Designation: F 1885 – 04

Standard Guide for Irradiation of Dried Spices, Herbs, and Vegetable Seasonings to Control Pathogens and Other Microorganisms[1]

This standard is issued under the fixed designation F 1885; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The purpose of this guide is to present information on the use of ionizing energy (radiation) in treating dried spices, herbs, and vegetable seasonings to reduce pathogens and spoilage microorganisms. Information on handling these commodities before and after irradiation is also provided.

This guide should be followed when using irradiation technology where approved by an appropriate regulatory control authority. It is not to be construed as a requirement for the use of irradiation, or as a rigid code of practice. While the use of irradiation involves certain essential requirements to attain the objectives of the treatment, some parameters can be varied in optimizing the process.

This guide has been prepared from a code of good irradiation practice, published by the International Consultative Group on Food Irradiation (ICGFI) under the auspices of the Joint Food and Agriculture Organization/International Atomic Energy Agency Division of Nuclear Techniques in Food and Agriculture, which serves as the Secretariat to ICGFI **(1)**.[2]

1. Scope

1.1 This guide covers procedures for irradiation of dried spices, herbs, and vegetable seasonings for microbiological control. Generally, these items have moisture content of 4.5 to 12 % and are available in whole, ground, chopped, or other finely divided forms, or as blends. The blends may contain sodium chloride and minor amounts of dry food materials ordinarily used in such blends.

1.2 This guide covers absorbed doses ranging from 3 to 30 kiloGray (kGy).

NOTE 1—U.S. regulations permit a maximum dose of 30 kGy. (See 21CFR 179.26 Irradiation in the Production, Processing and Handling of Food.)

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ISO/ASTM Standards*[3]

E 170 Terminology Relating to Radiation Measurements and Dosimetry

ISO/ASTM 51204 Practice for Dosimetry in Gamma Irradiation Facilities for Food Processing

E 1261 Guide for the Selection and Calibration of Dosimetry Systems for Radiation Processing

ISO/ASTM 51431 Practice for Dosimetry in Electron and X-ray (Bremsstrahlung) Irradiation Facilities for Food Processing

E 1539 Guide for Use of Radiation Sensitive Indicators

F 1640 Guide for Packaging Materials for Foods to be Irradiated

2.2 *Codex Alimentarius Commission (CAC) Recommended International Codes and Standards:*

STAN 1-1985 General Standard for the Labeling of Prepackaged Foods[4]

STAN 106-1983 General Standard for Irradiated Food[4]

CAC/RCP19-1979 (Rev. 1) Recommended International

[1] This guide is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.06 on Food Irradiation Processing and Packaging.

Current edition approved Jan. 1, 2004. Published February 2004. Originally approved in 1998. Last previous edition approved in 1998 as F 1885–98.

[2] The boldface numbers given in parentheses refer to a list of references at the end of the text.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact Customer Service at service @astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from Joint FAO/WHO Food Standards Program, Joint Office, FAO, Via delle Terme di Caracalla, 00100, Rome, Italy.

Code of Practice for the Operation of Irradiation Facilities for the Treatment of Food[4]

2.3 *U.S. Food and Drug Administration, Code of Federal Regulations:*[5]

CFR Title 21, Part 110 Current Good Manufacturing Practices in Manufacturing, Packaging, or Handling Human Food

CFR Title 21, Section 179.25 General Provisions for Food Irradiation

CFR Title 21, Section 179.26 Irradiation in the Production, Processing and Handling of Food

3. Terminology

3.1 *Definitions*—Other terms used in this guide may be defined in Terminology E 170.

3.1.1 *absorbed dose*—quantity of ionizing radiation imparted per unit mass of a specified material. The SI unit of absorbed dose is the gray (Gy), where one Gray is equivalent to the absorption of one joule per kilogram of the specified material (iGy = I J/kg).

3.1.1.1 *Discussion*—A commonly used definition of absorbed dose appears in Terminology E 170.

3.1.2 *absorbed dose mapping*—measurement of absorbed dose within a process load using dosimeters placed at specified locations to produce a one, two, or three-dimensional distribution of absorbed dose, thus rendering a map of absorbed dose values.

3.1.3 *dose distribution*—the variation in absorbed dose within a process load exposed to ionizing radiation.

3.1.4 *dosimetry system*—a system used for determining absorbed dose, consisting of dosimeters, measurement instruments and their associated reference standards, and procedures fro the system's use.

3.1.5 *Good manufacturing practice (GMP)*—procedure established and exercised throughout the production, manufacturing processing, packing, and distribution of foods, encompassing maintenance of sanitation system, quality control and assurance, qualification of personnel and other relevant activities, to ensure the delivery of commercially acceptable and safe product.

3.1.6 *process load*—one or more containers of product collectively transported through the irradiator as a whole, for example, a box, tote, pallet, or carrier.

3.1.7 *spices*—includes dried spices, herbs, and vegetable seasonings.

3.1.8 *transport system*—the conveyor or other mechanical system used to move the process load through the irradiator.

4. Significance and Use

4.1 The purpose of irradiation to decontaminate spices, as referred to in this guide, is to reduce the population of pathogens, other bacteria, molds, and yeasts present in the products **(2,3,4,5,6, 7)**.

4.2 The process will also kill any insects present, at all stages of development.

[5] Available from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402–9328.

5. Pre-Irradiation Product Handling

5.1 Upon receipt at the irradiation facility, inspect packages and containers of spices according to relevant Good Manufacturing Practices (GMPs) to ensure that their integrity has not been compromised. See for example 21 CFR 110.

5.2 Irradiation can be applied to spices as they are prepared for processing in-line, in bulk or in commercial packages.

5.3 Handling of spices in an irradiation facility should be in accordance with relevant and current GMPs. There are no special requirements for handling of spices prior to irradiation except for providing control measures to prevent post-irradiation re-contamination in storage facilities and for assuring separation of irradiated and non-irradiated product.

5.3.1 *Product Separation*—It may not be possible to distinguish irradiated from non-irradiated product by inspection. It is therefore important that appropriate means, such as physical barriers, or clearly defined staging areas, be used to maintain non-irradiated product separate from irradiated product.

6. Packaging and Product Loading Configuration

6.1 Packaging Materials.

6.1.1 Packaging spices prior to irradiation is one means of preventing post-irradiation contamination.

6.1.2 Use packaging materials suitable to the product considering any planned processing (including irradiation) and consistent with any regulatory requirements (see Guide F 1640).

6.2 Product Loading Configuration.

6.2.1 Irradiation will be facilitated if the product packages are geometrically well defined and uniform. With certain irradiation facilities, it may be necessary to limit use to particular package shapes and sizes based on the density of the product and validation testing at known product densities in the irradiation facility (see ISO/ASTM 51204 and 51431).

6.2.2 The size, shape, and loading configuration of a process load for spices to be irradiated should be determined primarily by considering design parameters of the irradiation facility. Critical design parameters include the characteristics of product transport systems and of the radiation source as they relate to the dose distribution obtained within the process load. The design parameters of the irradiation facility and product dose specifications should be taken into account in determining the size, shape and loading configuration of a process load (7.3).

7. Irradiation

7.1 *Scheduled Process*—Irradiation of food should conform to a scheduled process. A scheduled process for food irradiation is a written procedure that is used to ensure that the absorbed dose range and irradiation conditions selected by the radiation processor are adequate under commercial processing conditions to achieve the intended effect on a specific product in a specific facility. The scheduled process should be established by qualified persons having expert knowledge in irradiation requirements specific for the food and the processor's irradiation facility (21 CFR 179.25).

7.2 *Radiation Sources*—The sources of ionizing radiation that may be employed in irradiating spices are limited to the following: (see Codex STAN 106)

7.2.1 *Isotopic Sources*—gamma rays from radionuclides ^{60}Co (1.17 and 1.33 MeV) or ^{137}Cs (0.66 MeV);

7.2.2 *Machine Sources*—X-rays and accelerated electrons,

NOTE 2—The USA, other governments, and the Codex Alimentrius Commission currently limit the use of x-rays with energies not to exceed 5 MeV and the energies of electrons not to exceed 10 MeV.

7.3 *Absorbed Dose*— Food irradiation specifications from the owner of the spice should include minimum and maximum absorbed dose limits (see 7.3.3): a minimum necessary to ensure the intended effect and a maximum to prevent product degradation. One or both of these limits may be prescribed by regulation for a given application. See for example 21 CFR 179.26. It is necessary to configure irradiation parameters to ensure processing is carried out within these limits. Once this capability is established, it is necessary to monitor and record absorbed dose values during routine processing. (See 11.1.3.)

7.3.1 *Dosimetry System*—Routine dosimetry is part of a verification process for establishing that the irradiation process is under control. Select and calibrate a dosimetry system appropriate for the radiaion source being used and the range of absorbed doses required (see Guide E 1261).

7.3.2 *Absorbed-dose Mapping*—Verify that the product receives the required absorbed dose by using proper dosimeter measurement procedures, with appropriate statistical controls and documentation. Place dosimeters in or on the process load at locations of maximum and minimum absorbed dose. If those locations are not accessible, place dosimeters at reference locations that have been previously related to the maximum and minimum absorbed dose locations (see ISO/ASTM 51204 and 51431.)

NOTE 3—Radiation sensitive indicators (RSI's), such as labels, papers, or inks that undergo a color change or become colored when exposed to irradiation in the pertinent dose range are commercially available. The purpose of these indicators is to determine visually whether or not a product has been irradiated, rather than to measure the absorbed dose received by the product. These indicators are not dosimeters and must not be used as a substitute for proper dosimetry (see Guide E 1539.)

7.3.3 *Absorbed Dose Required to Accomplish Specific Effect*—The minimum absorbed dose that has been shown to achieve the intended objective of the treatment should be used. Each lot of spices may differ in microbial load from all other lots. The owner of the spice is responsible for specifying for each lot the absorbed dose required to reduce the microbial load to the acceptable quality level. Historical information on previously processed lots may be useful for determining the appropriate dose (see Table 1.) The irradiation facility is responsible for delivering the specified dose range. (See Practices E 1204 and E 1431.) The absorbed dose range for a given spice depends on the the type and number of microorganisms in the unprocessed spice, the radiation sensitivity of the microorganisms present, and the number of non-pathogenic microorganisms considered acceptable by the customer. See Section 9.

NOTE 4—Spices contain microorganisms indigenous to the soil and to the environment in which they are grown, and which survive the drying process. Generally, the numbers and types of microorganisms, most commonly bacteria, yeasts, and molds, vary with the particular material, its geographic origin, climatic conditions, harvesting, processing (for example, cleaning, drying), storage, transportation, and packaging. The most common bacteria in spices are the spore-formers such as the *Bacillus Species and Clostridia.* Vegetative bacteria such as salmonellae, *Escherichia coli*, and lactic acid bacteria can also be present. The most common molds are the *Penicillium* species, *Rhizopus* and some of the *Aspergillus* group. While it is theoretically possible to have only yeasts and molds present in a product, generally spices contain a broad spectrum of microorganisms, including bacteria as well as yeasts and molds.

TABLE 1 Suggested Minimum Doses[A] of Irradiation for Selected Spices, Herbs and Vegetable Seasonings

Product	Minimum Dose (kGy)
Allspice	4 to 8
Basil	6 to 12
Caraway	3 to 8
Cardamom	4 to 8
Celery Seed	4 to 8
Cinnamon	3 to 8
Coriander	4 to 8
Fennel	6 to 12
Garlic Powder	6 to 12
Ginger	4 to 8
Marjoram	6 to 12
Nutmeg	4 to 8
Onion Powder	7 to 15
Oregano	6 to 12
Paprika	3 to 8
Pepper, Black	6 to 12
Pepper, Red	3 to 8
Thyme	6 to 12
Turmeric	3 to 8

[A] If initial micro analysis indicates a higher than normal standard plate count, higher minimum doses may be required. See Refs **(1, 8, 9, 10, 11)**.

NOTE 5—To achieve the minimum absorbed dose throughout the process load, portions of the load will receive higher doses. The highest dose must be kept below the specified maximum absorbed dose.

7.3.3.1 Generally, yeasts and molds are controlled at a minimum absorbed dose ranging from 3 to 6 kGy. Vegetative bacteria are reduced or eliminated at a minimum dose ranging from 4 to 7 kGy, and spore forming bacteria are reduced to acceptable levels at a minimum 8 to 15 kGy dose range. Table 1 lists suggested minimum dose ranges for selected spices and herbs. Microbiological analysis of untreated product should be performed to determine the effective minimum absorbed dose. The maximum absorbed dose permitted to be used to reduce bacteria, yeasts, and molds may be specified by national regulatory authorities.

7.3.3.2 In general, dehydrated products show few quality changes from maximum absorbed doses up to 30 kGy. There may be some discoloration in vegetable seasonings such as onion powder and minor losses of volatiles for some other spices. These products are very stable under a wide range of radiation doses.

7.3.3.3 Absorbed doses effective for control of microorganisms are greater than those needed for insects. Therefore, the irradiation of spices for reduction of microorganisms also kills any insects present, at all stages of development.

7.4 *Re-Irradiation*— Spices irradiated in accordance with this guide shall not be re-irradiated.

7.4.1 Spices are not considered as having been re-irradiated when: the spice is prepared from materials that have been irradiated at low dose levels, for example, about 1 kGy, for another technological purpose, for example, onion and garlic for sprout inhibition; the food, containing less than 5 % of

irradiated spice, is irradiated, or when the full dose of ionizing radiation required to achieve the desired effect is applied to the spice in more than one installment as part of processing for a specific technological purpose. The cumulative overall dose absorbed should not exceed the maximum allowable dose. (See STAN 106-1983).

8. Post-Irradiation Handling and Storage

8.1 Handle and store irradiated spices in closed, clean, dry warehouse facilities with proper insect and rodent control to prevent post-irradiation contamination of products.

9. Criteria for Assessing Irradiation Efficacy

9.1 *Irradiation for Control of Pathogenic Bacteria*—Some local authorities have mandatory upper limits for pathogens, which, if exceeded, render the product unusable.

NOTE 6—In the United States, industry specifications commonly require that spices be pathogen free.

9.2 The criterion for total standard plate count cannot be specified unless the requirements of local conditions are known. Therefore, the final product specification regarding standard plate count should be determined locally; both pre- and post-irradiation treatment.

9.3 Failure to meet the criteria in 9.1 and 9.2 should direct attention to the manufacturing process and the re-establishment, if necessary, of GMP.

10. Labeling

10.1 Because some consumers and food processors may wish to choose between irradiated and non-irradiated products, many governments have adopted labeling requirements (see 5.2 of STAN 1-1985). Labeling will identify the product as irradiated and may also serve to inform the purchaser of the purpose and benefits of the treatment. An increasing number of countries are adopting the internationally recognized "Radura" symbol as a means of labeling (see Fig. 1). In some countries, for example the U.S. (21 CFR 179.26), the symbol must be accompanied by a statement, such as "Treated with Radiation" or "Treated by Irradiation."

FIG. 1 Radura Symbol

11. Documentation

11.1 The irradiation facility should establish records of its operation to enable verification of the irradiation treatment.

11.1.1 Ensure that each lot of spice to be processed is identified by lot number or other means, which allow it to be traced to its origin. Use this identifier on all documents.

11.1.2 Record and document the date the product arrives at the facility, the date the lot is irradiated, the starting and ending time of the irradiation, the date the product leaves the facility, the name of the person who reviews the processing records and releases the product, and any special conditions that could affect the irradiation process or irradiated product.

11.1.3 Record and document all dosimetry data associated with product absorbed-dose mapping and routine processing (see Practices E 1204 and E 1431).

11.1.4 Record and document any deviation from the scheduled process in order to assess the validity of the process.

11.1.5 Audit all documentation prior to product release to ensure that records are accurate and complete. If deficiencies are found, ensure that corrective action is taken and documented. The person making the audit should sign the documentation. All deficiencies should be made the subject of a separate file available for examination by a regulatory authority.

11.1.6 Retain all records about each lot irradiated at the facility for the period of time specified by relevant authorities and have them available for inspection as needed.

11.1.7 Ensure that documentation accompanying the shipment of irradiated product includes the name of the product owner; the name and address of the irradiation facility; description of the product irradiated, including the lot number or other identifier (see 11.1); the irradiation date; and any other information required by the product owner, irradiator, or government authority.

12. Keywords

12.1 bacteria; herbs; irradiation; labeling; microorganisms; molds; packaging; pathogens; processing; seasonings; spices; yeasts

REFERENCES

(**1**) International Consultative Group on Food Irradiation, *Code of Good Irradiation Practice for the Control of Pathogens and Other Microflora in Spices, Herbs, and Other Vegetable Seasonings*, ICGFI Document No. 5, Issued by the Secretariat of ICGFI, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna, Austria, 1991.

(**2**) Krishnaswamy, M. A., Patel, J. D., and Parthasarathy, N., "Enumeration of Microorganisms in Spices and Spice Mixtures," *J. Food Sci. Technol. Mysore*, Vol 8, 1971, pp. 191-194.

(**3**) Powers, E. M., Lawyer R., and Masuoka, Y., "Microbiology of Processed Spices," *J. Milk Food Technology*, Vol 38, No. 11, 1975, pp. 683-687.

(**4**) Julseth, R. M. and Deibel, R. H.," Microbial Profile of Selected Spices and Herbs at Import," *J. Milk Food Technology*, Vol 37, No. 8, 1974, pp. 414-417.

(**5**) Baxter, R., and Holzapfel, W. H., "A Microbial Investigation of Selected Spices, Herbs and Additives in South Africa," *J. Food Science*, Vol 47, 1982, pp. 570-574.

(**6**) International Consultative Group on Food Irradiation, *Consultation on Microbiological Criteria for Foods to be Further Processed by Irradiation* , World Health Organization, Geneva, Switzerland, 1989.

(**7**) Kilgen, M.B., *Food Irradiation: Principles and Applications*, R.R. Molins, ed., John Wiley & Sons, Inc., New York, 2001.

(**8**) Eiss, M. I., "Irradiation of Spices and Herbs," *Food Technology in Australia*, Vol 36, No. 8, 1984, pp. 362-363, 366, 370.

(**9**) Bachman, S. and Grezczynska, J., "Studies on Some Microbiological and Chemical Aspects of Irradiated Spices," In: Aspects of the Introduction of Food Irradiation in Developing Countries, IAEA, Vienna, pp. 33-41.

(**10**) Farkas, J., "Irradiation of Spices and Condiments," IFFIT Report No. 20, 1981.

(**11**) "Quality Maintenance and Safety in Spices and the Role of Irradiation"—Workshop, ICGFI, IAEA, Kerala, India, 1995.