Food Irradiation

Bisc. 419 Presentation

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What is Food Irradiation?

• Food Irradiation is a process whereby food is exposed to a carefully measured amount of intense radiant energy, called ionizing radiation.
History of food irradiation

• Food irradiation has a 50-year history of scientific research and testing.

• In 1955, the U.S. Army medical department started to assess the safety of irradiated foods.

• FDA soon approved irradiation for wheat and wheat powder in 1963.

• In the 1960s FDA approved it for wheat and white potatoes.

• In early 1970s NASA adopted the procedure to sterilize meats foods for astronauts to consume while in space.

• In 1980s, spices, seasonings, pork, and fresh fruits gained approval.

• Poultry was approved in 1990 and red meats in 1997.
What does food irradiation accomplish?

• Improves **microbiological** safety by:
  • Reducing infestation of grain, dried spices and dried or fresh fruits and vegetables.
  • Inactivating parasites in meats and fish.
  • Eliminating spoilage microbes.
  • Extends shelf life of foods.
  • Sterilizes foods.
  • Reduces the use of chemical fumigants and additives.
How does food irradiation work?

• Ionizing radiation has energy capable of producing ions and other transient reactive molecular species when collision occurs.

\[ \text{e}^- \quad \text{OH} \cdot \quad \text{H} \cdot \]

These reactive species are capable of degrading and altering biopolymers such as DNA and protein.

• Ionizing radiation causes DNA damage directly...
  
  • High energy radiation causes fragmentation of DNA --> inhibiting bacterial growth.

• Enzyme + DNA destruction ---> Microbial death
Process of food Irradiation

• Packaged food is passed under the source of irradiation at a certain speed to receive the desired amount of dose.

• Sources of Ionizing energy can be gamma rays from Co, Cs.

• In the United States, Co is most commonly used.

• Gamma radiation does not elicit neutrons, particles conferring radioactivity, and thus foods and packages are not made radioactive.
Dose and Effect

• Irradiation dose is measured in Gray (Gy), where 1 Gy = 100 rad.

• Parasites and Insect pests - Large amounts of DNA - Rapidly killed with Dosage value of 0.1 kiloGray.

• Bacteria - Have smaller DNA - D-values 0.3 to 0.7 kiloGray.

• Bacterial spore - due to inertiiness - 2.8 kiloGray.

• Viruses - Small DNA - Resistant to approved dosages for food.

• Prions, which cause mad cow disease, lack nucleic acids and thus are also not damaged by irradiation.
## Commonly Irradiated Products, Dose and Purpose

<table>
<thead>
<tr>
<th>Approval Year</th>
<th>Food</th>
<th>Dose</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>Wheat flour</td>
<td>0.2-0.5 kGy</td>
<td>Control of mold</td>
</tr>
<tr>
<td>1964</td>
<td>White potatoes</td>
<td>0.05-0.15 kGy</td>
<td>Inhibit sprouting</td>
</tr>
<tr>
<td>1986</td>
<td>Pork</td>
<td>0.3-1.0 kGy</td>
<td>Kill Trichina parasites</td>
</tr>
<tr>
<td>1986</td>
<td>Fruit and vegetables</td>
<td>1.0 kGy</td>
<td>Insect control, increase shelf life</td>
</tr>
<tr>
<td>1986</td>
<td>Herbs and spices</td>
<td>30 kGy</td>
<td>Sterilization</td>
</tr>
<tr>
<td>1990 - FDA</td>
<td>Poultry</td>
<td>3 kGy</td>
<td>Bacterial pathogen reduction</td>
</tr>
<tr>
<td>1992 - USDA</td>
<td>Poultry</td>
<td>1.5-3.0 kGy</td>
<td>Bacterial pathogen reduction</td>
</tr>
<tr>
<td>1997 - FDA</td>
<td>Meat</td>
<td>4.5 kGy</td>
<td>Bacterial pathogen reduction</td>
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</tbody>
</table>
Importance of Food Irradiation to Society

• Microorganisms destroy huge amounts of food causing economic problems.

• Additionally, consumption of microbially contaminated food causes serious infections and poisoning.

  • CDC estimates that food-borne bacteria caused 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the U.S. in 1998.

  • Outbreaks of E-coli 0157:H7, alone, are estimated to cause 62,458 illnesses, 1,843 hospitalizations and 52 deaths each year.
The Bad Guys and Bad Stuff

• Salmonella - virtually all species are pathogenic for humans.
  Causes: headache, chills, vomiting, diarrhea followed by fever (Salmonellosis or food poisoning).
  Food Products: Eggs, milk, meats, canned food (during food handling process).

• E-coli - several strains are implicated as pathogens (enterotoxic), particularly, the O157:H7 strain
  Causes: bloody diarrhea, kidney failure in children.
  Food Products: Contaminated uncooked or under cooked ground meats.

* Irradiation is considered the only effective means to ensure decontamination from this strain of E-coli.
Bad Guys and Bad Stuff continued...

• Campylobacter - C. jejuni, and C. fetus account for majority of diarrhea in children.

  Causes - high fever, nausea, cramps, watery and bloody stool.

  Food Products - Poultry, pork, raw clams, shellfish.

• Listeria monocutogenes - acid, cold and salt tolerant pathogen is widespread in soil and water.

  Causes - Listeriosis (mortality rate of 20-30%) characterized by meningitis and bacteremia.

  Food Products - Produce, dairy products, meats.

• H. Pylori -

  Causes - ulcers.

  Food Products - Specific foods are not known.
Bad Guys and Bad Stuff continued…

• Seeing the extent of burden posed by pathogens in food, it is important to have measures which inhibit their growth and keep food from becoming contaminated (i.e., preventive measures).

• Irradiation as an effective means of controlling microbes and thus preventing illnesses they cause.
Safety, Nutrient Loss, and Radiation Resistance

• During the process, unique radiolytic products are released. But FDA review has concluded that there is no cause for concern that these products are toxic.

• Irradiation does lead to loss of vitamins in foods, but the amount is comparable to losses which occur during cooking.

• Food and package materials are not made radioactive during the process of food irradiation.

• Creation of novel pathogens resistant to radiation is a theoretical threat…but so far no novel pathogens have been found.
Conclusion

• Food irradiation is an effective means of reducing microbes in food, which in turn can reduce food-borne illnesses and reduce economic costs.

• Food irradiation is regulated by such agencies as the FDA, and USDA. It is endorsed by WHO and CDC among other health agencies - It is safe.

• Concerns will always remain, but by following best management practices we can reap the benefits of the technology with minimal consequences.