Food irradiation: an effective but under-utilized technique for food preservations

1. **Principle of Food Irradiation**
   Food irradiation involves exposing food to controlled doses of ionizing radiation (gamma rays, electron beams, or X-rays) in a specialized facility, usually via a conveyor system. The radiation damages the DNA of microorganisms and insects, preventing them from reproducing and contaminating food. Importantly, irradiated foods **do not become radioactive** and retain their texture, flavor, and color.

2. **Radiation Sources Used**
   - **Gamma rays (Cobalt-60, Cesium-137):** Deep penetration, effective for bulk foods, but require radioactive sources and heavy shielding.
   - **Electron beams (≤10 MeV):** Produced by accelerators, non-radioactive, inexpensive, easy to switch off, but limited penetration depth.
   - **X-rays (≤5 MeV):** Highly penetrating, suitable for large volumes, non-radioactive, but costly to install and operate.
     Each source represents a balance between **safety, cost, and effectiveness**.
   -

3. **Dose Levels and Main Functions**
   - **Radurization (<2.5 kGy):** Low dose, extends shelf life, inhibits sprouting (potatoes, onions), slows fruit ripening, controls insects.
   - **Radicidation (2.5–5 kGy):** Medium dose, destroys non-spore-forming pathogens (Salmonella, E. coli), yeasts, and molds, reducing foodborne disease risk.
   - **Radappertization (>10 kGy):** High dose, sterilizes food by eliminating resistant spores, used for frozen meats, herbs, and spices.
     These three ranges allow irradiation to be tailored to **specific preservation and safety goals**.

4. **Practical Applications**
    - **Sprouting inhibition:** Potatoes, onions, garlic, ginger.
    - **Disinfestation:** Cereals, pulses, dried fruits, without chemical residues.
    - **Pathogen reduction:** Spices, fruits, vegetables, lowering foodborne illness risk.
    - **Shelf-life extension:** Meat, poultry, fish, fruits, with preserved taste and texture.
    - **Quarantine treatments:** Fruits and vegetables for export, meeting phytosanitary standards.
      → Irradiation is a **safe and effective alternative** to refrigeration or chemical fumigation.

5. **Major Advantages**
    - No radioactivity induced and no toxic residues.
    - Preserves texture, flavor, and color.
    - One process applicable to many commodities, with dose adjustments.
    - Can be combined with other preservation methods for enhanced safety.
    - Minimal impact on nutritional value compared to overcooking.
    - Reduces post-harvest losses and foodborne diseases.
    - Environmentally friendly and safe for workers under strict regulations.

6. **Limitations and Consumer Acceptance**
    - Some spore-forming bacteria (Clostridium, Bacillus) resist moderate doses.
    - Certain fruits/vegetables (tomatoes, cucumbers, grapes) may lose vitamins, texture, or color.
    - Lipid-rich foods (eggs, dairy) can develop off-flavors if irradiated in oxygen-rich environments.
    - High installation costs and strict regulation.

- **Consumer perception remains a barrier**: fears of radioactivity or mutations.
  → Clear communication, use of the **Radura symbol**, and education about benefits (food safety, reduced losses) are key to improving acceptance.