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EDITORIAL

Lipidomics

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Lipidomics can be defined as a quantitative snapshot of all lipids determined in a biological system (cell, tissue, body fluid, or organism) at a given time. In fact, the term "all lipids" should be understood as many as can be detected, identified, and quantified by the selected analytical methodology, which clearly demonstrates the importance of advanced analytical methods for lipidomic analysis. The state-of-art methods in lipidomic analysis are based mainly on tandem and/or high-resolution mass spectrometry (MS) used either as stand-alone MS without a chromatographic separation (shotgun lipidomics) or with the liquid-phase separation technique [such as liquid-chromatography (LC/MS) or supercritical fluid chromatography coupling] because of the possibility to analyze a large diversity of lipid molecules differing in many physico-chemical properties (polarity, solubility, molecular weights, etc.) having concentrations over several orders of magnitudes. Lipids have numerous important roles in living organisms, and their concentrations can differentiate healthy versus disease states for several serious diseases, such as cancer, Alzheimer's disease, or cardiovascular diseases to mention just a few of them. In the past, the lipidomic community was divided into two antagonistic groups accepting either LC/MS or shotgun MS, but nowadays most researchers have recognized the potential of both approaches for accurate and comprehensive quantitative information on the lipidome. Recently, MS imaging has been introduced as the third platform for lipidomic analysis because of its capability to describe the spatial distribution of lipids and other molecules in tissues, which contributes to a better understanding of dynamic processes in the organism. Future developments can be expected, for example, in MS imaging in lipidomics leading towards single-cell analysis, focus on very fine structural information (lipid enantiomers, regioisomers, and other types of isomerism) using dedicated LC/MS methods, better biological understanding of lipid functions in heath/disease conditions, lipid biomarker discovery, etc.

The diversity of lipids occurring in biological systems requires reliable analytical methods for their quantitation. Lipidomic studies typically bring about the necessity to quantify lipid species over multiple lipid categories, classes, and subclasses present at different concentration levels. Lipid classes can be differentiated by chromatographic separation using hydrophilic interaction liquid chromatography, normal-phase chromatography, or by characteristic scan events using triple quadrupole instruments, such as precursor ion or neutral loss scans. The reliable quantitation requires the use of at least one internal standard per lipid class, but differences in relative responses within the class should be considered as well because they are not negligible. The price or availability of lipid standards could be a serious problem, especially in case of less common or more complex lipid classes, so some simple approaches have been introduced based on the relative quantitation, which may be sufficient for certain biological questions focused just on relative changes of studied lipids. The typical task for lipidomics or, in general, for any omics techniques is the search for disease biomarkers. Unfortunately, mainly potential lipid biomarkers have been proposed so far and very rarely—if at all—lipid biomarkers have provided a convincing statistical relevance and robustness to be really introduced in clinical practice. Hopefully, significant instrumental and

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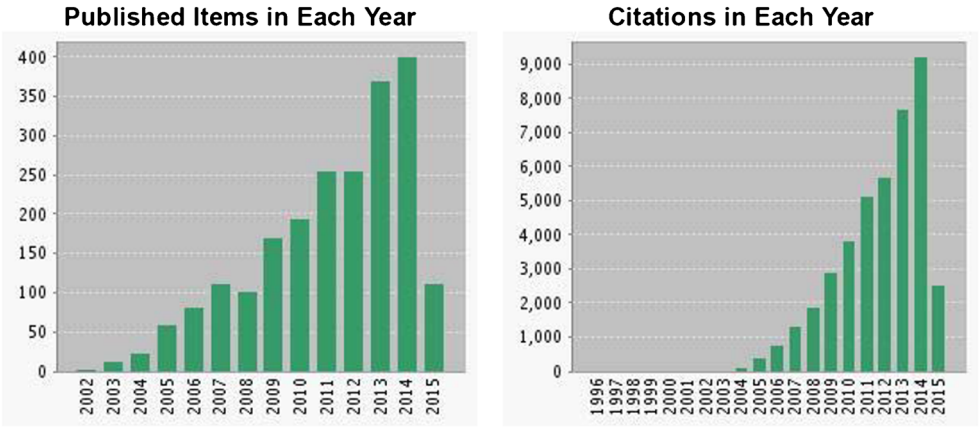

Fig. 1 Number of scientific papers and citations containing topical keywords "lipidomic" or "lipidomics" according to a Web of Science search on April 24, 2015

methodological improvements together with better statistical and bioinformatic tools can change this situation in the near future and valid lipid biomarkers will be discovered.

The first paper containing the keywords "lipidomic" or "lipidomics" occurred in 2002, while more than one paper has been published daily in the last 2 years (Fig. 1). The large interest in lipidomic research can be also illustrated by established lipidomic conferences, such as Lipid MAPS Annual Meeting, European Lipidomic Meeting, International Singapore Lipid Symposium, Australian Lipid Meeting, and numerous other lipid-related conferences organized worldwide. The special lipidomic sessions are organized in major analytical and bioanalytical conferences dealing with mass spectrometry and chromatography. It is just the right time for the preparation of the Topical collection on Lipidomics published in *Analytical and Bioanalytical Chemistry*, which presents 20 research papers and two critical reviews covering all major aspects of the lipidomic analysis and shows possible future directions. I would like to thank all authors for their careful preparation of manuscripts, and reviewers for their insightful comments on individual papers. I hope that this topical collection will serve as a valuable source of information on the state-of-art in lipidomic analysis for newcomers to the field as well as experts.

Michal Holčapek is Professor and Head of Mass Spectrometry Group at the Department of Analytical Chemistry, University of Pardubice. His research interests are mass spectrometry and its coupling with liquid-phase separation techniques with the specialization on lipidomic analysis. In the last few years, he has focused on lipidomic clinical applications with the goal to find lipid biomarkers for some serious human diseases. He is author or co-author of over 110 papers in international peer-reviewed journals with an H-index of 31; member of editorial boards of Analytical and Bioanalytical Chemistry, Analytical Chemistry, Lipids; guest editor of special volumes on Mass spectrometry – innovation and application (Journal of Chromatography A, 2010 and 2012); co-editor of a Virtual issue on Lipidomics (Analytical Chemistry, 2014) and co-editor of the book Extreme Chromatography: Faster, Hotter, Smaller (American Oil Chemical Society, 2011).