FOOD SAFETY – ITS ROLE IN HEALTH AND DEVELOPMENT: THE PROBLEMS RELATED TO OUR FOOD SUPPLY

Fritz Käferstein
International Food Safety Consultant, Nyon, Switzerland

Yasmine Motarjemi
Food Safety Manager, Néstle, S.A., Vevey, Switzerland

Gerry Moy
GEMS/Food Manager, World Health Organization, Geneva, Switzerland

Keywords: Food, contamination, food safety, foodborne disease, health, agriculture, trade, hazard, risk, pathogen, food additive, agro-chemical, chemical, shared responsibility.

Contents

Summary

This topic on Food safety – its role in health and development is divided into two main parts: : the first dealing with the major food borne hazards as well as a discussion of the various health and economic consequences associated with these hazards (i.e. the problems), which is discussed in this chapter.

The second part, divided into six different chapters, discusses the various strategies that have to be applied in order to prevent the contamination of our food supply and to facilitate national and international food trade without compromising safety (i.e. the solutions). . This part follows the concept of ***shared responsibility for food safety*** (i.e. the different roles to be played by all partners along the food chain, including governments, the agro-food industry and consumers), a concept that is now referred to as "farm -to-fork" and has been promoted by WHO for more than 20 years, since the 1980s.

Food safety – its role in health and development

The problems related to our food supply (F.Käferstein, Y.Motarjemi and G.Moy)
The solutions:

- The need for an international approach – the role of FAO and WHO (J.Schlundt and K.Miyagishima)
- Food safety at the national level – the role of governments (A.Reilly and R.Ellard)
- Food safety at the commercial level – the response of the agro-food industry (Y.Motarjemi)
- Primary industry: terrestrial and aquatic animal and plant production
- Manufacturing industry
- Food service industry
- Safe food at the family/household level – the responsibility of consumers (E.C. Redmond and C.Griffith)
- Consumer perception on food safety (L.Frewer, E.van Kleef and J.de Jonge)
- The role of FAO and WHO in assisting developing countries to improve their food safety systems (E.Boutrif and J. Schlundt)

Introduction

The German word for food *Lebensmittel* literally translates to "*a substance that supports life"*. Unfortunately, food is not always life supporting; food may acquire health damaging or even life threatening properties; the reason for this apparent contradiction is that food may, under certain circumstances, also contain biological, chemical and other hazards. Therefore, to fulfill its role of supporting life, it is of paramount importance that food is not only nutritious, but also ***safe*.**

In 1948, the availability, accessibility and affordability of food, i.e. the concept of food security, were recognized as a basic human right by the United Nations in its Universal Declaration of Human Rights**.** Surprisingly, it was not until 1992 that the Food and Agricultural Organization of the United Nations (FAO) and the World Health Organizations (WHO) convened the International Conference on Nutrition (FAO and WHO, 1992), which declared that ***« access to nutritionally adequate and safe food as a right of each individual »*** (emphasis added). Since then, food safety has been given much higher priority by countries and international organizations.

Where do we stand today? While it has now been recognized that food safety is a major determinant of health and certainly a human right, a great proportion of our fellow-citizens do not yet have the benefit of this basic human right. Considering the role that food safety plays in both health and development, it is obvious that the safety of our food supply needs to be substantially improved if its potential contributions to the Millennium Development Goals (United Nations General Assembly document A56/326, 2002) are to be realized. Furthermore, rapid changes that the world is undergoing are posing unprecedented challenges to authorities and stakeholders who are responsible for ensuring food safety. Changing lifestyles, shifting demographics, environmental degradation, growing international trade and travel and in particular, advances of new technologies are influencing the safety of our food supply. These need and deserve to be carefully monitored, evaluated and acted upon if people around the world are to enjoy not only nutritious, but also safe food to which they are entitled.

1. The Problems Related to our Food Supply

1.1. Introduction

In every part of the world people wage a constant battle against food contamination, foodborne diseases, and food wastage. Efforts to reduce these survival-threatening, devastating consequences of food contamination certainly started in prehistoric times. Cooking, smoking, and simple sun drying were probably the first methods used. Other more sophisticated technologies came along like fermentation and canning. More recently, advanced technologies in food preservation and packaging have been developed to make our food safer. However, despite these advances in food science and technology, the safety of our food supply is, at the beginning of the third millennium, still a cause of concern.

In 1983, a group of internationally renowned experts, convened jointly by FAO and WHO concluded that “Illness from contaminated food was perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity" (Report of a Joint FAO/WHO Expert Committee, 1984). In 1992, the FAO/WHO International Conference on Nutrition mentioned earlier recognized that hundreds of millions of people suffer from communicable diseases caused by contaminated food and drinking water. In the same year, the UN Conference on Environment and Development (United Nations Conference, Rio, 1992) recognized that food was a major vehicle for the transmission of environmental contaminants, both chemical and biological, to human populations throughout the world, and urged countries to take measures to prevent or minimize these threats. In 2000, the World

Health Assembly, the supreme governing body of WHO, unanimously adopted a strongly worded resolution that recognizes food safety as an essential public health function (World Health Assembly, 2000).

A wide range of biological and chemical agents, i.e., hazards, causes foodborne diseases, with varying degrees of severity, ranging from mild indisposition to chronic and/or life-threatening illness.

In the last decades of the of the 20th century, the world experienced an increase in certain foodborne diseases, including salmonellosis, campylobacteriosis as well as the emergence of new diseases, such as enterohemorrhagic *Escherichia coli* (EHEC) infections and listeriosis. Furthermore, the significant role of food in the transmission of cholera and other diarrheal diseases, particularly in children, mistakenly considered to be spread mainly by water, was recognized.

As a result of efforts to strengthen food safety systems, many countries have succeeded curbing the incidence of foodborne illness, but the battle is far from being won. In several industrialized countries, epidemiological studies have shown unexpectedly high prevalence of foodborne disease of 10% to 15% of the population. In the late 1990s, more accurate data from the US suggested that this figure may be as high as 25% (Mead, P.S.et al., 1999). While comparable studies in developing countries are lacking, one can safely assume that foodborne disease prevalence is higher in these countries and the health and resulting economic impact even greater. Some estimates are available on infant diarrhea, which is probably the most important food safety related disease in developing countries. In this case, the morbidity has remained virtually unchanged during the last 20 to 25 years (Käferstein, F.K., 2003). Annually, some 1.5 billion episodes of diarrhea occur in children under the age of five, resulting in some 1.8 million deaths. While various pathogens have been identified as a cause of diarrhea, it is now estimated that up to 70% of diarrheal episodes may be foodborne.

It is certain that contaminated food will continue to plague mankind in the twenty-first century, especially as several global trends continue to negatively influence the safety of food and drinking water. Such trends include population growth, uncontrolled urbanization, and increase in international trade in food (see chapter 1.10).

		Transmission [b] by				
Hazards	**Important reservoir or carrier**	**water**	**food**	**Person to person**	**Multiplication in food**	**Examples of some incriminated foods**
BACTERIA						
Bacillus cereus	Soil	-	+	-	+	Cooked rice, cooked meats, vegetables, starchy puddings
Brucella spp	Cattle, goats, sheep	-	+	-	+	Raw milk, dairy products
Campylobacter jejuni	Chickens, dogs, cats, cattle, pigs, wild birds	+	+	+	- [c]	Raw milk, poultry

Clostridium botulinum	Soil, mammals, birds, fish	-	+	-	+	Fish, meat, vegetables (home preserved), honey
Clostridium perfringens	Soil, animals, man	-	+	-	+	Cooked meat and poultry, gravy, beans
E. coli enterotoxigenic	Man	+	+	+	+	Salad, raw vegetables
E. coli enteropatogenic	Man	+	+	+	+	Milk
E. coli enteroinvasive	Man	+	+	0	+	Cheese
E. coli enterohaemorrhagic	Cattle, poultry, sheep	+	+	+	+	Undercooked meat, raw milk, cheese
Listeria monocytogens	Environment	+	+	-	+	Cheese, raw milk, coleslaw
Mycobacterium bovis	Cattle	-	+	-	-	Raw milk
Salmonella typhi and *paratyphi*	Man	+	+	±	+	Dairy products, meat products, shellfish, vegetable salads
Salmonella (non-*typhi*)	Man and animals	±	+	±	+	Meat, poultry, eggs, dairy products, chocolate
Shigella spp	Man	+	+	+	+	Potato/egg salads
Staphylococcus aureus (enterotoxins)	Man	-	+	-	+	Ham, poultry and egg salads, cream-filled bakery products, ice-cream, cheese,
Vibrio cholerae O1	Man, marine life	+	+	±	+	Salad, shellfish
Vibrio cholerae, non-O1	Man,marine life	+	+	±	+	Shellfish
Vibrio parahaemolyticus	Seawater, marine life	-	+	-	+	Raw fish, crabs and other shellfish
Vibrio vulnificus	Seawater, marine life	+	+	-	+	Shellfish
Yersinia enterocolitica	Water, wild animals, pigs, dogs, poultry	+	+	-	+	Milk, pork, poultry
VIRUSES						
Hepatitis A & E viruses	Man	+	+	+	-	Shellfish, raw fruit and vegetables
Calici viruses	Man	+	+	-	-	Shellfish, salad
Rotavirus	Man	+	+	+	-	0
PROTOZOA						
Cryptosporidium parvum	Man, animals	+	+	+	-	Raw milk, raw sausage (non-fermented)
Cyclospora	Man	+	+	0(unlikely)	-	Raspberries

cayetanensis						
Entamoeba histolytica	Man	+	+	+	-	Vegetables, fruits
Giardia lamblia	Man, animals	+	±	+	-	Vegetables, fruit
Toxoplasma gondii	Cats, pigs	0	+	-	-	Undercooked meat, raw vegetables
HELMINTHS						
Ascaris lumbricoides	Man	+	+	-	-	Soil-contaminated food
Clonorchis sinensis	Freshwater fish	-	+	-	-	Undercooked/raw fish
Fasciola hepatica	Cattle, goats	±	+	-	-	Watercress
Opisthorchis viverrini/felineus	Freshwater fish	-	+	-	-	Undercooked/raw fish
Paragonimus spp	Freshwater crabs	-	+	-	-	Undercooked/raw crabs
Taenia saginata and *T. solium*	Cattle, swine	-	+	-	-	Undercooked meat
Trichinella spiralis	Swine, carnivores	-	+	-	-	Undercooked meat
Trichuris trichiura	Man	0	+	-	-	Soil-contaminated food
NATURAL TOXINS						
Mycotoxins						
- aflatoxins	Peanuts, maize, dried figs, tree nuts	-	+	-	-	Raw and processed products made from these
- ochratoxins	Plant products	-	+	-	-	Nuts, rice, coffee, beer
- trichothecenes	Grain	-	+	-	-	Bakery products
- ergot alkaloids	Rye	-	+	-	-	Bakery products
- fumonisins	Maize		+			Maize-based foods
Phycotoxins						
shellfish poisoning: - paralytic - diarrheic - amnesic - neurotoxic	Shellfish	-	+	-	-	Shellfish and shellfish-based foods
- ciguatoxin	Reef (fin) fish	-	+	-	-	Foods based on reef fish
Inherent plant toxins						
- glycoalkaloïds	Nightshade plants	-	+	-	-	Green potatoes, green tomatoes
- cyanogens	Cassava	-	+	-	-	Improperly prepared foods made from these
- amatoxins	Toxic mushrooms	-	+	-	-	Misidentified mushrooms

[a] Adapted from WHO Technical Report Series, No. 705, 1984 (The role of food safety in health and development: report of a Joint FAO/WHO Expert Committee on food safety)
[b] Almost all acute enteric infections show increased transmission during the summer and/or wet months, except infections due to rotavirus and *Yersina enterocolitica*, which show increased transmission in cooler months.
[c] Under certain circumstances some multiplication as been observed. The epidemiological significance of this observation is not clear.
+ = yes - = no ± = rare 0 = no information

Table 1. Some major pathogens (hazards) that are the cause of the most common foodborne diseases[a]

-
-
-

Bibliography

Angst,F. and R.Steffen (1997). Update of the epidemiology of travelers' diarrhea in East Africa. *J.Travel Med*. **4** :118-120. [This paper discusses the relative risks of contracting diarrhea in various parts of the world]

Cartwright R.Y. and M.Chahed (1997). Foodborne diseases in travelers. *World Health Statistics Quarterly* **50** (1/2): 102-110. [This paper refers to the need to educate food handlers in tourist establishments]
EUFIC (2006). *Food Today*. November/December 2006. [A report on the application of nanotechnology in food production and processing]

Fidler, D.P.(1997). Trade and health: the global spread of diseases and international trade. *German Yearbook of International Law* **40:** 300-305. [A jurist's perspective and a historical account of the link between international trade and health]

International Conference on Nutrition. (1992). *World Declaration and Plan of Action*, Rome, Italy, December 1992. FAO and WHO, 1992 [This is the first international conference referring explicitly to safe food as a right of each individual]

Käferstein, F., Motaremi, Y. and Bettcher, D.W. (1997). Foodborne disease control: a transnational challenge. *Emerging Infectious Diseases* **3**(4): 503-510. [The paper calls for international collaboration to combat foodborne illness]

Käferstein, F.K. (2003). Food safety: the fourth pillar in the strategy to prevent infant diarrhea. *Bulletin of the World Health Organization* **81** (11): 842-3. [An urgent call for a holistic strategy for the prevention of infant diarrhea, combining the promotion of breastfeeding, the vaccination against vaccine-preventable childhood diseases, the provision of safe drinking water and proper sanitation **and** the provision of safe food]

Käferstein, F.K. and Y.Motarjemi (2000). *Foodborne diseases related to travelers: a public health challenge*. Proceedings of the 1st NSF International Conference and Exhibition on Food Safety in Travel and Tourism, Barcelona, Spain, April 2000. [This presentation discusses the importance of food safety for the tourism industry]

Kinnon, C.M. (1998). World trade: bringing health into the picture. *World Health Forum* **19:** 397-406. [This article calls upon the public health community to recognize the link between health and trade but

not to overreact]

Mead, P.S., Slutsker, L., Dietz, V., McCaig, L., Bresee, J., Shaprio, C., Griffin, P. and Tauxe, R.(1999). Food-related illness and death in the United States. *Emerging Infectious Diseases* **5:** 607-625. [CDC's most up-to-date and the most scientifically reliable estimate of the extent of foodborne diseases in the US]

Miyagishima, K. and F.K.Käferstein (1998). Food safety in international trade. *World Health Forum* **19**(4):407-411. [This paper introduces the SPS agreement of WTO]

Motarjemi, Y., Käferstein, F., Moy, G. and Quevedo, F. (1993). Contaminated weaning food: a major risk factor for diarrhea and associated malnutrition. *Bulletin of the World Health Organization* **71**(1): 79-92. [A per-reviewed scientific article providing evidence that infant diarrhea is far more frequently than originally thought caused by contaminated food and that the role of water has been in the past overestimated in the epidemiology of this disease complex]

Motarjemi, Y., Käferstein, F., Moy, G. and Quevedo, F. (1993). Health and development aspects of food safety. *Archiv für Lebensmittelhygiene*, **44**(2): 35-41. [A general article on food safety]

Ryan, C.A., Nickels, M., Hargrett-Bean, N., Potter, M., Endo, T., Mayer, L., Langcop, C., Gibson, C., McDonald, R. and Kennedy, R. (1987). Massive outbreak of antimicrobial-resistant salmonellosis traced to pasteurized milk. *JAMA*, **258** : 3269 [A case report about one of the larger foodborne disease outbreaks]

Sterling, C.R. and Y.R.Ortega. (1999). *Cyclospora : an enigma worth unraveling. Emerging Infectious Diseases* **5**(1). [Cyclospora emerged as a new, previously unknown foodborne *parasite]*

United Nations (1947). *General Agreement on Tariffs and Trade*, Article XX (b). UN New York, pp.188-316.

United Nations (1992). *Agenda 21*,United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June 1992. [20 years after the 1st UN Conference on the Human Environment (Stockholm, 1972), the Rio-Conference assembles the political leaders of the world to obtain their commitments for the protection of the environment and the protection of human health]

United Nations, (2002). *Road map towards the implementation of the United Nations Millennium Declaration*. New York, NY, (United Nations General Assembly document A56/326) [This document contains the targets for development agreed upon by the international community]

WHO (1973). *Handbook of Resolutions and Decisions of the World Health Assembly and the Executive Board*, Vol.1, 1948-1972 (Resolution WHA 2.15, page 55). WHO Geneva, Switzerland. [Contains all resolutions adopted by the World Health Assembly between the establishment of WHO in 1948 and 1972]

WHO (1984). *The role of food safety in health and development*. Report of a Joint FAO/WHO Expert Committee on Food Safety. Technical Report Series Nr.705. Geneva. [This report identifies the problems caused by contaminated food and proposes strategies to resolve them]

WHO (1988). Outbreak of hepatitis A – Shanghai.. *Weekly Epidemiological Record* 63**:** 9192. [A case report about one of the larger foodborne disease outbreaks]

WHO (1990). *Global estimates for health situation assessment and projections*. WHO Geneva, Switzerland, WHO/HST/90.2. [An attempt to quantify the burden of disease]

WHO (1992). Regional Publications, European Series, Nr. 42. WHO, Geneva. [A comprehensive summary of the known facts related to the disastrous outbreak in Spain in 1981-82]

WHO (1992). *Toxic oil syndrome: current knowledge and future perspectives*.

WHO (1993). Prevention of hepatitis A. Weekly Epidemiological Record **68**: 25. [WHO advice to the restaurant industry to consider the use of the newly available hepatitis A-vaccine for food handlers]

WHO (1997*). Human listeriosis*. WHO Geneva, WHO/FNU/FOS/97.1. [A comprehensive and authoritative report about foodborne listeriosis]

WHO (1997). *Prevention and control of enterohemorrhagic Escherichia coli (EHEC) infections*. Report of a WHO Consultation, Geneva, Switzerland, April/May 1997. WHO/FSF/FOS/97.6. [Following several major foodborne outbreak caused by EHEC, WHO convened an expert consultation to provide guidance

to the global public health community for prevention of such infections]

WHO (2003). *Communicable Diseases 2002 – global defense against infectious threat*, edited by M.K.Kindhauser. WHO Geneva, Switzerland. WHO/CDS/2003.15. [Contains a listing of the major communicable diseases and strategies to contain them]

WHO Study Group (1995). *Control of foodborne trematode infections*. Report of a WHO Study Group. WHO Technical Report Series Nr. 849. WHO Geneva, Switzerland. [An authoritative account of the most important foodborne trematode infections, their public health significance and recommendations for their prevention]

WHO. (2007) *E.coli in Spinach* INFOSAN Information note No. 01/2007. World Health Organisation, Geneva [A brief update on the facts related to a spinach-borne *E.coli* outbreak in theUS in 2006]

Wilson J, and Otsuki T (2003). *Balancing risk reduction and Benefits from Trade in Setting Standards. In: Food safety in food security and food trade.* Edited by L. J. Unnevehr, International Food Policy Research Institute (IFPRI Vision Focus Brief # 10, 2003) [This brochure contains 17 policy briefs on food safety in food security and food trade]

World Health Assembly. (2000). *Resolution WHA53.15, 20 May 2000*. [This resolution on *food safety* is the first ever in the 50 years history of WHO. It calls upon WHO member states to commit themselves towards improvement of food safety and thus towards improvement of health and economic development]

Biographical Sketches

Fritz Käferstein, after studying at veterinary schools in Gießen and Berlin (both in Germany), received his veterinary degree in 1962 from the University of Gießen. He obtained in 1964 his Ph.D. for a thesis on the identification and significance of the presence of antibiotic residues in meat. At that time he worked as research assistant at the Veterinary Faculty of the University of Gießen (Germany).

From 1968 to 1972, F.K. worked for the New Zealand Department of Agriculture as a Supervising Veterinarian in the meat industry. Upon his return to Germany, he joined the German Federal Health Office, first as Chief of the Food Safety Unit in the Robert-von-Ostertag-Institut and later as Director of the Center for Monitoring and Health Evaluation of Environmental Chemicals in Food. In this capacity he was also directing the WHO Collaborating Center for Food Contamination Monitoring and collaborated closely with various groups in WHO.

In 1977, F.K. was appointed by the President of Germany as Director and Professor.

In 1980, he was offered by WHO the management of the just established Food Safety Programme, which got its own administrative structure in 1985. During his time with WHO, F.K. developed food safety from a marginal to a core and priority public health programme and initiated the concept of shared responsibility for food safety. He retired from WHO in July 1998 as Director of the Programme on Food Safety and Food Aid. During the 18 years with WHO, F.K. served also as WHO Joint Secretary of the Codex Alimentarius Commission.

At the invitation of the US Food and Drug Administration/Center of Food Safety and Applied Nutrition (Department of Health and Human Services) and the Food Safety and Inspection Service (US Department of Agriculture), he served from November 1998 to September 2001 as Distinguished Visiting Scientist for these two food safety agencies. During that time, he was instrumental in the preparation for and the adoption of, by the World Health Assembly in May 2000, a WHO Resolution that identified food safety as an essential public health function. Also during that time, he worked as Adjunct Fellow at the Center for Food and Nutrition Policy at the Georgetown University, Washington, D.C. and lectured food safety at the School of Public Health, Yale University, New Haven, CO.

As of November 2001, F.K. retired from all official positions and works now as International Food Safety Consultant.

In 1998, F.K. received the R.E. Engel Award for outstanding contribution and dedication to food irradiation. In 1999, F.K. was invited to deliver the Ivan Parkin lecture at the annual meeting of the International Association of Food Protection and received an award to honor his contributions and dedication to the field of food safety. F.K. is the winner of the Walter F. Snyder Award 2000 of the National Environmental Health Association. In 2000, F.K. was selected as an Honorary Diplomat of the

American Veterinary Epidemiological Society. F.K. is a Founding Fellow of the International Academy of Food Science and Technology and a Member of the WHO Expert Advisory Panel on Food Safety.

F.K. has published extensively in per-reviewed journals and has spoken at numerous international symposia and conferences on various aspects of food safety.

Dr. Yasmine Motarjemi has a Masters Degree in Food Science and Technology from the University of Languedoc, in Montpelier, France, and a Ph.D. degree in Food Engineering from the University of Lund in Sweden.

After ten years of research and academic work at Lund University on water activity and heat and mass transfer in foods, in 1990 she joined the Food Safety Programme of the World Health Organization (WHO) and was responsible for the surveillance and prevention of foodborne illnesses. During the ten years of service at WHO, she also served as the WHO representative to many Codex Alimentarius Committees.

In 2000, Dr. Motarjemi joined Nestlé, in Vevey, Switzerland, as Food Safety Manager in the Quality Management Department.

Dr. Motarjemi is author or co-author of numerous publications in the area of foodborne diseases and food safety among which two WHO books.

Dr. Gerald Moy is a staff scientist with the Programme of Food Safety at WHO in Geneva. He serves as manager of the GEMS/Food Programme, which has established a global database for food contamination.

He received his Bachelors Degree in Chemistry from the University of Wisconsin and his Doctorate from Oregon State University in physical organic chemistry in 1976. This was followed by a postdoctoral fellowship in biophysics at the University of New Mexico. In 1978 he joined the US Food and Drug Administration, where he served as Consumer Safety Officer for food additives and animal drugs, and as Desk Officer for Multilateral Programs. In 1987 he became the Food Safety Advisor for the WHO Western Pacific Regions Environmental Health Centre based in Kuala Lumpur, Malaysia. Since 1991, Dr. Moy has been at WHO headquarters in Geneva.

His numerous publications include a chapter in Mycotoxins in Agriculture and Food Safety (Marcel Dekker), and in International Standards for Food Safety (Aspen), and the article, "Healthy Marketplaces: An Approach for Ensuring Food Safety and Environmental Health," in the Journal of Food Control.