Food Irradiation: FDA’s Perspective

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Food Additives Amendment - 1958
- Defines “food additive” (w/ GRAS exemption)
- Requires premarket approval of new uses of food additives, if not GRAS or otherwise exempt from the definition
- Establishes the standard of data review
- Establishes the standard of safety
- Establishes formal rulemaking procedures

Food additive regulations are located in Title 21 of the U.S. Code of Federal Regulations (21 CFR)
Section 201(s) of the FD&C Act

Definition of “Food Additive”

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)***
Source of FDA’s Authority over Food Irradiation

- Section 409 – Defined “unsafe food additive”
  - A food additive is considered unsafe unless the substance and use conform to:
    - An exemption for investigational use; or
    - A regulation that prescribes the conditions under which such additive may be safely used

- Foods containing unapproved food additives are considered adulterated under section 402 of the Act
  - Section 402(a)(7) – “a food shall be deemed adulterated if it has been intentionally subjected to radiation, unless the use of radiation was in conformity with a regulation or exemption in effect pursuant to section 409...”
FDA’s Premarket Approval Authority

- In order to approve a food additive, FDA must conclude its use is safe and issue a regulation.
  - FDA’s safety standard is “reasonable certainty of no harm…”

- The burden of establishing the safety of the proposed use is on the sponsor

- FDA has the responsibility to conduct a full and fair evaluation of the relevant scientific data and information

*FDA evaluates the additive’s intended technical effect, but does not consider possible benefits*
Basics of the Food Additive Petition Process

- Section 409 provides a process for petitioning for a food additive regulation
- Requirements for submitting a petition are found in 21 CFR 171.1
- Any interested party may petition the agency
  - Petition can be for a new additive or expanded use of an approved additive
- FDA reviews the data submitted
- FDA makes a determination of safety
- Granting a petition results in a regulation in 21 CFR
  - Regulations are generic and anyone in compliance with the conditions outlined in the authorizing regulation may use the additive
Safety Considerations for Evaluating a New Use of Ionizing Radiation to Treat Food

Assess the impacts of ionizing radiation on:

- Safety of Radiolytic Products
  - Chemical Composition
  - Potential Toxicity
- Nutritional Adequacy
- Changes in Microbiological Profile

SAFE?
Safety of Radiolytic Products: Impacts on Chemical Composition

- Radiation-induced chemical reactions:
  - Influenced by physical state of the food (solid, liquid, dry, or frozen) and dose
  - Extent of chemical changes are greater when water or oxygen is present
  - Radiolytic products formed are generally similar to chemicals produced during heating of food

Petition should address the chemical changes resulting from the petitioned use of ionizing radiation
Safety of Radiolytic Products: Potential Toxicity

- Some chemicals may be formed that are of toxicological concern at high doses
  - These chemicals are also found in non-irradiated food at similar or higher concentrations (e.g., furan, alkylcyclobutanones)

- Hundreds of “toxicology” studies have been assessed
  - No effects noted in most studies
  - Studies that reported effects are mainly due to dietary deficiencies (i.e., abnormal diet for the animal)

- Integrated toxicological database
  - Toxicology data on a given food may be applied to the toxicological evaluation of foods of a similar generic class
Safety of Radiolytic Products: Potential for Furan Formation

- Considered a possible human carcinogen by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP)
- Can be generated through treatment of food with sources of radiation
- Found in foods that have undergone other forms of processing, including heat treatment
- Multiple pathways for formation, including:
  - Thermal degradation of reducing sugars
  - Thermal oxidation of polyunsaturated fatty acids
  - Formation from ascorbic acid and various sugars (fructose, sucrose, and glucose)
Nutritional Adequacy

- Minerals are not affected by ionizing radiation
- Irradiation of macronutrients has been well-studied
  - Protein
  - Lipid
  - Carbohydrates (to a lesser extent)
- Micronutrients are evaluated on a case-by-case basis due to variable sensitivity under different conditions
- Nutrient losses are considered in the context of the total diet
Nutritional Adequacy

Recent evaluations have assessed:

- Foods irradiated at a wide range of doses
- Susceptibility of vitamins to irradiation (including within the food matrix)
- Significance of the food as a source of the vitamin
  - Levels of the vitamin in food
  - Published information about relative contribution to the total dietary intake
- Other considerations, such as bioavailability
Microbiological Considerations

- Sensitivity to ionizing radiation varies by species
  - Measured as $D_{10}$ value (i.e. dose required to reduce a bacterial population by 90%)
  - Example $D_{10}$ values: 
    - *Salmonella* spp.: 0.36 - 0.77 kGy
    - *Listeria monocytogenes*: 0.35 - 0.7 kGy
    - *E. coli* O157:H7: 0.25 - 0.39 kGy

- Sensitivity of the microorganism varies with the environment
  - Temperature, water activity, pH, salt, etc.

- Petition should identify and address the pathogen of public health significance
Microbiological Considerations for Phytosanitary Use

- Intended technical effect for insect control, not for reduction of microorganisms

- Dose levels above 1 kGy have the ability to affect the spoilage microorganisms
Other Considerations: Scope

Increasing Complexity
As a condition of use, FDA requires that foods treated with ionizing radiation bear the radura label and must state on the label “Treated with radiation” or “Treated by irradiation”
Other Considerations: Packaging

- Food should be packaged prior to treatment with ionizing radiation in a way to limit recontamination
  - Not all food will be contained in “closed” packaging (e.g., fruit)
- Packaging subjected to ionizing radiation incidental to the treatment of food shall be in compliance with:
  - 21 CFR 179.45
  - A threshold of regulation (TOR) exemption under 21 CFR 170.39
  - An effective food contact notification
Petition for a New Use of Ionizing Radiation: Data Needed to Support Safety Determination

- Information relied upon may be (see 21 CFR 170.21(a)):
  - Data generated by the petitioner
  - Data generated by a contract lab
  - Literature in peer-reviewed journals
  - Data in FDA’s files obtained through a Freedom of Information (FOI) Act request
  - Other sources

- Data obtained on a food under specific conditions may be extrapolated to draw conclusions regarding the safety of similar food treated with ionizing radiation under related conditions
Foods Permitted to be Treated with Ionizing Radiation Under FDA’s Regulations

- Fresh Fruits and Vegetables
- Meat (from cattle, sheep, swine, or goat)
- Poultry
- Shell Eggs
- Iceberg Lettuce and Fresh Spinach
- Spices
- Seeds for Sprouting
- Molluscan Shellfish
- Crustaceans

Regulations describing conditions of use are found in 21 CFR 179.26
Resources

- FDA’s website (fda.gov):
  - Webpage for Food Irradiation: [http://www.fda.gov/Food/IngredientsPackagingLabeling/IrradiatedFoodPackaging/default.htm](http://www.fda.gov/Food/IngredientsPackagingLabeling/IrradiatedFoodPackaging/default.htm)

- The Electronic Code of Federal Regulations (see Title 21, Part 179)
  - [www.ecfr.gov](http://www.ecfr.gov)

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