

**FOOD
TOXICOLOGY**
A Perspective on the
Relative Risks

Food Toxicology

A Perspective on the Relative Risks

edited by

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Preface

The Institute of Food Technologists (IFT) and the International Union of Food Science and Technology each year sponsor a two-day basic symposium, held in conjunction with the annual IFT meeting. The contents of this book are the proceedings of the 12th Basic Symposium, "Food Toxicology: A Perspective on the Relative Risks," which was held June 17-18, 1988, immediately prior to the 48th Annual IFT Meeting in New Orleans.

During the past 20 years we have witnessed a dramatic increase in public awareness of the safety and wholesomeness of the food supply. A very specific example of the public's concern and anxiety regarding protection from exogenous carcinogens was the passage of Proposition 65 in California several years ago. During the past 20 years there have been significant changes in the way in which food is processed and distributed on a worldwide basis. These changes present formidable challenges to people in the food industry and in regulatory agencies who are responsible for the safety and wholesomeness of our food.

During this same period of time, and particularly over the past decade, there has been a great deal of activity on the part of academicians, people in the food industry, and people in regulatory agencies to improve our knowledge base and to improve our ability to define and control risks associated with deleterious substances in food. Some of the people from academia, from the food industry, and from governmental agencies who

have been involved in these activities were speakers at the symposium and are authors of the chapters in this book.

Much of the attention has been focused on the carcinogens that find their way into our food. Accordingly, several chapters are devoted to selected groups of carcinogens such as mycotoxins and N-nitroso compounds. Not all food toxicology problems relate to risks for cancer, so we included several chapters that deal with risk factors other than carcinogens. Finally, there are several chapters in which authors from various backgrounds provide overall perspectives on how risk assessment has progressed and how it is being used in making difficult regulatory decisions.

This symposium was the result of discussions by the symposium organizers when they were members of the Committee on Food Protection, National Research Council/National Academy of Sciences several years ago. The purpose of the symposium was to provide an update and a discussion of the many issues involved in defining and dealing with risk from deleterious substances in our food.

The symposium organizers want to thank the members of the IFT Basic Symposium Committee for approval and support of the program. The committee members included Drs. Merle D. Pierson (Chairman), R. V. Josephson (Past Chairman), J. A. Maga, R. A. Scanlan, C. Akin, B. Klein, V. N. Mohan Rao, L. Wicker, and N. Fogg-Johnson. We are grateful for enthusiastic support and help from R. E. Morse, 1987-1988 IFT President, H. W. Mattson, IFT Executive Director, J. B. Klis, IFT Director of Publications, Anna May Schenck, JFS Associate, Scientific Editor, and other IFT staff members who provided support and coordination for the symposium.

Most especially, the speakers and contributing authors are gratefully acknowledged for their contributions to the symposium and this book. It is their expertise and hard work that resulted in a successful symposium and publication of this volume.

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1

A Perspective on Diet and Cancer

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INTRODUCTION

Food safety is a complex and multifaceted subject. It is a matter that the public is intensely interested in, and for this reason hardly a day goes by without some mention of food safety in the popular press. Unfortunately, but perhaps understandably, the public's perception of this issue is somewhat different from that of many scientists conducting research in the area or charged with maintaining the safety of the food supply.

Popular articles written for the public often focus on diet/health issues. Examples include numerous articles on diet and cancer, which tend to conclude that the risk of developing some major cancers may be reduced by selecting the "right foods." Invariably such articles include a list of foods to eat and foods to avoid.

By contrast, the U.S. Food and Drug Administration (FDA), the federal agency that is charged with protecting the nation's food supply, has expressed a somewhat different view of food safety risks (Schmidt, 1975). The FDA has concluded that of the potential sources of harm associated with foods, the largest by far is microbiological contamination, followed closely by nutritional imbalance including the excessive consumption of food as well as nutritional deficiencies. By contrast, the emotionally

charged issues of pesticide residues and the use of food additives are of much less public health significance.

Microbiological issues are usually straightforward: dangerous microorganisms and microbial toxins should not be in food, and foods that contain them at levels that can cause illness should not be consumed. Anyone who is familiar with the evidence is bound to agree with the FDA's conviction that microbial contamination is the most serious of the known hazards to health that are associated with food.

By contrast, issues like diet and cancer are considerably more uncertain. Cancer is a very complex disease, the origins of which are only dimly understood. Diet and nutrition may affect it, but we don't yet know how.

TRENDS IN CANCER MORTALITY

The American Cancer Society (ACS) publishes annual summaries of changes in cancer mortality in the U.S. (ACS, 1987). Cancer is basically a disease of old age, meaning that your chance of contracting it goes up with each birthday, so the ACS adjusts their data to compensate for the fact that the average age of Americans is higher today than it was in years past.

The ACS data reveal some surprising trends. Death from stomach cancer used to be very common but today is rare. Since the 1930s it has steadily declined. On the other hand, death from lung cancer used to be very rare but today is common. Since the 1930s it has steadily increased. Death from virtually all other forms of cancer has remained relatively constant for the past 50 years. In fact, were it not for lung cancer we would be experiencing a significant overall decline in age-adjusted cancer mortality.

These trends have developed in the face of the revolutionary changes in food production, processing, and preservation methods that have occurred during the past 50 years, including the now widespread use of pesticides, food additives, and processed fats and oils. There is nothing in the U.S. cancer death statistics to indicate that any of these changes has been harmful.

There's another side to this coin, however. (Did I hear someone say that there always is—just ask any professor?) Since cancer risk increases with age, and because the U.S. population is aging, it follows that the overall cancer death rate (not adjusted for age) must also be on the rise. This in fact is true, all the more given that deaths from other killer diseases, such as heart disease and stroke, are declining (CAST, 1987). More of us will die of cancer because we will live longer, and our risk of dying from another

chronic affliction is declining. Whether this represents good or bad news is, of course, a subject for debate.

CARCINOGENS IN FOOD

It does not take an expert to note that there is widespread public concern about carcinogens in food. This too is a bad news/good news issue, but the former is often emphasized to the neglect of the latter.

The bad news is that exposure to dietary carcinogens is an unavoidable fact of life. Given the large number of naturally occurring carcinogens in the environment, it is now (and undoubtedly always will be) impossible to eat a meal devoid of traces of these substances (Ames, 1983; CAST, 1987). Further, as analytical methods are refined and more chemicals studied for carcinogenic activity, this bad news will seemingly mount.

On the other hand, the concentration of carcinogens in the diet is amenable to management through technology. Improvements in detection and control continuously move the dietary carcinogen exposure level downward. More importantly, based on growing scientific evidence (Boutwell, 1985), it is virtually certain that today in the U.S. the levels of dietary carcinogens are not the limiting factor in determining cancer risk. There is no reason whatever to believe that further reduction in the already very low levels of carcinogens in our diet will perceptibly reduce the incidence of cancer. This view may seem extraordinary, perhaps even revolutionary, but it is one that I share with many colleagues in the diet/cancer research field (Boutwell, 1985).

ANTICARCINOGENS IN FOOD

Another bit of good news about our food supply is that it contains numerous anticarcinogens, substances that inhibit carcinogenesis in animal models (Wattenberg, 1983). Personally I find anticarcinogens to be particularly interesting. They belong to a larger class of substances that modulate carcinogenesis and hence may appropriately be referred to as modulators.

Modulators include tumor promoters and enhancers as well as inhibitors. Paradoxically, many modulators both inhibit and enhance carcinogenesis in animals, depending on conditions of test. Some modulators, like the phenolic antioxidant butylated hydroxyanisole (BHA),

may actually appear to cause (initiate) cancer in some rodent strains when fed at relatively high levels for prolonged periods (Lam, 1988). However, when fed at lower levels for limited periods of time, the same substance affords protection against the deleterious effects of concurrent exposure to a carcinogen such as benzo[a]pyrene (Wattenberg, 1983).

There is limited epidemiological evidence that anticarcinogens in food may provide humans with some protection against cancer. It has been suggested that ensuring adequate intake of such substances may prove to be the most practical way to reduce cancer risk via dietary means (Doll and Peto, 1981). Of course, implementation of this proposal depends on identifying the most important dietary anticarcinogens and establishing a safe and effective level of intake. Unfortunately studies to date of specific potential anticarcinogens, such as *beta*-carotene, have been disappointing (Pariza, 1988).

Perhaps we expect too much. The process of carcinogenesis is multidimensional and its modulation complex and paradoxical. It is naive to hope for a single dietary "magic bullet." We must even consider the possibility that a factor that inhibits cancer in me may have no effect upon, or may even enhance, cancer in you.

However, there is reason for guarded hope. In an ongoing prospective epidemiological investigation in Japan, Hirayama (1985) has found that the risk of dying from colon cancer is much lower among subjects who report consuming both meat and green and yellow vegetables on a daily basis (Table 1.1). By contrast, colon cancer mortality was 3 to 4 times greater for those eating on a daily basis meat but not vegetables, but not meat, or neither meat nor vegetables. One interpretation of these findings is that anticarcinogens in foods of both plant and animal origin may act in concert to reduce cancer risk.

TABLE 1.1 Relationship Between Daily Meat or Vegetable Consumption and Colon Cancer Risk

| Dietary pattern | Colon cancer risk (rate per 100,000) |
|--|---|
| Neither meat nor vegetables on a daily basis | 14.9 |
| Meat but not vegetables on a daily basis | 18.43 |
| Vegetables but not meat on a daily basis | 13.67 |
| Meat and vegetables on a daily basis | 3.87 |

Source: Hirayama (1985).