

## THE HISTORY OF FOOD IRRADIATION

### Introduction

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Food irradiation is a technology that can be safely used to reduce food losses due to deterioration and to control contamination causing illness and death. Proven as wholesome and toxicologically safe over many years, global commercialization of the process lags in spite of the general knowledge that it can offer all these benefits while eliminating the need for the use of many potentially harmful chemicals. In part, the industry and the scientific community have not been successful in promoting the technology and in educating the public. Noteworthy is the progress that has been made since the beginning in the early 1900's in the areas of applications research, regulatory developments, and international harmonization, as well as commercial applications.

### History of Applications Research

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The use of radiation in food processing is by no means new. Meats, fish, fruits and vegetables have been preserved for centuries by the sun's energy. Lately, infrared and microwave radiation has been added to the list of radiant energies in food processing.

The idea of using ionizing radiation in food preservation almost immediately followed Henri Becquerel's discovery of radioactivity in 1895. The suggestion to use ionizing energy to destroy pathogenic and spoilage microorganisms in food was published in a German medical journal, the same year. In the early 1900's, patents were issued in the United States and the United Kingdom describing the use of ionizing radiation to destroy microorganisms in food. Interestingly, they felt the advantage of this technique was that the improvements could be made without using any chemical additives - a concept which is even more valid today. Back then, the technology was not commercially viable as the only known ionizing radiation source was radium and it was not easily available.

Other studies and patents followed. There are reports of scientists using X-rays to kill insects, eggs and larvae in tobacco leaves and to eliminate Trichinosis parasites found in pork. Once again, the commercial viability of the process was precluded by the high cost and difficulties in acquiring ionizing radiation sources. In recent decades, more practical ionizing radiation sources became available, with the emergence of nuclear reactors. With this, food irradiation became a technically and commercially feasible process and a more concerted research into the safety and applications started to take place.

The modern era of food irradiation applications research began when the United States Atomic Energy Commission (USAEC) initiated a coordinated research program in the use of ionizing radiation for food preservation in 1950 and began to provide spent fuel rods from nuclear reactors. Most of these experiments took place at the National Laboratory in Lemont, Illinois. Already in the early stages of this process, the limitation of spent fuel rods became increasingly apparent, especially with regard to exact dosimetry. Cobalt-60 (Co-60), a deliberately produced radioisotope was found considerably more suitable for this purpose. Cobalt-60 sources were made available by the USAEC to several U.S. academic institutions, such as the Massachusetts Institute of Technology (MIT), University of California at Davis, University of Washington at Seattle and University of Florida at Gainesville, in the early 1960's. Afterwards, the Marine Products Development Irradiator, with 235 kCi (kilocuries) of Co-60 was built by the National Marine Fisheries Services at Gloucester, Massachusetts, followed by a Grain Products Irradiator with 35 kCi of Co-60 at the USDA's Entomological Research Centre in Savannah, Georgia.

The U.S. Armed Forces played an important role in the early years of food irradiation research. The U.S. Army Natick Laboratories at Natick, Massachusetts acquired a 1.3 MCi (megacurie) cobalt source and an 18 kW (kilowatt) electron linear accelerator. Food irradiation research commenced in early 1950's. After 1960, the U.S. Army concentrated on high dose applications, to develop sterile meat products, to substitute for canned or

frozen military rations. The U.S. Army continues to be an active member of the global community of researchers in the field of food irradiation.

Reports of successful experiments in the United States stimulated similar efforts in other countries. Shortly, national research programs were underway in Belgium, Canada, France, The Netherlands, Poland, Russia, Germany and United Kingdom. However, health authorities in these countries still hesitated to grant permissions to market irradiated foods. Hot debates about the safety of irradiated foods for human consumption were recognized as the major obstacle to commercialization of the process. As a result of this recognition, under the sponsorship of the International Atomic Energy Agency (IAEA) in Vienna and the Food and Agriculture Organization (FAO) in Rome, a group of 19 countries - which promptly grew to 24 - formed the International Project on Food Irradiation (IFIP), in 1970, with headquarters in Karlsruhe, Germany. The World Health Organization (WHO) in Geneva was associated with the project in an advisory capacity. Resources of the member countries were pooled to carry out chemical analyses and animal feeding studies on a wide range of irradiated foods, such as meat, fish, fruit, spices, wheat and rice. The Joint FAO/IAEA/WHO Expert Committee on Food Irradiation (JECFI) convened meetings in 1970, 1976 and 1980. At the 1980 meeting, the JECFI decisively stated:

1. "The Committee concluded that the irradiation of any food commodity up to an overall average dose of 10 kGy presents no toxicological hazard; hence, toxicological testing of foods so treated is no longer required."
2. "The Committee considered that the irradiation of food up to an overall average dose of 10 kGy introduces no special nutritional or microbiological problems..."

Based on JECFI findings, the World Health Organization published a document titled "Wholesomeness of Irradiated Foods ", in Geneva, in 1981. The document concluded that no further toxicological or nutritional research is needed on foods irradiated up to an overall dose of 10 kGy.

Nevertheless, global research in food irradiation continues. To date, food irradiation has been studied more than any other food process. All evidence gathered from almost a century of scientific and technical research leads to the conclusion that food irradiation is a safe, beneficial and practical process.

## **International Consultative Group on Food Irradiation**

When the International Project on Food Irradiation (IFIP) had successfully completed its task of examining the wholesomeness of foods irradiated up to the dose of 10 kGy and was terminated in 1982, the governments of participating nations and the international agencies FAO/IAEA/WHO felt that the international platform provided by IFIP since 1970 was very useful and should be renewed. The International Consultative Group on Food Irradiation (ICGFI) was conceived at a 1983 meeting convened by the UN agencies FAO, IAEA and WHO. The three UN agencies and 19 founding member governments' representatives signed a declaration, which established the ICGFI in 1984.

The major objective of ICGFI is to evaluate global developments and to provide a focal point of advice on the application of food irradiation to member states. The highest priority is assigned to its program of work to promote public information on food irradiation, discussing the process in an objective manner. It provides publications on the safety, the effectiveness and commercialization of the process, legislative aspects and control of irradiation facilities and also organizes training courses for plant technical personnel, food inspectors, journalists and others. ICGFI membership has grown to 44 member states in 1995.

## **History of Regulatory Developments**

The first country to grant a clearance for human consumption of irradiated foods was the former Soviet Union. In March 1958, the former Soviet government granted a clearance to irradiate potatoes to inhibit sprouting and a year later, a clearance was given for grain to be irradiated for insect infestation. Canada, in those days, was not lagging behind and granted a clearance in 1960 for sprout inhibition in potatoes at a maximum dose of 10 kilorad (kRad) or 0.1 kilogray (kGy). This dose was increased in 1963 to 15 kRad (0.15 kGy). In 1965, a clearance to irradiate onions up to the same dose was added to the list. The first clearance to irradiate foods in

the USA was granted by the FDA in 1963, as a result of a petition to "Process Wheat and Wheat Products for the Control of Insect Infestation".

The 1980 JECFI statement on wholesomeness and microbiological and toxicological safety of irradiated foods and the 1981 WHO publication of the "Wholesomeness of Irradiated Food" brochure prompted the publication of another UN sponsored document on food irradiation. The Codex Alimentarius, under the auspices of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), published in 1984 the "Codex General Standard for Irradiated Foods and Recommended International Code of Practice for the Operation of Radiation Facilities Used for the Treatment of Foods". The publication of this document had a profound influence on further international developments and formed the basis of legislation in many countries. It reiterates JECFI's statement that: "The irradiation of foods up to an overall average dose of 10 kGy introduces no special nutritional or microbiological problems". It also identifies acceptable sources of ionizing radiation and provides dose and energy limit guidelines. The "International Code of Practice" portion of the document provides a recommendation for global GMP standards for the operation of a food irradiation facility.

Historically, Canada and USA listed irradiation under their respective legislation regulating additives. Needless to say, this concept caused quite some confusion as it is well known that irradiation is a process using electromagnetic energy, rather than an additive. The rationale of the agencies is that irradiation is administered as if it were an additive, to be able to take advantage of stricter controls in the legislation governing additives. The USFDA continues to administer irradiation in this manner, whereas the Health Protection Branch of Health Canada reclassified irradiation as a food process in March 1989.

## International Approvals

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To date, clearances are in place in the USA for spices and dry aromatic ingredients, fresh fruits and vegetables ("fresh foods"), pork, poultry, red meats, shell eggs and food enzymes. Canadian legislation has remained unchanged since the 1989 reclassification of irradiation as a process, rather than an additive. Foods cleared to date include potatoes, onions, wheat and wheat flour, spices and dry aromatic ingredients.

Globally, national legislation is still very divergent. This lack of international harmonization is seen as a major impediment to international trade as it constitutes a non-tariff barrier. For instance, the European Union has still not reached agreement on a guideline for the regulation of food irradiation, due to resistance from Germany. In contrast to Germany, The Netherlands, Belgium and France routinely irradiate many foods. Regulatory developments in the Republic of South Africa deserve a separate mention as, in addition to being one of the pioneers in commercialization, it is also the only country where precooked, shelf-stable meat products irradiated at 45 kGy are allowed for retail sale. To date, 40 countries have collectively approved irradiation of more than 50 different foods.

## History of Labeling

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Labeling of foods treated with ionizing energy has been one of the most controversial issues related to commercial production. The Joint FAO/IAEA/WHO Expert Committee concluded that for irradiated foods which had been approved as safe to eat, there was no valid scientific reason for identifying the products with a label at the retail level when similar labeling is not required for the other commonly used processing methods (WHO, 1981).

The United Nation's Codex Alimentarius Commission, after receiving the recommendations of the Joint FAO/IAEA/WHO Expert Committee, referred the labeling issue to its Committee on Labeling. This committee, which meets every 2 years, usually in Ottawa, Canada, is concerned with uniformity in labeling among the approximately 130 Codex member countries, including Canada and the United States, to facilitate international trade. The committee agreed to recommend that the use of a logo or symbol be optional, but that the label of an irradiated food should carry a written statement indicating that it had been irradiated.

In both the United States and Canada, wholly irradiated foods, which are sold either in pre-packaged or bulk form, must be identified as having been irradiated, by using the international irradiation symbol. Additionally, the statement "Treated with Radiation", "Treated by Irradiation" or "Irradiated" is required. Other statements that

explain the reason for irradiation, or the benefits, may be used on the same label. The main purpose of the label is to advise consumers of the choice, rather than to warn. Indeed, in some countries, the irradiation label has become a symbol of high quality. Irradiated ingredients representing 10% or more of a finished product are to be described as "irradiated" on the list of ingredients. Ingredients in processed foods (i.e., spices) which represent less than 10% of a finished product have no labeling requirements. Foods that have been subjected to irradiation treatment are to be identified as such in any advertisements.

## History of Commercialization

The first commercial use of food irradiation occurred in 1957 in Stuttgart, Germany, when a spice manufacturer decided to improve the hygienic quality of his product by treating it with accelerated electrons produced by a Van de Graaff electron accelerator. The machine was dismantled later in 1959.

In Canada, irradiation of potatoes to inhibit sprouting was first approved in 1960. Shortly afterwards, an irradiation company named Newfield Products Ltd. was formed at Mont St. Hillaire, near Montreal. The plant was designed to process some 15,000 tons of potatoes per month, using a Co-60 source. After the first year of operation, Newfield Products ran into financial difficulties and ceased operation.

A significant event took place in December 1988. A number of UN agencies, namely the FAO, WHO, IAEA, ITC and GATT (now renamed WTO) sponsored the International Conference on the Acceptance, Control of, and Trade in Irradiated Food in Geneva. Official delegations from 57 countries brought 220 participants together, comprising government officials at the senior policy-making level, experts in international law, health, energy, and food, and representatives of consumer unions. An International Document on Food Irradiation was adopted by consensus, which made recommendations on inter-governmental and governmental activities, process control and trade.

The IAEA/WHO/FAO Joint Division publishes reports on volumes of commercially irradiated food products. Still, it is difficult to obtain reliable information on quantities of commercially irradiated products because such information, which comes from irradiation companies, is often considered commercially confidential. However, each year, about 500,000 tons of food products are commercially irradiated in some 26 countries, notably in The Netherlands, France, Belgium, South Africa and Ukraine. It is reported that the grain irradiator in the port of Odessa, Ukraine, radiation disinfests about 300,000 tons of grain per annum. Other countries where foods are commercially irradiated are Canada, Hungary, Japan, Thailand and USA.

In terms of commercial developments in North America, perhaps the most important milestone in commercialization was the establishment of the first North American dedicated food irradiation facility. Food Technology Services Inc. (FTSI, formerly Vindicator) was commissioned in the last quarter of 1991, in the town of Mulberry, near Tampa, Florida. This state-of-the-art pallet irradiation facility has started its commercial activities by irradiating strawberries and citrus for sale in Miami and Chicago. Presently, a variety of irradiated fruits and vegetables are regularly distributed in retail outlets in Florida, Illinois, Ohio and Indiana. Some quantities of poultry are being processed for institutional customers and a number of articles are processed under military food research programs. As well, the facility supplies irradiated food to NASA for use in the space program.

## Conclusion

Food irradiation technology safely preserves food and controls pathogens. Many years of in depth research have resulted in regulatory approvals for this process in a growing number of countries. The commercialization of food irradiation is also increasing. Retail stores that offer irradiated products for sale are experiencing positive consumer responses. Given a free choice and factual information, consumers are choosing irradiated foods.

Irradiation has been researched more than any other food process. It has come a long way since the pioneering days of early 1900's. Important UN agencies such as the World Health Organization and the Food and Agriculture Organization now recognize irradiation as another important method of controlling pathogens and food spoilage. Consumers and food processing companies will benefit from the commercialization of this process.

## About MDS Nordion

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*MDS Nordion ([www.mdsnordion.com](http://www.mdsnordion.com)) is a world leader in medical isotopes, radiation and related technologies. It is a business unit of MDS Inc. (TSX:MDS)(NYSE:MDZ). MDS is a global life sciences company that provides market-leading products and services our customers need for the development of drugs and diagnosis and treatment of disease. We are a leading global provider of pharmaceutical contract research, medical isotopes for molecular imaging, radiotherapeutics, and analytical instruments. MDS Inc. has more than 5,500 highly skilled people in 29 countries.*