

**APPENDIX 1**

**FOOD IRRADIATION,  
A TECHNICAL REPORT  
TORONTO PUBLIC HEALTH**

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## FOOD IRRADIATION, A TECHNICAL REPORT

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## SUMMARY

Food irradiation is a method of food preservation and sterilization that is undertaken at irradiation facilities. Food irradiation, often referred to as “cold pasteurization”, is a technology that has been identified as safe in reducing the risk of foodborne illness as part of high-quality food production, processing, handling, and preparation.

Food irradiation has been described as a safe and effective technology that can prevent many food borne diseases by organizations such as the WHO and FAO. Under Schedule No. 668 of the Food and Drug Regulations, which came into effect in April 1989, food irradiation is classified as a food process. This process has been approved by more than 40 countries around the world and has been endorsed or supported by numerous national and international food and health organizations, such as the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and professional groups. Widespread use of irradiation remains controversial because of public concern regarding the safety of the technology and the wholesomeness of irradiated foods.

This report provides an overview of food irradiation, safety and wholesomeness issues and highlight alternatives to the technology. The report concludes with a summary of future steps.

## INTRODUCTION

Microorganisms and parasites can contaminate food at various stages of production, processing, storage and distribution. These biological agents, some of which are pathogenic to man and animals may be able to survive preservation treatments and pose health risks to humans. Thus, food whether it is raw or processed, may carry some level of risk of foodborne illness if not properly handled and prepared before consumption.

Recent well-publicized outbreaks of foodborne illness have heightened general interest in food safety. Food irradiation, often referred to as “cold pasteurization”, is a technology that has been identified as safe in reducing the risk of foodborne illness as part of high-quality food production, processing, handling, and preparation.<sup>1</sup> This process has been approved by more than 40 countries around the world and has been endorsed or supported by numerous national and international food and health organizations, such as the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and professional groups.

Widespread use of irradiation remains controversial because of public concern regarding the safety of the technology and the wholesomeness of irradiated foods. This report will provide an overview of food irradiation, review safety and wholesomeness issues and highlight alternatives to the technology.

## THE PROCESS OF IRRADIATION

Food irradiation is a method of food preservation and sterilization that is undertaken at irradiation facilities. Food irradiation has been described as a safe and effective technology that can prevent many food borne diseases by organizations such as the WHO and FAO. Under Schedule No. 668 of the Food and Drug Regulations, which came into effect in April 1989, food irradiation is classified as a food process.

Food irradiation is a process by which food is exposed to a controlled source of ionizing radiation through an irradiator - an enclosed chamber for a defined period of time.<sup>1</sup>

Ionizing radiation comes from radioactive materials such as cobalt-60 or cesium-137, or from X-rays or from beams of electrons. Three different irradiation technologies produce ionizing energy. The first technology utilizes the radiation that is given off by the radioactive materials cobalt-60 or cesium-137, which produce high-energy photons, called gamma rays. Gamma rays are highly penetrating and can be used to treat full boxes of fresh or frozen foods to a depth of several feet.

Cobalt-60 has a half-life of 5.3 years and degrades to non-radioactive nickel.<sup>2</sup> Cesium-137 has a half-life of 30 years. It is obtained by reprocessing nuclear fuel elements; therefore, no supplies of commercial quantities of cesium-137 exist. Thus, cobalt-60 has become the choice for gamma radiation.<sup>3</sup> Over 80% of the cobalt-60 available in the world market is produced in Canada by CANDU reactors (nuclear-generated electricity reactors).<sup>1,3</sup>

The second technology utilizes electron beams or the e-beam. The e-beam is a stream of high-energy electrons, propelled out of an electron gun. This electron gun is capable of accelerating electrons to near the speed of light by means of an accelerator. This apparatus has been compared to a larger version of the device in the back of a TV tube that propels electrons into the TV screen at the front of the tube, making it light up.<sup>1</sup> Since electrons cannot penetrate very far into food (only to a depth of three centimetres or one and one-half inches), the thickness of the item to be treated is limited to six centimetres or three inches with double-sided treatment. Therefore, electrons can be used only for treatment of thin packages of food and free flowing grains.<sup>3</sup>

The third and newest technology is X-ray irradiation or X-irradiation, which is still under development. X-rays of various energies are produced when a beam of accelerated electrons is directed at a metallic target (usually gold or other metal), producing a stream of X-rays coming out of the other side. X-rays can pass through thick food, like the cobalt gamma rays, however, the efficiency of conversion from electrons to X-rays is generally less than 10%.<sup>3</sup>

The duration of exposure to ionizing energy, density of food, and the amount of energy emitted by the irradiator determine the amount or dose of radiant energy, which in turn, determines the effects of the process on foods.<sup>1,5,6</sup>

## **EFFECTS OF IRRADIATION ON FOOD**

Radiation doses are measured in international units called Gray (Gy [1 Gy = 100 rad]). (Appendix 1) Food is generally irradiated at levels from 50 Gy to 10 kGy (1 kGy = 1000 Gy), depending on the goals of the process. Under the Food and Drug Regulations, upper limits have been placed on the energy levels of the source to make sure that the food does not become radioactive.<sup>4</sup>

The actual dose required to treat food varies with the specific pathogen and the specific circumstances of the food. Low dose irradiation (up to and including approximately 1 kGy) is used primarily to inhibit sprouting, delay ripening of produce or kill or render sterile insects and other higher organisms that may infest fresh food. Medium-dose irradiation (1 to 10 kGy) pasteurizes food and prolongs shelf life. High-dose irradiation (>10 kGy) sterilizes food.<sup>5</sup>

## **RADIOLYTIC SAFETY**

Irradiation of food does not induce additional radioactivity, because the sources of radiation approved for use in food irradiation are limited to those producing energy too low to induce subatomic particles.<sup>1,5,6,8</sup> Chain reactions cannot occur; therefore, no radioactivity is added to the food nor the packaging materials. However, studies related to the effects of irradiation on foods packaged in modern materials are ongoing.<sup>8-10</sup>

## **TOXICOLOGICAL SAFETY**

All foods are radioactive to some extent as a result of exposure to natural background radiation.<sup>7</sup> However, opponents of irradiation indicate that the effects of irradiation on food are markedly different from that of food processes that utilize non-ionizing radiation such as cooking, microwaving or canning.<sup>8</sup> Experimental studies have shown increased amounts of carcinogenic compounds in irradiated foods compared to non-irradiated food.<sup>8,28</sup> One study revealed that

irradiated fats, especially unsaturated fats, have the potential to form highly reactive carcinogenic or toxic compounds.<sup>28</sup>

Opponents of food irradiation are also concerned about the presence of radiolytic products produced during processing. As described earlier, gamma radiation produces electrically charged fragments of the original chemical structure called ions. These ions (or free radicals) are of concern because free radical damage is implicated in cellular changes indicative of cancer, atherosclerosis and in aging.<sup>8</sup>

In the United States, the Food and Drug Administration (FDA) coined the term “unique radiolytic products” to describe the theoretical possibility that molecules unique to the process of food irradiation could be generated.<sup>11</sup> The process of irradiation does add a small amount of energy to food. As such, radiolytic products are generated. The FDA has estimated that ten percent of the resulting radiolytic products may be unique.<sup>8</sup> However, the implications of the unique radiolytic products on human health requires further clarification.

### **NUTRITIONAL QUALITY**

In general, nutrients most sensitive to heat treatment, such as the B vitamins and ascorbic acid, are also sensitive to irradiation. In pure solution, thiamin is the most sensitive to radiation, followed by vitamin C, pyridoxine (B<sub>6</sub>), riboflavin (B<sub>2</sub>), and niacin. Of the fat soluble vitamins, vitamin E is the most radiosensitive, followed by vitamins A and K. Vitamin D is relatively radiostable.<sup>12</sup> However, irradiation studies on pure vitamins or on food samples may vary substantially in complex food substances.

Although some foods have been tested for their nutrient quality after irradiation, the majority of food components and combinations of foods have not been evaluated.<sup>8</sup> Study results vary depending on the food source<sup>6</sup>, and experimental conditions<sup>8</sup>. This also raises questions about the need to add vitamins to foods to replace those lost due to processing.

### **LABELLING**

Canadian regulations requires all prepackaged irradiated food products to be labelled as such and bear the international symbol for irradiated food, the Radura (Appendix 2) when offered for sale. This regulation applies to domestic and imported food.

Foods with 10% or more of irradiated ingredients must identify the ingredients as being “irradiated”. This means that if an irradiated ingredient constitutes less than 10% of a finished product, neither the ingredient nor the finished product are required under the Canadian Food and Drug Regulations to be labeled as irradiated.

Unlike whole-irradiated foods, irradiated spices are not required to be labeled as irradiated. Similarly, labelling is not required in restaurants, schools, hospitals, or by food caterers or food service providers when irradiated foods are being served.

A listing of the agencies involved in regulating aspects of the food irradiation process in Canada. (Appendix 3)

## BENEFITS OF FOOD IRRADIATION

Treatment by ionizing radiation is beginning to be more widely used in combination with existing technologies.<sup>1-4</sup> These technologies include cooling, cooking or heating, canning, chemical treatments, and steam pasteurization.

Treatment of food by ionizing radiation is used to extend shelf life and reduce food losses by eliminating spoilage microorganisms, improve microbiologic safety, and/or reduce the use of chemical fumigants and additives.<sup>2,3</sup> It can be used to reduce pathogenic microorganisms such as *Esherichia coli* 0157:H7 (E. Coli), Salmonella, *Campylobacter jejuni*, *Listeria monocyogenes* and *Vibrio*; decontaminate grain, dried spices, and dried or fresh fruits and vegetables; reduce insect infestation in stored dried products; and, inhibit sprouting of products such as potatoes, yams, onions, garlic, ginger, chestnuts and other sprouting plants.<sup>3</sup>

Treating foods with ionizing energy also offers many benefits to consumers, retailers, and food manufacturers. Proponents suggest that food irradiation can contribute to improvements in both the quality and quantity of the food supply, which relates to better health and nutritional status. Irradiation, as a process used to meet quarantine requirements, also holds promise as an alternative to chemical fumigation and other methods to prevent infestation. Mandatory labeling also gives consumers an informed choice when buying food products.

## INCIDENCE AND SOURCES OF FOODBORNE ILLNESS

The irradiation of food has been used effectively to reduce pathogenic microorganisms such as *Esherichia coli* 0157:H7, Salmonella, *Campylobacter jejuni*, *Listeria monocyogenes* and *Vibrio parahaemolyticus*. These microorganisms are of primary concern from a public health standpoint because of the severity of the illnesses and/or because of the higher number of outbreaks and individual cases associated with these pathogens.<sup>13,28</sup>

While accurate numbers concerning the extent of foodborne illness in Canada are not available, Health Canada estimates there are about 2 million cases each year, based on actual reports of 10,000 to 30,000 cases of foodborne illness with some 30 deaths.<sup>14, 15</sup> Canadian health authorities believe that for every case reported, there are at least 100 cases that are not reported.<sup>16</sup> The medical cost and productivity losses for foodborne illness are further estimated at over \$1 billion per annum.<sup>17</sup> Recent U.S. data based on active surveillance rather than passive reporting estimates the annual incidence of foodborne diseases at 76 million including 325,000 hospitalizations and 5,000 deaths. Underreporting is also considered to be a major complication in providing accurate estimates in the US.<sup>18</sup> From 1993 to 1997, 68 percent of US outbreaks were of unknown origin.<sup>19</sup> Applying such findings to the Canadian population would result in an estimated incidence of food borne illness of 7.6 million cases per year (using the 10% rule for applying American Statistics to Canada). However, with DNA fingerprinting, increased public awareness and media interest, the reporting of foodborne outbreaks and issues should increase and media accounts will proliferate.

There is a paucity of data on the sources of foodborne illness in Canada. Based on a compilation of known outbreaks involving identified food vehicles, the US Centre for Science in the Public Interest (CSPI) concluded that from 1990 - 2001, seafood was the food vehicle associated with the highest percentage of outbreaks (defined as more than more person becoming ill from the same food source) at 21 percent, while salads and fresh produce combined resulted in the highest percentage of actual cases of foodborne illness at 22 percent (Fig. 1).

**Selected Food Sources for Known Outbreaks  
1990 - 2001**

<b>Food Vehicle</b>	<b># of Outbreaks</b>	<b>%</b>	<b># of Cases</b>	<b>%</b>
• Dairy	69	4	2,931	4
• Pork	44	3	2,680	4
• Breads	43	3	1,343	2
• Beverages	26	2	1,228	2
• Other meats	18	1	422	1
• Game	15	1	98	0.1
• Seafood	348	21	5,394	7
• Eggs	275	17	10,954	15
• Multi-ingredients	247	15	11,187	15
• Produce	153	9	9,751	13
• Beef	140	9	6,229	8
• Salads	94	6	12,110	16
• Poultry	82	5	4,343	6
• Other	69	4	5,056	6.9
<b>TOTAL</b>	<b>1623</b>	<b>100</b>	<b>73,726</b>	<b>100</b>

**Fig. 1. Food sources for known outbreaks of foodborne illness based on an evaluation of US Centres for Disease Control data and media accounts of known outbreaks (CSPI, 2002).**

Isaacs, et al. (1998) explained that the overall surveillance of enteric diseases in Ontario currently relies on the reporting of disease events by local public health units to a centralized information system known as RDIS (Reportable Diseases Information System). An examination of RDIS outbreak data from 1993 to 1996 in which 31 percent (13,023/41,385) of the records in the data set had information on the source of infection (food or other source) and risk setting (home, restaurant, etc.) found that there were 1,348 outbreaks of enteric disease (approximately 340 per year) reported in Ontario. Over one-half of the outbreaks (76) were reported to be associated with person-to-person transmission; their association with food as the original source of infection is not known.

Limitations in surveillance data means that direct assertions about which specific foods are responsible for the majority of foodborne illness, and in which food consumption setting the majority of cases of foodborne illness occur, are impossible. However, from limited data and anecdotal reporting of specific outbreaks, restaurants and food service establishments are a significant source of foodborne illness.

## IRRADIATED FOOD IN CANADA

A variety of foods have been approved for irradiation in Canada, for different purposes. Specifications exist in the Food and Drug Regulations for the use of the irradiation process on a limited number of foods. The Table to Division 26 of the Regulations lists the foods that can be irradiated and the respective purpose and conditions of use for each product. Currently, food irradiation is permitted on potatoes and onions to inhibit sprouting during storage; on wheat, flour, and whole wheat flour to control insect infestation during storage; and on whole or ground spices and dehydrated seasoning preparations to reduce microbial load.<sup>25</sup>

Before irradiation can be applied to other food products, Health Canada must conduct a review to establish the chemical, toxicological and microbiological safety, and the nutritional quality of the proposed uses of the item. At present, Health Canada has been presented with several applications to allow the irradiation of fresh and frozen ground beef, fresh and frozen poultry, and prepackaged fresh, frozen, prepared and dried shrimp and prawns to control pathogens, reduce microbiological load and to extend durable shelf life as well as to irradiate mangoes as a disinfestations treatment to control fruit flies and the mango seed weevil.

<b>Foods Approved for Irradiation in Canada</b>			
<b>Food Product</b>	<b>Purpose of Irradiation</b>	<b>Dose Permitted</b>	<b>Date of Approval</b>
Potatoes	Sprout Inhibition	Up to 0.1 kGy	November 1960
Onions	Sprout Inhibition	Up to 0.15 kGy	March 1965
Wheat, flour	Insect disinfestations	Up to 0.75 kGy	February 1969
Onion powder, spices and certain dried vegetables and seasonings	Decontamination	Up to 10 kGy	October 1984
<b><i>Proposed Amendment:</i></b> <i>Chicken, ground beef, shrimp and prawns using cobalt-60, cesium-137, electrons from machine sources</i>	<i>Control pathogens, reduce microbial load and extend durable shelf life</i>	<i>Up to 10 MeV* or from machine source up to 5 MeV*</i>	<i>Under consideration by Health Canada▲</i>
<i>Mangoes using cobalt-60</i>	<i>Disinfestation</i>		<i>Under consideration by Health Canada▲</i>

\* MeV = Million electron volts

▲ Pre-published in Canada Gazette, Part 1 on November 23, 2002. Public may provide comments within 90 days after this date. The proposed amendments to the Regulations remain proposals until sanctioned by the Governor-in-Council.

In the United States (US), the US Department of Agriculture (USDA) has approved the use of irradiation on a wider range of foods than is currently permitted or proposed in Canada. The approved areas of use in the US include the areas of use covered in the Canadian regulatory proposal with the exception of shrimps and prawns. Consideration is being given by the US government to new proposed uses for the irradiation of shrimp, crustaceans and other seafood

products, however, these items are not yet approved.<sup>25</sup> On the other hand, the USDA has approved the use of irradiation on fruits and vegetable imports.<sup>24</sup>

### **IRRADIATED FACILITIES IN CANADA**

The irradiation of food has never been carried out on a large commercial scale in Canada.<sup>8</sup> Food is being irradiated for sale at the Canadian Irradiation Centre of the Institut Armand Frappier at Laval, Quebec (associated with the Université du Québec).<sup>8</sup> The Institute was officially opened in May 1988, and in 1989 began commercial irradiation of 100-200 tonnes of spices per year. This amount accounts for less than 5% of Canadian spice consumption. Some of these irradiated spices are presently being sold in the Canadian market in manufactured food products, although most are irradiated for export.<sup>8,27</sup> Large scale irradiation trials under commercial conditions can be conducted at the Institute. Pilot-scale or experimental irradiation facilities for small amounts of food such as fruits and vegetables can also be found in Quebec and Manitoba, respectively.

In addition, there are four licensed facilities in Canada (all residing in Ontario), which are used for the irradiation of non-food items such as medical equipment. These include Isomedix Corporation in Whitby, Sterirad in Markham, Ethicon Ltd. in Peterborough and Atomic Energy of Canada Ltd. in Kanata.<sup>8</sup> Both those for and against food irradiation speculate as to whether these facilities could provide food irradiation services on a commercial basis in the future.<sup>8,27</sup>

Strict regulations govern the transportation and handling of radioactive material. Irradiation facilities using radioactive material are constructed to withstand earthquakes and other natural disasters without endangering the community or workers.<sup>6</sup>

## **OCCUPATIONAL AND ENVIRONMENTAL ISSUES**

The process of treating food with radioactive materials makes this process a nuclear technology. Every technology raises the possibility of potential risks. However, the nuclear technology of food irradiation raises concerns about worker and environmental safety.

### **WORKER SAFETY**

The International Atomic Energy Agency (IAEA) indicates that the health effects of radiation may be divided into those that occur early and those that occur late.

Short term: The IAEA acknowledges that exposure to high levels of radiation can harm exposed tissues of the human body.<sup>29</sup> Protection of workers against radioactivity can not be guaranteed. While some literature has indicated that low-level radiation risks are difficult to quantify, other studies have shown that high energy rays of irradiation directly damage the DNA of living organisms and induce changes that make an organism unable to grow or reproduce.<sup>13,29</sup> When these rays interact with water molecules in an organism, they generate transient free radicals that can cause additional indirect damage to DNA. Studies have indicated that complex life forms with large DNA molecules are affected by relatively low doses.<sup>8,13</sup> For humans, the lethal dose is 4 Gray.

Long-term: The IAEA acknowledges studies of populations exposed to radiation (e.g., survivors of the atomic bombing of Hiroshima and Nagasaki) may lead to the delayed induction of cancer and, possibly, of hereditary damage.<sup>29</sup> The IAEA also indicated that these effects appear to occur at random in irradiated populations.<sup>29</sup>

## **ENVIRONMENTAL SAFETY**

Proponents of food irradiation have indicated that gamma rays do not give off neutrons, which means that they do not make anything around them radioactive.<sup>1,5,6</sup> Governmental regulations require that while in use, the radioactive material must be contained in stainless steel “pencils” to prevent leakage and must be protected by the thick walls of the irradiator to prevent any rays from escaping.<sup>3,24</sup> When not in use, the radioactive material must be stored in a pool of water which absorbs the radiation harmlessly and completely.<sup>3,24</sup>

Opponents of food irradiation have indicated that since food must be able to freely pass in and out of irradiators, the possibility of radiation exposure is relatively greater than in a closed structure such as a nuclear power plant.<sup>8</sup>

Although there is no radioactivity involved with e-beams, some shielding is necessary to protect workers from the electron beams, but not the thick concrete walls that are required to stop gamma rays.

Using X-rays to irradiate food does not pose the same risk to the environment as the use of cobalt-60 and other radioactive isotopes, because the machine that produces the accelerated electrons can be switched on and off, and no radioactive substances are involved.<sup>1</sup> However, literature has indicated that although X-rays have good penetrability into food, they are not being considered for irradiation facilities in Canada nor for irradiators being exported by Canada.<sup>8</sup> This is due to their lower efficiency of conversion. To date, only four commercial X-ray irradiation units have been built in the world since 1996.<sup>1</sup>

Opposing this technology, critics of irradiation warn that irradiation facilities create hazardous wastes through their use of radioactive materials.<sup>8,26</sup> Examples drawn from anecdotal reports cite radioactive water having been flushed down toilets into the public sewer system, radioactive waste thrown into the garbage, radiation leakage, facilities having caught fire and equipment malfunctioned.<sup>30</sup> Further investigation is required to inspect and monitor the environmental safety and risks associated with this technology.

## **ECONOMIC CONSIDERATIONS**

Cost/benefit analyses are difficult to complete as there are no large scale or full time commercial food irradiators operating in Canada.<sup>8,25</sup> To be exact, only research irradiation facilities exist in Canada.

Opponents to the technology believe that cost estimates of irradiation are speculative and underestimated by the industry and government due to government subsidizes to irradiation and nuclear technology. A discussion paper by the Ottawa Science Council in 1987 estimated the

capital costs of a food irradiator in Canada to be a minimum of \$1.3 million for a small irradiator, not including the cost of land or cobalt-60.<sup>8,27</sup>

Those for and against food irradiation indicate that the costs of installing, operating, inspecting and monitoring food irradiation facilities are substantial.<sup>8,24,25</sup> However, those for irradiation indicate that these costs may be offset by an overall lowering of the processing costs and other benefits such as a reduction of product wastage due to pathogen contamination. Proponents believe that these suggested benefits are warranted in order to reduce the costs related to longer durable shelf life and reduce spoilage along the distribution chain.<sup>25</sup>

Proponents lay emphasis on the benefits of food irradiation as being an optional process and recognize it as one method of reducing levels of pathogenic bacteria, other microorganisms and parasites that contribute to the reduction in disease incidence and consequently an associated reduction in public and personal health needs.<sup>25</sup>

## **ALTERNATIVES TO IRRADIATION**

Food irradiation does not replace proper food production or handling. Even with treatments that destroy 99.9% of pathogens, some could survive.<sup>6</sup> Bacteria that cause spoilage are more resistant to irradiation than pathogens and requires a higher treatment.<sup>5,6</sup> Therefore, the handling of foods processed by irradiation should be governed by the same food safety precautions as all other foods. Food irradiation cannot enhance the quality of food that is not fresh or prevent contamination that occurs after irradiation.

The safety of our food cannot be guaranteed, but the rules of safe food handling such as proper sanitation, packaging, storage and preparation can reduce bacteria and other microorganisms that could cause food borne illness. To this end, the basic principles for the prevention and control of food borne illness include three methods to protect the health of consumers.

The first method is to improve the hygienic quality of raw food products at the agricultural and fisheries level. By applying accepted codes of good agricultural and animal husbandry practices, including improvement in the environmental conditions under which animals are raised, the hygienic quality of raw food products can be improved. The second method involves the application of food processing technologies, such as cooking or heating, canning, chemical treatments, and steam pasteurization, which can prevent or reduce the transmission of food borne pathogens as well as extend shelf-life. For example, regardless of hygienic improvements in the quality of milk, it is still not possible to consistently produce safe raw milk. Hence, the pasteurization process still remains the most reliable method to prevent the transmission of bovine tuberculosis, brucellosis and other milk-borne diseases.<sup>21</sup> The third is most crucial in protecting the health of consumers, especially if the first two fail, involves the continuous education of food handlers on the principles of safe food preparation. Professionals as well as those responsible for food preparation in the home need to be more aware of the hazards posed by certain foods likely to be contaminated and to take care to assure they are handled safely.

Food safety education combined with the practice of safe food handling is perhaps the best defense against food-borne disease.

## **PUBLIC ACCEPTANCE OF FOOD IRRADIATION**

As with change, new food technologies traditionally have been met with resistance. When pasteurization was first developed in the late 19<sup>th</sup> century, it was considered highly suspect.<sup>20,21</sup> Proponents for food irradiation quickly highlight the fact that objections raised about pasteurization at that time, are similar to the concerns raised today about irradiation.<sup>20, 21,26</sup> Opponents worry that irradiation might be used to mask spoilage and enable the sale of unsafe food.<sup>8</sup>

In addition to health and food safety concerns, irradiation has also raised concerns related specifically to expansion of the nuclear technology itself.<sup>8, 22, 23</sup>

Public opinion and perception of food irradiation plays an important role in consumer acceptance to irradiated foods. In the mid-1960's there was a short period when potatoes were commercially irradiated to inhibit sprouting.<sup>8</sup> After this short marketing, potatoes or other whole foods were not commercially irradiated until 1987. At this time, a large supermarket chain, A&P Food Store, attempted to sell irradiated potatoes in Hamilton, Ontario. A large public outcry occurred and A&P pulled the product off the shelves. Consequently, test marketing of irradiated whole foods in Canada since 1987 has been limited.<sup>8</sup>

More recent studies also indicate that consumers are continuing to question the safety of our food supply. Reports from consumer surveys revealed that consumers are concerned about the carcinogenicity of irradiated foods, risk to workers in irradiation facilities, pollution from irradiation facilities, and risk of transportation of radioactive materials.<sup>25,26</sup>

## **CONCLUSIONS**

The science of food irradiation spans back as early as 1921 to kill *Trichinella* species in pork. The process of food irradiation is mature and the scientific consensus on its efficacy and safety is strong. International bodies, such as the WHO and the FAO, recognized the irradiation process as one of the various ways of reducing levels of organisms that cause food borne illness and disease in food products.

Irradiation of food cannot substitute for excellent food safety measures during food production, processing and preparation. However, food irradiation may serve as a complement to established techniques that can add to food safety, increase shelf life, reduce loss from spoilage and increase the diversity of foods available to the population. Before considering these public health benefits, the scientific evaluation concerning the wholesomeness of irradiated food should be reviewed.

Widespread use of food irradiation would necessitate a thoroughly debated investigation into the benefits of expanding this technology and the risks involved. Representatives involved in such a debate should include industry stakeholders as well as public health organizations within the various levels of government. Moreover, careful monitoring and continuous evaluation of all food processing techniques are prudent precautions.

## References:

1. Centre for Disease Control and Prevention. *Frequently Asked Questions about Food Irradiation*. Available at: <http://www.cdc.gov/ncidod/dbmd/diseaseinfo/>. Accessed on June 6, 2002
2. Shea K. and the Committee on Environmental Health. *Technical Report: Irradiation of Food*. American Academy of Pediatrics. 2000;106(6):1505-10
3. International Consultative Group on Food Irradiation. *Facts about food irradiation. A series of Fact Sheets from the International Consultative Group on Food Irradiation*. Food and Environmental Protection Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. 1999
4. Health Canada. *Frequently Asked Questions about Food Irradiation*. Available at: [http://www.hc-sc.gc.ca/food-aliment/fpi-ipa/e\\_faq\\_food\\_irradiation.html](http://www.hc-sc.gc.ca/food-aliment/fpi-ipa/e_faq_food_irradiation.html). Accessed July 23, 2002
5. Murano EA. ed. *Food Irradiation: A Source Book*. Ames, IA: Iowa State University Press; 1995
6. ADA Reports. Position of the American Dietetic Association: Food Irradiation. *Journal of the American Dietetic Association*. 2000;100(2):246-53
7. International Atomic Energy Agency. Facts about food irradiation. Available at: <http://www.iaea.org/worldatom/inforesource/other/food/q&a.html>. Accessed on June 6, 2002
8. Graham KM. *Food Irradiation A Canadian Folly*. 1<sup>st</sup> ed. Paper Birch Publishing. 1992
9. Lee M., Sebranek JG., Olson DG., Dickson JS. *Irradiation and packaging of fresh meat and poultry*. *Journal of Food Protection*. 1996;59:62-72
10. Olson DG. *Irradiation of Food*. *Food Technology*. 1998;52:56-62
11. Lagunas-Solar MC. *Radiation processing of foods: an overview of scientific principles and current status*. *Journal of Food Protection*. 1995;58:186-92
12. Diehl J. *Safety of Irradiated Food*. 2<sup>nd</sup> ed. New York, NY: Marcel Dekker Inc.; 1995
13. Centre for Disease Control and Prevention. *Food Safety and Irradiation: Protecting the Public from Foodborne Infections*. Available at: [http://www.cdc.gov/ncidod/eid/vol7no3\\_supp/tauxe.htm](http://www.cdc.gov/ncidod/eid/vol7no3_supp/tauxe.htm). Accessed on July 19, 2002
14. Health Canada. *Policy Development for Raw Foods of Animal Origin*. Health Canada, 2000. Available at: [http://www.hc-sc.gc.ca/food-aliment/english/organization/microbial\\_hazards/rfao.html](http://www.hc-sc.gc.ca/food-aliment/english/organization/microbial_hazards/rfao.html)
15. Health Canada. *Health Canada Policy-Food Safety Assessment Program*. Health Canada, 2001a. : [http://www.hc-sc.gc.ca/food-aliment/english/organization/food\\_safety\\_assessment/policy.html](http://www.hc-sc.gc.ca/food-aliment/english/organization/food_safety_assessment/policy.html)
16. Farber JM. And Todd ECD. *Safe Handling of Foods*. New York, NY Marcel Dekker Inc. ; 2000
17. Health Canada. *Policy Development Framework for the Management of Risks Associated with the Consumption of Raw Food of Animal Origin (RFAO)*. Health Canada, 2001b. Available at: [http://www.hc-sc.gc.ca/food-aliment/english/organization/microbial\\_hazards/policy\\_development\\_framework.html](http://www.hc-sc.gc.ca/food-aliment/english/organization/microbial_hazards/policy_development_framework.html)
18. Mead PS., Slutsker L., Dietz V., McCaig LF., Breesee JS., Shapiro C., Tauxe RV. And Griffin PM. *Food-related Illness and Death in the United States. Emerging Infectious Diseases*. Available at: <http://www.cdc.gov/ncidod/eid/vol5no5/mead.htm>

19. Olsen SJ., MacKinon LC., Gouilding JS., Bean NH. And Slutsker L. *Surveillance for Foodborne Disease Outbreaks – United States, 1993-1997. Morbidity and Mortality Weekly Review*. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss4901a1.htm>
20. Frank JF. and Barnhart HM. Food and dairy sanitation. In: Last JM., Wallace RB., eds. *Macy-Rosenau-Last Public Health and Preventive Medicine*. 13<sup>th</sup> ed. Norwalk, CT: Appleton & Lange; 1002:606-7
21. Kaferstein FK. And Gerald GG. *Public Health Aspects of Food Irradiation*. *Journal of Public Health Policy*. Summer 1993:149-63
22. Bruhn CM. *Consumer attitudes and market response to irradiated food*. *Journal of Food Protection*. 1995;58:175-81
23. Lovett RA. *Getting rational about irradiation*. *Eating Well*. October 1998:57-63
24. United States Department of Agriculture (USDA). *USDA Animal and Plant Health Inspection Services*. USDA, 2002
25. Department of Health. *Regulations amending the food and drug regulations (1094 – Food irradiation)*. *Statutory Authority: Food and Drugs Act. Regulatory Impact Analysis Statement*. Retrieved November 26, 2002, from [http://canada.gc.ca/gazette/part1/ascII/g1-13647\\_e.txt](http://canada.gc.ca/gazette/part1/ascII/g1-13647_e.txt)
26. Macfarlane R. *Integrating the consumer interest in food safety: the role of science and other factors*. *Food Policy*. 2002;27:65-80
27. Mills S. Discussion Paper. *Issues in food irradiation*. Ottawa, Science Council of Canada
28. Murray DR. *Biology of food irradiation*. Taunton, Somerset, Research Studies Press Ltd; 1990
29. International Atomic Energy Agency. *Radiation Safety*. International Atomic Energy Agency, Division of Radiation and Waste Safety. Retrieved November 29, 2002, from <http://www.iaea.org/worldatom/Press/Booklets/Radiation/radsafe.html>
30. No author. *The dangers of irradiation facilities*. Public Citizen. Protecting Health, Safety & Democracy. Retrieved November 29, 2002, from <http://www.citizen.org>

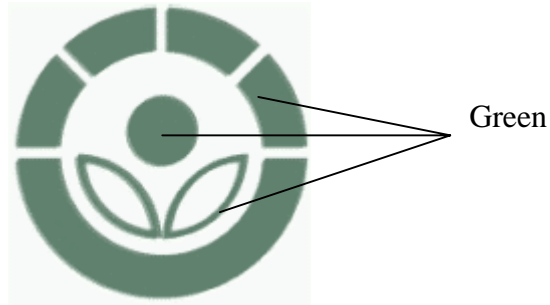
## Appendix 1: Scientific and Technical Terms Related to Food Irradiation

Cold Pasteurization	Irradiation at pasteurizing doses. Industry must demonstrate that all vegetative pathogens are destroyed.
Gray	The SI unit of measurement of absorbed radiation. One joule of energy is absorbed per kilogram of matter being irradiated.
Half-life	The time taken by a radionuclide to decay to half the levels of radioactivity originally present.
Irradiator	The part of a radiation facility that houses the source of irradiation.
Ionizing Radiation	Radiation capable of converting atoms and molecules to electrically charged particles called ions by removing electrons. The type of radiation used in processing materials is limited to radiation from high-energy gamma rays, x-rays and accelerated electrons.
RAD	Term formally used to measure radiation. 100 rad = 1 Gy.
Radiation	Ionizing radiation
Radiolytic Product	A substance produced from irradiation.
Radionuclides	Also known as radioactive isotopes or radioisotopes; naturally occurring and man-made; emit radiation as they revert to a stable state.

## Appendix 2: The Radura

### Internationally-used “Radura” Symbol

Logo used to identify irradiated food in Canada and internationally by members of the Codex Alimentarius Commission.



It is difficult to determine, without laboratory testing, whether a food has been irradiated. Foods irradiated at appropriate doses do not look or taste any different than non-irradiated foods. Consumers must therefore rely on the label to tell if a food has been irradiated.

Canadian regulations require that:

- all prepackaged food products that have been irradiated must carry a statement “treated with irradiation”, “treated by irradiation” or “irradiated” and display the internationally used "radura" symbol (above) on the principal display panel of the label;
- when an irradiated food is not sold in prepackaged form, a sign displaying the radura symbol must be located next to the point of sale; and
- this requirement applies to domestic and imported foods.

Food products with 10% or more of irradiated ingredients must identify the ingredients as being "irradiated" in the list of ingredients.

Source: Health Canada ([http://www.hc-sc.gc.ca/food-aliment/fpi-ipa/e\\_faq\\_food\\_irradiation.html](http://www.hc-sc.gc.ca/food-aliment/fpi-ipa/e_faq_food_irradiation.html))

## **Appendix 3: Government Agencies Responsible for the Regulation of Irradiation in Canada**

### **List of the Agencies involved in the Regulations of Food Irradiation in Canada.**

#### **Health Products and Food Branch of Health Canada:**

- Responsible for establishing standards related to the safety of foods sold to the Canadian consumer
- Evaluates the safety of foods and the effectiveness of food irradiation, and assesses the chemical, microbiological and nutritional changes that occur in foods during the irradiation process before approving any new use of irradiation to ensure the safety and nutritional quality of food

#### **Canadian Food Inspection Agency (CFIA):**

- Responsible for all enforcement and compliance issues relating to irradiated foods
- Administers the regulations relating to the labelling of irradiated products under the Food and Drugs Act and the Consumer Packaging and Labelling Act

#### **Canadian Nuclear Safety Commission:**

- Previously the Atomic Energy Control Board or AECB
- Regulates the development, applications and use of atomic energy in Canada through the Atomic Energy Control Act and Regulations
- Concerned with the environmental and occupational safety aspects of irradiation facilities and the transportation of radioactive materials through Canada's comprehensive licensing system