

2nd Edition

Richard Lawley, Laurie Curtis and Judy Davis

The Food Safety Hazard Guidebook



RSC Publishing

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Food Safety Info, London, UK, Email: richard@fsinfo.plus.com



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Preface

Food safety is important. Consumers have a right to expect that those who supply the food that they buy have taken every care to manufacture products that will do them no harm. Those with a responsibility for the regulation of the global food industry recognise this principle and legislate accordingly. This confers a legal and a moral duty, as well as an economic incentive, on all food businesses to ensure that the food they supply is as free from food safety hazards as is practically possible. The food business that tries to evade its responsibilities in this regard will not remain in business for very long.

The business of managing and regulating the safety of the food supply chain has come a long way in the last 30 years or so. Prompted by the emergence of new food safety hazards, such as the bacterial pathogens *Listeria monocytogenes* and *E. coli* O157, powerful new techniques for evaluating and managing the risks presented by these threats have been developed. For example, hazard analysis critical control point, or HACCP, has now become the food safety management system of choice worldwide. Similarly, the technique of risk assessment has been developed to the point where it can be applied to almost anything. There now exists a comprehensive toolbox of techniques for managing the safety of food, and a plethora of training and guidance options for learning how to use the tools. As a result, there is now little to excuse any food business that fails to protect its customers from known food safety hazards.

Although food safety management tools are now widely available, they are still virtually useless unless they are supported by adequate and accurate information. HACCP does not work unless its practitioners have access to enough data and scientific knowledge to enable them to understand hazards and how to control them effectively. For example, there is little point in deciding that pasteurisation is the best way to control a bacterial pathogen unless its heat resistance is known. There is plenty of information available,

in countless excellent books and other publications, and increasingly online. Unfortunately, accessing that information can be problematic, especially for smaller food businesses.

The *Food Safety Hazard Guidebook* is an attempt to address that problem by distilling the key facts about a wide range of individual food safety hazards into a single text. We have tried to adopt a clear format and to keep the information included as concise as possible so that it is easy to find the important facts. We would not claim for one moment that the book is a comprehensive or exhaustive reference work on food safety hazards, and it is not meant to be. As the title suggests, it is intended as a guidebook rather than an encyclopaedia, and has been conceived as a portal for the immense and ever expanding body of scientific knowledge that exists for food safety. To that end, we have included “Sources of Further Information” in every chapter for those needing more detail. As authors, we have drawn on our experience of supplying the technical and scientific information that food safety professionals require to address a real need for accessible knowledge.

This second edition of the guidebook retains the layout and structure of the first, but updates and extends the content to keep the book as relevant as possible to current food safety issues. Our objective for this edition remains the same, to produce a book that is accurate and reliable, as up-to-date as possible, and above all, useful.

Disclaimer

The material contained in this book is presented after the exercise of every possible care in its compilation, preparation and issue. However, the authors can accept no liability whatsoever in connection with its application and use.

Contents

Food Safety Hazards	1
Section 1: Biological Hazards	
Chapter 1.1 Bacteria	9
1.1.1 <i>Aeromonas</i>	9
1.1.2 <i>Arcobacter</i>	14
1.1.3 <i>Bacillus</i>	17
1.1.4 <i>Campylobacter</i>	22
1.1.5 <i>Clostridium botulinum</i>	27
1.1.6 <i>Clostridium difficile</i>	34
1.1.7 <i>Clostridium perfringens</i>	38
1.1.8 <i>Cronobacter</i>	44
1.1.9 Enterococci	50
1.1.10 <i>Escherichia coli</i>	53
1.1.10.1 Verocytotoxin-producing <i>Escherichia coli</i> (VTEC)	54
1.1.10.2 Enteraggregative <i>Escherichia coli</i> (EAEC)	59
1.1.11 <i>Helicobacter pylori</i>	63
1.1.12 <i>Listeria</i>	67
1.1.13 <i>Mycobacterium avium</i> subspecies <i>paratuberculosis</i>	74
1.1.14 <i>Plesiomonas shigelloides</i>	78
1.1.15 <i>Pseudomonas aeruginosa</i>	81
1.1.16 <i>Salmonella</i>	83
1.1.17 <i>Shigella</i>	90
1.1.18 <i>Staphylococcus aureus</i>	94
1.1.19 Streptococci	100

1.1.20	<i>Vibrio cholerae</i>	103
1.1.21	<i>Vibrio parahaemolyticus</i>	107
1.1.22	<i>Vibrio vulnificus</i>	112
1.1.23	<i>Yersinia enterocolitica</i>	116
1.1.24	<i>Yersinia pseudotuberculosis</i>	120
1.1.25	Other Enterobacteriaceae	124
Chapter 1.2	Viruses	127
1.2.1	Adenoviruses	127
1.2.2	Astroviruses	130
1.2.3	Hepatitis A Virus	133
1.2.4	Hepatitis E Virus	137
1.2.5	Highly Pathogenic Avian Influenza Viruses	141
1.2.6	Noroviruses	146
1.2.7	Parvoviruses	151
1.2.8	Rotaviruses	153
1.2.9	Sapoviruses	157
1.2.10	Enteric Picornaviruses	160
Chapter 1.3	Parasites	163
1.3.1	Protozoa	163
1.3.1.1	<i>Cryptosporidium</i>	163
1.3.1.2	<i>Cyclospora</i>	168
1.3.1.3	<i>Entamoeba</i>	172
1.3.1.4	<i>Giardia</i>	176
1.3.1.5	<i>Toxoplasma</i>	180
1.3.2	Nematodes	185
1.3.2.1	Anisakids	185
1.3.2.2	<i>Trichinella</i>	190
1.3.3	Other Parasites	195
Chapter 1.4	Prions	200
Section 2:	Chemical Hazards	
Chapter 2.1	Biological Toxins	207
2.1.1	Fungal Toxins	207
2.1.1.1	Aflatoxins	207
2.1.1.2	Citrinin	213
2.1.1.3	Cyclopiazonic Acid	216
2.1.1.4	Deoxynivalenol	219

2.1.1.5	Ergot	224
2.1.1.6	Fumonisin	228
2.1.1.7	Moniliformin	233
2.1.1.8	Ochratoxins	236
2.1.1.9	Patulin	241
2.1.1.10	Sterigmatocystin	245
2.1.1.11	Trichothecenes	248
2.1.1.12	Zearalenone	253
2.1.1.13	Other Mycotoxins	258
2.1.2	Plant Toxins	263
2.1.2.1	Cucurbitacins	263
2.1.2.2	Cyanogenic Glycosides	266
2.1.2.3	Furocoumarins	270
2.1.2.4	Glycoalkaloids	273
2.1.2.5	Grayanotoxin	278
2.1.2.6	Lectins	280
2.1.2.7	Pyrrolizidine Alkaloids	284
2.1.3	Fish Toxins	288
2.1.3.1	Azaspiracids	288
2.1.3.2	Brevetoxins	291
2.1.3.3	Ciguatoxins	295
2.1.3.4	Cyclic Imines	299
2.1.3.5	Domoic Acid	302
2.1.3.6	Gempylotoxin	306
2.1.3.7	Okadaic Acid Toxins	309
2.1.3.8	Palytoxins	313
2.1.3.9	Pectenotoxins	316
2.1.3.10	Saxitoxins	319
2.1.3.11	Tetrodotoxin	324
2.1.3.12	Yessotoxins	327
2.1.4	Biogenic Amines	330
2.1.4.1	Biogenic Amines (Excluding Histamine)	330
2.1.4.2	Scombrototoxin (Histamine)	334

Chapter 2.2 Non-biological Chemical Contaminants 339

2.2.1	Contaminants Produced During Processing	339
2.2.1.1	Acrylamide	339
2.2.1.2	Advanced Glycation End-Products	345
2.2.1.3	Benzene	348
2.2.1.4	Chloropropanols	351
2.2.1.5	Ethyl Carbamate	355
2.2.1.6	Furan	358
2.2.1.7	Heterocyclic Amines	361
2.2.1.8	Polycyclic Aromatic Hydrocarbons (PAH)	364

2.2.2	Contaminants From Food Contact Materials	368
2.2.2.1	Bisphenol A	368
2.2.2.2	Phthalates	373
2.2.2.3	Semicarbazide	378
2.2.3	Environmental Contaminants	382
2.2.3.1	Dioxins and PCBs	382
2.2.3.2	Heavy Metals	388
2.2.3.3	Melamine	397
2.2.3.4	Perchlorate	402
2.2.4	Veterinary Residues	405
2.2.4.1	Antibiotics	405
2.2.4.2	Hormones	410

Section 3: Allergens

Chapter 3.1 Food Allergy 417

Chapter 3.2 Specific Allergens 421

3.2.1	Celery	421
3.2.2	Cereals	424
3.2.3	Crustaceans	427
3.2.4	Hens' Eggs	430
3.2.5	Fish	433
3.2.6	Lupin	436
3.2.7	Cows' Milk	439
3.2.8	Molluscs	442
3.2.9	Mustard	445
3.2.10	Peanuts	448
3.2.11	Sesame	451
3.2.12	Soya	454
3.2.13	Sulfite	457
3.2.14	Tree Nuts	460

Chapter 3.3 Allergen Control Options 463

Chapter 3.4 Allergen Legislation 466

Section 4: HACCP and Food Safety Management Systems

Chapter 4.1 HACCP and Food Safety Management Systems 473

Section 5: Food Safety Legislation

Chapter 5.1 Food Safety Legislation 487

<i>Contents</i>	xi
Section 6: Sources of Further Information	
Chapter 6.1 Sources of Further Information	497
Abbreviations and Acronyms	506
Subject Index	508

Food Safety Hazards

Food Safety

The term *food safety* has no universally accepted definition. In fact, it is sometimes used, wrongly, in relation to defects in food commodities that are much more to do with food quality than with safety. For example, microbial spoilage of food may make it unattractive, or even inedible, but if neither the micro-organisms concerned, nor the by-products of their growth and metabolism have any adverse effect on health, then it is not strictly a food safety issue, but one of acceptability. For the purposes of this book, food safety can usefully be defined as the practice of ensuring that foods cause no harm to the consumer. This simple definition covers a broad range of topics, from basic domestic and personal hygiene, to highly complex technical procedures designed to remove contaminants from sophisticated processed foods and ingredients.

Essentially, the practice of food safety can be distilled down to three basic operations:

- Protection of the food supply from harmful contamination.
- Prevention of the development and spread of harmful contamination.
- Effective removal of contamination and contaminants.

Most food safety procedures fall into one, or more than one, of these categories. For example, good food hygiene practice is concerned with the protection of food against contamination, effective temperature control is designed to prevent the development and spread of contamination, and pasteurisation is a measure developed to remove contaminants.

Food Safety Hazards

A *food safety hazard* can be defined as any factor present in food that has the potential to cause harm to the consumer, either by causing illness or injury.

Food safety hazards may be biological, such as pathogenic bacteria, chemical, such as a toxin produced during processing, or a physical object, like a stone or piece of metal. In other words, hazards are the factors that food safety practice seeks to protect against, contain and eliminate from foods. In order to be effective, food safety practice must be informed about the nature of these hazards, and food safety procedures must be science-based. A thorough understanding of biological and chemical hazards is the first essential step in their control. This is less important for physical hazards, which also tend to have a much lower potential impact on public health. Physical hazards are not considered further here.

Biological Hazards

It is generally biological hazards that pose the greatest immediate food safety threat to the consumer. For example, the ability of food-poisoning bacteria to cause large outbreaks of acute illness within a short time is a threat with which most food businesses are likely to have to contend. There are few foods that are not vulnerable to biological hazards at some point in their manufacture, storage and distribution.

Technically, biological hazards may include larger organisms, such as insects and rodents. However, these rarely present a direct threat to health and are not considered further here. It is microorganisms and certain food-borne parasites that are of most concern as food safety hazards.

Bacteria

A significant number of bacterial species can be classified as food safety hazards. Some of these, such as *Salmonella* and *Listeria monocytogenes*, are very well known and familiar to consumers, whereas others are much less common and less well understood. Examples include *Vibrio parahaemolyticus*, a comparatively rare cause of food poisoning associated with seafood, and *Yersinia enterocolitica*, a cause of gastroenteritis that predominantly affects young children. *Campylobacter* is another example of a less well known cause of food-borne illness. Few consumers have heard of this organism, yet it is now the cause of more reported cases of food poisoning than any other agent, including *Salmonella*. *Campylobacter* is also less familiar to the food industry and there are still many unknowns surrounding its transmission to humans. This underlines the importance of continued research and scientific investigation for increasing our understanding of biological hazards.

Bacterial food safety hazards fall into one of two categories according to the mechanism by which they cause illness.

Infection

Most food-borne bacterial pathogens cause illness by multiplying in the gut after ingestion of contaminated food. They may then provoke symptoms by invading the cells lining the intestine, or in some cases, invading other parts

of the body and causing more serious illnesses. *Salmonella*, *Campylobacter* and *E. coli* O157 are all examples of bacteria that cause infective food poisoning. This type of food poisoning is usually characterised by a delay, or incubation time, of at least 8–12 hours (sometimes much longer) before symptoms develop.

This category also includes some bacteria that produce symptoms by multiplying in the gut and producing toxins, rather than by actively invading the tissues. An example of this type is *Clostridium perfringens*, a food-poisoning bacterium usually associated with cooked meat products.

Intoxication

There are a few food-borne pathogenic bacteria that produce illness not by infection, but by intoxication. These organisms are able to grow in certain foods under favourable conditions and produce toxins as a by-product of growth. The toxin is thus pre-formed in the food before ingestion and in some cases toxin may still be present even after all the bacterial cells have been destroyed by cooking. *Bacillus cereus* and *Staphylococcus aureus* are examples of bacteria able to cause intoxication, but the most important and potentially serious cause of intoxication is *Clostridium botulinum*. Intoxications usually have much shorter incubations times than infections, because the toxins are pre-formed in the food.

Viruses

Viral gastroenteritis is very common worldwide. There are a number of viruses that are capable of causing food-borne infections, although in most cases, other forms of transmission are more common. Perhaps the best known are noroviruses and hepatitis A, which has been responsible for a number of serious food-borne disease outbreaks, often as a result of poor personal hygiene by infected food handlers.

‘New’ viruses may also pose a threat to food safety. For example, highly pathogenic avian influenza viruses primarily affect birds, but in some cases may be transmitted to humans and cause serious disease. So far, there is no direct evidence that this transmission can be food borne, but these viruses are a source of great concern to the poultry industry and there is still much to learn about them.

Parasites

A wide range of intestinal parasites can be transmitted to humans *via* contaminated foods, although for most, faecal–oral, or water-borne transmission are more common. These organisms are much more prevalent in developing countries with poor sanitation, but the increasingly global nature of the food supply chain may increase their importance in the developed world. Currently, protozoan parasites are the most important, but other types also need to be considered as food safety hazards.

Protozoans

The protozoan parasites that can cause food-borne illness in humans include several well known species, such as *Entamoeba histolytica*, the cause of amoebic dysentery, and *Cryptosporidium parvum*. However, in recent years, some unfamiliar species have emerged as threats to food safety, especially as contaminants in imported produce. An example is *Cyclospora cayetanensis*, the cause of several outbreaks of gastroenteritis in the USA associated with imported fruit.

Other Types of Parasite

Other types of food-borne parasite include nematode worms, such as *Trichinella spiralis* and the anisakid worms found in fish, and cestodes (tapeworms), such as *Taenia solium*. Although many of these are far less prevalent in developed countries than was once the case, thanks to improved sanitation, they are still significant causes of illness worldwide.

Prions

Prions are a relatively recent threat to food safety and are still not fully understood, but their probable involvement in potentially food-borne new variant Creutzfeldt–Jakob disease (vCJD), an invariably fatal brain disease, has lead to considerable concern.

Chemical Hazards

The presence of chemical hazards in food is usually less immediately apparent than that of bacteria and other biological hazards. Acute toxicity caused by food-borne chemical contaminants is now very rare in developed countries. Of much more concern is the potentially insidious effect of exposure to low levels of toxic chemicals in the diet over long periods. In some cases this can lead to chronic illness and there is also the risk that some contaminants may be carcinogenic.

There is potential for an enormous range of chemical contaminants to enter the food chain at any stage in production. For example, agricultural chemicals, such as herbicides and insecticides, may contaminate fresh produce during primary production, some commodities may contain ‘natural’ biological toxins, and chemicals such as detergents and lubricants may enter food during processing. It is also possible for chemical contaminants to leach out of packaging into foods during storage.

Some of the main classes of chemical contaminant important in food safety are as follows:

- Agricultural chemicals, pesticides *etc.*
- Veterinary drugs

- Natural biological toxins
 - Fungal toxins
 - Plant toxins
 - Fish toxins
- Environmental contaminants (*e.g.* dioxins and heavy metals)
- Contaminants produced during processing (*e.g.* acrylamide)
- Contaminants from food contact materials (*e.g.* plasticisers)
- Cleaning and sanitising chemicals
- Adulterants (*e.g.* illegal food dyes)

The total number of potentially harmful chemicals that may contaminate food is very large. For example, UK legislation contains maximum residue levels (MRLs) for over 28 000 pesticide/commodity combinations. It is therefore not practical to cover pesticides here in anything but the most general terms. Fortunately, the use of pesticides is very strictly controlled in many countries and residues in imported foods are regularly monitored. Links are provided in the “Sources of Further Information” section for readers needing specific information on pesticides.

The list of potential adulterants is also an extensive one. Almost by definition, adulterants are often compounds that would not be expected to be present in foods and little may be known about their health significance if present in the diet. Recent examples include synthetic Sudan dyes found in imported spices and other commodities in the EU. These are illegal for food use, but the health effects of low levels in foods are uncertain, and there has been some discussion over their food safety significance. For these reasons, it is not practical to cover potential adulterants here, with one notable exception. The industrial chemical melamine has been found in food commodities and ingredients, especially from China. Its presence in foods has been found to cause potentially serious kidney damage in animals and humans and it was responsible for a very large outbreak of illness among Chinese infants, which led to at least six deaths. Because of the seriousness of this incident, the widespread nature of potential contamination and the known health hazard, melamine is included here.

The Chemical Hazards section focuses on contaminants that are known to be food safety hazards, and which have received some attention from food safety researchers and regulators to establish the level of risk they carry.

Allergens

In recent years, the problem of food allergy has been growing in importance for the food industry as the number of people, particularly children, affected by allergy symptoms has increased. Food manufacturers have been encouraged to respond to this development, particularly in terms of labelling foods clearly. Along with clear allergen labelling comes a responsibility to ensure that such labels are accurate. When foods are labelled as not containing specific allergens, it is extremely important that they do not become contaminated with those allergens during production. This is vital for allergens such as peanuts, which

may cause life-threatening anaphylactic reactions in sensitive individuals. The presence of undeclared allergens in foods is a growing cause of product recalls in the EU, North America and elsewhere.

The control of allergens in food is now a rapidly developing aspect of food safety, which many manufacturers will need to be concerned with. Fourteen specific major food allergens are currently recognised by EU legislation, although many more foods are likely to be capable of causing allergic reactions in sensitive individuals.

These are:

- Celery
- Crustaceans
- Egg
- Fish
- Lupin
- Milk
- Molluscs
- Mustard
- Peanuts
- Soya
- Sesame
- Sulphur dioxide and sulfites
- Tree nuts
- Wheat

It is probable that food allergies will continue to grow in importance in the coming years, and that further allergens will be recognised in legislation.

The Obligations of Food Businesses

In most countries, the safety of the food supply is regulated by national and local authorities. Food businesses are required to meet the demands of food safety regulations, at the very least, in order to protect consumers from hazards in food. These are likely to include the setting up of an effective food safety management system, such as hazard analysis critical control point (HACCP). In addition, many food businesses will need to meet the requirements of their customers, such as large retail chains, or will need to comply with the food safety provisions of third party audit schemes. Most of these will expect more extensive food safety measures than are required by relevant legislation.

Most businesses will find it necessary to adopt a risk assessment and HACCP-based approach to addressing food safety, and there is considerable assistance and support available to help with this. Nevertheless, it is important that every food business develops at least a basic understanding of the specific food safety hazards that may be relevant to their products and processes. Only then can food safety management systems operate effectively. The following pages are designed to help provide that basic understanding.