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EMERGING PROBLEMS OF FOODBORNE ILLNESS AND THEIR IMPACT ON FOOD SCIENCE AND THE FOOD INDUSTRY

The World Health Organization in 1993 "Food contamination is probably the most widespread world health problem."

Introduction

Food and waterborne illnesses present a problem that no country has solved. Even our knowledge of the current situation is limited - in the U.S.A. still no cause is identified for more than half of the reported cases each year. Because illnesses are

so common, we accept them and are complacent until a major outbreak occurs. Two decades ago, I had a research proposal that was given a high score for funding by the U.S.A. Food and Drug Administration peer review panel but was removed by the Advisory Council because "we already know enough to prevent all foodborne illness if we just applied what we know." Emerging pathogens soon proved that to be false.

As food scientists, our goal is to contribute to food quality. Quality characteristics must include nutritious, palatable, and safe. I'm going to review the current and emerging challenges for prevention of microbial and protozoal causes of unsafe food. (Chemical contaminants, including pesticides, metals, unsafe preservatives and other additives, are important as well.) Total quality management and assurance to facilitate international marketing has been guided by an international set of standards, the ISO 9000 series issued in 1987 by the International Organization for Standardization (Hedman, 1994). Adherence to and the success of this system can be verified and certified by a third party registrar. A second system which focuses on the prevention of microbial problems is the Hazard Analysis Critical Control Point (HACCP) process. This also has international acceptance (ICMSF, 1988; Codex, 1991).

Successful application of HACCP or other preventive approaches can save the food industry the costs of a foodborne

illness problem which include: product recall, plant closings and cleanup, product liability costs, reduced product demand, and insurance premiums. There will also be a reduction in consumer and societal costs. Roberts (1993) estimated that the medical and productivity costs of microbial foodborne illness in the U.S.A. were $5-6 billion annually. Researchers have estimated that there are about 30 cases of acute gastroenteritis a year per 100 people in the Netherlands. At least half are caused by microorganisms.

For the success of a HACCP process, a solid research base is necessary, microbial hazards must be identified for each food (Notermans et al., 1994). As food scientists, we are involved in both the knowledge and its application. Of special concern are the emerging pathogens since these may cause new problems. This concern is not limited to the domestic issues. A 19-member panel recently studying this issue in the U.S.A. (Lederberg et al., 1992, p. v) stated that there is "nowhere in the world from which we are remote and no one from whom we are disconnected." The threats they identified were: global interdependence, modern transportation, trade, and changing social and cultural patterns. These are also keys to prevention of emerging problems!

Emerging (and re-emerging) pathogens are a concern in the food industry. Lederberg et al. (1992) have identified a number related to food: Listeria monocytogenes, Campylobacter jejuni,

Aeromonas species, E. coli O157:H7, Vibrio cholerae, Helicobacter pylori, Vibrio vulnificus, and Streptococcus pyogenes (A).

The Challenges of Change

Why may we expect continued emergence of pathogens? I'm going to use the 7 factors identified by Lederberg (et al. 1992) as my outline.

1. Changing human demographics and behavior.

In the U.S.A., we are targeting education in safe food practices to those groups at high risk; pregnant women and their infants, children, the elderly and those with compromised immune systems. Numbers of people in the last two groups are increasing steadily worldwide. Causes of impaired immunity include AIDS, use of cortisone-related drugs, treatment for cancer and for organ implants, diabetes, and liver and kidney diseases.

Changes in the way people live also change food habits. In industrialized countries, 60% of women are employed outside the home so time available for shopping and meal preparation has decreased. "Time-saving" is a desired quality of foods. As developing countries change toward

this pattern, more ready-to-eat convenience foods will be marketed and less production and preparation will occur at home. The food industry can anticipate changes and consider how best to be sure that food remains safe until eaten. In the U.S.A. guidelines have been developed for the expanded offerings of refrigerated foods (National Food Processors Assoc., 1989).

Changing food habits are a factor too. In the U.S.A. ethnic foods, such as sashimi (raw fish); rare meats (rare breast of duck), and fresh rather than processed foods, are now popular. Populations that always cooked just enough food for one meal and never had leftovers now cook food ahead to save time. Salads are promoted as the "healthy food" or to save cooking energy but may carry high risk for foodborne illness if there has been fecal contamination from water or pickers.

Consumers are demanding reduced-calorie foods. Changes in food formulations can influence food safety. Botulism from eating yogurt? Reduced calorie yogurt caused botulism in England in 1989. The hazelnut-flavored yogurt was made by a local dairy and had been a safe product. What changed? To respond to consumer demand for low-calorie yogurt, the high-sugar canned hazelnut conserve (jam), was replaced with an artifically-sweetened

canned hazelnut puree. Hazelnuts are low acid so, of course, C. botulinum could germinate and grow in that product. The manufacturer forgot that the role of sugar was not only to sweeten but also to preserve. Twenty-seven people were affected; one died (O'Mahoney et al. 1990).

A change in food preparation may be small but still deadly. In the U.S.A., potatoes have traditionally been baked in the oven so the skin becomes crisp. If they are wrapped in foil, the skin stays soft and the potato stays hot longer. The restaurant practice of storing baking potatoes wrapped in foil at room temperature resulted in several outbreaks of botulism traced to potato salad. Leftover foil-wrapped potatoes can indeed support toxin production as our research showed (Sugiyama et al. 1981).

2. Technology and Industry

We think of commercial canning operations as safe, yet in the U.S.A. spot checks of canned mushrooms revealed the presence of botulism toxin. Why? Commercial canners had new machines which mechanized packing of mushroom pieces/slices. Formerly an expensive hand operation, this was quickly accepted technology. The pack was tighter so heat transfer was slower and spore destruction was not achieved.

New food processing technologies can affect food safety. Some, such as food irradiation, can reduce the number of pathogens on raw products. Others, such as aseptic packaging, can improve quality but maintain safety. In order to anticipate problems, mathematical modeling is being refined (Buchanan, 1994). However, because of interactions of all parts of a system, it is still necessary to test each product to confirm the safety of the food or process.

Economic development and land use

Plankton have had a worldwide explosion in numbers as sewage and fertilizer increasingly pollute coastal waters (Levins et al., 1994). Vibrio cholerae is associated with plankton as a reservoir. The new strain of Vibrio cholerae 0139 (Bengal) first recognized in Oct. 1992 has now spread to much of southern Asia. There is potential for many victims since prior infection with V. cholerae 01 does not give immunity. Cholera has implications for the food industry if unsafe water is used or if contaminated raw fruits, vegetables, or seafoods are not heated before consumption.

Water purity and safety are another concern. In treated water, survival of pathogens must be balanced

with minimizing chloride reaction products. Reduced chlorination of public water supplies in Lima, Peru may have contributed to the reemergence of cholera in South America. Population pressures, such as a mass influx of people in Zaire created conditions for epidemics which may not be confined.

4. International travel and commerce

Tourism is a major income activity in many countries. Tourists want the security of there being a supply of safe food and water.

Certainly the quality of food is important as import/export trade grows. A problem may readily become international.

5. Microbial adaptation and change

This may include successful adaptation to new hosts, increased virulence, or new symptoms of infection. The emergence of a major foodborne illness problem was probably due to Escherichia coli O157:H7 genetically gaining the ability to produce two Shiga-like toxins, resulting in a severe disease. Its history is (Neill, 1994):

1982 U.S.A.: Outbreaks in Oregon (Feb.-Mar) and Michigan (May-June). Outbreaks in Canadian nursing home. The organism was identified and considered to be a rare serotype of verotoxin-producing E. coli (VTEC).

1983 The organism was linked to Hemolytic Uremic Syndrome (HUS). Continued sporadic cases and small outbreaks.

1987 First International Symposium on VTEC Infections. Clinicoepidemiologic studies worldwide indicated that the organism had a wide geographic distribution. 100 strains of E. coli O157:H7 quite distinct from other VTEC serotypes appeared to represent a single clone which was widely distributed and had recently descended from a common ancestor (80 different phage types).

1991 Griffin and Tauxe stated that this serotype was a problem in Argentina, Mexico, Australia, China, Japan, Korea, India, Thailand, Israel, and Europe, and a major concern in South Africa and Swaziland.

1993 Largest outbreak in Northwest U.S.A. with 800 patients, 40 with HUS, and 4 deaths. Diseases caused by this organism are now believed to be the 4th most costly foodborne disease in the U.S.A. with estimated medical

and productivity losses of $216-580 million (Marks and Roberts, 1993).

The impact of several strains of salmonellae may also reflect genetic adaptation. Are the interiors of uncracked eggs free from salmonellae? We used to think so. Then a new strain of Salmonella enteritidis emerged. This strain can colonize the reproductive tract of the hen and infect the egg as it is being formed. In the U.S.A. this became the most frequently reported serotype before control measures were effective. In the same years, England and parts of Europe had a similar problem. Roberts and Sackett (1994) reported that Salmonella infections in England and Wales increased from 12,000 in 1982 to 31,000 in 1992. This was largely due to an increase since 1987 in S. enteritidis phage type 4 (64% of all Salmonella reported). (Because of the "iceberg effect of submerged illness," there were probably 100 unreported cases for every one reported.) This epidemic has not impacted the food processing industry, which was already using pasteurized egg products, as much as it did the foodservice and institutional preparation of food.

6. Breakdown of public health measures

   a. Drug and vaccine development have been counted on but require continued investment.

b. Vaccination.

c. Good hygiene. In the food industry, who teaches and monitors employees? Do we have effective hand sanitizers?

d. Water and sewage treatment .

Treatment is important at both production and consumer levels to control viruses, bacteria, and protozoa.

e. Safe food distribution practices.

Can we document time and temperature control? Can disease-carrying rodents and cockroaches contact the food in transit or storage?

f. Safe food handling practices.

In the U.S.A., the federal government in 1994 required handling instructions on all raw and partially cooked meat and poultry products. Research has shown that many consumers do not know or practice safe procedures. Foodservice workers are often untrained and do not know which practices are risky.

g. Vector control.

Rats, mice, and cockroaches can all contaminate foods with potentially harmful bacteria as well as cause food loss.

Complacency

"Only a thin veneer protects humankind from potentially devastating disease epidemics" (Lederberg et al., 1992, p. 106).

Surveillance is very important. The Centers for Disease Control and Prevention (CDC) in the U.S.A. have recently developed a strategy to address emerging threats (CDC, 1994). Food safety issues are a prominent part. Priorities include improved surveillance. The food industry assumes a partnership in this effort.

The second priority, increasing applied research, will also bring benefits to industry. More rapid and precise methods for identifying microorganisms will be useful in monitoring some raw materials, processing steps, and finished products.

The third priority for prevention and control includes improving safety of our food supply as well as an immediate goal of improving consumer practices. A global consortium of epidemiology/biomedical research programs/centers utilizing existing networks and research facilities is proposed. One of several immediate needs which make implementation urgent is that "changing food-industry practices, dietary choices, and globalization of food supplies will bring new challenges to provide a diet safe from pathogens."

Summary

There is a direct and continuing challenge to food scientists. You can increase food safety for the world.

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Education

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
University of Illinois, Urbana	B.S.	1950	Home Economics Education
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University of Wisconsin, Madison	Ph.D.	1959	Foods; Minor-Bacteriology

Department of the Army, Ft. Detrick, Maryland, National Research Council Postdoctoral Fellowship 1968-Microbiology

PROFESSIONAL EXPERIENCE

1969-1994	Professor and Head, Nutrition and Food management Department, Oregon State University
1982-1990	Associate Director, Oregon Agricultural Experiment Station (part-time)
1980-1986	Associate Dean for Research, College of Home Economics(part-time)
1984	Acting Dean, College of Home Economics (January-April, 1981 and 1984)
1976(July-Dec)	Visiting Professor, Department of Food Mocrobiology and Toxicology and Food Reaserch Institute, University of Wisconsin, Madison
1959-1969	Associate Professor and Professor, Foods and Nutrition, Purdue University, Lafayette, IN
1956-1957	Instructor in Foods and Nutrition, University of Wisconsin, Madison

MAJOR RESEACH INTEREST

Food Microbiology with emphasis on public health aspects.

BOOK: CO-AUTHOR

VanGarde, S. J. and M. Woodburn. 1994. Food Presevation and Safety. Iowa State University Press, Ames.

PUBLICATIONS

More than 50 professional articles have been published in the fields of food science and food microbiology.