

# Food Irradiation

Lane A. Highbarger, Ph.D.

Division of Biotechnology and GRAS Notice Review

Office of Food Additive Safety

Center for Food Safety and Applied Nutrition

October 19, 2010



# Federal Food, Drug, and Cosmetic Act

## ■ Sec. 201(s): Food Additive Definition

- Any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; including any source of radiation intended for any such use)\*\*\*



# Federal Food, Drug, and Cosmetic Act

- Sec. 201(s): Food Additive Definition
- Any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; including any source of radiation intended for any such use)\* \*\*



# Federal Food, Drug, and Cosmetic Act

## ■ Sec. 201(s): Food Additive Definition

- Any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; including any source of radiation intended for any such use)\*\*\*



# Sources of Irradiation

- Cobalt 60 - 1.33 MeV
- Cesium 137 - 662 keV
- Electron accelerators operated at  
10 MeV or less
- X-ray generators operated at  
7.5 MeV or less





# A Brief History of Food Irradiation

- **1905** Begins the era of food irradiation.
- **1958** Congress defines a source of radiation as a food additive.
- **1980** Foods irradiated up to 10 kGy considered to be safe and wholesome.
- **1997** Foods irradiated at any dose should be considered as safe and as wholesome as foods treated by any other conventional process.
- **2001** Irradiation is used to eliminate possible traces of Anthrax.
- **1984-2009** FDA approves the use of irradiation in a variety of foods.



# Why Irradiate Food?

- Low Dose (<1 kGy)
  - Control insects
  - Inhibit maturation
  - Inhibit sprouting
- Medium Dose (1-10 kGy)
  - Extend shelf life
  - Reduce microorganism level
- High Dose (> 30 kGy)
  - Sterilize - analogous to canning
  - Decontaminate certain food additives, e.g., spices



# Foods Permitted to be Irradiated Under FDA's Regulations

■ All foods	Arthropod Control	1 kGy max
■ Dry Enzyme Preps.	Microbial Control	10 kGy max
■ Fresh Foods	Maturation Inhibition	1 kGy max
■ Spices/Seasonings	Microbial Control	30 kGy max
■ Poultry	Microbial Control	3 kGy max
■ Seeds for sprouting	Microbial Control	8 kGy max
■ Shell eggs	Microbial Control	3 kGy max
■ Meat and meat byproducts	Microbial Control	4 kGy/7 kGy
■ Molluscan shellfish	Microbial Control	5.5 kGy max
■ Fresh lettuce and spinach	Microbial Control	4 kGy max
■ NASA	Sterilization	44 kGy min





# Other Irradiated Substances

■ Medical equipment	Microbial Control
■ Laboratory animal diets	Microbial Control 50 kGy max
■ Poultry feed	<i>Salmonella</i> spp. 25 kGy max
■ Pet foods, treats and chews	<i>Salmonella</i> spp. 50 kGy max



# Susceptibility

- Mammals > Insects > Single Cell Organisms > Viruses; (Prions Likely Resistant)
- $D_{10}$  – The radiation dose needed to inactivate 90% of the microbial load in the food medium

# Bacterial Susceptibility

- All bacteria have different susceptibilities to radiation (values in kGy)
  - *Salmonella spp.* – 0.36 - 0.77
  - *Listeria monocytogenes* – 0.35 - 0.7
  - *E. coli* O157:H7 – 0.25 - 0.39
- A 99.999% reduction =  $5 \times D_{10}$  value

# Safety Considerations

- Radiological Safety
- Chemical Change and Potential Toxicity
- Nutritional Adequacy
- Potential Microbiological Hazard

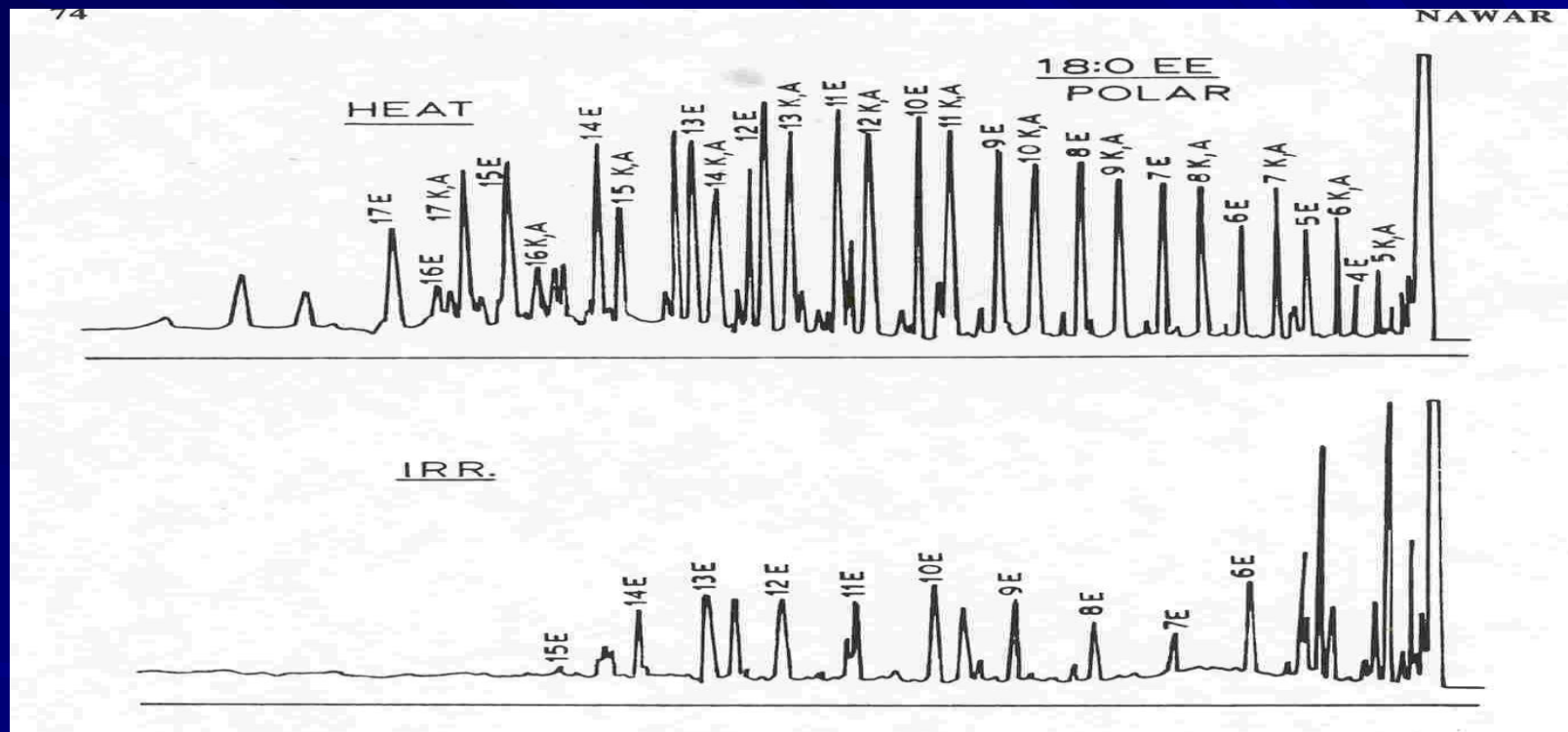


# Chemical Change

- Energy stimulates chemistry
- Increases when liquid is present
- Initiates reaction with air
- Generally little – but not necessarily negligible change
- Can be controlled by controlling conditions



# Heated Lipid (180 °C for 1 hour) vs. Irradiation at 120 kGy



# Nutrition Issues

- Vitamins are labile to heat and irradiation
- Minerals insensitive



# Microbiological

- Radiation sensitivity varies with species
- Sensitivity varies with environment
  - Temperature; water Activity; pH; Salt; etc

# Foods Currently Under Review

- Crustaceans
- Multiple-ingredient foods
- Non-refrigerated meat food products
- Poultry
- Dietary supplements



# Labeling Criteria

- The FDA requires that irradiated foods bear the radura label and must state on the label “Treated with radiation” or “Treated by irradiation”



- There is no statutory requirement specific to irradiation



# Controversy and Questions

## ■ Objections

- Consumer
- Public Citizen / Center for Food Safety

## ■ Formal Correspondence



# Web Based Information Resources

## Food Safety and Irradiation

Food Irradiation Processors Alliance – <http://www.fipa.us/>

Kansas State University – <http://www.foodsafety.ksu.edu/en/>

USDA Fact sheet –

[http://www.fsis.usda.gov/Fact\\_Sheets/Irradiation\\_and\\_Food\\_Safety/index.asp](http://www.fsis.usda.gov/Fact_Sheets/Irradiation_and_Food_Safety/index.asp)

FSIS on labeling – <http://www.fsis.usda.gov/OPPDE/larc/Policies/IrradiationQA.htm>

Food Safety dot gov – <http://www.foodsafety.gov/>

**Printable information:** Irradiated Lettuce and Spinach –

<http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM143389.pdf>

**Recent News:** *E. coli* O145 in romaine lettuce –

[http://www.cdc.gov/ecoli/2010/ecoli\\_o145/index.htm](http://www.cdc.gov/ecoli/2010/ecoli_o145/index.htm)

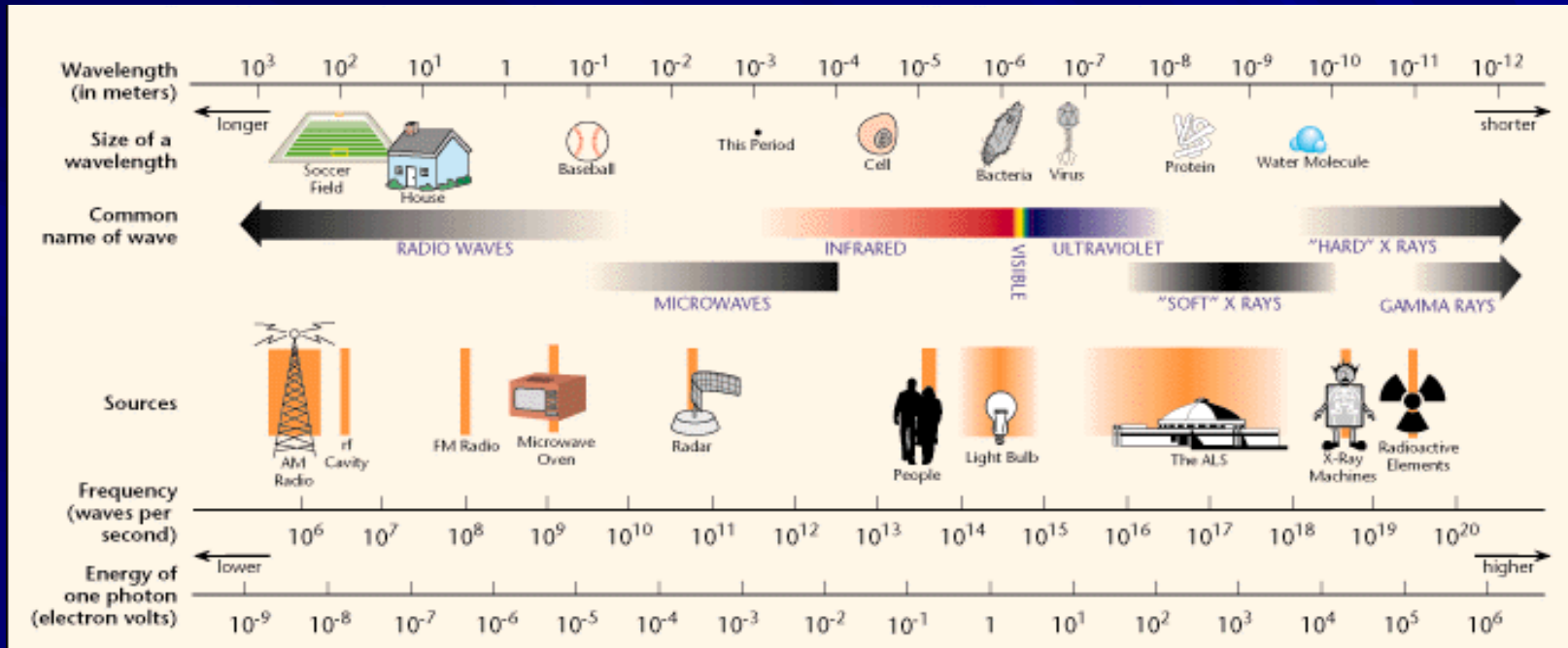
WSJ Blog on *E. Coli* –

<http://blogs.wsj.com/health/2010/05/07/health-blog-qa-what-to-do-about-e-coli/>

# Questions?



# Radiation Spectrum

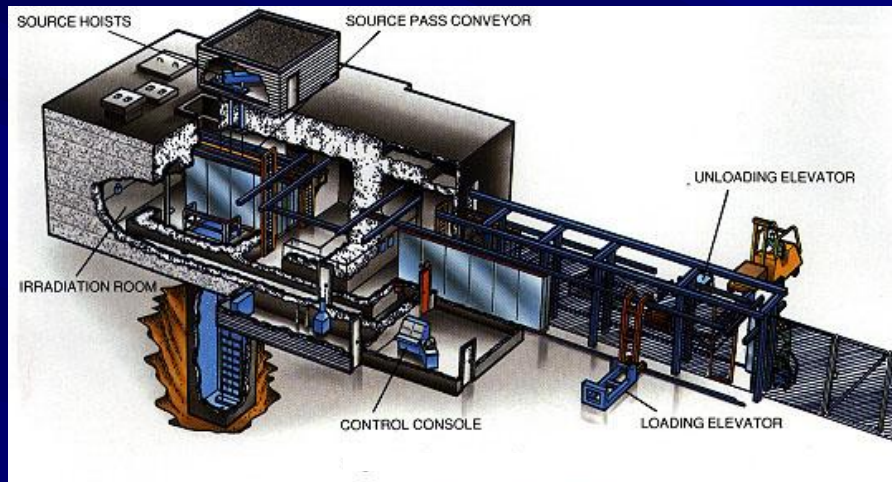


# Dose – What it means

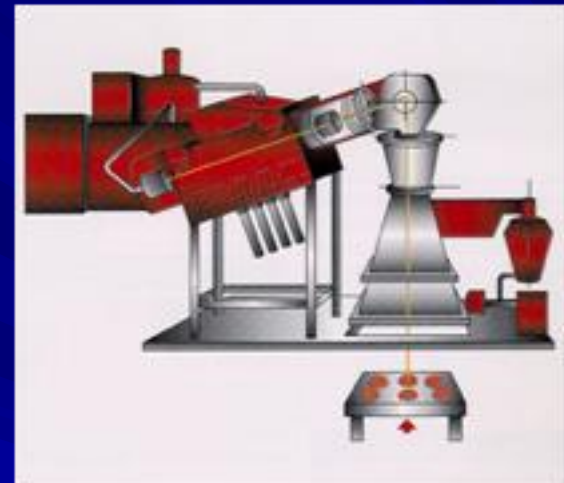
- Irradiation doses are measured in gray (Gy)
  - Gy is measured in joule/kg absorbed energy
  - $1 \text{ Gy} = 1 \frac{\text{J}}{\text{Kg}} = 1 \text{ m}^2 \cdot \text{s}^{-2} == \text{Sievert}$
- Applied dose = energy source  $\times$  time exposed
- Absorbed dose depends on other factors



# Food Irradiation



Gamma



Electron beam

# Method of Action

- E-beam – shallow penetration
  - Converted to x-ray for more penetration
- Gamma – ‘deeper’ penetration
- All act *via* similar mechanisms

