Supporting document 2

Overview of the food irradiation process and a Glossary of Technical terms (Approval)

Gamma rays and X-rays form part of the electromagnetic spectrum, like radio waves, microwaves, ultraviolet, and visible light rays. Gamma rays and X-rays are in the short wavelength, high-energy region of the spectrum. Both gamma and X-rays can penetrate foods to a depth of several decade centimetres. Energies are too low to induce radioactivity in any material, including food.

Although several techniques are available for food irradiation (gamma rays, e-beam, and X-rays), the most widely used are gamma rays from Cobalt 60 followed by e-beam. However, e-beams must be converted to X-rays to penetrate large items such as meat carcasses.

Gamma ray, electron beam, and X-ray sources are used for a variety of industrial processes. Gamma radiation is preferred because it can penetrate deeply, whereas ‘‘e-beams’’ penetrate food to a depth of only 3.80 cm.

The high-energy radiation (gamma/e-beam/X-ray) can produce ions or charged particles after being absorbed by matter.
Radiation destroys microbes or spoilage organisms by partial or total inactivation of genetic material in living cells, either by direct effects on DNA or through production of radicals and ions that attack DNA.

In insects, ionising radiation breaks chemical bonds within individual molecules and between molecules, thereby disrupting normal cellular function in the insect. Insect response to irradiation varies with the insect species and life stage and the absorbed dose received by the insect. Tissues with undifferentiated, actively dividing cells are most susceptible to irradiation. Consequently, eggs are normally the most susceptible life stage and adults are the most tolerant. Insect gonads and midgut contain dividing cells, and irradiated insects are often sterile and stop feeding soon after treatment.

Absorption of ionising radiation by food molecules may result in the breaking of chemical bonds and the formation of free radicals and charged ions, leading to the formation of radiolytic products. These radicals are usually unstable and very reactive; however, they are subsequently converted to stable end-products. There is a linear relationship between radiation dose and amount of products produced. The presence of water and oxygen can influence the radiolytic process.

Glossary of frequently used terms

Dose (absorbed): The absorbed dose, sometimes referred to simply as ‘dose’, is the amount of energy absorbed per unit mass of irradiated food product.

Dose Limit: The minimum or maximum radiation dose absorbed by a food product prescribed in Standard 1.5.3 to produce a specific technological effect.

E-Beam

The e-beam is a stream of high-energy electrons, propelled out of an electron gun. This electron gun apparatus is a larger version of a standard television tube.

Gamma rays are produced by radioactive isotopes such as Cobalt 60 and Caesium 137 have initial energies from 0.66 to 1.33 MeV.

Cobalt 60 is produced by exposing pure natural cobalt-59 pellets to a neutron source in a nuclear reactor to produce radioactive Cobalt 60. The Cobalt-60 pellets are encased in double stainless steel cylinders, called pencils. *Gamma rays* are produced continuously and emitted in all directions.

Caesium137 is produced as a result of uranium fission and may be reclaimed as a by-product of nuclear fuel processing. This is not available in sufficient quantities to play a role in commercial food irradiation.Caesium-137 decays to non-radioactive barium.

Ionising radiation - radiation from high-energy gamma rays, X-rays, and accelerated electrons with energy high enough to dislodge electrons from atoms and molecules and to convert them to electrically charged particles called ions.

X-rays

X-rays are a form of electromagnetic radiation with a wide range of short wavelengths. X-rays are produced when charged particles, moving with a very high velocity, are slowed rapidly by striking a target (e.g. tungsten). They use the same technology that produces electron beams, but they have more flexibility in food processing applications because of their greater penetrating power. The X-ray machine is a more powerful version of the machines used in many hospitals and dental offices to take X-ray pictures.

References

Arvanitoyannis IS (2010) Irradiation of food commodities: techniques, Applications, Detection, Legislation, Safety and Consumer Opinion. First edition 2010 Elsevier Inc.

Murano EA (1995) *Food Irradiation: A Source Book.* Ames, IA: Iowa State University Press.

WHO (1994) The Safety and Nutritional Adequacy of Irradiated Food. Geneva.

WHO (1999) High-dose irradiation: wholesomeness of food irradiated with doses above 10kGy. A Report from a Joint FAO/IAEA/WHO Study Group. *WHO Technical Report Series 890.*