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Food Toxicity and Safety

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Foreword

It is indeed a great pleasure that I write this Foreword for the book entitled, *Food Toxicity and Safety* edited by Dr. Debapriya Mondal and A/Prof. Mohammad Mahmudur Rahman.

Globally, food safety due to chemical contamination is a biggest concern, which emerges as a new challenge to the scientific community. Contamination of food usually occurs due to the overuse of many chemicals in various industrial and agricultural applications, as well as food packing and pose a significant threat to human health. These chemicals are of great significance to both environmental as well as public health concerns. For a long time, production of chemicals was associated with heavy pollution of the environment and posed serious health risks to humans. It was estimated that about 350,000 chemicals substances have been registered for production and utilized over the past 30–40 years. Among them, many chemicals are persistent in nature such as per and poly-fluoroalkyl substances, heavy metals, pesticides, microplastics and nanomaterials. Due to the persistent nature of these chemicals, they last long time in the environment and cause significant concern. When crops are grown in historically contaminated lands, these chemicals are taken up by food crops and finally human are exposed through food consumption. Hence, there is a growing interest in understanding the behaviour, fate and transport, exposure pathways of such chemicals, which are utmost important to develop potential mitigation strategies to reduce exposure from food contamination and protect public health.

I have been fortunate to work with both editors, who are highly knowledgeable and bring vast experiences on food contamination with emerging pollutants, human exposure and their potential mitigation strategies. This book is an example of their outstanding scholarly contributions in this research field.

The book *Food Toxicity and Safety* is a timely and useful contribution in bringing the current views of experienced researchers on food contamination, exposure science and food safety. This book examines a diverse range of contaminants across food types, reviews international regulations for management of food hazards and may throw light on overall food safety and be a guide for agricultural managers, policymakers, researchers, and practitioners.

I extend my sincere appreciation to the editors and all authors of each chapter for their contributions and sharing their visions on this crucial topic "food contamination with chemical pollutants and food safety". I hope that the research outlined in this book will attract reader's curiosity. I believe much efforts need to be directed to mitigate this challenging issue but the collective efforts presented in this book will provide an understanding to enhance the awareness of food contamination with chemical pollutants and will inspire all of us to contribute in reducing chemical exposure to humans from food, clean-up our planet, and finally save the future generations.

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Preface

Food with emerging and legacy chemical contamination is one of the major exposure pathways causing significant health issues and economic burden to the exposed populations. One of the greatest dangers to the security of nutritional intake is the unintended and undesirable presence of chemical contaminants regularly used in various agricultural and industrial applications. Accumulation and uptake of toxic pollutants are now well-established concerns, which constitute a major risk to all living beings. Both inorganic and organic pollutants enter the food chain due to various reasons including human led contamination of naturally occurring elements, like when crops are grown in contaminated agricultural lands. For example, the presence of arsenic in soil and irrigation water resulting in accumulation in crops. Also, anthropogenic contamination includes pesticide or heavy metals accumulation in food crops due to its widespread use. Thus, understanding the impact of contaminants exposure from food components is crucial and research on reducing exposure from food is critical. With increasing global food demand, it is an important responsibility of all growers, regulators, distributors, and consumers to ensure food safety.

Among the 17 SDGs, Goal 3 seeks to ensure healthy lives and promote well-being for all at all ages. In addition, Goal 12 seeks to ensure sustainable consumption and production patterns. As the book is designed to reduce human exposure to chemical contaminants via food consumption, this book supports SDGs 3 and 12. In this book, we have accumulated chapters on food safety issues with different contaminants across the globe to increase the public awareness on this topic. Additionally, management practices of food contamination are essential especially for developing countries for sustainable food production and food safety which has also been addressed in few of the chapters.

In the first part of this book, we have provided research on the current challenges in food contamination, with special reference to emerging contaminants particularly pesticides residues and other chemical contaminants such as PFOS, nanoparticle, micro- and nano-plastics along with its impacts and regulatory issues. This part consists of six chapters covering the related topics. The first chapter "Mitigation of Contaminants in Foods: Pesticide Residues, Heavy Metals, Mycotoxins in Various Food Commodities and Strategies for Their Mitigation to Ensure Food Safety"

discusses the multiple food contamination issues including heavy metals, pesticides, mycotoxins etc. in various food commodities and the potential mitigation strategies to ensure food safety. The second chapter "Enhancing Food Safety: Processing Techniques to Remediate Pesticide Residues" reports how processing techniques impacts the pesticide residues in food and the possible remediation options. The third chapter "Pesticide in Food Chain: Impact and Regulation" discusses the impacts and regulations of pesticides in food chain issue. The fourth chapter "The Silent Threat of Perfluorooctane Sulfonate (PFOS): A Review of Its Global Impact on the Environment and Human Health" provides an overview of the silent threat of perfluoro-octane sulfonate (PFOS) impacts on the environment and human health. The fifth chapter "Nanoparticles in Crops: A Food Safety Issue" deals with nanoparticles in food crops and the sixth chapter "Microplastics and Nanoplastics Generated in Kitchen" with both micro- and nano-plastic particles generated in kitchen.

In the second part of this book consists of four chapters which cover existing knowledge on heavy metal contaminations in food chain from various countries. The seventh chapter "Heavy Metal Contamination and Human Exposure in Urban Environments and Foods" discusses the contamination of heavy metals and its exposure to human in urban environments and foods. The next chapter "Heavy Metals in Tumbes River—A Potential Risk for Health and Food Security in Northwest of Peru" discusses potential food security issues and health risks from Peru. In the following chapter "Rhizo-Immobilization of Cd by Plant Growth Promoting Rhizobacteria -A Review", the application of plant growth promoting rhizobacteria is discussed to mitigate cadmium stress in crops. The final chapter "Metal(Loid) Toxicity in Rice and Its Prevention" of this part covers the toxicity of metal(loid)s in rice and its prevention techniques.

The next part of this book (the third part) consists of four chapters which covers a range of investigations of arsenic exposure in food chain. Since arsenic is recognized as carcinogen element and exposure of arsenic to human mainly occurs through food and drinking contaminated water, this part provides an overall understanding of food contamination with arsenic along with its relevant risk estimations. The eleventh chapter "Assessment of Arsenic Exposure in Rice Grain with Special Emphasis on Its Bioaccumulation, Food Safety and Health Hazards from Lower Gangetic Plain of West Bengal, India" assesses the bioaccumulation of arsenic in rice grain and the health risk evaluation from an arsenic endemic area of West Bengal located in the lowest Gangetic plain. The next chapter "Occurrence of Arsenic in Food and Concerns for Human Health" provides an overview of arsenic in food and human health risk concern from India. In the following chapter "Deriving the Guideline Values of Arsenic in Soil for Rice Cultivation: A Way Forward to Ensure Food Safety", Mandal et al. discusses guideline value of arsenic in soil for rice farming which is crucial for regulatory perspectives. The final chapter "Food Toxicity Caused by Transfer of Arsenic Through Groundwater Irrigation: Perspectives from Africa" of this part covers the transfer of arsenic in food due to the irrigation with arsenic contaminated water from Africa.

We hope that this book will assist government and non-government personnel, policymakers, regulators, agricultural managers not only in developing countries

but also globally to tackle the food contamination issues. We hope that all chapters included in this book covering a wide range of exposure pathways of chemical contaminants from food and the related risks, would be useful to the wider scientific community and advance the knowledge and improve our understanding towards minimizing the exposure of pollutants and protect the environment and the public health.

This book unravels the existing knowledge gaps and future research directions on the food contamination with various emerging pollutants such as nanomaterials, pre and per fluoroalkyl substances, microplastics, toxic and carcinogenic elements including arsenic and their potential solutions in reducing human exposure. Leading scientists from all over the world contributed 14 chapters on various topics. We would like to extend our sincere thanks to all contributors for their relentless time and efforts to draft the chapter, proofread and format until publishing this book. Without their enormous support, it would not be possible to publish this book. We are grateful to all authors.

We would extend our sincere thanks to the Director General Dr. Amitava Bandopadhyay from the Centre for Science and Technology of Non-aligned and Other Developing Countries (NAM S&T Centre) for his enthusiasm and cooperation form the beginning till end of publication of this book. Special thanks to the Ms. Jasmeet Kaur Baweja, Senior Programme Officer, NAM S&T Centre for her interest and willingness to support, without which this book would never have been possible.

Finally, we would like to thank the UK Health Security Agency and the University of Newcastle, Australia for their support during editorial handling process.

The supports from the publisher (Springer Nature Singapore Pte Ltd.), especially from Dr. Loyola D'Silva, Executive Editor is greatly acknowledged.

London, UK
Callaghan, Australia

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Introduction

Food Safety is a global public health concern. In recent years, a number of extremely serious outbreaks of food borne diseases have occurred. Food borne diseases are widespread and pose a serious threat to human health in both developed and developing countries. In addition to the direct health consequences, food borne diseases can impose a substantial strain on the healthcare system and considerably reduce socio-economic growth and productivity. Bacteria, viruses, parasites and chemical substances are significant sources of food borne illnesses, though in many cases, it is difficult to link the effects with a particular food. Other sources of contamination of food are pesticide residues, mycotoxins and heavy metal(loid)s such as arsenic, lead, mercury and cadmium. Arsenic toxicity can be caused by contaminated groundwater used for drinking, food preparation and irrigation purposes. Toxin accumulation may also have severe consequences on human health, including mutagenic and carcinogenic effects, and physiological abnormalities. Safety of food is essential for human health. It also contributes to national food and nutrition security, support economy, trade and tourism and underpins sustainable development.

Climate change is expected to have considerable impacts on food safety and would likely to increase the risks from existing and emerging foodborne diseases through increase in extreme weather events, increase in air and water temperatures and changes in precipitation frequency and intensity.

Governments should make food safety a public health priority, as they play a pivotal role in developing food policy based on science-based standards established by the national food authorities, regulatory frameworks and implementing effective food safety systems. Food safety is a shared responsibility among different national authorities and requires a multi-sectoral, One Health approach, to be addressed in all the steps of the food chain.

Considering the importance of the subject, the *Centre for Science and Technology of the Non-aligned and Other Developing Countries (NAM S&T Centre), New Delhi* [An Intergovernmental Organisation] has brought out this book titled *Food Toxicity and Safety*. The book addresses the serious issue of food safety and toxicology and put food hazards and their associated human health risks in a true perspective.

The book comprising 15 chapters contributed by scientists and experts from countries including Australia, India, Peru, USA, UK and Zimbabwe and is divided into four parts, as listed below. The first part of the book deals with the challenges in food safety such as chemical contaminants, nanoparticles used in agriculture in the form of fertilizers and pesticides, microplastics, and organic pollutants like perfluoro-octane sulphonate and consist of six chapters. The second part is dedicated to heavy metal contamination in food such as high cadmium exposure and associated health risks and consists of four chapters. The third part of the book includes four chapters that highlight arsenic contamination in the food and food chain system—a serious threat to food security and human health. To summarize and provide a way forward, a chapter has been included in the fourth part of the book written by the Editors.

The book is an informative source of reference to the researchers and scientists working in the area of food science and technology, food regulators, policymakers, producers, healthcare providers, educators, consumers and other stakeholders.

The leading international research and academic publisher—Springer Nature, Singapore has published this Book. We are thankful to Dr. Loyola D'Silva, Executive Editor, Springer Nature, Singapore for his encouragement and kind support; and Mr. Sivananth S., Production Editor, Springer Nature, Chennai, India for handling all technical and administrative matters related to this publication. I am confident that our association with "Springer" would lead to more such valuable collaborative endeavours in the future.

We express our gratitude to Distinguished Laureate Prof. Ravi Naidu, Global Innovation Chair and Director of the Global Centre for Environmental Remediation (GCER), College of Engineering, Science and Environment, The University of Newcastle, Callaghan, New South Wales, Australia for writing the *Foreword* of this book in spite of his very busy schedule.

I would like to express my gratitude to the Editors: Dr. Debapriya Mondal, Senior Epidemiology Scientist, Environmental Epidemiology Group, Chemical and Environmental Effects Department, Radiation, Chemical and Environmental Hazards Directorate, UK Health Security Agency, London; and Dr. Mohammad Mahmudur Rahman, Associate Professor, Global Centre for Environmental Remediation (GCER), College of Engineering, Science and Environment, The University of Newcastle, Callaghan, New South Wales, Australia, for sparing their valuable time for technical editing of the papers published in this book. We are also thankful to our esteemed reviewers for their critical reviews of each chapter included in this book.

I will take this moment to express my sincere gratitude to Mr. Madhusudan Bandyopadhyay, Senior Adviser, NAM S&T Centre for his kind advice and guidance in various stages of planning and execution of this book project. Further, I am also thankful to Ms. Jasmeet Kaur Baweja, Senior Programme Officer, NAM S&T Centre for her significant contributions in coordinating this book project.

I also acknowledge the help and support received from the entire team of the NAM S&T Centre, particularly Mr. Pankaj Buttan, Data Processing Manager; Mr. Rahul Kumra, Assistant Administrative Officer; Mr. Sunil Kumar, Accounts Manager and Mr. Jayakumaran, Public Relations Manager, NAM S&T Centre for their support in bringing out this publication.

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