CHAPTER 17

Successful Marketing of Irradiated Foods

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17.1 Introduction

The extensive list of medical and scientific organizations endorsing or supporting irradiation of food should be used extensively to convince retailers and the public of the widespread support for food irradiation. Irradiation of food is already approved in the United States for most perishable foods and has been endorsed by the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA), United States Department of Agriculture (USDA), American Medical Association, and European Commission Scientific Committee on Food. In fact, hundreds of credible groups support irradiation while a very limited number of special interest groups opposed to the technology rely on inaccurate and outdated information as well as half-truths to create unwarranted fear and suspicion. Unfortunately, because of a widespread lack of understanding of the risks and consequences of food-borne disease and of the effectiveness and safety of irradiation – and because of intense opposition from antinuclear activists and other special interest groups – irradiation of food as a public health measure has not yet reached its full potential and achieved widespread consumer acceptance.

Both retailer and consumer perceived concerns can largely be addressed by ensuring that retailers are prepared to offer accurate and timely responses to

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any potential consumer concerns raised. Political and or commercially motivated issues such as eat local *versus* imports can be addressed through progressive in-store merchandising that offers multiple choices that empower the consumer with choices to meet their own unique needs and beliefs. Often irradiated products have a distinct advantage in either quality and or price, which are both key consumer decision-making factors that attract consumers.

Building trust in the systems that will deliver and regulate food irradiation is essential. Health and scientific organizations can play a significant role in creating greater awareness of the benefits of irradiation. Governments must become more proactive and take a science-based stand. Conditions must be created whereby consumers can exercise their free choice of buying or not buying irradiated food. More efforts should be made by industry and governments to address issues such as lack of irradiation capacity, packaging approvals, optimizing supply chain reliability, and developing facilities to treat food where food is finally packaged.

In this chapter, the arguments raised by critics of highly beneficial technologies, such as pasteurization, immunization, and chlorination, will be compared to arguments raised by critics of food irradiation. I will present statistics on preventable foodborne illnesses caused by contaminated food, summarize consumer acceptance studies at leading universities, and finally show that significant progress is being made in the introduction of irradiated food at supermarkets in the US and many other countries. Finally, I will provide suggestions for future actions that will help expand the use of food irradiation.

17.2 Background

Many innovations, even those with obvious advantages, require a lengthy period between the time at which they become available and when they are widely accepted.[1] Technologies such as pasteurization, immunization, and chlorination are now considered by health experts to be ''pillars of public health'', yet each of these lifesaving innovations was met with suspicion and resistance when first introduced.

Despite widespread media attention from food recalls, serious illness, and death, food irradiation technology remains underutilized and often misunderstood.

Irradiation is one process with multiple purposes,[2] for example:

- **Prevention of Foodborne Illness** – irradiation can be used to effectively eliminate organisms that cause foodborne illnesses, such as *Salmonella* spp., *Escherichia coli*, *Listeria* spp., *Vibrio* spp., and *Toxoplasma gondii*.
- **Control of Insects** – irradiation can be used to destroy insects that threaten local agriculture by ''hitchhiking'' in or on imported tropical fruits. Irradiation also eliminates the need for harmful pest-control practices, including hot water dips, fumigation, and methyl bromide among others.

- **Preservation** – irradiation can be used to destroy or inactivate organisms that cause spoilage and decomposition and extend the shelf life of foods.
- **Disinfestation:** irradiation is a disinfestation tool that can destroy insects and larvae that often consume harvested crops before they reach the consumer. There are estimates that in many countries as much as 30–40% of the harvest never reaches the consumer because of spoilage caused by weevils that could easily be killed by irradiation.
- **Delay of Sprouting and Ripening** – irradiation can be used to inhibit sprouting (*e.g.*, potatoes) and delay ripening of fruit to extend freshness.
- **Sterilization** – irradiation can be used to sterilize foods, which can then be stored for years without refrigeration. Sterilized foods are useful in hospitals for patients with severely impaired immune systems, such as patients with AIDS or undergoing chemotherapy. The National Aeronautics and Space Agency (NASA) has served irradiated foods to astronauts on space flights for many years. Foods that are sterilized by irradiation are exposed to substantially higher dose levels of treatment than those approved for general use.

17.2.1 Food Safety

There is virtually unanimous agreement by scientific and medical associations and scientific groups that irradiation is not only safe, but also that its widespread use would dramatically improve the safety of our food. Food irradiation has the potential to reduce the incidence of foodborne diseases and has earned virtually unanimous support or approval from international and national medical, scientific, and public health organizations, as well as food processors and related industry groups.

Dr Robert Tauxe of the US Centers for Disease Control and Prevention estimates that if 50% of poultry, ground beef, pork, and processed meats in the United States was irradiated, the potential benefit of the irradiation would be a 25% reduction in the morbidity and mortality rate caused by these infections (Table 17.1). This estimated net benefit is substantial; the measure could prevent nearly 900 000 cases of infection, 8500 hospitalizations, more than 6000 catastrophic illnesses, and 350 deaths each year. Given the probable number of unreported and undetected foodborne illnesses, this reduction is likely to be even greater.[3]

17.2.2 Insect Control

Irradiation is widely considered the most effective and environmentally friendly phytosanitary technology available to prevent the importation of harmful insect pests that may hitchhike on imported produce. As a result, there is a significant increase in the amount of irradiated produce entering the international market. The list of countries marketing irradiated produce is growing rapidly as producers, importers, and consumers begin to

Table 17.1 Potential number of health problems prevented annually if 50% of meat and poultry was irradiated.

Pathogen	Cases	Hospitalizations	Major complications	Deaths
E. coli O157:H7 and other STEC[a]	23 000	700	At least 250 cases of hemolytic uremic syndrome	20
Campylobacter	500 000	2600	250 cases of GBS	25
Salmonella	330 000	4000	6000 cases of reactive arthropathy	140
Listeria	625	575	60 miscarriages	125
Toxoplasma	28 000	625	100–1000 cases of congenital toxoplasmosis	94
Total	881 625	8500	6660 catastrophic illnesses	352

[a]STEC – Shiga toxin-producing *E. coli*.

understand the benefits of irradiation and that irradiation is often the most effective technology available to protect local agriculture. In many cases, irradiation is the only viable option to gain this market access. For example, irradiation is a mandatory treatment for at least 17 fruits from Hawaii to enter the US mainland. Irradiation is mandatory for import into the United States of a wide variety of fruit from at least a dozen countries. High on the list are litchis, mangoes, and guavas among others. For more information on the current status of countries using food irradiation, go to http://www.foodirradiation.org.

17.3 The Common Past of Food Technologies

While there has been a significant increase in the availability of irradiated foods in the market place, in the US, one still has to look very hard in supermarket to find foods that have been irradiated. There continues to be apprehension by retail management about offering irradiated food, although in many cases irradiated food items, especially imported produce and pet treats, have been on their shelves for several years. The mention of the word *irradiation* still creates a certain amount of apprehension in some corporate offices and in the minds of a small number of consumers.

Let's take a look at the gradual acceptance of several technologies that were controversial when first introduced but that are now commonplace. These include pasteurization, immunization, and chlorination, each of which are now considered lifesaving and have indeed saved thousands of lives.

17.3.1 Pasteurization

The process of heating or boiling milk for health benefits was recognized during the early 1800s. During the 1850s, Louis Pasteur discovered that

heating could eliminate bacteria. This process became known as pasteurization and was highly controversial at that time.

As society industrialized at the turn of the 20th century, increased milk production and consumption led to outbreaks of milk borne diseases. Common milk borne illnesses included typhoid fever, scarlet fever, septic sore throat, diphtheria, tuberculosis, and diarrheal diseases.[4]

A century ago, milk products caused approximately 1 out of every 4 outbreaks due to food or water in the United States. Today, far less than 1% of all food and waterborne illnesses can be traced to dairy products. In fact, dairy products cause the fewest outbreaks of all the major food categories (*e.g.*, beef, eggs, pork, poultry, produce, seafood). This drastic improvement in the safety of milk over the last 100 years is believed to be due primarily to pasteurization and improved sanitation and temperature control during the processing, handling, shipping, and storage of fresh milk products.

The controversy over banning raw milk sales has raged since pasteurization was first introduced well over a century ago. Throughout decades of debate, the public health and medical communities have remained steadfast in their support of pasteurization as a key measure to protect the public health.

Pasteurization became mandatory for all milk sold within the city of Chicago in 1908, and in 1947 Michigan became the first state to require all milk for sale within the state to be pasteurized.

As late as the 1930s, many in the dairy industry resisted the widespread use of pasteurization. Even today, there is a movement by some to promote raw, unpasteurized milk. One of multiple concerns expressed was that the promotion of pasteurized milk would cast a negative shadow over the non-pasteurized product and force milk handlers to install ''expensive'' equipment to pasteurize milk. Anti-pasteurization activists continue to spread misinformation about pasteurization. Many of the arguments made have been around for more than a century.

During the 1920s, the US dairy industry and insurance companies promoted so-called certified raw milk as a more acceptable alternative to pasteurization. It was only through the insistence of medical and scientific groups that the dairy industry abandoned its ''good milk'' *versus* ''bad milk'' concerns and embraced pasteurization as a lifesaving technology that would help make all milk safe.[5]

Pasteurization took nearly 70 years to be fully accepted in the United States, and the arguments against it were almost identical to those used today against food irradiation. Among some 70 concerns raised by the critics of pasteurization were the following:[6]

- ''We must not meddle with nature.''
- ''This process changes the properties of the food.''
- ''Dangerous substances could be formed.''
- ''This process could be carelessly done and accidents could happen.''

- ''Pasteurization will increase the price of the product. We have a direct and prompt food distribution system.''
- ''It is not necessary.''

None of these doomsday predictions turned out to be true; however, the campaign against pasteurization, including resistance from dairy producers and processors, significantly delayed its introduction, with the effect that thousands of people suffered chronic illnesses, developed long-term health consequences, or died. The question of legal responsibility for inflicting this suffering was never explored.

17.3.2 Anti-vaccination Movement

Vaccination is one of the most successful programs in modern medicine, reducing and in some cases even eliminating serious infectious diseases. Public support for the vaccination program remains strong, especially in the United States where vaccination rates are currently at an all-time high of >95%.[7]

Despite a long history of safety and effectiveness, vaccines have always had their critics: some parents and a tiny fringe of doctors question whether vaccinating children is worth what they perceive as the risks. In recent years, the anti-vaccination movement, largely based on poor science and fear mongering, has become more vocal and even hostile.[8]

Regardless of the growing scientific consensus that vaccines are safe, a stubborn vocal minority still claims otherwise, threatening the effectiveness of this public health program.

17.3.3 Anti-chlorination Movement

Science shows that adding chlorine to drinking water was the biggest advance in the history of public health, virtually eradicating waterborne diseases such as cholera. The majority of our pharmaceuticals are based on chlorine chemistry. Simply put, chlorine is essential for our health.[9]

Despite science concluding no known health risks—and ample benefits—from chlorine in drinking water, some environmental groups have opposed its use for more than 20 years.[1]

According to the WHO: ''In a study on the effects of progressively increasing chlorine doses, on healthy male volunteers (10 per dose), there was an absence of adverse, physiologically significant toxicological effects in all of the study groups''.[10]

17.3.4 Genetically Modified Organisms (GMOs)

The most recent technology controversy involves genetically enhanced crops commonly known as *genetically modified organisms* or GMOs. Despite objections raised by critics, there is virtually unanimous agreement that

genetically enhanced crops are safe. The GMO issue is more difficult from a consumer acceptance standpoint because the benefits are generally for the farmer and not usually for the consumer.

In 2014, the state of Vermont became the first state in the US to require the labeling of genetically engineered foods. There is no guarantee of legal action, of course, but legislators, officials, and GMO advocates are preparing for the state to be sued over the new law.[11]

The African country of Zimbabwe has chosen to reject any food aid that includes genetically modified ingredients just as Zimbabweans are suffering from the worst drought in two decades and up to three million people are in need of emergency relief. The people of Zimbabwe may starve but at least the country will be GMO-free![12]

17.3.5 Resistance to ''New'' Technologies

Many, perhaps most, of the arguments against pasteurization, vaccination, chlorination, and genetically enhanced seeds are similar to arguments against food irradiation.

Although food irradiation, sometimes called ''cold pasteurization'', has been described as the ''most extensively studied food processing technology in the history of humankind'' and is endorsed or supported by virtually every medical and scientific organizations, the process is still considered a relatively ''new'' technology.

It is human nature to resist change and to fear the ''unknown''. Critics who believed the earth was flat stifled exploration of the ''new world''. Arguments against constructive change take many forms. University of Houston economics professor and noted author Thomas R. DeGregori says: ''One common argument against change is the search for a *risk-less* alternative''.[13] DeGregori says: ''Every change has its risks; some real, others imagined. Whether a change is political, scientific, or technological, a simple assertion of risk should not in and of itself be an argument against that change. We must measure the benefits of change against the risks of not changing''.

Christopher Columbus and other explorers faced a multitude of risks, but their ships did not drop off the edge of the earth.

Those who wish to maintain the *status quo* and convince others that the risks outweigh the benefits often make impossible demands for a zero-risk society. Those who choose to believe that the earth is flat despite overwhelming scientific evidence to the contrary have every right to do so. In a free society, proponents of the ''Flat Earth Theory'' have a right to their own set of opinions, but those opinions do not alter the fact that the earth is demonstrably and unequivocally spherical.

17.3.5.1 Risk versus *Benefits*

DeGregori says: ''If we examine the many changes over the past century, changes that have reduced infant and child mortality by more than 90%,

have given Americans nearly 30 years of added life expectancy, have recently caused an even more rapid growth in disability-free years of life, and have allowed comparable or greater advances in other countries, we will find that all those changes carried risks.''[13]

Technologies such as chlorination of water, pasteurization of milk, synthetic fertilizers, chemical pesticides, modern medicine, genetically enhanced organisms, immunization, and irradiation, to name a few, all faced and continue to face various levels of opposition. Most cities use chlorine to purify their water, most parents want their children immunized against dreaded diseases, and very few people would consider drinking unpasteurized (raw) milk because of the known risks. Yet these lifesaving technologies all have their risks. Chlorine is toxic and immunization can sometimes cause the disease it was intended to prevent. Pasteurized milk tastes different than milk straight from the cow, can be re-contaminated, and will spoil if not refrigerated. By comparison, the risks of irradiation, if there are any, are ''unknown'' because after years of study, scientists have not found any.[14] Weigh that against the known risks of contracting bacterial illnesses from the consumption of food that harbors unseen pathogens.

17.3.5.2 World's Safest Food Supply; Safe Enough?

Food safety is at the top of every food processor's list of priorities. The public demands safe food and the marketing of an unsafe product is a recipe for disaster. Recalls are expensive, damage the brand image, and almost always result in litigation. A foodborne illness outbreak resulting in hospitalization or death is always a serious threat to a company's viability.

In the US and other highly developed countries, we often hear the words 'we have the world's safest food supply'. The food industry has invested hundreds of millions of dollars in technology to make food safer. Any claim about producing the world's safest food is open to challenge. The CDC estimates that 48 million foodborne illness cases occur in the US every year. At least 128 000 Americans are hospitalized and 3000 die after eating contaminated food.[15]

17.4 Consumer Acceptance of Foods That Have Been Irradiated

Acceptance of irradiation has been slowed down by several factors. First, the term ''irradiation'' is sometimes confusing or alarming to consumers because of its perceived association with radioactivity. Second, the general public poorly understands the causes, incidence, and prevention of foodborne disease. Third, health professionals and the media are largely unaware of the benefits of food irradiation. Finally, certain activist groups, because of their beliefs about food production issues, nuclear power, international trade, and industrialization, as well as the introduction of

technologies, have conducted an anti-irradiation campaign. These same groups and individuals oppose most other new technologies and in many cases are against even technologies such as pasteurization, immunization, chlorination, and other widely accepted technologies.

17.4.1 Summary of Retail Experience

There is now sufficient experience to show that when labeled irradiated foods are offered for retail sale, consumers will purchase and continue to purchase irradiated foods, implying that irradiated foods may be marketed profitably and without risk to reputation. The experience has been gained in several countries including those with sophisticated, well-informed consumers with active lobby groups who favor 'natural' and minimally processed foods, such as the US and New Zealand. Though vocal at times, opposition seems to have little impact on most consumers who, at the moment of purchase, make decisions on the basis of what they see in front of them and price. This does not imply unanimous acceptance of irradiated food, but it does imply that many of the concerns expressed by retailers reluctant to place irradiated foods on the shelves is unwarranted.

No food is purchased or wanted by all consumers. Consumers buy products based on their wants and needs and not simply because the products are available. The retailers will make future decisions based on actual sales to consumers.

17.4.2 Understanding Consumer Attitudes

It is not hard to conceive why it was originally thought that consumer resistance was the major barrier to the acceptance of food irradiation. Special interest groups and anti-food irradiation lobbyists declared that irradiated products were neither wanted nor needed, a position seemingly justified by the slow acceptance. The public may often equate irradiated food with radioactivity and any new technology involving radiation or radioactivity has been mistrusted despite the long-term use of such technologies in medicine and industry.

The question is why, in view of the significant examples of successful retail sale that now exist, the belief in consumer resistance still persists among some food producers and retailers? The answer probably lies in the early surveys of consumer opinion about food irradiation, an overly simplistic interpretation of the results and their use by anti-nuclear and anti-irradiation lobbies.

The literature on surveys of consumer opinions on food irradiation has become extensive. Articles on the US consumers' perception of food irradiation and irradiated meat are numerous and have been reviewed by Eustice and Bruhn.[16]

Besides the US, there are now data from the EU, Canada, Brazil, Australia, New Zealand, and a few developing countries. The methodologies, size of the

studies, and rigor of the analyses vary widely, but there are some clear trends:[17–22]

- First, most respondents have never purchased or consumed irradiated food. Their opinion is sought about an abstract concept. Generally, it is found that:
- The majority of respondents have not heard of irradiation or know very little about the process.
- The initial reaction of most consumers asked if they would purchase irradiated food is negative.
- When provided with factual evidence, the number of respondents willing to consider purchasing irradiated food increases, often then comprising a majority of consumers even if asked to consider paying a premium. Providing negative information at the same time as positive information offsets the increase in acceptance.
- For fresh produce, irradiation is viewed more favorably than chemical treatments when a similar level of information is provided about the technologies.
- Irradiation is viewed much less favorably than other physical processes such as cold storage with which the respondents feel they are familiar. Social scientists have now examined consumer reactions to novel technologies in greater depth through studies in which genetic modification, nanotechnologies, or high pressure are assessed together with irradiation. These studies show that irradiation is not unique in engendering both general and organized opposition. A full discussion of these important recent findings is beyond the scope of this review but the studies show clearly that:
- The issue of acceptance of a new food technology has much to do with trust in the systems in place to regulate and deliver the technology. The issues are greater than the risk perception *per se*.
- Technologies that are not perceived as ''natural'' or which are thought to alter the character of the food generate greater opposition than technologies that are familiar or perceived as more ''natural''.
- Labeling can help provide some degree of control, although one-third of respondents in a US survey would consider the word ''irradiated'' on a label to be a warning.
- Information can be valuable in increasing positive responses to novel technologies, but the information must be focused on the benefits to consumers. Technical details of the process often lead to consumers feeling they cannot understand the process and that it will be out of their control. New technologies, which are perceived as being of benefit mainly to the food industry, tend to be distrusted.

It is estimated that, in 2015, US retailers sold approximately 5000 ton of irradiated ground beef and approximately 20 000 ton of irradiated fruits, mainly litchis, persimmons, mango, papaya, purple sweet potatoes, and

guava. Spices have been commercially irradiated since 1986. Approximately one-third of the commercial spices consumed in the US, *ca*. 80 000 ton, are irradiated annually.[23]

17.4.3 Defining Moment in Food Safety

The successful commercial introduction of irradiated ground beef went largely unnoticed. According to food safety expert Morton Satin, when irradiated ground beef was introduced, consumers gained a reasonable expectation of buying products that offered much greater food safety and lower risk. As a consequence, untreated ground beef acquired the character legally defining a product having a built-in defect.

Extensive evidence from several countries shows that labeled irradiated foods (fresh and processed meats, fresh produce) has now been successfully sold over a long period by food retailers. There is no record of any irradiated food having been withdrawn from a market simply because it had been irradiated. Although there are some consumers who choose not to purchase irradiated food, a sufficient market has existed for retailers to have continuously stocked irradiated products for years, even more than a decade.

The long-standing belief among food producers and retailers that consumer resistance is the major barrier is no longer justified and there are lessons to be learned from the successful experiences. Provision of factual, positive information on the benefits of food irradiation to consumers and the food trade is still necessary. However, strategies to increase retail sales of irradiated foods should be modified in light of recent studies on consumer attitudes to novel food technologies generally.

Studies show that it is trust in the systems and institutions rather than perceptions of risk that dictate consumer attitudes and govern the adoption of a new technology. Retailers play an essential role in communicating the benefits of new products to consumers and it is likely that positive messages on irradiated food from retailers and food producers will generate the most favorable response from consumers.

Historically, large retail food chains have only engaged to a limited extent with food irradiation experts. It is vital to ensure that the message about successful retailing of irradiated food is continuously presented to leading retail stakeholders, and to take every opportunity to put irradiated food on retail shelves. If food irradiation proponents are persuaded that trying to convince consumers directly to accept the process should not be their sole strategy, then more effort can be put into working collaboratively with the food trade to address issues such as lack of irradiation capacity, optimizing supply chain reliability, and developing facilities to treat food where food is finally packaged.

No single intervention can provide 100% assurance of the safety of a food product. That is why meat and poultry processing plants use a multiple barrier (hurdle) approach utilizing several types of interventions, such as thermal processes combined with chemical and antimicrobial treatment to

achieve pathogen reduction. These technologies have successfully reduced, but not eliminated, the amount of harmful bacteria in ground beef. Food irradiation does not eliminate the need for established, safe food handling and cooking practices, but when used in combination with other technologies including an effective Hazard Analysis Critical Control Points (HACCP) program, irradiation becomes a highly effective and viable sanitary and phytosanitary treatment for food and agricultural products. Irradiation is one of the most effective interventions available because it significantly reduces the dangers of primary and cross-contamination without compromising nutritional or sensory attributes.

17.4.4 Barriers to Acceptance

The most significant obstacle to increased consumer acceptance of irradiated foods may well be the lack of availability in the marketplace. A survey of retail and foodservice beef purchasers was conducted in January and February 2004 by the National Cattlemen's Beef Association to measure the awareness of and attitudes toward irradiation technology among foodservice and retail establishments that do and do not offer irradiated beef, measure the willingness to offer irradiated ground beef among those that do not offer it, identify barriers/issues to offering irradiated ground beef including researchable knowledge gaps, and both identify successful retailers and determine which practices help them sell this product.[24]

The study showed that about four in ten knowledgeable past users and nonusers of irradiated ground beef reported lack of availability as the main reason for not offering irradiated ground beef to their customers. This same study showed that respondents were relatively positive about purchasing irradiated ground beef. Almost half of past users were very (14%) or somewhat (33%) likely to purchase the product within the next year, and more than a fourth of the knowledgeable nonusers were very (4%) or somewhat (23%) likely to do so. In addition, a majority of the current purchasers (58%) indicated that they would increase the amount of irradiated ground beef they buy (*versus* 23% intending to reduce the amount). These data show a growing rather than a shrinking market.

17.5 Future Directions

Food irradiation should contribute appropriately to safer food, a more secure food supply, and facilitated trade in fresh produce. As a result of the early marketing trials of irradiated food, several authors noted that the willingness of consumers to purchase irradiated food may be greater than indicated by their initial response to a general survey when irradiated food was not actually available.[25] This willingness to purchase irradiated foods has been confirmed in thousands of supermarkets in the US and several other countries.

Nevertheless, there remains an unsubstantiated belief in massive consumer resistance to irradiated food to the present day, which unfortunately has discouraged efforts to interest key sectors of the food trade in the technology. In the real world, consumers buy products because they want that product. The fact that an item has been irradiated (or processed with another technology) is not at the forefront of their minds.

Previously, the response of irradiation advocates has often been to stress the need to provide consumers with more information about the process. Numerous consumer studies have shown that, when given a choice and even a small amount of accurate information, consumers are not only willing to buy irradiated foods but also often prefer them over food treated by other means. Dozens of market research studies (mostly in the US) conducted over the past three decades repeatedly demonstrate that 80 to 90% of consumers will choose irradiated products over non-irradiated after they hear the facts and understand the benefits. Studies have also shown that no amount of information would convince those who generally reject any new product. Most of these studies were done before irradiated food became commercially available.[26]

17.5.1 Future Strategies

The now overwhelming success of actual retail of irradiated foods and the evidence from sophisticated studies of consumer attitudes to novel food technologies suggest future strategies to increase the commercial use of food irradiation. Elements of a future strategy should include:

- Take every opportunity to place the evidence of successful, long-term marketing of labeled irradiated foods in front of food producers and retailers.
- Increase the amount of irradiated food on retail shelves through seeking the cooperation of entrepreneurial retailers, who are likely to be small or medium-sized. Retailers who serve ethnic markets are likely to be open to marketing irradiated produce because in many cases the product cannot be imported unless it is irradiated.
- Develop coalitions of stakeholders that believe in the value of food irradiation and that would have the trust of consumers. Consumers view food producers and retailers as less biased than irradiation processors.
- Provide information and support to producers and retailers on a technology that is very unfamiliar to them. This must come from regulatory authorities, academics, and, despite the caution above, the irradiation industry. The role of regulatory authorities is crucial. The US and New Zealand cases benefited from the attitude of food authorities that make science-based rules. Wherever food irradiation is considered too sensitive an issue to make science-based decisions, the public debate is dominated by vocal opponents.

- Stress the benefits of irradiation that are focused on the food and the consumer rather than the technicalities of the process. For example, in the case of meat, giving consumers a guarantee that they will not be poisoned by a pathogen is what will matter most. Consumers can relate to a non-chemical phytosanitary treatment that protects local agriculture and the environment, as well as providing produce that is exotic or out of season. However, extension of the shelf life of fresh produce is not necessarily seen as a benefit by consumers who have become used to the notion of fresh (meaning just harvested) produce.
- Take into consideration that both positive and negative points of view will coexist in any public discussion on food irradiation. As time progresses and food that has been irradiated becomes more readily available, resistance will diminish and become negligible.

  Ensuring that labeling of irradiated food is both consistent and fair. Labeling is a very difficult issue to balance. Consumers see mandatory labeling as empowering them and providing greater control over what they buy. An assurance that irradiated foods would be labeled played a significant role in decreasing opposition to irradiated foods in Australia and New Zealand. The food industry, however, sees labeling as a barrier to irradiation since consumers are likely to perceive it as a warning given that competing technologies are usually not required to be labeled (for example, competing phytosanitary treatments) and it carries some extra costs.
- National regulations on the labeling requirements should be consistent. For example, requiring that the tiniest quantity of irradiated ingredient in a processed food be mentioned on the label is extreme.
- Adjusting promotional strategies to recognize that irradiated food can appear to run counter to some recent shifts in consumer opinion, specifically towards minimal processing, the attraction to naturalness and 'organic', and for locally produced food.

17.5.2 Food Producer Requirements

We have made the point that for too long the food trade has believed that consumers will not purchase foods that have been irradiated. Equally, food irradiation advocates may have concentrated on consumer acceptance for too long at the expense of other barriers that need to be addressed. Briefly, these include:

- Producers do not relate easily to irradiation processing. Consider the likely reaction of a fruit grower who for years has used hot water treatment in the packing shed or an insecticide spray in the field with a new requirement to send his fruit to a distant facility that requires special authorization and has hazard signs. The sterilization of health-care products can be a useful analogy for growers.

- Irradiation requires the shipment of products to a specialized contractor during which time they are out of the control of the producer with a transportation time and a cost that comes on top of the price charged by the irradiation company. Food generally being a perishable commodity, smooth operation of supply chain logistics is even more essential than for health-care products.
- Affordable irradiation devices that could be placed in-line in, for example, a fruit packing house or meat-processing chain would go a long way to encouraging the adoption of the process. Such equipment is a research concept at present but would be the ideal answer for the final step in a HACCP or quarantine system; it would also empower the user.
- The number of irradiation facilities is limited and since most are located to capture non-food products, they are not necessarily in the right place for food manufacturers or traders. In addition, these facilities are often optimized to treat at much higher doses than those required for food. These factors result in a lack of capacity to treat food at present, keeping commercial volumes low. The result is to feed doubts about the potential for food irradiation to expand.
- Food generally involves high volumes. If only a fraction of a specific food can be treated, this creates problems for trade. These include practical issues of having two production streams and can include perception issues. For example, meat produced under good manufacturing practices (GMP) is rightly regarded as safe, but what would be the issues for a dual market, one with safe meat and one for irradiated meat that is even safer?
- Gamma irradiation is currently the predominant technology for food irradiation. Gamma facilities are safe and able to irradiate up to pallet sizes of products of high density. They will undoubtedly continue to have an important role for many years. It is important to point out that a gamma ray photon and an X-ray photon of the same energy are, in every way, identical.

17.6 Conclusions

Louis Pasteur said: ‘‘To those who devote their lives to science, nothing can give more happiness than making discoveries, but their cups of joy are full only when the results of their studies find practical applications.’’[27]

Pasteur did not live long enough to realize the magnitude of the impact resulting from his efforts. Neither did Marie Curie, whose landmark research on radiant energy and radiation earned her a Nobel Prize in 1904 and set the stage for the use of irradiation of food and medical products.

The first successful marketing of irradiated ground beef took place in Minnesota in May 2000, when several retailers began to offer frozen ground beef that had been irradiated. Minnesota-based Schwan’s, Inc., a nationwide foodservice provider through home delivery started marketing irradiated ground beef in 2000. Omaha Steaks of Nebraska has successfully marketed

irradiated ground beef through mail order since 2000. Today, all non-cooked ground beef offered by Schwan's and Omaha Steaks is irradiated.

Rochester (New York)-based Wegmans, with over 90 supermarkets in New York, New Jersey, Pennsylvania, and Virginia, is a strong believer in the irradiation process and is one of the most visible marketers of irradiated ground beef. Although Wegmans takes every measure to ensure that all its ground beef products are safe, the retailer views irradiation as a value-adding process that offers the consumer an additional layer of food safety protection.

Despite the progress made in the introduction of irradiated foods into the marketplace, many consumers and even highly placed policy-makers around the world are still unaware of the effectiveness, safety, and functional benefits that irradiation can bring to foods. Education and skilled marketing efforts are needed to remedy this lack of awareness.

Morton Satin says:[28] ''Pathogens do not follow political imperatives or moral philosophies, they simply want to remain biologically active. Strategies to control them, which are based on political ideals or myth-information, will not be effective. If we want to get rid of pathogens, we have to destroy them before they harm us. Food irradiation is one of the safest and most effective ways to do this. An international coordinated effort to develop effective knowledge transfer mechanisms to provide accurate information on food irradiation to policymakers, industry, consumers, and trade groups is vital to meet today's food safety needs.''

During the twentieth century, life expectancy in the US increased from 47 to 78 years.[29] Many public health experts attribute this dramatic increase to the ''pillars'' of public health: pasteurization, immunization, and chlorination. Some of these same experts predict that food irradiation will become the fourth pillar of public health. Time will tell whether this prediction is correct.

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