# FAQs

**1.** What are the sources of radiations approved for food irradiation?

Irradiation is the controlled application of energy from ionizing radiations. The following types of ionizing radiations are allowed for use in food irradiation.

i. Gamma rays from the radionuclides Cobalt – 60 (Maximum energy 1.17 - 1.3 MeV) or Cesium - 137 (Maximum energy 0.67 MeV).
ii. X - rays generated by machines operated at or below an energy level of 5.0 – 7.5 MeV.
iii. Electrons produced commercially by machine sources at or below an energy level of 10 MeV

**2.** What is the mechanism of action of radiation for food preservation?

When ionizing radiations of approved energy levels pass through foods, there are collisions between ionizing radiations and food particles at the molecular levels. Ion pair is produced when the energy from these collision is sufficient to dislodge an electron from an atomic orbit. Molecular changes occur when collisions provide sufficient energy to break chemical bonds between atoms and form free radicals. Formation of ion pairs, free radicals, reaction of free radicals with other molecules, recombination of free radicals and related physical and chemical phenomena provide mechanisms by which microorganisms and food constituents are altered during irradiation. These changes help preserve foods.

**3.** Why irradiation is called a cold process?

Irradiation is a cold process or cold pasteurization process as it can destroy microbes without substantial increase in the temperature of food and without causing any significant physical and chemical changes in it. When food is irradiated to an absorbed dose of 10 kGy, the product temperature may rise only by 2.5 ºC, hence the technology is considered non – thermal, thus better preserving the freshness and the nutritional quality of the food compared to thermal processing.

**4.** What about inducing radioactivity in the food constituents when food is irradiated?

Radiation at low energy level does not induce radioactivity in the food constituents. It will not produce any harmful toxic residues in food and can be used to treat pre - packed commodities. Irradiation achieves disinfestations of insects, enzyme inhibition, destruction of microbes responsible for spoilage and elimination of pathogens and parasites of hazardous nature.

**5.** Write a brief note on resistance of microorganisms to radiations.

The most radiation resistant microorganism in foods is *Clostridium botulinum.* Acid values below pH 4.5, aerobic conditions, extreme dryness in foods and refrigeration below 4ºC prevent growth and toxin formation by this organism. In foods where these conditions do not exist, the food is irradiated with the dosage sufficient to destroy this organism. Food with pH > 4.5, *Cl.*

*botulinum* is not a problem but other spoilage organisms must be inactivated perhaps with lower radiation dosages. Bacterial spores are more resistant to the germicidal action of ionizing radiations than are the vegetative cells.

**6.** Write a brief note on resistance of enzymes to radiations.

Most food enzymes are more resistant to ionizing radiations than even the spores of *Cl. botulinum.* Inactivation of enzymes requires very high doses of the order of 200 kGy (20 M rad). Such a high dosage destroys food constituents and impairs safety of food. For these reasons, irradiation alone is not suitable for food stability. Hence combination of processes is employed. Enzymes are more easily inactivated by heat (even blanching) and by certain chemicals.

**7.** What is radurisation?

Use of low doses (up to 1 kGy) for food irradiation is referred to as radurisation. These low doses would substantially reduce the pathogenic and spoilage microorganisms and enhance the keeping quality of meat and meat products. Radurisation is used along with refrigeration to maintain quality. The shelf life of fresh meats in refrigeration (2 - 4°C) is normally 3 days. It has been demonstrated that the shelf life of radurised fresh meats is 5 weeks at the same temperature. Radurisation is helpful if fresh meat is to be transported in chilled condition to the desired places. Radurisation reduces the levels of potential pathogens such as *Salmonella spp* and spoilage organisms such as *Pseudomonas spp.* Also it causes insect disinfestations and parasite inactivation. However, radurisation may induce oxidation of myoglobin to metmyoglobin and drip from cut surfaces. This may help develop some off flavors in meat. Addition of sodium tripolyphosphate, use of oxygen permeable and moisture impermeable plastic wrapping with dosage of about 1 kGy prolongs the storage life of meats up to 3 weeks. The dosage up to 1 kGy does not induce lipid oxidation.

**8.** What is radicidation?

Application of medium radiation dosage of 1 - 10 kGy for food preservation is referred to as radicidation. This dosage is necessary to reduce the number of viable non - sporing pathogenic microorganisms and spoilage bacteria so that none is detectable. Doses for this purpose are usually less than 10 kGy. Meat and poultry are frequently contaminated with pathogens such as Salmonella, Campylobacter and Listeria, which are inactivated by this dosage of irradiation.

**9.** What is radappertisation?

Radappertisation is an alternative to commercial preservation by thermal sterilization, freezing and drying. The process is called as cold sterilization. The doses used are high in the range of 10 - 45 kGy. It is similar to thermal processing of canned meat products. Reduction in numbers of microorganisms will be to the point of commercial sterility. Very few microorganisms survive following the radappertisation process. The product is shelf - stable (long term storage without refrigeration). The meat products can be kept at ambient temperature for years with the application of radappertisation without affecting palatability, nutritive quality and wholesomeness. Products subjected to radappertisation should be packed properly to prevent

microbial recontamination and the deleterious effects from light, oxygen and moisture. Both metal containers and flexible packages are used under vacuum to prevent rancidity of lipids.

**10.** What are radiolytic products when meat is irradiated?

The radiolytic products from all meats (including poultry and fish) are essentially the same. They include several chemicals such as alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, aldehydes, esters and sulphur compounds. Degree of formation of radiolytic components increases with dosage as well as with increased product temperature.

**11.** Why meat irradiation should be combined with other treatments?

In many instances irradiation alone may not be successful in providing safe meat. Combination of different treatments showed better results for maintaining the quality of irradiated meat products through their synergistic antimicrobial effect. Most food enzymes are more resistant to ionizing radiations than even the spores of *Clostridium botulinum.* Inactivation of enzymes requires very high doses of the order of 200 kGy (20 M rad). Such a high dosage destroys food constituents and impairs safety of food. For these reasons, irradiation alone is not suitable for food stability. Hence combination of processes is employed. Enzymes are more easily inactivated by heat (even blanching) and by certain chemicals.

**12.** Describe combination treatments for effective preservation of meat.

Incorporation of ascorbic acid and spice powders in to meat products may offset the ill effects of irradiation by minimizing the production of off odors / flavors. Similarly addition of alpha tocopherol in to ground meat combined with packaging retards lipid oxidation in the irradiated meat. The role of preservative such as nitrite in meat curing is color fixation and imparts flavor to the product. More importantly, nitrite inhibits the growth of *Clostridum botulinum* and provides protection against the organism. The nitrite in cured meats forms nitrosamines that are carcinogenic. Radiation destroys *Cl. botulinum.* Hence, nitrite requirement in meat curing can be reduced by 50% if the meat is subjected to radiation.
Irradiation in combination with vacuum packaging, edible coating film containing natural antimicrobial compounds or modified atmosphere packaging significantly reduce bacterial growth and increase both safety and shelf life for some types of refrigerated products. High dosage of radiations required for enzymes in meat or poultry products is detrimental. The dosage can be reduced substantially by vacuum packaging in subfreezing temperatures to prepare sterile shelf stable products with excellent sensory properties. Such products have been used extensively by military organizations, during space flights and by hospitals.

**13.** How meat color is affected by irradiation?

Meat color is the primary quality attribute of fresh meat that affects consumer acceptance. Heme pigments, especially myoglobin, are responsible for meat color. Irradiation influences the release of iron from heme pigments. Ozone, a strong oxidizing agent, is produced from oxygen during irradiation. Ozone oxidizes myoglobin causing bleaching discoloration. Pre – slaughter feeding of antioxidants to livestock or addition of antioxidants directly to the product may help maintain meat color during irradiation.

**14.** How fat in meat is affected by irradiation?

Irradiated fats show a tendency for autoxidation in the late post – irradiation period leading to off odors / flavors due to increased rancidity. However, peroxide value of irradiated meat may remain unchanged if meat is blanched and vacuum packed in cans or flexible pouches before irradiation.

**15.** Describe how meat proteins are affected by irradiation.

Damage caused to proteins by irradiation includes deamination, decarboxylation, reduction of sulphur linkages, oxidation of sulfhydryl groups, breakage of peptide bonds and changes in valency states of the coordinated metal ions. Irradiation reduces water binding capacity of muscle proteins resulting in increased drip loss. The solubility of collagen is increased by irradiation resulting in to breaking of peptide chain to yield lower molecular weight units and hence increasing the tenderness quality of meat. Irradiation decreases viscosity of liquid egg white suggesting the denaturation of albumen proteins. However, digestibility, biological value, net protein utilization and amino acid composition are same as untreated meat as shown by feeding rats. Changes in proteins due to irradiation of meat may also influence the emulsion characteristics of proteins, which in turn affect sensory quality attributes of meat emulsion products.