Food Poisoning & Food Hygiene

Betty C. Hobbs and
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Fourth Edition

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Preface to fourth edition

The aim of this book, as outlined in the first edition, is to bring essential facts about food poisoning and its prevention to everyone engaged in the processing of food, whether they are working in kitchens, shops, factories, or even farms. The text is composed for those who teach the principles which govern the prevention of food poisoning including medical, veterinary, and environmental health officers, supervisory staff responsible for the preparation and service of food in school, hospital, university, and industrial canteens, managerial personnel in food stores, and teachers in schools and technical colleges for catering and domestic science. It is with these disciplines in mind and to all those whose help is needed in tracing the source of infection through to the victim that this book was written and dedicated.

The facts are derived from the practical experience and knowledge gained by many workers interested in public health and hygiene during the past. Efforts to initiate preventive methods against food poisoning and food spoilage have influenced the method of presentation. The text of the fourth edition has been expanded to include more examples of outbreaks, recent statistics and notes on epidemiology and spoilage. The chapters on Kitchen Design and Equipment, Legislation and Control of Infestation have been largely rewritten; chapters 11, 12, and 13 have evolved from the original chapter 11. A short Bibliography for further reading has been included.

Revision of the Preface led to consideration of the current situation; the remarks have been transferred to the Introduction. Thus Chapter 1 includes both 'Historical perspective' and the 'Current situation'.

1978

B. C. H.
R. J. G.

Acknowledgements

The facts assembled in this book come from the experience of many workers in the field of food poisoning and food hygiene. We acknowledge them with gratitude and give thanks to our present helpers and critics.

Although much of Mr L. Kluth's contributions have been brought up-to-date by other writers, the basis of Chapters 16, 17, and 18, designed by him originally, remains the same; we remember him with gratitude and affection. We thank Mr R. J. Govett, Environmental Health and Technical Services Officer, London Borough of Brent for his earlier work on Chapter 16, and for further revisions of Chapters 17 and 18. Mr John B. Simpson, Senior Environmental Health Officer, City of Canterbury, and Mr David Ward, Principal Architect, North Yorkshire County Council made detailed revisions of Chapter 16, and the present text is largely contributed by them; we acknowledge their work with gratitude. We thank the Pest Infestation Control Laboratory, Ministry of Agriculture, Fisheries and Food, and also Mr P. L. G. Bateman, Rentokil Ltd., East Grinstead, for extensive revisions to Chapter 17. Dr Henrietta E. Schefferle revised, updated, and typed Chapter 18. Her thoroughness and care will be much appreciated by readers; we thank her for the hours spent so willingly on the task. Mrs Isobel M. Maurer and Dr J. C. Kelsey checked Chapter 15, and Mrs Maurer read the whole of the third edition for revisions; in addition Dr Kelsey contributed the section on 'Canvas and hutted camps' in Appendix B — we are grateful for their help. Mr W. Clifford's illustrations remain together with his photographs and those of Mr J. Gibson, and we thank them for this valuable material which adds interest to the book. The lecture notes in Appendix A were designed by Miss Catharine F. Scott, School Meals Organizer (retired) of the County of North Yorkshire, and the late Miss Irene J. Martin, who was Domestic Science Organizer in the County of North Yorkshire; their contribution has proved to be invaluable. The notes in their original form appeared in *Hygienic Food Handling* published by the St John

Ambulance Association. Short courses on Food Hygiene are given to those working in the School Meals Service and also to various groups of food handlers by the St John Ambulance Association together with the Association of Environmental Health Officers. We are grateful also for Miss Scott's help with information about the School Meals Service for Chapter 19.

Sir Graham Wilson, the late Professor R. Cruickshank, and the late Lt-Col. H. J. Bensted are remembered for their inspiration and help with the groundwork of the book. The immense practical work of Miss Nancy Cockman in the compilation and typing of the previous editions will always be acknowledged and our work together remembered with gratitude and thankfulness.

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Part 1
Food poisoning and food-borne infection

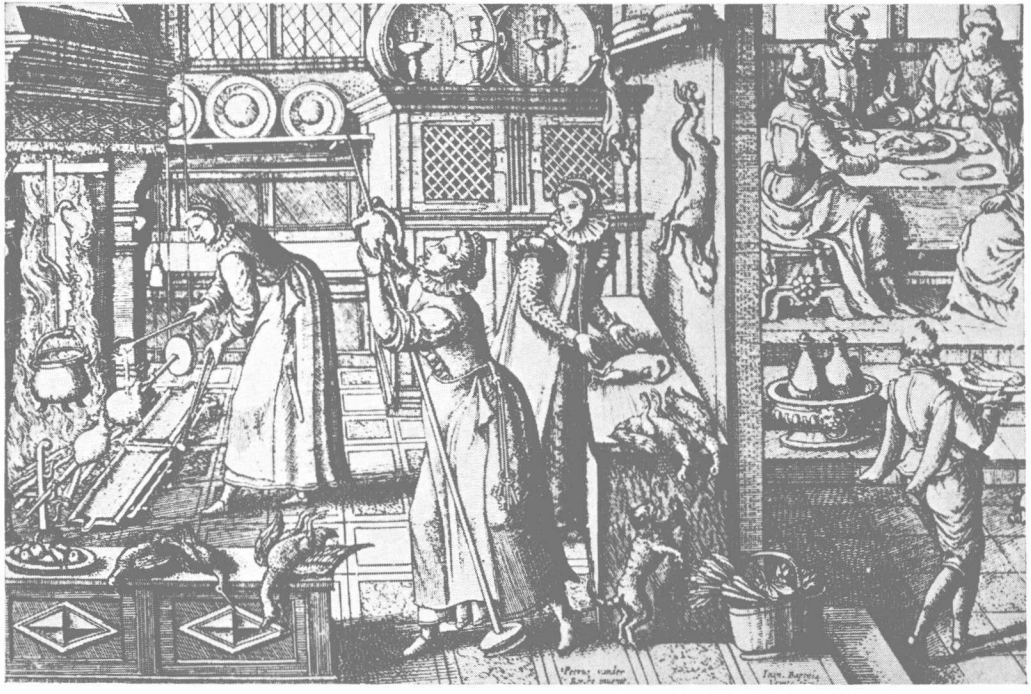

Fig. 1 Ancient kitchen

1

Introduction

Historical perspective

Food hygiene is a subject of wide scope. It aims to study methods for the production, preparation, and presentation of food which is safe and of good keeping quality. It covers not only the proper handling of every variety of foodstuff and drink, and all the utensils and apparatus used in their preparation, service, and consumption, but also the care and treatment of foods known to be contaminated with food-poisoning bacteria which have originated from the animal host supplying the food.

Food should be nourishing and attractive. It must be visibly clean and it must also be free from noxious materials. These harmful substances may be poisonous chemicals and even chemicals harmless in small amounts but damaging in large quantities. They may enter the food accidentally during growth, cultivation, or preparation, accumulate in the food during storage in metal containers, form in the food through interaction of chemical components, or they may be concentrated from the natural components of the food. Micro-organisms or germs may be introduced directly from infected food animals, or, from workers, other foods, or the environment during the preparation of foods. Poisonous substances may be produced by the growth of bacteria and moulds in food.

This book has been written for those engaged in food handling, with the purpose of explaining simply, in so far as our knowledge permits, the nature of these various dangers, how they arise, and how some of them can be prevented.

Noxious substances in food give rise to illness called food poisoning or gastroenteritis, which is usually characterized by vomiting and/or diarrhoea, and various abdominal disturbances. Food poisoning is no new disease, it has been recognized throughout the ages. Centuries ago the laws of the Israelites contained detailed information on foods to be eaten and foods to be abhorred, as well as

on their methods of preparation and the cleanliness of the hands of the consumers. About 2000 BC, as recorded in the Book of Leviticus, Moses not only made many laws which protected his people against the ravages of infectious disease but also laid down rules about the washing of hands after killing animals for sacrifices and before eating. Many of these rules were based on a practical knowledge of personal hygiene and the necessity for cleanliness of those suffering from certain diseases.

Laws were given about edible animal life and concerned animals, birds, and whatever swims in the water or crawls upon the earth. Prohibited animals included swine, now known to be frequent excreters of salmonella organisms, as well as reservoirs of parasites such as *Trichinella spiralis* and *Taenia solium*, and small creatures which scurry or crawl such as mice, rats, and lizards, also well known to harbour salmonellae. Other crawling things and those that slither such as snails and snakes were forbidden. Of the water creatures only those with fins and scales could be eaten, which eliminated sea mammals, shell-fish and crustaceans. Among the prohibited birds there is a long list of those which are scavengers on land or at sea — they include the vulture and eagle, and the heron and seagull. Flying insects with four legs were forbidden but those that jump such as locusts, crickets, and grasshoppers could be eaten. The dead bodies of such creatures could defile those that touched them.

The accounts of food poisoning recorded in ancient history have generally been associated with chemical poisons — more especially with those deliberately introduced — but this is undoubtedly due to the fact that our knowledge of non-chemical, that is bacterial food poisoning, dates back no further than the latter part of the nineteenth century. Indeed the term ptomaine, i.e. alkaloid, poisoning was often used and may still be seen in the popular press to describe an outbreak of food poisoning which we know to have been caused by pathogenic or disease-producing micro-organisms or germs. The ptomaines are basic chemical substances formed by the breakdown or digestion of putrefying tissues; they were previously thought to be poisons formed in tainted foods, as food poisoning was assumed to be associated with taint. Now we know that foods heavily contaminated with food-poisoning germs may be normal in appearance, odour, and taste.

There are some naturally occurring substances in plant life, such as deadly nightshade and toadstools, which can cause illness if consumed; also, food may become contaminated during its preparation, with arsenic, zinc, copper, tin or other heavy metals, or with pesticides or disinfectants, with disastrous results. The amount of food poisoning due to these natural or chemical poisons is, however, small and it is not intended to enlarge on this subject. Nearly all our

food poisoning is caused by the contamination of food by germs, the majority of which can grow actively in the food.

The study of micro-organisms including those known to cause disease is called microbiology. This term covers all aspects of the following subjects: (a) bacteriology, from the Greek word 'bactron', a rod — from the appearance of the first germs, tiny straight rods, seen through a microscope; (b) virology — viruses are among the smallest known micro-organisms; (c) mycology — the study of fungi and moulds; and (d) parasitology — organisms of different orders which parasitize man and animals. Bacteria, germs, microbes, micro-organisms, or simply organisms as they are variously called — and all these names will be used interchangeably in this book — were first seen and described in 1675 by a man who was not a professional scientist. van Leeuwenhoek was a linen draper in the town of Delft in Holland but he was also an enthusiastic maker of lenses and magnifying apparatus. It was his hobby to examine objects of nature through the lenses which he mounted together to form a primitive microscope. One day, looking through his microscope at a drop of pond water, he saw not only a number of tiny animalcules but also tiny rods, many of which moved about actively within the microscope field. He described their size as one thousand times smaller than the eye of a louse. Next he took scrapings from his own teeth and, placing them under the microscope, he saw similar objects to those he found in the water. His drawings leave no doubt that these were the first bacteria to be described, but the significance of his findings was not appreciated at the time. Indeed, it was not until Louis Pasteur, the great French chemist and bacteriologist, demonstrated the essential part that bacteria played in fermentation processes in relation to wines and beers that the scientific world understood the significance of van Leeuwenhoek's observations made nearly 200 years before.

Pasteur developed methods of growing bacteria so that a more intimate study of them could be made. After his work on fermentation he turned his attention to the silkworm plague which was threatening to ruin the silk trade, then of paramount importance in France. He showed that the disease was caused by a bacterial infection of the silkworm and he was able to suggest successful measures for its control. After this he investigated diseases of animals and man, proving beyond doubt that bacteria were a necessary cause of many diseases. Pasteur's name will be forever associated with the dreadful disease, rabies, and the method he devised for its prevention, but another aspect of his work is of particular importance in the study of food hygiene. He was able to show clearly and completely that the old theory of spontaneous generation, that is life arising from the inanimate, was false. In other

words, if a particular food product was sterilized by heat, living bacteria would not appear in the food unless they came from outside, from the air, from the hands, or from some other infected material.

About the same time Robert Koch was also making great discoveries in Germany; he found that anthrax, tuberculosis, and cholera were caused by bacteria and he devised methods to grow these germs. From this time onwards the march of discovery in the field of bacteriology was rapid. From Europe, America, Japan, and other parts of the world bacteriologists were fired with enthusiasm for their new science, and soon the causative microbes of gonorrhoea, erysipelas, diphtheria, typhoid fever, dysentery, plague, gangrene, boils, tetanus, scarlet fever, and other illnesses had been found.

After thousands of years of darkness and superstition a great light was thrown on the cause of infection, and the door was opened for a vast study of the relation of bacteria to disease in animals and man. This study led to a knowledge of the way in which bacterial infections spread and, as a result, methods of prevention and of cure were found. Joseph Lister, applying the theories of Pasteur to surgery, discovered that wounds became septic by the action of bacteria. He introduced the use of antiseptics and disinfectants that would kill bacteria, and there was an immediate reduction in wound sepsis.

Before 1850 the sanitary conditions in Britain were poor. From 1840 onwards began the Great Sanitary Awakening. Edwin Chadwick belonged to a family with a strong belief in personal cleanliness — a most unusual virtue in those days — and in 1842 he was instrumental in bringing out a *Report on the Sanitary Conditions of the Labouring Population of Great Britain.* The principle that environment influenced the physical and the mental well-being of the individual was introduced and, as the connection between filth and disease was gradually understood, measures were taken to control the disposal of sewage and the purity of water supplies.

In 1854 John Snow recognized that drinking water was concerned in the spread of cholera. William Budd in 1856 concluded that typhoid fever was spread by milk or water polluted by the excretion of an infected person. Prince Albert died of typhoid fever in 1861. John Snow and William Budd were amongst the earliest epidemiologists, for at that time there were no means to grow the organisms responsible for typhoid fever and cholera. In 1874 an outbreak of typhoid fever occurred in the Swiss town of Lauren and it was traced to polluted water; the result was that water supplies and sewage systems were redesigned to eliminate this danger. The chlorination of drinking water in Britain was initiated by Alexander

Houston in 1905 during a typhoid epidemic in Lincoln, and its use has helped to abolish water-borne disease in this and other countries.

Toward the end of the nineteenth century the danger of infection by milk was discovered and in cities such as London, the heat treatment of milk by pasteurization began; this heat treatment kills many bacteria in the milk, including those that are harmful. The pasteurization of all supplies is not yet complete so that outbreaks of food poisoning and brucellosis still occur from tuberculin-tested raw milk and they will continue to do so until all milk is heat treated before distribution. The incidence of tuberculous infection in children drinking raw milk is now negligible in Great Britain, because most of the milk is pasteurized and also because the infection of cows has been almost eliminated by the destruction of animals found to be infected when subjected to the tuberculin test. A scheme for the eradication of brucellosis is in progress. A brief description of certain milk-borne and food-borne diseases is given in Chapter 8.

Acute poisoning and infection spread by food contaminated with disease-producing bacteria must have occurred from time immemorial, and they will continue to do so until we learn methods of control.

Drinking water is purified by sedimentation, filtration, and chlorination; milk is heat treated and carefully packed in clean bottles or cartons; ice-cream mix is heat treated, cooled quickly, and stored cold until frozen; liquid whole egg is heat treated (pasteurized), cooled quickly, and frozen. Some foods are preserved by heat, cold, dehydration, or chemicals before they reach the kitchen, but many of them are not. Raw foods can introduce food-poisoning organisms into kitchens and processed foods can be contaminated in the kitchen by other foods and by those preparing meals for consumption. To prevent the spread of infection by foodstuffs, therefore, we must either stop certain bacteria from entering food or, if they have entered unavoidably, make it impossible for growth to occur. When it is known that raw foods are consistently contaminated from animal or human sources, investigations should be made to find out how to produce such foods free from infection. If raw foods known to be a source of infection cannot be treated to make them safe before distribution, food hygiene education should ensure that food handlers are aware of the dangers and of the methods to reduce the risks which may lead to food poisoning.

The first description of food-poisoning bacteria, later known to be salmonella, was given by Dr Gaertner in 1888; these bacteria were isolated from the organs of a man who had died from food

poisoning during an outbreak in Germany affecting 59 other persons. Similar bacteria were found in the meat served to the victims, and also throughout the carcass of beef from which the meat was cut. About the same time the so-called ptomaines, previously thought to cause food poisoning, were extracted from putrid foods and were found to be harmless if taken by mouth. These discoveries convinced many workers that the ptomaine theory of poisoning was wrong and, under the influence of Savage in the UK and Jordan in the United States, food poisoning gradually came to be associated with specific bacterial contamination.

In 1896 van Ermengem in Belgium described the organism, *Clostridium botulinum*, which is responsible for a very serious form of food poisoning known as botulism. *C. botulinum* produces in food a highly poisonous toxin affecting the nervous system and often causing death. Fortunately, botulism is rarely described in the United Kingdom, although it still occurs in other parts of the world.

In the years 1909 to 1923 many of the bacteria now known to be responsible for a large proportion of food-poisoning incidents were grouped together under the generic name *Salmonella*, in honour of Dr Salmon who isolated the first member of the group, the hog cholera bacillus, in 1885.

From 1914 onwards another group of bacteria, the staphylococci, were found to be concerned with food poisoning. Certain strains of staphylococci produce in food a poisonous substance or toxin which, if swallowed, gives rise to quick and violent reactions.

From 1945 to 1953, a fourth major causal agent of food poisoning was investigated and described, the anaerobic sporing bacillus *C. welchii* (now known as *C. perfringens*); this organism is similar to *C. botulinum* but the illness is usually mild with less disastrous results.

From time to time various common bacteria are shown to be responsible for food poisoning. They may be present in large numbers in the raw food or on surfaces or equipment, survive preparation or recontaminate the food after cooking.

The safety of food thus depends on freedom from the bacteria known to cause food poisoning and also from mass bacterial contamination usually resulting from careless storage. Clean food is free from visible dirt and bacterial spoilage; not all spoilage bacteria cause food poisoning and conversely the food-poisoning bacteria may not cause visible spoilage even when present in enormous numbers. The aim of food hygiene should be the production and service of food which is both safe and clean.

Under poor storage conditions bacteria can grow to large and dangerous numbers. Four main factors are important: (a) the initial safety of raw foods before their introduction into manufacturing establishments, shops, canteen and home kitchens; (b) the hygiene

and care of those responsible for handling food during production and service; (c) the conditions under which food is stored; and (d) the general design and cleanliness of kitchens and equipment.

The incidence of food poisoning appeared to increase after World War II; outbreaks and sporadic cases are still common today even though knowledge of preventive methods has increased. Table 1 gives the recorded cases of bacterial food poisoning in England and Wales for the years 1965 to 1976. At the turn of the century food was cheap and tastes were simple. The small eating houses used for midday meals were often dingy with underground basement kitchens and inadequate washing facilities. Nevertheless, intestinal infections or intoxications from meals taken in these

Table 1 Recorded cases of bacterial food poisoning (England and Wales, 1965–76)

Year	1965	1966	1967	1968	1969	1970
Number of cases	7917	5818	7367	7103	8207	8634
Year	1971	1972	1973	1974	1975	1976
Number of cases	8079	6020	8574	8591	11 943	11 000

restaurants appeared to be rare. Mostly the meals consisted of freshly roasted or boiled meat with vegetables all freshly cooked and quickly served to relatively small groups of customers. Dessert dishes when available consisted of boiled puddings and fruit tarts.

With the increased facilities the habits of people changed; the cinema became popular, motor transport increased, and there were more attractive restaurants to meet a growing need. Immediately after World War I the popularity of large restaurants increased; they served food at reasonable prices but often pre-cooked. Made-up meat dishes and cream-filled cakes, prepared ahead of requirements and ideal for bacterial growth, became popular also. After World War II almost the whole nation participated in communal feeding, when in addition to the public restaurant, canteens were set up in factories, schools, and offices. Although the habit of communal feeding had been growing for years the nation was entirely unprepared for this enormous change-over. Canteen kitchens, often converted in a hurry, were of unsuitable design and inadequate for the number of meals required. Kitchens originally intended for serving a certain number of meals were forced to provide double or even treble that number, sometimes with limited equipment and inadequate staff. At the same time few of the people in charge of these catering establishments had any knowledge of the

precautions necessary for the preparation, cooking, and serving of meals on this large scale.

Under such conditions it is not surprising that errors occurred in the bulk handling of food. Large numbers of persons were served from one canteen kitchen, and a single infected dish could affect many; whereas a similar incident in a small household would affect one or two persons only.

Another factor of importance was the growing import trade of protein foods needed to feed the increasing human and animal population. Egg products, meats, coconut, and dried feeding stuffs for animals, all now known to contain food-poisoning organisms, were brought into the country in enormous quantities. They were eaten raw, were cooked, or were used in the bulk manufacture of many foods which were purchased more and more by the busy housewife with a family to feed and a job to do.

Other problems in Britain during and after World War II included shortages of certain foods and more particularly of meat. The housewife and the canteen supervisor acquired the habit of hoarding left-overs and cooking their small cuts of meat the day before they were required in order to slice them more economically when they were cold. Some of these habits have remained and provision for cold storage is still inadequate with approximately two-thirds of British households equipped with refrigeration.

From 1960 onwards, factory farming became popular and the production of foods, poultry, and meat, particularly, increased. Convenience foods helped the army of housewives working both inside and outside their homes.

In 1939, a public health bacteriological service was instituted which supplemented the work of the public and private analysts. The number of laboratories increased, and they provided more facilities for the investigation of food-poisoning outbreaks. Also, teaching on the subject of food hygiene became popular. In 1950, for the first time, the combined recorded food-poisoning incidents from the Public Health Laboratory Service, and the Department of Health and Social Security, which receives all notifications of food poisoning from local authorities, were gathered together, so that a great deal of information on food poisoning hitherto unrecorded was brought to light. In 1955, legislation on food hygiene was passed.

What are the aims, therefore, for personal hygiene, food storage, the general design of kitchens and their equipment, and the safety of basic food ingredients? First, it must be recognized that the natural hosts of food-poisoning bacteria and viruses are the human and animal body. Second, efforts should be made to reduce the rates of excretion of salmonellae by animals and poultry by eliminating