Food Related Risks: A Food Scientist's Perspective

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Safety, Risks and Hazards

The term "safety", while commonly used when discussing foods, has little scientific meaning. "Safety" implies an absence of harm, just as "honesty" implies a lack of dishonesty. Such terms cannot be quantified in a scientific or general sense and so are not scientifically useful. *Scientists think of food safety in terms of hazards and risks.* A *hazard* is the capacity of a thing to cause injury or harm while *risk* is the statistical probability that harm will result (NRC,1983). The difference between hazard and risk can be understood by using the analogy of traveling to Europe by boat. The hazard is that the boat will sink and you will drown. The risk depends on the type of vessel you are traveling on; if it is the *Queen Elizabeth,* your risk is low, if it is a wooden row boat, your risk is high. Scientists think of food safety in terms of hazards and risks, usually in a comparative sense. *Hazard analysis* identifies a food substance which at some level or amount, might cause harm. *Risk assessment* gives the probability the harm will occur. *The magnitude of risk depends on the potency of a toxicant and the dose encountered.*

Food-Related Risks

All foods, regardless of source, have both environmental and human health risks associated with their production, manufacture, and consumption. These risks are generally qualitatively similar whether foods or additives are from traditional sources or derived from biotechnology. Biotechnology has presented few, if any, new Or unknown challenges in food safety. Food related risks resulting from biotechnology differ from traditional risks only in the speed with which they can

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be introduced into the diet and their potential to quantitatively change American diets. The major challenge to regulating food safety from biotechnology relates to the numbers of safety decisions which must be made. Regulators of food safety and those developing new foods or additives from biotechnology must insure (and convince the consumer) that non-traditional foods are of equal or lower risk and greater benefit than traditional foods.

The health-related risks associated with foods, regardless of the source of the food, can be divided into six categories:

1. Pathogenic microorganisms Microbiological risks, such as the occurrence of pathogenic bacteria like *Salmonella enteritidis* or *Listeria monocytogenes,* in foods are the most well characterized food-related risks (Ryser and Marth, 1989) and are usually given top priority. Pathogenic foodborne microorganisms are responsible for hundreds of confirmed deaths of United States residents each year (Archer and Kvenberg, 1985). The actual number of deaths is probably well into the thousands per year. Biotechnologically-derived foods must insure that they do not increase these risks by altering foods. For example, genetic alterations of tomatoes which produce desirable cultural or disease-resistance characteristics would increase microbial risks if the acid content were reduced to the point where the pH was greater than 4.6 and microbes could more readily grow.

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One of the f°°d-related objectives of biotechnology that has not been adequately addressed is the role of biotechnology in reducing food-borne disease. For example, naturally occurring compounds which at relatively low levels can inhibit the production of toxin by *Clostridia botulinum.* If added to foods, either as the chemical, or through inoculation, or biotechnologically, the potential for botulism would be greatly decreased.

2. *Nutrition-related disorders* The risks resulting from the misuse of foods are nutrition related. With a few exceptions, United States residents do not suffer from a lack of nutrients in the classical nutrition sense, but imbalances are common. Nutritional misuse of foods may be the most common food safety problem in the United States. The over-consumption of fat in the American diet, for example, has been discussed by several health authorities as undesirable and as increasing our risks of chronic disease. Less than optimal intake of some nutrients such as iron by some seg-

ments of the population is a further example of a food-related health risk. Changes in major components (e.g., fat) of the American diet may be possible through biotechnology. These may have both beneficial and negative nutritional impacts.

In addition, nutrition research is advancing our understanding of the relations between diet and chronic disease (U.S. HHS, 1988). Less-than-optimal diets increase the risk of chronic life-threatening disease including heart disease and cancer. As a recent study from the National Research Council (NRC) points out, application of biotechnology shows promise as a way to improve the nutritional attributes of some foods (NRC, 1988).

3. *Naturally-Occurring Toxicants.* Recent evidence suggests that the occurrence of natural toxicants in the diet may be a larger risk than commonly perceived (Ames *et al.*, 1987). We have learned to avoid acute toxicants but the role of low levels of substances such as aflatoxin (a mycotoxin derived from molds), plants toxins, or the formation of mutagens when foods are cooked is unknown (Sugimura, 1986).

This food-related risk may be the greatest unknown and largest problem for foods derived from biotechnology. There are cases where new varieties of edible plants obtained by traditional plant breeding contain sufficiently increased amounts of a toxin compared to the older variety to cause acute toxicity in humans (Concon, 1988). For chronic toxicants, such as naturally-occurring chemical carcinogens, the problems become more difficult. How should one view a new vegetable variety with both desirable cultural attributes and an increased level of a compound that will cause tumors in laboratory animals when fed at very high levels? This question is not unlike the debate surrounding the occurrence of low levels of human-made carcinogens such as pesticides, in foods. The speed with which new plant and animal breeds may be derived increases the odds of co-developing naturally occurring toxicants.

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4. Adventitious contaminants One of the consequences of modern life is the contamination *of* the environment by potentially toxic substances. Modern food production and processing can result in the adventitious addition of trace amounts of some of these substances to our foods. Polychlorinated biphenyls (PCBs) are prime examples (Safe, 1987). The occurrence of extremely small amounts of PCBs in food cannot be totally prevented, but most toxicologists would

agree that current levels do not represent a significant hazard. Adventitious additives can also migrate from food contact surfaces such as plastic packaging (Hollifield *et al.*, 1988).

Despite much publicity, we control these risks reasonably well because we usually understand much about these contaminants.

5. *Pesticide residues* Pesticide residues are a risk but at a much lower level than is commonly perceived. Premarket testing requirements (especially for newer pesticides) and strict monitoring of residue levels has helped ensure that this risk remains low (Gunderson, 1988). Biotechnology can produce plants with greater disease resistance, and hence, a reduced need for pesticides but caution must be exercised. Pest resistance is often a result of phytochemical defenses. Cancer or other toxic risks could be increased when resistance results from increased biosynthesis of naturally occurring toxicants. We may be trading the risk from human-made pesticides of known toxicity for plant-derived pesticides of unknown toxicity. A major food safety problem in viewing biotechnology as an approach to decreased dependence on human-made pesticides will be developing way of comparing risks from human-made pesticides to those of naturally occurring pesticides.

6. *Food additives* Despite the common perception otherwise, a considerable amount is known about the safety of food additives. Strict toxicological and use testing of each substance used as an intentional food additive is required. Labeling of foods containing food additives is also required. In fact, there is indirect evidence that some additives (e.g., BHT) may reduce cancer risks (Doll and Peto, 1981).

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Biotechnology may produce a variety of new additives or produce current additives more cheaply. These additives will have to undergo the same rigorous safety testing procedures as current additives.

Identifying Hazards and Determining Risks

Much effort has been expended in testing for hazards that may be associated with foods. For microbial contaminants, significant progress has been made in the use of rapid screening methods. These methods are generally based on some fundamental biological or genetic principle; immunoassay, for example. Chemical contaminants can be routinely detected in foods at levels lower than 1 jig per kilogram of food. For many contaminants this equates to a daily intake of less then 10 nanomoles per day per person.

The problem is not in qualitatively or quantitatively identifying food-borne hazards but rather interpreting the risks associated with the hazards, if present. This is the same dilemma that foods derived from biotechnology must face. For chemical hazards, the fledgling science of risk assessment (NRC, 1983) seems the best currently available tool to assess risk, although the methods are not without sincere critics. Risk assessment, in some form, has partially replaced the zero tolerance approach of older risk control laws such as the Delaney Clause. The Delaney Clause sets a zero tolerance for food additives which "are shown to cause cancer in man or animals" (NRC, 1987).

It has been standard practice to essentially set a zero tolerance for some microbiological hazards; if a food contains certain pathogenic bacteria such as *Listeria monocytogenes*, then its associated risk is deemed too high. Unfortunately, this zero tolerance is unworkable and often ignored. Once again the problem is assessing the degree of risk associated with low numbers of a given pathogenic bacteria in foods. Put another way, how many of a specific pathogenic bacteria must be consumed in order to represent a significant risk? This number has not been determined for most pathogens. How new technologies such as packaging might influence microbiological risk is also of current concern.

Conclusions

The hazards associated with foods in general have been determined. Biotechnology presents few hazards not previously considered and in some cases could substantially reduce risks. Unfortunately, food products derived from biotechnology will face the same dilemma as traditional foods when it comes to determining the magnitude and acceptability of each individual risk.

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