Guidance Note No. 07/2018

Irradiated Food is Safe

Busting myths around it

SUMMARY

Radiation processing of food or food irradiation is a physical process in which food commodities, bulk or pre-packaged are exposed to controlled doses of energy of ionizing radiation such as gamma rays or X-rays to achieve different technological objectives. These technological objectives include extension of shelf-life, destruction of storage and quarantine insect pests, and killing of parasites, pathogens and spoilage microorganisms. Radiation processing can thus be used for enhancing food safety, food security and international trade. India is exporting radiation-hygienized spices and dry ingredients to several countries since 2000. It became mandatory in 2007 to treat Indian mangoes with gamma radiation for control of quarantine insect pests before export to the USA. New Zealand imports several tropical fruits and vegetables from Australia after their treatment with radiation. China has the largest number of food irradiation facilities in the world and is the largest user of the technology for ensuring food safety and security. In India more than a dozen irradiation facilities have been established by private entrepreneurs for treatment of food.

KEY TAKEAWAYS

- The irradiation process involves exposing food to a specified dose of ionizing radiation inside a biologically shielded irradiation chamber.
- On the basis of dose requirements, the applications of food irradiation could be classified as low dose, medium dose, and high dose applications.
- Studies show that food irradiation presented no toxicological, nutritional or microbiological problems.
- The Codex Alimentarius Commission adopted in 1983 a General Standard for Irradiated Foods and Recommended International Code of Practice for Operation of Irradiation Facilities used in the Treatment of Food.
- In India, regulations on radiation processing have been notified under Food Safety and Standards (Food Products Standards and Food Additives) Amendment Regulations, 2016.
- Radiation technology offers several advantages for processing food which are listed below:
  - It is a physical, non-additive process, causes minimal change in food
  - It is highly effective compared to chemicals and fumigants
  - It does not leave harmful residue in food
  - It can be applied to bulk as well as pre-packaged food
  - It is a cold process and preserves food in natural form
  - It does not destroy heat-labile aroma constituents of food
  - The process is safe to workers and friendly to environment.

This Guidance Note has been prepared by Dr. A.K. Sharma, Raja Ramanna Fellow, DAE, and Consultant, FSSAI. This note contains information collected and compiled by the author from various sources and does not have any force of law. Errors and omissions, if any can be kindly brought to our notice.

I. Technology

The irradiation process involves exposing food to a specified dose of ionizing radiation inside a biologically shielded irradiation chamber. The dose is determined by the residence time of the food inside the irradiation chamber and is pre-set after taking into consideration the dose rate, and the source strength. The details of the process are given in Annex-II.

II. Technological benefits

On the basis of dose requirements, the applications of food irradiation could be classified as low dose, medium dose, and high dose applications. Major technological benefits that can be achieved by radiation processing of food include:

Low dose

- Disinfestation of insect pests in stored products
- Inhibition of sprouting in tubers, bulbs and rhizomes
- Delay in ripening and senescence in fruits and vegetables

Medium dose

- Destruction of microbes responsible for food spoilage

High dose

- Elimination of parasites and pathogens of public health importance in food

So, radiation technology can be called as one process with multiple uses as depicted in the Figure 1 below

Figure 1: Uses of radiation technology

III. Safety and wholesomeness of irradiated foods

Foods processed by radiation have been subjected to a thorough assessment of safety in national and international laboratories. These studies show that food irradiation presented no toxicological, nutritional or microbiological problems.The Codex Alimentarius Commission adopted in 1983 is a General Standard for Irradiated Foods and Recommended International Code of Practice for the Operation of Irradiation Facilities used in the Treatment of Food. A revised Codex General Standard for Irradiated Foods was published in 2003. In addition, a number of Scientific Bodies and Associations have also endorsed the safety of radiation processed foods. These include, American Medical Association, the American Gastroenterological Association, American Dietetic Association, American Meat Institute, and Institute of Food Technologists. The food products that can be irradiated are listed in Table 1 (Annex-I).

IV. Food Irradiation facilities in India

A Food Irradiation Processing Laboratory (FIPLY) was established in the Food Technology Division, Bhabha Atomic Research Centre (BARC) in 1967, where a cobalt-60 gamma irradiation unit, called Food Package Irradiator, was installed. This facility is still used to carry out large scale test trials on food commodities. It has provided design concept and process parameters for all the modern day commercial food irradiation plants in India.

In the year 2000 the Department of Atomic Energy (DAE) established a 30 tons per day capacity Radiation Processing Plant at Vashi, Navi Mumbai for microbial decontamination of spices and dry ingredients. Another irradiation facility, KRUSHAK was set up at Lasalgaon, near Nashik in 2002 for the treatment of agricultural commodities. Later in 2006, it was upgraded for quarantine treatment of mango, and received approval from USDA for export of Indian mangoes to USA. Since then a few more irradiation facilities have been approved by USDA including one operated by the Maharashtra Agricultural Marketing Board at Vashi, Navi Mumbai. At least a dozen more plants that came up in last decade in the private sector are also irradiating spices, cereals, pulses and their products, and other dry food ingredients. These facilities also process allied products like Ayurvedic herbs and herbal preparations.

V. Regulations

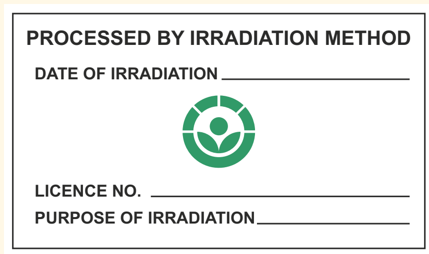
For commercial application of the technology in India, Atomic Energy (Control of Irradiation of Food) Rules were notified in 1991, and later amended in 1996. In 2012, a new amendment resulted in the notification of the current Atomic Energy (Radiation Processing of Food and Allied Products) Rules, 2012. Atomic Energy Regulatory Board (AERB) is the regulatory authority in India for enforcing these rules.

In 1994, Government of India amended Prevention of Food Adulteration Act (1954) Rules and approved irradiation of onions, potatoes and spices for domestic market. Additional items were approved in April 1998 and in May 2001. After establishment of the Food Safety & Standards Authority of India (FSSAI) under the Food Safety & Standards Act, 2006, the new regulations on radiation processing have been notified under Food Safety and Standards (Food Products Standards and Food Additives) Amendment Regulations, **2016.**

In February 2004, Ministry of Agriculture, Government of India, amended plant protection and quarantine regulations to include irradiation as quarantine measure in the Plant Quarantine (Regulation of Import into India) Order, 2003, enabling use of the technology in overcoming quarantine barriers and getting market access.

The new regulations have approved radiation processing of food and agro commodities on generic food class basis. Licensed radiation processing facilities have to comply with the conditions of approval, operation, and process control prescribed under the Atomic Energy (Radiation Processing of Food and Allied Products) Rules, 2012.

Further, as per Food Safety Standards (Food Product Packaging and Labelling) Regulations, 2011, the irradiated products are labelled and can be identified with the 'Radura' logo shown below in a typical label:



VI. Public perception

There has been a problem of perception with the radiation technology. Since radiation is commonly linked with the destructive power of atom, myths and misconceptions abound, mainly due to misinformation. The confusion begins with the general inability of people to differentiate between the process of irradiation and the radioactivity as a contaminant in food as in case of accidents like Chernobyl and Fukushima. It is important for public to know that radiation processing facilities have inbuilt safety features that prevent human exposure to radiation. Several studies have shown that when industry and consumers are educated and made aware of the benefits of the technology and its safe use, there is a clear change in attitude. There is willingness to pay by the consumer for the value addition and quality enhancement achieved through food irradiation. In fact, today irradiated foods are available in several countries. Radiation processing of fresh fruits and vegetables, spices, meat and meat products is being increasingly carried out to meet the requirements of quality and quarantine and gain market access. No adverse comments have been reported from the consumers in these markets. Further efforts are required to demystify food irradiation for the public.

VII. Global use of the technology

Food irradiation is permitted in more than 60 countries and the volume of food processed by radiation for value addition is increasing. China, followed by the USA, is the major user of the technology. Spices, dry vegetable seasonings, meat and meat products, herbs and herbal products, fresh fruits and vegetables are currently the major commodity groups where irradiation technology is frequently used. In irradiated fresh fruits and vegetable category, USA (mainland) and New Zealand are the largest importers, while US (State of Hawaii), Australia, Mexico, Vietnam, Thailand, and India are the major exporters.

VIII. Commercial prospects in India

The cost of setting up a food irradiation facility may vary with the needs of the processor and the ancillary facilities that go along with the plant such as storage structures, both ambient and low temperature. In India, radiation processing can be undertaken both for export and domestic markets. For exports, food could be processed for shelf-life extension, hygienization, and for overcoming quarantine barriers. Radiation processing can be used for restructuring costs of bulk commodities in export markets, and for selling value added packaged commodities directly in retail markets. Radiation processing can be used for storage of bulk and packed commodities for retail distribution and stocking. A list of the radiation processing facilities approved by the AERB for treatment of food is available at http://www.britatom.gov.in.

Today, the required expertise, know how, and adequate sources of radiation are available in India for setting up advanced radiation processing facilities. The much needed enabling legislations are in place. The government is also encouraging private entrepreneurs to set up radiation processing plants in an effort to improve food processing infrastructure in the country. The global trade and consumer acceptance of irradiated food has shown favourable trends. These developments are expected to accelerate growth of the technology in the country, which so far remains underutilized.

IX. Frequently Asked Questions (FAQs)

1. What is radiation processing of food?

Radiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation.

2. What is ionizing radiation?

Ionizing radiations are short wavelength radiations of the electromagnetic spectrum. X-rays and gamma rays are examples of ionizing radiation.

3. What are the sources of gamma rays and X-rays?

Gamma rays are emitted by radioisotopes such as Cobalt-60 and Caesium-137 while electrons and X-rays are generated by machines using electricity.

4. How do you irradiate food?

Radiation processing of food is carried out inside a radiation shielded chamber. Food either pre-packed or in-bulk placed in suitable containers is sent into it with the help of an automatic conveyor.

5. How is the dose given to food determined?

The absorbed dose is determined by the residence time of the carrier or tote box in irradiation position. Absorbed dose is checked by placing dosimeters at various positions in a tote box or carrier.

6. What are dosimeters?

Dosimeters are physical or chemical devices which when exposed to ionizing radiation show measurable changes.

7. What are the advantages of radiation processing of food?

Irradiation is a cold process and can be used to pasteurize and sterilize foods without causing changes in freshness and texture of food unlike heat.

8. How is irradiation different from chemical treatment?

Unlike chemical fumigants, irradiation does not leave any harmful toxic residues in food and is more effective. It is more efficient and can be used to treat even pre-packed commodities.

9. Does the irradiation process make food radioactive?

No. The process is akin to baggage X-ray on the airports. The food itself never comes in contact with the radioactive material. Gamma rays, X-rays and electrons prescribed for radiation processing of food do not induce any radioactivity in foods.

10. What is the difference between "Irradiated" and "Radioactive" food?

Radiation processed foods are those that have been exposed to radiation to bring about the desired technological benefits. Radioactive foods, on the other hand, are those that become contaminated with radionuclides, for example during nuclear accidents. Contamination with radionuclides never occurs during radiation processing.

11. Does irradiation affects the nutritional value of food?

No. Extensive scientific studies have shown that irradiation has very little effect on the main nutrients such as proteins, carbohydrates, fats and minerals. Vitamins show varied sensitivity to food processing methods including irradiation. Very little change in vitamin content is observed in food exposed to low doses.

12. Can irradiation make spoiled food good, or clean up "dirty foods"?

No. Like any other food treatment, irradiation cannot reverse the spoilage process and make bad food good. A food that looks, smells and tastes bad, cannot be saved by any treatment including irradiation.

13. Is there any risk in irradiating foods in contact with plastic or other packaging materials?

No. Results of extensive research have shown that almost all packaging materials currently used in food industry are suitable for irradiation. Many packaging materials including laminated plastic films with aluminium foil used for packaging of foods are routinely sterilized by irradiation.

14. How can radiation processed foods be identified in the market?

Radiation processed food cannot be recognized by sight, smell, taste or touch. As per Food Safety Standards (Food Product Packaging and Labelling) Regulations, 2011, the irradiated products need to be labelled and can be identified with the 'Radura' logo.

FSSAI Regulations

FSSAI (2016) Food Safety and Standards (Food Products Standards and Food Additives) Amendment Regulations, 2016.

Other References

1. *Roberts, P., and Hénon, Y.M. (2015) Consumer response to irradiated food: Purchase versus perception, Postharvest Rev., 3, 1-6.*
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4. *Sharma, A. (1998) Mycotoxins: risk evaluation and management in radiation-processed foods. In: Mycotoxins in Agriculture and Food Safety, Sinha, K.K. & Bhatangar, D. (eds,), Marcel Dekker Inc. NY.*
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6. *WHO (1994) Safety and nutritional adequacy of irradiated food, WHO, Geneva.*
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8. *WHO (1981) Wholesomeness of irradiated food, Technical Report Series No. 659, WHO, Geneva.*

Table 1

	Food	Purpose
1	Bulbs, stem and root tubers and rhizomes	Inhibit sprouting
2	Fresh fruits and vegetables (other than Class 1)	Delay ripening
		Insect disinfestation
		Shelf -life extension
		Quarantine application
3	Cereals and their milled products, pulses and their milled products, nuts, oil seeds, dried fruits and their products	Insect disinfestation
		Reduction of microbial load
4	Fish, aquaculture, seafood and their products (fresh or frozen) and crustaceans	Elimination of pathogenic micro organisms
		Shelf -life extension
		Control of human parasites
5	Meat and meat products including poultry (fresh and frozen) and eggs	Elimination of pathogenic microorganisms
		Shelf -life extension
		Control of human parasites
6	Dry vegetables, seasonings, spices, condiments, dry herbs and their products, tea, coffee, cocoa and plant products	Microbial decontamination
		Insect disinfestation
7	Dried foods of animal origin and their products	Insect disinfestation
		Control of moulds
		Elimination of pathogenic micro organisms
8	Ethnic foods, military rations, space foods, ready-to-eat, ready-to-cook/minimally processed foods.	Quarantine application
		Reduction of microbial load
		Sterilization
9	Food additives	Insect disinfestation
		Microbial decontamination
		Sterilization
10	Health foods, dietary supplements and nutraceuticals	Insect disinfestation
		Microbial decontamination
		Sterilization

The Process Details

The radiation and sources recommended for this purpose include gamma rays from radioisotopes such asCobalt-60 and Caesium-137, and accelerated electrons and X-rays generated from machine sources.

The process involves exposing food to a specified dose of ionizing radiation inside a biologically shielded irradiation chamber. The irradiation chamber is shielded with concrete walls usually about 1.5-1.8 meters thick. The goods to be irradiated are conveyed to the irradiation chamber through a labyrinth, which prevents radiation from reaching the work area and the operator room. When the facility is not in operation, the source rack housing Cobalt-60 pencils is stored under water at a depth of about 6 meters. The water column thus, absorbs the radiation and acts as a shield to prevent radiation to come out in the cell area. During the processing of a commodity, the source rack is brought up to the irradiation position after activation of all safety devices. The goods in palette carriers or tote boxes are mechanically positioned around the source rack and are turned around their own axis so that the contents are irradiated from both the sides to get a uniform dose (Figure 2).

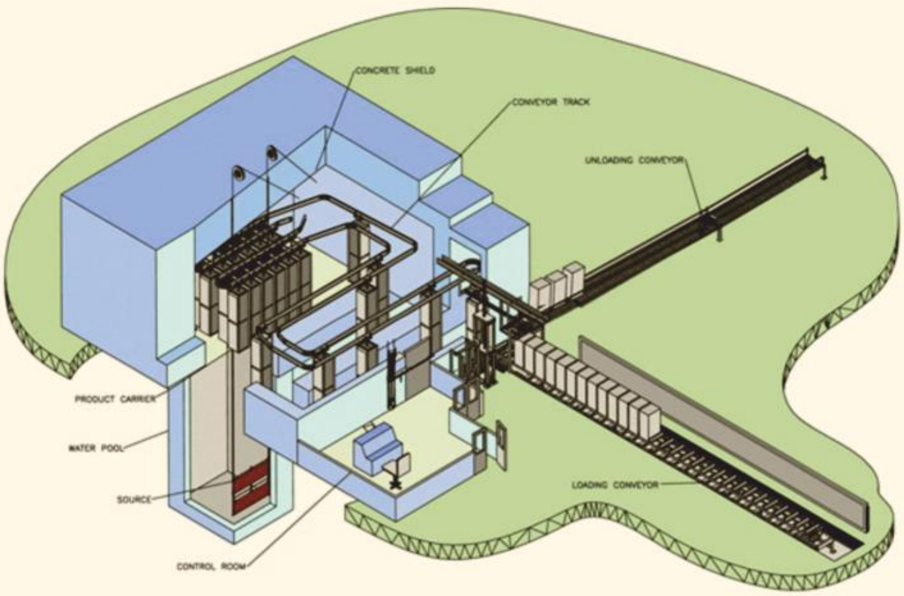

Figure 2: Irradiation facility

The dose is determined by the dwell time of the carrier or tote box in the irradiation chamber and is pre-set after taking into consideration the dose rate, which in turn depends upon the source strength. Depending on the dose, food irradiation applications are divided in to low dose (less than 1 kGy), medium dose (1-5 kGy), and high dose (above 5 kGy). Gy is the unit of radiation energy absorbed and equals 1 joule/kg of food. Dosimetry is carried out to measure the dose absorbed in a commodity by placing dose meters at various positions in a tote box or a carrier. The whole operation is controlled through a SCADA system from a control room outside the shielded area. Although Cobalt-60 irradiators still rule the radiation processing scene around the world, many countries are now deploying electron beam machines for food processing. These facilities obviate the need to produce, handle, store and move large radioactive sources.