SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)
Coimbatore.

Unit II - Topic 4

Preservation by Food Irradiation

Food irradiation is the process of exposing food to controlled levels of ionizing radiation to kill harmful bacteria, pests, or parasites, or to preserve its freshness. It is also called cold pasteurization as it kills harmful bacteria without heat.

Mode of Action

Irradiation can directly impair critical cell functions or components like DNA and indirectly form radiolytic products/ free radicals from water, which are responsible for 90 per cent of DNA damage. Irradiation results in a variety of changes in living cells based on the dosage. For example- high doses kill microbes/ insects; low doses destroy some of the enzymes that lead to fruit ripening, thereby, delaying it and it also interfere with cell division, thereby limiting/ preventing the reproduction of microbes, insects, parasites, etc.

Radiation In Food Preservation

Ionizing radiation is the radiation with enough energy to remove electron(s) from atoms and molecules and to convert them to electrically-charged particles called ions. But, at dose levels approved for food irradiation, these radiations cannot penetrate nuclei and thus, food can never become radioactive. Other types of radiation energy i.e. infrared and microwaves are non-ionizing radiations with longer wavelengths. Infrared radiation is used in conventional cooking. Microwaves, due to their relatively longer wavelength, have lower energy levels but are strong enough to move molecules and generate heat through friction. Three types of ionizing radiations are approved to be used for food irradiation.

- Electron beams generated from machine sources operate at a maximum energy of 10 million electron volts (MeV).
- X-rays generated from machine sources operate at a maximum energy of 5 MeV.
- Gamma rays are emitted from Co-60 or Ce-137 with respective energies of 1.33 and 0.67 MeV.

Electron beams

Electron beams are the streams of very fast moving electrons produced in electron accelerators. Electron beams have a selective application in food irradiation as they can penetrate only one and one half inches deep into the food commodity. Due to poor penetration, shipping cartons (pre-packed bulk food commodities) are not irradiated with electron beams. Electron beams can be switched on or off at will and require shielding as they are generated through machine sources.

X-rays

Just like electron beams, X-rays are also generated through machine sources. X-rays are photons and have much better penetration and are able to penetrate through whole cartons of food products. X-rays also can be switched on or off at will and therefore, require shielding.

Gamma rays

Gamma rays are produced from radioisotopes either Cobalt-60 (Co-60) or Cesium-137 (Ce-137). Contrary to electron beams and X-rays, radioisotopes cannot be switched off or on at will and they keep on emitting gamma rays, therefore radioisotopes require shielding. Co-60 source is kept immersed under water when it is not in use and Ce-137 is shielded in lead. Due to their continuous operation, radioisotopes need to be replenished from time to time. Gamma rays are photons and have deep penetration ability.

Units of irradiation

Radiation dose is the quantity of radiation energy absorbed by the food as it passes through the radiation field during processing. The gray (Gy) is the unit used to measure absorbed dose of radiation and is equal to one joule of energy absorbed per kg of matter being irradiated.

1 Gy (Gray) = 100 rad (radiation absorbed dose)
1 Kilogray (kGy) = 1000 Gy

International health and safety authorities have endorsed the safety of irradiation for all foods up to a dose level of 10 kGy. Recent evaluation of an international expert study group appointed by Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) showed that food treated according to good manufacturing practices (GMPs) at any dose above 10 kGy is also safe for consumption, making irradiation parallel to heat treatment of food.
In India, the Ministry of Health and Family Welfare amended the Prevention of Food Adulteration Rules (1954) through a Gazette notification dated August 9, 1994, permitting irradiation of onion, potato and spices for internal marketing and consumption. In 1998 a number of other food items were permitted for radiation processing . Approval for additional items like fresh, frozen and dried sea foods and pulses have been given under FSSA regulations (2011).

Food items approved for radiation preservation under PFA Rules, 1955 and FSSA regulations, 2011

Name of food	Purpose	Dose (kGy)	
		Minimum	Maximum
Onion	Sprout inhibition	0.03	0.09
Potato		0.06	0.15
Ginger, garlic and shallots		0.03	0.15

(Small onion)			
Mango	Disinfestation	0.25	0.75
Rice		0.25	1.00
Semolina (sooji, rawa), wheat atta and maida		0.25	1.0
Raisin, figs and dried dates		0.25	0.75
Meat and meat products including chicken	Shelf-life extension and pathogen control	2.5	4
Spices	Microbial decontamination	6	14
Fresh sea foods	Shelf-life extension and pathogen control	1.0	3.0
Frozen sea foods		4.0	6.0
Dried sea foods	Disinfestation	0.25	1.0
Pulses			

Terminology for Radiation Treatment of Foods

Radurization

Radurization process involves irradiation applied to obtain a substantial reduction in number of spoilage organisms, thereby extending the shelf life of food 3 to 4 fold. It is applied at dosage of 0.5-10 kGy. Irradiation of 5 kGy eliminates most of the spoilage organisms.

Radicidation

Radicidation aims at reducing considerable number of non-spore forming pathogenic microorganisms (other than viruses) and parasites. It is applied at dosage of 3.0-10 kGy and improves the hygienic quality of the food and also reduces the risk of public exposure to pathogens.

Radappertization

Radappertization refers to irradiation applied to prepackaged, enzyme-inactivated foods to reduce the number and/or activity of microorganisms. For example - 12D reduction in C. botulinum spores. It is applied at dosage of 25-60 kGy. The process renders the food shelf stable without refrigeration.

Nutritional Quality of Irradiated Foods

Irradiation does not considerably raise the temperature of the food and nutrient losses are small and often significant as compared to other methods of preservation such as canning, drying and heat pasteurization.

Macronutrients like carbohydrates, proteins, and fats, undergo little change during irradiation even at doses over 10 kGy. Similarly, the essential amino acids, minerals, trace elements and most vitamins do not suffer significant losses.

Different types of vitamins have varied sensitivity to irradiation and it depends on the complexity of the food system and the solubility of the vitamins in water or fat. Vitamin losses can be minimized by irradiating the food in frozen form or by packaging it in an inert atmosphere such as under nitrogen. Four vitamins are recognized as being highly sensitive to irradiation: B1, C (ascorbic acid), A (retinol) and E (alpha-tocopherol). However, B1 is even more sensitive to heat than to irradiation.

Advantages and Disadvantages of Food Irradiation

The advantages and disadvantages of food irradiation are enlisted in .

Advantages and disadvantages of food Irradiation:

Benefits	Limitations
Radiation processing does not change texture and freshness of food, unlike heat. In fact, it is difficult to distinguish between irradiated and non-irradiated food on the basis of colour, flavour, taste, aroma or appearance.	Radiation processing cannot be applied to all kinds of foods.
Radiation processing does not affect significantly nutritional value, flavour, texture and appearance of food.	Radiation processing cannot make a bad or spoiled food look good i.e. it is not a magic wand.
Radiation cannot induce any radioactivity in food and does not leave any harmful or toxic radioactive residues on foods as is the case with chemical fumigants.	It cannot destroy already present pesticides and toxins in foods.
It is a very effective method due to its highly penetrating nature of the radiation energy and can be used on packed food commodities.	Compliance of a particular food commodity to radiation processing has to be tested first in a laboratory.
Prepackaged foods can be made sterile thus improving shelf-life.	Only those foods for which specific benefits are achieved by applying appropriate doses and those duly permitted under the PFA Rules, (1955) and now FSSA regulations (2011) can be processed by radiation.
The radiation processing facilities are environment friendly and are safe to workers and public around.	--