Ensuring Food Quality and Safety

A. Introduction

Food losses caused by pests, contamination and spoilage are enormous. It is estimated[1] that 42% of the production of the eight major food and cash crops of the world are lost to pests, with post harvest losses adding a further 10%. Despite the use of modern food processing and distribution systems, food borne diseases still pose a widespread threat to human health as well as being an important factor in reducing economic productivity in all countries.

Ensuring the safety and quality of foods and agricultural commodities is therefore one of the essential dimensions of national responses to tackle the twin challenges of expanding urbanization and improved public health. Food contaminants, such as mycotoxins and radionuclides, as well as pesticides and veterinary drug residues, may have negative effects on human health as well as adversely affect the environment. The establishment of scientifically sound and accepted international standards can help to ensure the production of safe, high quality foods as well as facilitate international trade. The utilization of appropriate technologies and quality management systems through the application of good agricultural and manufacturing practices also enables countries to improve the availability of wholesome and nutritious foods and to increase their foreign exchange earnings through greater access to international and domestic food commodity markets.

The role of the analytical laboratory in the application of good production practices throughout the food chain, as opposed to the more traditional end-product testing of products, is also being strengthened with a view towards ensuring food safety and the reduction at their source of hazards arising from chemical and microbiological contamination. These activities entail the development of analytical methods and procedures that enable governments to evaluate the impact of their application of good production practices, including the identification and use of environmental indicators related to water and soil. To help meet these needs, protocols have been developed for the use of radio-labelled compounds to optimise different steps, and estimate measurement uncertainty, during the development of analytical techniques used in regulatory programmes for residues of pesticides and other contaminants in food and environmental samples.

Parallel with these developments has been the establishment of legal and regulatory infrastructure at the international, national and local levels aimed at improving the environmental management of agricultural systems so as to ensure the efficient and safe use of agricultural production inputs, while also having in place emergency action procedures to minimize the risk of contamination arising from nuclear accidents. Collaborative efforts between UN organizations and other relevant governmental and non-governmental agencies through current joint activities is a critical aspect of these activities, for example, collaboration between FAO and IAEA for emergency planning and response to nuclear emergencies and radiological events affecting agriculture.

The IAEA works in close collaboration with FAO, the WHO and others to be at the forefront of international research and coordination efforts dedicated to food safety issues. These efforts include the promotion of public health, international trade, and economic development in Member States through contributions to the accelerating expansion in the use of food irradiation techniques, the creation of international food safety standards, and the harmonization of Member States' legislation regarding food safety.

B. Food irradiation

In response to increasing consumer demands for safe, wholesome and nutritious foods, many countries have introduced stricter sanitary and phytosanitary controls on the food industry. The increasing relevance of these controls for consumers and policy makers alike has resulted in a heightened interest in food irradiation as a valuable technique for dealing with food safety issues. Food irradiation can destroy the microbes that carry disease, reduce the need for harmful chemicals used to control insect pests in fruits and vegetables, and serve as a useful addition to conventional food processing technologies (such as pasteurization, curing, and drying) that are used to preserve and extend the shelf-life of foods.

Sanitary applications of food irradiation have long been used to target harmful food-borne micro-organisms such as *Salmonella* and *E.coli*, primarily in animal products such as poultry, seafoods and beef. However, a recent rise in outbreaks of food-borne diseases traced to produce is leading to concerted efforts in some countries to expand the use of these applications to fruits and vegetables.

Food irradiation is also a valuable tool to address losses due to food spoilage and deterioration, the control of microbes and other organisms that cause food borne diseases, and the fulfilment of sanitary (human health) and phytosanitary (plant health) requirements. In addition to the continuing use of irradiation for sanitary purposes, many countries have increased their use of irradiation for phytosanitary applications, especially those applications related to quarantine measures. International standards and codes of practice have been developed to foster the application of this food processing technology in collaboration with the Joint FAO/WHO Codex Alimentarius Commission (Codex) and the International Plant Protection Convention (IPPC).

B.1. The food irradiation process

Food irradiation is a process of exposing either packaged food or food in bulk to precisely controlled amounts of ionizing radiation. The process is entirely automated, involving no human exposure to radiation sources. It is also not sensitive to temperature, meaning it can be carried out in a climate-controlled environment to keep food fresh. Most importantly, irradiation does not increase radioactivity levels in food or otherwise make it dangerous for human consumption. Applications of irradiation doses may be categorised in three ranges, viz.

Low Dose Applications (up to 1 kGy): sprout inhibition in bulbs and tubers; delay in fruit ripening; insect disinfestation including, quarantine treatment and elimination of food borne parasites.

Medium Dose Applications (1 kGy to 10 kGy): reduction of spoilage microbes to improve shelf-life of meat, poultry and seafoods under refrigeration; elimination of pathogenic microbes in fresh and frozen meat, poultry and seafoods; reduction of number of microorganisms in spices to improve hygienic quality.

High Dose Applications (above 10 kGy): sterilization of packaged meat, poultry and products which can be stored without refrigeration; sterilization of hospital food; product improvement for increased juice yield or improved re-hydration.

Food irradiation is normally applied by electron beam/x-ray (*Figure I-1*) or with the use of Cobalt-60 (gamma irradiation, Figure *I-2*).

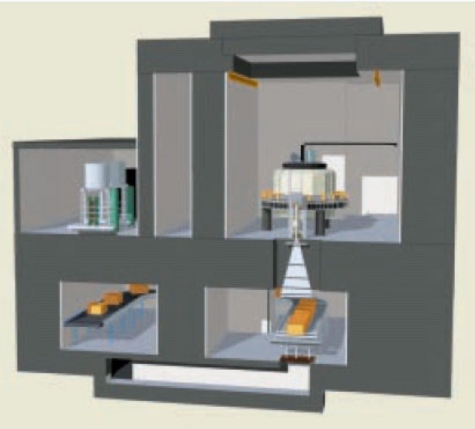

FIG. I-1. Electron beam irradiator

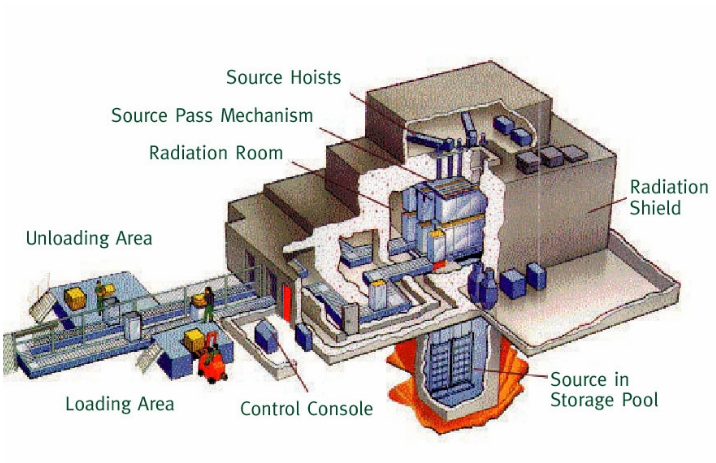

FIG. I-2. Gamma irradiator

Much research has not shown any adverse safety issues from food irradiation techniques, culminating in the revision in 2003, of the relevant Codex and IPPC standards and codes.[2] Overall, the response to food irradiation from national authorities has been positive, and when consumer concerns are addressed through sound information campaigns and the provision of mandatory food product labelling, there is steady progress in the public acceptance and implementation of these techniques.

To date, health and safety authorities in over 60 countries worldwide have approved the irradiation of over 60 kinds of food stuffs. These include spices, grains, poultry, beef, seafoods, fruits, vegetables and other food products. An estimated 500,000 metric tons of various foods are treated annually in approximately 180 gamma irradiation facilities that use radioactive sources such as cobalt-60 and cesium-137, as well as in about a dozen electron beam facilities.[3]

Phytosanitary applications of irradiation target insect pests, such as fruit flies, which can infest and destroy harvested grains and produce. Though the value of these applications was first recognized in the early 1970s, particularly as a quarantine treatment, rising health, safety, and environmental concerns related to insecticide use have considerably magnified interest in these techniques.

In 1989, the US Animal and Plant Health Inspection Service (APHIS) published the first rule to allow the use of irradiation as a phytosanitary treatment and in January 2006, the US regulatory framework was expanded to approve the treatment of imported fruits and vegetables. To date, India, Mexico and Thailand have already signed Framework Equivalence Work Plans to allow for the export of irradiated fresh fruits to the USA. Although the USA is presently the only country applying irradiation as a quarantine treatment on a commercial scale (4,000 metric tons annually), other countries, such as Australia and New Zealand, have carried out initial market trials with irradiated fresh fruits.

Future research and development of sanitary and phytosanitary techniques is expected to focus on complex foods such as prepared meals; the application of higher doses of radiation along with other complimentary and supplementary technologies such as controlled atmosphere packaging; high pressure processing; antimicrobial compounds and edible coatings, and the prevention of allergic reactions to foods.

The IAEA supports research and development in food irradiation techniques to assist Member States in obtaining the necessary expertise and equipment to apply them, and to foster international efforts to establish guidelines for the use of radiation for sanitary and phytosanitary purposes. The IAEA collaborated with the IPPC in the development of Guidelines for the Use of Irradiation as a Phytosanitary Measure to cover specific irradiation doses for generic groups of insect pests. Further efforts will focus on the urgent need to increase training for quarantine inspectors of national plant organizations, to continue research on insect groups sensitive to irradiation, and to study the tolerance of certain fruits to irradiation.

C. Emergency preparedness and response to nuclear emergencies affecting agriculture

Emergency planning and response to nuclear emergencies and radiological events is of growing importance in joint international activities, particularly with regard to increasing the capabilities of relevant organisations' ability to respond to such events. International cooperation is facilitated through the mechanisms pursuant to the relevant IAEA Conventions namely the *Convention on Early Notification of a Nuclear Accident*, and the *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*. In this context, FAO, in particular, has declared pursuant to Article 14, paragraph 5(c) of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency that it is competent to "… advise governments on measures to be taken in terms of the agricultural, fisheries and forestry practices to minimize the impact of radionuclides and to develop emergency procedures for alternative agricultural practices and for decontamination of agricultural, fisheries and forestry products, soil and water".

The FAO actively participates in the IAEA sponsored Interagency Committee on Response to Nuclear Accidents (IACRNA), whose purpose is to coordinate the arrangements of the relevant international intergovernmental organizations for preparing for and responding to nuclear and radiological emergencies. The IACRNA considers, among other issues, the implementation of Cooperative Arrangements between FAO and IAEA related to nuclear emergencies.[4]

Other collaborative activities under these Conventions helped to ensure the successful adoption of the revised *Codex Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency for Use in International Trade.*

D. Seafood Safety Research

Radiotracer and radioassay nuclear techniques are particularly useful for generating information on the biokinetics and food-chain transfer of metals and toxins in marine organisms, including those that are consumed as seafood. Such information could be better linked to analyses that support risk-based management decisions with respect to the safety assessment of commercially important seafoods intended for human consumption. In support, the IAEA has initiated research on applications of radiotracer and radioassay technologies to seafood safety risk analysis to generate data on priority contaminants in seafood organisms with regard to human consumption, sale and export, and to assess the application and relevance of these experimentally-derived and field-based data to the management of these contaminants in seafoods. The specific research objectives include:

- The integration of current studies on the application of nuclear techniques to the study of the bioaccumulation and food chain transfer of contaminants in seafoods, with risk management decisions in relation to assessment of their suitability for human consumption;

- The identification of scientific data needed on the bioaccumulation of priority contaminants in seafoods through linkages with international standardization bodies;

- The generation of data that are relevant to the management of contaminants in seafoods through the application of radiotracer, radioassay and related nuclear technologies.

It is envisioned that these studies will assist in the improvement of safety and suitability of commercially important seafoods intended for human consumption. They may also assist in any future international standardization processes through expert bodies for the potential establishment of maximum levels for contaminants already evaluated (lead, cadmium) as well as contaminants not evaluated to date (harmful algal blooms, persistent organic pollutants and other toxins).

---

[1] Crop Production and Crop Protection - Estimated Losses In Major Food and Cash Crops; E-C Oerke, H-W Dehne, F Schönbeck and A Weber; Elsevier; 1994.

[2] Joint FAO/WHO Codex Alimentarius Commission General Standard for Irradiated Foods – as well as the associated Code of Practice for Radiation Processing of Food. The Guidelines for the Use of Irradiation as a Phytosanitary Measure were also finalized by the Interim Commission for Phytosanitary Measures.

[3] For more detailed information, please refer to the IAEA Clearance of Irradiated Foods Database at http://nucleus.iaea.org/NUCLEUS/nucleus/Content/Applications/FICdb/FoodIrradiationClearances.jsp?module=cif

[4] http://www-naweb.iaea.org/nafa/emergency/index.html