Food Irradiation for Fresh Produce

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Executive Summary

Growing interest in irradiating produce

Two outbreaks in late 2006 of food-borne illness involving *E. coli O157:H7* on spinach and lettuce have intensified the sense of urgency about reducing the risks of pathogens in fresh produce. Members of the produce industries, government regulatory agencies and consumers all share the desire to take effective steps to eliminate or sharply reduce risks from *E. coli* and other produce-born disease-causing organisms.

In the current climate, interest has grown in the possibility that food irradiation, a long-available technology already being used as an anti-bacterial treatment for some poultry and ground beef, could be applied to mitigate problems associated with human pathogens in fresh fruits and vegetables. Irradiation has also been used to kill insects in and extend shelf life of some fresh produce, but it has not been applied to control pathogens in those foods. Some advocates have recently claimed that irradiation could have solved produce safety problems long ago, if its use had not been inhibited by political opposition and industry and government timidity. But the facts are much more complex.

Current status of irradiation for fruits and vegetables

While irradiation in theory has a significant potential to enhance produce safety, its use for this purpose first needs to be approved by the US Food and Drug Administration. A petition seeking such approval was submitted to the FDA by a food industry coalition in 1999, but approval has not been granted yet. The basic reason for this delay is a lack of good scientific information on critical issues the FDA would have to resolve in order to conclude that irradiation of produce is effective and safe.

While irradiation can undeniably kill food-borne bacteria, radiation at doses useful for that purpose can adversely affect the sensory quality of foods. Early studies of irradiated fruits and vegetables indicated that these fresh, plant-derived foods are more sensitive to radiation damage than meats, spices, or grains. In fact, the doses of radiation required to reduce pathogen levels to effectively safe levels generally caused unacceptable sensory damage in fresh produce. For many years it was therefore assumed that fresh fruits and vegetables, and related products like nonpasteurized fruit juices and pre-cut salads were not suitable candidates for food irradiation.

Promising recent research, but much more still needed

With growing awareness of the magnitude of pathogen contamination of produce, that conclusion is being reassessed. Research in the past decade or so has explored the use of lower doses of irradiation on fresh produce, to find out whether acceptable reductions in pathogen loading can be achieved while preserving the taste, aroma, color and texture of the foods.

This still relatively small field of research has produced some promising evidence that it may be possible, in many cases, to strike the right balance between pathogen reduction and preserving produce quality. Particularly if irradiation is combined with other anti-microbial treatments and food preservation steps, recent studies suggest that irradiation may eventually be usefully applied to some current produce-pathogen problems. However, this same research indicates that applying food irradiation to a particular food-pathogen combination requires knowledge about a large number of parameters that affect the results of irradiation. The problems are complex, and research to date has identified many needs for additional and better data. Without the FDA's approval, a horse-and-cart problem exists: There is no current market for irradiated produce, and therefore minimal economic incentives to spend the money to answer the challenging scientific questions that need to be answered to support both an FDA decision and commercial-scale produce irradiation. Although food irradiation is used in several other countries, research needed to implement it here is likely to advance slowly, and produce irradiation will probably not be commercially practical in this country for years, unless the situation changes radically.

Safety steps are needed now

Given the urgency of reducing risks from pathogens in produce, the industries and the regulatory agencies involved cannot wait for irradiation to arrive like a deus ex machina to solve these problems. Instead, those stakeholders must act now, using available Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP) and safety systems such as Hazard Analysis by Critical Control Points (HACCP). These well-tested, feasible risk-reducing measures can undoubtedly be more effectively applied than they have been to date (guided by some well-focused research), and should significantly reduce the risks from produce-borne pathogens.

The clear choice for the produce industries today is to move ahead forcefully and rapidly with proven, currently available risk-reduction measures. Research may eventually show that irradiation of produce is feasible, effective and worth doing as an added safety step in specific cases. But by the time research gets that far, many of these problems may already have been solved by other means.

The critical scientific and practical questions

This report examines the research topics on which more extensive data are needed to determine how useful food irradiation might be as a partial solution to produce safety problems. The topics covered include:

How effectively can irradiation reduce pathogen loads on fresh produce?

Laboratory research to date suggests that irradiation can reduce pathogen populations on fruits and vegetables of various types by about 100- to 100,000 fold. Irradiation of meats has been reported to cut bacterial loading by 100- to 1,000,000-fold. The criterion for effectiveness for processes like heat pasteurization, used to control pathogens, is at least a 100,000-fold reduction. A critical question is clearly whether the generally lesser pathogen reductions attainable on irradiated produce make the foods "safe enough."

The available studies also show that the degree of reduction of bacterial populations depends on many factors, including the type, variety and physical characteristics of the foods involved; the type of radiation used; the strain of bacteria; how well the particular food supports re-growth of the bacteria that survive; how long and at what temperatures the food is stored after irradiation; and numerous other variables. Irradiation protocols must be carefully tailored to fit the specific needs of specific food-pathogen combinations under specific conditions. There is no one-size-fits-all approach. Research is needed both to develop applications for specific problems, and to determine whether results obtained in controlled laboratory experiments can be replicated on a commercial scale.

Will irradiated produce retain acceptable sensory quality?

Recent research suggests that irradiated fruits and vegetables can often have acceptable sensory quality, although the low doses required to preserve food quality may provide bacterial load reductions that are less than optimal. The most promising approaches combine low-dose irradiation with other anti-bacterial treatments (e.g., warm-water dips, modified atmosphere packaging) or with other food preservation techniques (e.g., adding sorbic acid to irradiated juices).

Available studies have found no serious loss of sensory quality (flavor, texture, aroma, and appearance) for many fresh fruits and vegetables tested with such regimes. However, more extensive research is still needed to determine

the best combinations of measures and irradiation doses for specific produce varieties and pathogens. Results are likely to be highly specific to food variety, pathogen and other aspects of the problem to be solved. Given the complexity of sensory quality, developing the needed data poses a considerable research challenge.

Is irradiated produce safe to eat?

Many expert authorities have reviewed the evidence over the years, and concluded that irradiated foods do not pose significant health risks to people who eat them. Some important scientific uncertainties remain, though, and some new safety questions related specifically to irradiation of fruits and vegetables still need to be evaluated. Recent studies indicate that irradiation of high-carbohydrate foods, such as fruit juices, creates small amounts of furan, a chemical that causes cancer when fed at high doses to lab animals. Amounts formed by irradiation are very small, and less than amounts formed when foods are cooked, but more data are needed.

Concern also exists that irradiating fruits and vegetables in their packaging (the preferred method, as it prevents post-irradiation bacterial recontamination) could make chemicals from packaging materials migrate into foods. Some packaging materials used for produce today have not been tested for this potential problem, and research is needed on effects of irradiation at realistic doses on specific foods in their likely actual packaging.

Does irradiation of produce have other disadvantages?

Awareness that fruits and vegetables were going to be irradiated, or had been irradiated, might dispose people at all steps from farm to table to be less attentive to proper sanitation procedures. For example, growers and processors might apply GAP and GMP less aggressively, or retailers and consumers might neglect proper refrigeration in the mistaken belief that irradiated foods were sterilized. If so, irradiation could devolve from being one additional safety measure (its proper role) to become an end-of-the-line “clean-up” for a sub-optimal production process, or it could generate a “false sense of security” in the safety of irradiated produce. No one wants these outcomes to occur, but they are reasonable concerns and would need to be addressed through stakeholder education programs.

Is irradiation of produce economically feasible?

Although food irradiation facilities cost millions of dollars to build and operate, they would not need to be built specifically to irradiate fruits and vegetables. If the FDA approves produce irradiation, members of the industry could use existing facilities (those that irradiate meat, for instance). There would be significant logistical challenges—transporting crops to and from irradiation sites, funneling produce through irradiation during the intensity of a harvest season. It seems likely that irradiated produce would cost more than non-irradiated versions, but how much more is unclear.

The biggest economic challenge lies in projecting market demand for irradiated fruits and vegetables. Demand for other irradiated foods (such as beef and poultry, for example) has not grown rapidly, and most irradiated foods still comprise only a very small fraction of their markets. Without strong market demand, it is unlikely that investors would choose to absorb the large up-front (research) costs needed to support specific new applications of food irradiation. It is unclear, therefore, whether economic conditions would favor the growth of a market for irradiated fruits and vegetables, even if this irradiation use were authorized by the FDA. Even if irradiated fruits and vegetables do eventually appear on the market, the vast majority of produce will remain non-irradiated.

Will consumers accept irradiated produce?

Some will and some won't. Some people will be attracted by the perception that irradiated produce is safer, while others will find the unanswered safety questions, or the thought that irradiation might come to be used as a back-stop for inadequately safe production practices, troubling, and choose not to buy irradiated fruits and vegetables. Some might choose organic produce because they know it is not irradiated, while others might avoid organic for exactly the same reason. In the end, the acceptability of irradiated produce will depend primarily on its sensory quality (it will need to be comparable to non-irradiated produce), and on the perception that it really is safer, i.e., delivers added value, especially if it costs more than non-irradiated produce. If these conditions are met there is no reason why most consumers would not be willing to try irradiated fruits and vegetables.

Conclusion

Food irradiation seems to have some potential to be a useful tool for managing problems of pathogens on fresh produce. But the research needed to support these applications is a relatively new and still small field. A great deal more research is needed to answer basic scientific questions and work out practical details. The FDA has not approved irradiation of fresh produce for pathogen control, largely because some of the scientific data needed to support a regulatory decision do not exist yet. Given the complexity of the problems, the amount of research that still needs to be done and the lack of market demand to drive that research, it seems unlikely that irradiation of fresh produce will become a practical reality for several years, perhaps even longer.

The critical questions—whether irradiation can make pathogen-contaminated fruits and vegetables acceptably safe without unacceptably altering their sensory quality, whether commercial-scale produce irradiation is technically and economically feasible—cannot be adequately answered at present. It is not clear yet whether fresh fruits and vegetables irradiated for safety reasons will eventually reach the market. Even if they do, the vast majority of produce will remain non-irradiated for the foreseeable future.