers with global distribution. These facts result in a significant challenge for the food industry to provide, and food safety regulatory agencies to ensure, accurate food allergen labeling. Success in meeting this challenge depends, to a great extent, on the performance of food allergen analytical methods. Research in the development, validation, and application of food allergen analysis has advanced rapidly and expanded in new directions over the past few years. To assess the progress in this field, we organized a three-day symposium on Advances in Food Allergen Detection, which was held at the 243rd National Meeting of the American Chemical Society (ACS) in March 2012 in San Diego, CA, and was sponsored by the ACS Division of Agricultural and Food Chemistry.

The objective of the symposium was to provide a forum for the leaders in the field to report and discuss food allergen analysis from regulatory, clinical, and analytical biochemistry perspectives with emphases on methods research status, new developments, and knowledge gaps. The symposium consisted of five sessions with a total of 25 presentations delivered by speakers who represented academic, government, and industrial institutions in 10 countries. The first session, titled "General Aspects of Food Allergens", featured presentations that provided an overview of food allergen research history, food labeling policies, and clinical issues, which established a scientific foundation, regulatory environment, and human health motivation for the food allergen analysis research presentations in the subsequent sessions. The keynote presentation, given by Stephen Taylor (University of Nebraska, Lincoln, NE, USA), provided a historical perspective on the progress that has been made from the late 1980s to the present with respect to allergen detection methodologies. Susan Wasserman (McMaster University, Hamilton, ON, Canada) presented a comprehensive review of deficiencies in knowledge and clinical practice in anaphylaxis management, which point to a need to develop better strategies for preventing, treating, and managing food allergies. Regulatory perspectives on food allergens in the United States and Canada were discussed by Steven Gendel (FDA, College Park, MD, USA) and Michael Abbott (Health Canada, Ottawa, ON, Canada), respectively. These talks provided overviews on both labeling regulations for food allergens in the United States and Canada and tools that are being used by FDA to monitor and evaluate allergen-related recalls. In the final talk of the first session, Bruno De Meulenaer (Ghent University, Ghent, Belgium) described studies that illustrated the lack of robustness of receptor-based analytical assays for food allergen detection and the need for alternative methods.

The focus of the second session, titled "Rapid Methods for Detecting Allergens", was on methods based on immunochemical and DNA-based strategies, which long have been the industry standard methods and for which there is extensive experience. There have been significant advances in these methods including an increased number of commercially available enzyme-linked immunosorbent assays (ELISA) and polymerase chain reaction (PCR) kits, a wider array of detectable allergens, improved performance, and multiplexed formats. Commonly noted important method aspects were efficient sample preparation, appropriate controls and standards, consideration of antibody cross-reactivity, and the effects of food processing on allergen analytes, which necessitate optimization of the method for the specific allergen/food matrix application. The initial talk of this session was given by Sabine Baumgartner (BOKU, Tulln, Austria), who provided an overview of the development and performance of immunochemical methods for detecting protein allergens in foods. The development and application of an ELISA method for detecting a specific toxic peptide derived from gluten (gliadin) was discussed by Donna Houchins (Romer Laboratories, Tulln, Austria). Anne Eischeid (FDA, College Park, MD, USA) summarized research aimed at a quantitative real-time PCR assay for detection of shrimp and blue crab crustacean shellfish allergens. Multiplexed immunochemical assays and multiplexed

DNA-based methods, which allow the rapid, simultaneous detection of multiple protein allergens, were described, respectively, by Eric Garber (FDA, College Park, MD, USA) and Askild Holck (Nofima, Aas, Norway).

The next two sessions focused on alternative detection methods, mainly those based on mass spectrometry (MS). Food allergen protein analysis by MS is a rapidly emerging strategy, the development of which is similar to that of a human biomedical research initiative aimed at protein biomarker discovery for disease diagnostics, with the analogous focus on food allergen biomarkers. The presentations highlighted the analytical advantages of this approach, which include molecular specificity, identification of modified allergen proteins, high detection sensitivity, quantitation, and the capability for highly multiplexed analysis, although with greater cost, analysis time, and technological complexity compared with immunochemical and DNA-based methods. Talks given by Linda Monaci (ISPA, Bari, Italy) and Petra Lutter (Nestle, Lausanne, Switzerland) focused on the use of LC-MS/MS methods for detecting peptide markers of milk proteins in a variety of different food matrices (wine, infant foods, and breakfast cereals). An LC-MS/MS method for the simultaneous detection of seven allergens (milk, egg, soy, peanut, hazelnut, walnut, and almond) and how this method compared with ELISA methods were described by Bert Popping (Eurofins, Hamburg, Germany). Christine Hebling (FDA, College Park, MD, USA) discussed the characterization of peanut protein abundance changes and modifications as a function of thermal processing using an enhanced protein solubilization procedure and a sophisticated protein fractionation method, both combined with high-resolution MS analysis. Peter Scholl (FDA, College Park, MD, USA) described the use of intact, isotopically labeled α-S1-casein as an internal standard for LC-MS/MS quantitative analysis, as well as the evaluation of the effects of thermal processing on milk proteins in baked biscuits. Efforts at Health Canada on developing LC-MS/MS methods for measuring levels of hydrolyzed gluten in beer and other foods were summarized by Terry Koerner (Health Canada, Ottawa, ON, Canada). Scott Young (Dow Chemical, Midland, MI, USA) reported on the development of a novel LC-UV/MS assay for intact lipid transfer proteins in maize. The final presentation in the alternative methods sessions was given by Sabina Rebe Raz (RIKILT, Wageningen, The Netherlands), who described the development and performance of a biosensor based on imaging surface plasmon resonance with allergen antibodies and capable of rapid profiling of multiple allergens.

The presentations in the final session of the symposium, titled "Critical Challenges for Food Allergen Detection", focused on the challenges of food allergen analytical method standardization, validation, and harmonization across multiple laboratories in the wide variety of institutions and countries. The discussion emphasized the need for appropriate food reference materials, well-characterized pure allergen standards, and an understanding of the chemical fate of allergens in samples, with a distinction between allergen-spiked and -incurred matrices. Franz Ulberth (IRMM, Geel, Belgium) and Carmen Diaz (Eurofins, Hamburg, Germany) delivered overviews on the needs and current efforts to validate allergen detection methods and to identify reference materials that could be used to calibrate allergen detection methods. Approaches in Japan for validating ELISA methods for allergenic ingredients in processed foods were discussed by Shinobu Sakai (National Institute of Health Sciences, Tokyo,

Japan). The complex nature of food processing and production that increases the challenge of allergen detection was addressed by Joseph Baumert (University of Nebraska, Lincoln, NE, USA) and Tong-Jen Fu (FDA, Bedford Park, IL, USA), who provided overviews of how ELISA- and DNA-based methods for allergenic foods are affected by thermal processing methods (frying, baking, boiling, retorting, and UHT). The use of allergen surrogates or indicators for evaluating protein cross-contact/contamination during washing of fresh-cut vegetables was summarized by Barbara Kerkaert (Ghent University, Ghent, Belgium). The final presentation was given by Lauren Jackson (FDA, Bedford Park, IL, USA), who covered the approaches and challenges for detecting allergenic food residue in the food-processing environment.

Food allergen detection has advanced significantly in recent years, resulting in improved traditional methods as well as new strategies with promising potential. Several challenges remain, such as the need for a more thorough understanding of processing-induced food allergen chemistry and consequential analysis matrix effects, improved method reference materials, broader method validation and harmonization, and continuing improvements in analysis speed, sensitivity, selectivity, and simplicity. This research is crucial to enable complete and accurate food allergen labeling that provides food-allergic consumers with confidence in their choices of safe and healthy foods.

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Notes

The authors declare no competing financial interest.

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