Preface

Food toxicology is deeply rooted in the history of civilization. In their quest for food, our ancestors must have attempted to eat a variety of plants and animals and soon recognized that there were harmful as well as beneficial effects of their consumption. The selection by nomadic humans of only a handful of plant species for domestication and cultivation from the estimated 350,000 species of plants documented in the annals of botany and plant sciences is certainly not a chance occurrence. Gathering peoples perhaps accidentally found the very species that were the most predisposed to domestication, as well as the most well-suited to fulfill human nutritional requirements. Our experience throughout history has taught us much about how to avoid injury from consuming natural products. We now know which products not to eat under any circumstances, which can be eaten under some circumstances, and how to process other products to render them safe for consumption.

History has thus taught us how to classify all substances into two classes: those that are safe and those that are harmful or poisonous. Such a classification, however, is not warranted in a strict scientific sense, primarily because a strict line of demarcation classifying and separating beneficial and harmful chemicals cannot be drawn, and because the degree of harmfulness of any compound is essentially related to the amount consumed. In fact, over 400 years ago Paracelsus pointed out that "all substances are poisons; there is none which is not a poison. The right does differentiates a poison and a remedy." Indeed, the entire concept of toxicity needs to be evaluated from the viewpoint of a risk/benefit concept associated with the consumption of any given material. There is no such thing as absolute safety.

Our daily lives are still shaped by our acceptance of numerous acceptable risks. Nearly everything we consume, including salt, sugar, starch, fat, protein, some minerals and vitamins, and even water, has a harmful effect when consumed in high enough concentration. Hazardous substances associated with food include toxic or antinutritive compounds that are naturally present in plants and animals; toxins that are produced ruing processing; incidental contaminants such as pesticides, antibiotic drug residues, and environmental pollutants; and foodborne pathogens. However, this does not mean that food is hazardous to human beings. Toxic components in foods—although they should indeed be minimized—are inevitable hazards of living. A substance that is considered to be toxic/antinutritive has a more or less pronounced capacity to induce deleterious effects on an organism when tested by itself in certain doses. This does not always happen under usual dietary conditions. We consume many toxic substances in our normal diet every day without showing any signs of intoxication. This is probably because natural toxicants usually exert their effects only when other potentiating substances are available. Also, the concentration of these compounds occurring naturally in food is often so low that the item must be consumed in extraordinarily large amounts daily over a prolonged period for intoxication to occur.

Similarly, most toxic effects of potentially hazardous chemicals are not additive. In fact, antagonistic reactions that make some ingredients interfere and reduce the toxic

effects of other components are not unusual. Thus, many natural products that are common in the human diet have found wide acceptance not because they are free of toxic substances, but because they do not contain enough toxins to be harmful when consumed in reasonable quantities as part of a balanced diet—or because cooking or another process eliminates their toxic activity. In the vast majority of instances, our food supply is quite wholesome. In the unfortunate incidents when some link(s) in the food production, processing, and distribution scheme fail(s), such foods, when consumed, have produced adverse toxic responses that vary in severity from insignificant to fatal.

As compared with naturally occurring toxic/antinutritive compounds in the human food chain, the situation is quite different with microbial contaminant of foods. In fact, perhaps the greatest damage, in terms of both mortality and morbidity worldwide, can be directly attributed to microbial contamination. Although changes and improvements in food processing operations as well as in sanitary practices have contributed to an important increase in the life span of humans in the last century, these significant improvements are now challenged by the appearance of microbes resistant to multiple antibiotics (e.g., *Salmonella* sp. and the emergence of new bacterial and fungal pathogens (e.g., *Campylobacter, Listeria, E. Coli* 0157:H7, fumonisins). In the United States alone, between 6.5 million and 81 million cases of foodborne illness and as many as 10,000 related deaths from seven major foodborne pathogens occur each year, costing $6.6 billion to $37.1 billion in economic losses. The situation is grim even in developing countries where water-borne and food-borne diseases such as cholera, jaundice, and diarrhea—which impair human health to a great degree, and therefore the body's efficiency of food absorption—are perhaps more important factors affecting human health than many naturally occurring toxic/antinutritive compounds in the food chain. These effects are further magnified by a shortage of such basic commodities as a clean and safe supply of drinking water and adequate food for subsistence—this alone was good enough motivation for me to undertake this project.

The primary aims for *Handbook of Food Toxicology* are twofold. (1) to provide basic coverage of the principles of toxicology relevant to food science and nutrition, and (2) to provide the latest information on various toxic and microbial hazards associated with modern-day foods. This book is divided into two parts that comprise a total of 18 chapters. The first part, consisting of Chapters 1–6, deals with the science and principles of toxicology, manifestations of toxic effects, biotransformations of toxicants relevant to food science and human nutrition, and some of the regulatory and QA/QC issues. Chapters 7 through 18 describe the basic aspects of toxicity associated with commonly occurring dietary components and substances (naturally occurring, intentionally added, or incidental), as well as those associated with microbial contamination of foods. A basic understanding of the principles behind the occurrence of microbes in the food chain and their toxicity or toxic mechanisms not only allows us to appreciate the complexity of our food supply but is essential for developing newer and safer food production, processing, handling, and distribution technologies.

No single food toxicology book can cover all aspects of the toxicity and safety of the myriad of food used in many different ways by humans worldwide. Indeed, volumes and monographs are available on the topic of practically every chapter in this book, and even on those of many of the chapter sections. Every effort, however, was made to cover important toxic hazards associated with food consumption. For some toxins, only historical viewpoints are described, since research during the past decade on many of these compounds (e.g., flavonoids, phytates, antioxidants) has shown several positive health benefits associated with their consumption as part of a normal, well-balanced diet. In contrast, in-depth coverage is provided on microbial toxins and food pathogens, since these appear to be the predominant causes of morbidity and mortality associated with our food supply. Hopefully, this book represents a compromise between the historical views associated with the traditional, well-known toxic components found in our food supply and the exciting new developments occurring on several other fronts, especially on foodborne infections and intoxications. It is my sincere hope that the information presented in this book will serve professionals in many disciplines, including agriculture, food science, nutrition, microbiology, toxicology, public health, medicine, and other health-related areas. Selected chapters can also be used as college-level teaching material.

Finally, it is inevitable in a book of this breadth that omissions, occasional errors, and lapses in the accuracy of interpretation will have escaped the detection of even the most assiduous proofreaders. I hope that any such mistakes are both minor and minimal, and I accept full and exclusive responsibility for them. I welcome comments and suggestions for improvement and for correction of any errors.

Sincere appreciation is extended to the editorial and production staff of Marcel Dekker, Inc., especially to Ms. Maria Allegra, Ms. Lila Harris, Ms. Katie Stence, Ms. Theresa Stockton, and Ms. Susan Thornton. Without their cooperation and tremendous patience, this book would

never have been written. I gratefully acknowledge the original treatise in this field: the late Professor Jose M. Concon's groundbreaking two-volume *Food Toxicology*, published in 1988. In fact, the origin of this book can be traced back to his monumental work in the field. I am also greatly indebted to Professor D. K. Salunkhe of Utah State University, who first encouraged me to undertake this task.

Finally, no words will ever fully describe the untiring and continued support and encouragement provided by my wife Usha and daughter Maithili during the arduous task of putting together this book.

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