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carbohydrate analysis

*high performance liquid chromatography
and capillary electrophoresis*

edited by

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Preface

Carbohydrates and glycoconjugates are very important biological species involved in many life processes. Because of the structural diversities and the multilateral importance of carbohydrates, the analytical methodologies used to analyze them continue to evolve. Over the last two decades, high performance liquid chromatography (HPLC) has been extensively used in the separation and isolation of carbohydrate species, and as a result a large number of HPLC methodologies have been developed to suit the analysis of a wide variety of carbohydrate and glycoconjugate samples. More recently, the many sound potentials of high performance capillary electrophoresis (HPCE), including its high resolving power and high separation efficiencies, have been explored in the areas of glycoconjugates and carbohydrates. The objective of this book is to provide a comprehensive review of carbohydrate analysis by HPLC and HPCE by covering the separation methods for all classes of carbohydrates including mono- and disaccharides; linear and cyclic oligosaccharides; branched oligosaccharides (e.g., glycans); polysaccharides; glycoconjugates (e.g., glycolipids, glycoproteins); carbohydrates in food and beverage; compositional carbohydrates of polysaccharides; carbohydrates in biomass degradation; etc.

The book is well balanced in terms of its content. Among other things, this book (i) covers the fundamental aspects of the various modes of HPLC and HPCE that are currently applied to the analysis of carbohydrates, (ii) discusses analytical and preparative separations, (iii) describes the principles of detection and quantitative determination of carbohydrates by HPLC and HPCE, (iv) reviews sample preparations and (v) provides an ample amount of important applications. These various topics were discussed and reviewed by many outstanding contributors. Their efforts, collaboration and dedication have made the production of this book possible.

The content of the book is organized into three major parts. The first part consists of one chapter (Chapter 1) that reviews enzymatic and chemical methods currently utilized in sample preparation. The importance of part I, *The Solute*, stems from the fact that most often it takes more time to prepare a given carbohydrate or glycoconjugate sample than to analyze it.

The second part is on *Analytical and Preparative Separations*, and encompasses a series of 8 chapters. Seven of these chapters (Chapters 2 through 8) describe in detail the different HPLC and HPCE systems currently used in analytical separations of carbohydrates and glycoconjugates. An additional chapter (Chapter 9) reviews the various aspects of semi-preparative and preparative HPLC for the isolation of small and large quantities, respectively, of intact and pure

carbohydrates and glycoconjugates. Interactive modes of chromatography based on nonspecific interactions, e.g., reversed-phase, hydrophobic interaction, hydrophilic interaction and ion-exchange, are treated first (Chapters 2 through 5) followed by Chapter 6 on biospecific interaction (affinity) in chromatography and capillary electrophoresis. Noninteractive chromatography or size-exclusion chromatography is reviewed in Chapter 7. Each of these chapters discusses the underlying retention of carbohydrates, the mobile and stationary phases, the operational aspects and applications of each branch of HPLC to carbohydrates. Chapter 8, which is on HPCE, provides the reader with (i) an overview of the fundamentals of capillary electrophoresis (ii) an in-depth treatment of the electrophoretic system that is useful for the separation of a wide variety of carbohydrates species and related compounds and (iii) a comprehensive review of HPCE methodologies and applications.

The third part is on *The Detection*, a topic as important as the separation part. In general, carbohydrates lack chromophores or fluorophores in their structures. This inherent property of carbohydrates causes difficulties in determining these species at low levels. The book contains a series of 8 chapters (Chapters 10 through 17) covering in detail the different direct and indirect detection methods that have been introduced for the sensitive detection of carbohydrates. The various detection topics include electrochemical, refractive index, mass spectrometry, light scattering, chiroptical, pre- and post-column derivatization reactions for optical detectors (UV, Vis and fluorescence), post-column enzyme reactors, indirect UV and fluorescence detection, low wavelength UV and other miscellaneous modes of detection. Each of these chapters discusses the basic principles, advantages and limitations, and applications of the particular detection technique.

The book is useful for a wide audience including separation scientists, analytical chemists and biochemists, carbohydrate chemists, glycoprotein and glycolipid chemists, molecular biologists, biotechnologists, etc. Also, the book can be a useful reference for both the experienced analyst and the newcomer as well as for the users of HPLC and HPCE, undergraduate and graduate students, postdoctoral, etc.

As editor of, and contributor to, this book, I am very grateful to the United States Department of Agriculture for the financial support of my research program. Also, I would like to express my warmest appreciation and thanks to my wife, Lupis, and children, Miriam and Edward for their support, encouragement and understanding during the months spent on editing, and also writing part of, this book.

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